A cooperative agreement
between the
Office of Prevention,
Pesticides, and
Toxic Substances
of the
U.S. Environmental
Protection Agency
and the
Institute of Science
and Public Affairs
at the
Florida State University

CAPRM II

March 2003

Chemical And Pesticide Results Measures

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

AUG 7 2003

MEMORANDUM

SUBJECT: Distribution of Chemical and Pesticides Results Measures Report

FROM: Stephen L. Johnson
Assistant Administrator

TO: Distribution

The Office of Prevention, Pesticides, and Toxic Substances (OPPTS) has a firm and expanding commitment to the development and use of environmental indicators. Such indicators offer EPA, the states, and our various stakeholders an opportunity to evaluate our progress in delivering measurable and meaningful environmental results to the American people. Moreover, these measures show us where we need to focus increased attention and resources to combat either emerging issues, or where our traditional approaches to longstanding issues should be re-thought.

In that light, I am delighted to announce the availability of a report: *Chemical and Pesticides Results Measures II* (CAPRM II) which OPPTS has worked to develop with the Florida State University and a variety of our state and tribal partners, and a number of additional stakeholders. We have made printed copies of the Report available to not only those who participated directly in the development of the Report but also to other Offices and EPA Regions. Despite the high cost of printing and distributing large numbers of bound copies of color reports, EPA has approximately 900 copies available for initial distribution.

Also, the Institute of Science and Public Affairs at the Florida State University will be making CAPRM II along with its predecessor CAPRM materials available on the Internet at: http://www. pepps.fsu.edu.

Please feel free to contact either Sarah Campney at Florida State University at (850) 644-1733 or Dr. Ronald T. McHugh of OPPTS at (202) 564-0339 if you have any questions.

CHEMICAL AND PESTICIDES RESULTS MEASURES II

The Chemical and Pesticides Results Measures (CAPRM) project is a cooperative agreement between the U.S. Environmental Protection Agency (EPA), Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and the Program for Environmental Policy and Planning Systems (PEPPS) of the Institute of Science and Public Affairs of The Florida State University

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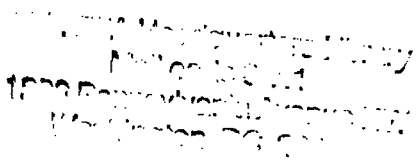

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The indicators in CAPRM and CAPRM II should be viewed as a tool for the collective use of states, tribes, local governments, nongovernmental organizations, and the private sector for their joint and separate purposes. While the system was developed in cooperation with the EPA, the final selection of indicators and their presentation is solely the result of decisions made by the CAPRM Technical Advisory Workgroup and the professional staff of PEPPS. While the EPA might find parts of the systems useful for their purposes, the CAPRM and CAPRM II indicator systems were not specifically developed for the agency and should not be construed as carrying any official EPA endorsement. The indicators in CAPRM and CAPRM II are not subject to the Data Quality Guidelines.

This document and all other CAPRM and CAPRM II materials can be viewed on the Internet at:
http://www.pepps.fsu.edu./
http://www.pepps.fsu.edu./CAPRM/index.html

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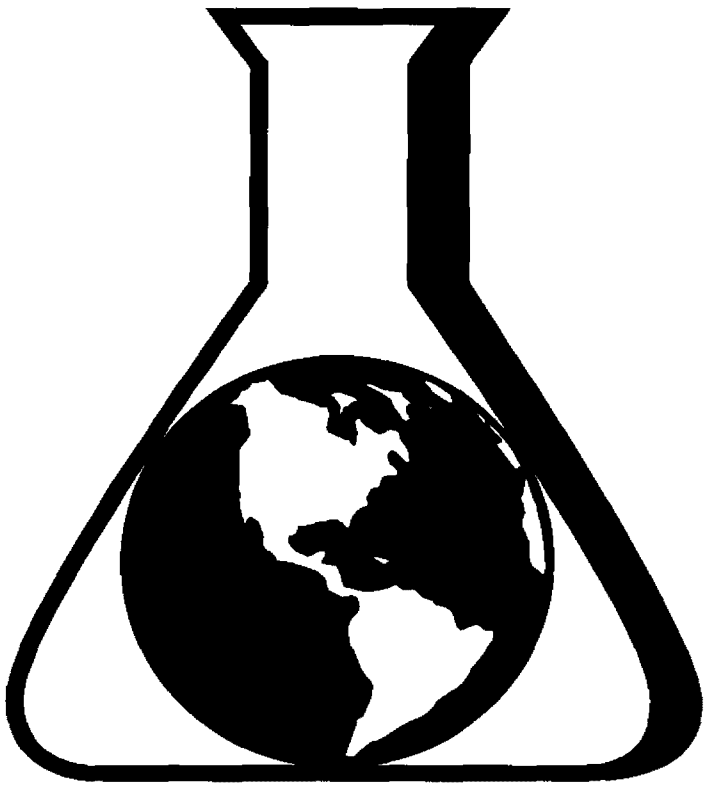
INTRODUCTION



CHEMICAL AND PESTICIDES RESULTS MEASURES (CAPRM)

PROJECT SUMMARY

The Chemical and Pesticides Results Measures (CAPRM) project is a cooperative agreement between the U.S. Environmental Protection Agency (EPA), Office of Prevention, Pesticides and Toxic Substances (OPPTS) and the Program for Environmental Policy and Planning Systems (PEPPS) of the Institute of Science and Public Affairs (ISPA) of Florida State University. The purpose of this agreement is to develop a national set of chemical, pesticide and pollution prevention indicators that can be used by states, tribes, nongovernmental organizations and the private sector, as well as the EPA ,to describe and understand environmental trends and conditions concerning chemical and pesticide issues.

During the first year of the project, an external workgroup of representatives from state government, the private sector, and nonprofit organizations, with the support of CAPRM project staff and an internal OPPTS workgroup, identified strategic issues relating to chemicals and pesticides and provided oversight of the development of 74 indicators capable of measuring changes in environmental results associated with those issues. Meeting in February, June, and September of 2000, the workgroup undertook the following tasks:

- The identification of a structure of strategic issues that reflect the major concerns that OPPTS will face over the next 20 years;.
- The elaboration of each of these strategic issues into a suite of sub-issues that collectively define their major components;
- The preliminary identification of the types of indicators that should be used to measure each of the sub-issues;
- The provision of guidance to staff concerning available data sources capable of supporting indicators;
- The recommendation of a final set of environmental indicators; and
- The coordination of the CAPRM process with other relevant indicator efforts.

All of this work resulted in the publication of a document entitled *CAPRM: Chemical and Pesticide Results Measures* in February of 2001.

In 2001, the project was extended to build upon the work contained in the initial document. The goals of the second phase of the project were to:

- Review, revise, and expand the issue structure;
- Revise and update indicators from the initial set to improve their utility and to include new data points;
- Focus additional indicator development attention on several important existing areas that require more support, to include pollution prevention, product stewardship, human health, and childrens health;

- Develop exploratory indicators for use by Indian tribes; and to

- Develop an exploratory set of environmental justice indicators to measure, at the national level, any differential impacts relating to chemicals and pesticides as they affect the health of populations divided by race and income.

This document represents the results of this effort. The issue structure has been revised and expanded, and the number of indicators has increased from 74 to almost 150.

The indicators in CAPRM should be viewed as a tool for the collective use of states, tribes, local governments, nongovernmental organizations, and the private sector for their joint and separate purposes. While the system was developed in cooperation with the EPA, the final selection of indicators and their presentation is solely the result of decisions made by the workgroup and the professional staff of PEPPS. While the EPA may find parts of the system useful, the CAPRM indicator system was not specifically developed for the agency and should not be construed as carrying any official EPA endorsement. The indicators in this document are not subject to EPA's Data Quality Guidelines.

The Context for the Chemical and Pesticides Results Measures

Over the past ten years, the growth in the use of indicators at both the federal and the state level has been significant. In 1990, only a few states were using indicators in any direct manner and only two -- Florida and North Carolina -- had made any explicit attempt to systematically develop and document a comprehensive environmental indicator system. The EPA was only in the beginning stages of building indicator systems. In 2001, the situation is dramatically different. Now almost all states have at least begun to develop indicator systems or closely related environmental reporting documents. Guided by the outstanding community-based programs in Seattle, Washington, and Jacksonville, Florida, hundreds of communities all over the nation are in the process of developing indicator systems. At the federal level, there are a number of inter-agency and intra-agency groups working to develop indicator systems and, perhaps more importantly, begin the process of redesigning federal environmental monitoring systems. A driving force has been the Government Performance and Results Act (GPRA) which has required all federal agencies to prepare strategic plans that are driven by both mission-based and program performance metrics. The EPA Office of Water has developed a set of national water indicators and built a system for measuring watershed environmental health called the Index of Water Indicators. The EPA Office of Air and Radiation (OAR), in cooperation with PEPPS, conducted the National Air and Radiation Indicators Project (NARIP), a stakeholder-driven process that produced 83 national level indicators reflecting the major environmental concerns of OAR. The EPA Office of Solid Waste and Emergency Response (OSWER), with the assistance of PEPPS, is presently supporting the development of Waste Indicators for the Environment (WISE), a project very similar to CAPRM designed to assist OSWER stakeholders in developing a set of indicators capable of measuring their key activities. The EPA-led Chesapeake Bay Program and Great Lakes Program are outstanding examples of comprehensive indicator-driven ecosystem management programs. Developing ecosystems programs such as the Mid-Atlantic Integrated Assessment (MAIA), the Mid-Atlantic Highlands Assessment (MAHA), the Western Pilot Study, and the Estuarine and Great Lakes Program demonstrate the potential for high quality indicator systems in a variety of ecosystems and geographic areas. The most recent indicator-based project conducted by EPA is the development of a State of the Environment Report, an effort that could broad and lasting effects on agency planing and management activities.

The timing for CAPRM is excellent. At the national level, the Governmental Performance and Results Act (GPRA) requires all federal agencies to cast their budgets within goal-driven and indicator-supported strategic planning processes. For the EPA, strong environmental indicators are critically important to demonstrate to Congress progress toward its mission-oriented goals. Agencies with inadequate measurement systems are disadvantaged when program efficacy and goals achievement must be documented for Congress. The development of the EPA Strategic Plan, the

agency's response to GPRA, demands strong and comprehensive measurement inputs. As GPRA becomes more closely associated with budget success, agency measurement systems will become more important.

Indicators have become an important part of the federal-state relationship in environmental matters. The Core Measures process is a cooperative attempt by the EPA and the states to develop common terminology and measures to support the foundation of their program and funding relationship. The most substantial potential for indicator development lies with the National Environmental Performance Partnership System (NEPPS). Under NEPPS, the measurement and achievement of results, rather than the completion of specified program activities, will become the foundation of the EPA-states relationship.

Document Structure and Format

The fundamental structure of CAPRM was established by an iterative process involving the external workgroup and an internal EPA indicator workgroup to identify the key strategic issues that the OPPTS will face over the next 20 years. These major issues were then further examined to identify the principal dimensions or components of each strategic issue. This resulted in the identification of an additional 30 sub-issues. This structure of issues and sub-issues became the framework around which indicator development proceeded. CAPRM I reflects that framework in its organization.

All of this activity demonstrates a clear convergence of the measurement of environmental conditions with performance-based management, a trend that is likely to continue.

In CAPRM I attention was focused on seven environmental issues:

- Globalization of Environmental Effects,
- Sustainability,
- Food,
- Waste,
- Products,
- Human Health, and
- Ecological Health.

In CAPRM II the issue structure was expanded and refined to accommodate the revised objectives of the project. Three categories of issues were created. First, a group of basic environmental issues relating to chemicals and pesticides was identified. These issues are:

- Human Health,
- Ecological Health,
- Chemical and Pesticide Safety and Use,
- Food Safety,
- Product Safety, and
- Transboundary Movement of Chemicals and Pesticides.

Additionally, three issues associated with special populations were identified for which there are special concerns with regard to their risk from exposure to chemicals and pesticides:

- Children,
- Environmental Justice (ethnic groups and persons of low income),
- Tribes.

Finally, there are two cross-cutting policy issues that have meaning for all of the other issues that help define how we are doing in reducing the impacts of all of our pollution and waste related activities:

- Product Stewardship, and
- Pollution Prevention.

Each of the issues is presented in turn. Each issue section has a text introduction that describes the context for the issue, justifies its importance, and provides essential background information. This summary includes information for the general issue as well as for each of the sub-issues.

Following the introduction, individual indicators are presented and organized by sub-issue. Each individual indicator page has a header that:

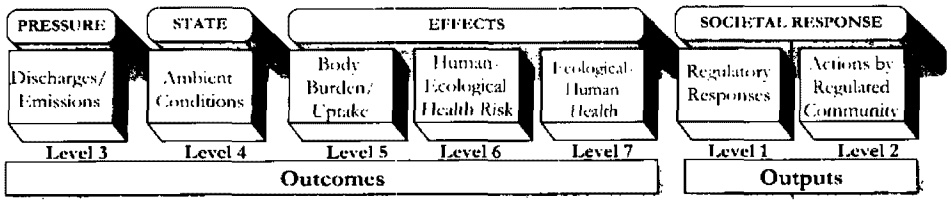
- Identifies the strategic issue;
- Identifies the sub-issue;
- Identifies the specific indicator;
- Characterizes the indicator with regard to the Pressure-State-Effects-Response model and the Hierarchy of Indicators (to be explained later within this Introduction); and
- Classifies the indicator with regard to data availability.

Following the header is/are:

- A brief discussion that identifies why the indicator is of importance;
- A data display, when available;
- A bulleted summary of data trends;
- Relevant notes about the data display;
- A discussion of the major limitations and characteristics of the data; and
- The references used to describe the indicator issue and sources from which the data were obtained.

The following page is a sample indicator sheet, with detailed item descriptions.

ISSUE TITLE
ISSUE SUB-TITLE



TYPE A

TYPE B

TYPE C

Indicator: Indicator Key

In this system, the shaded box identifies our assessment of how the indicator should be characterized.

WHAT TYPE OF DATA ARE WE COLLECTING?

Hierarchy of Indicators

The Hierarchy of Indicators measures the quality of indicators employed to reflect environmental values. The ability of individual indicators to provide information varies significantly. High quality indicators are those directly measure the health of humans and wildlife. Unfortunately, there are relatively few areas where such definitive, end-result kinds of measures are available. Where such quality indicators are not available, other, less direct, measures must be used.

Data types 1 and 2 measure administrative, bureaucratic, or activity measures and are only weakly associated or completely unassociated with the capacity to measure environmental quality.

Data types 3-7 are measures that reflect indicators of environmental performance. As the indicators progress from type 3 to type 7, the quality of environmental information increases.

Pressure-State-Response

Pressure indicators: measures of pressures on the environment caused by human activities.

State indicators: measures of the quality of the environment and the quality and quantity of natural resources.

Effects indicators: measures the impacts of a change in the state of the environment.

Response indicators: measures that demonstrate what and how much society is doing to respond to environmental changes and issues.

THIS PARTICULAR INDICATOR IS A LEVEL 3/PRESSURE INDICATOR.

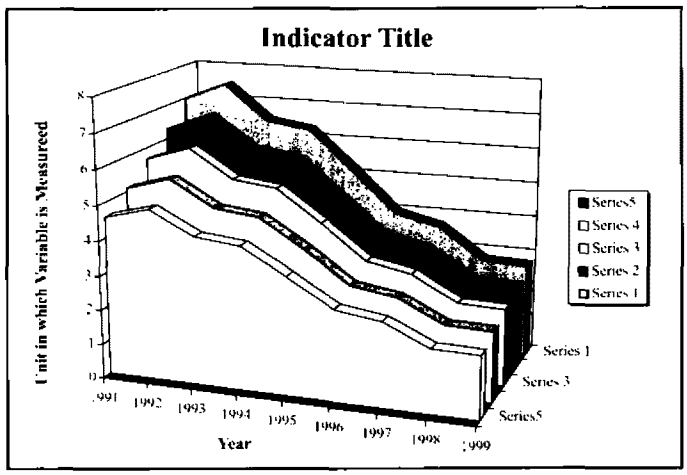
Classification of Availability

Type A: Indicators for which adequate data are available now and can be used to support the indicator without significant cost considerations.

Type B: Indicators which are presently feasible and for which data exist but cannot be provided due to inordinate cost, analytical complexity, time limitation or legal constraints.

Type C: Prospective indicators for which indicator quality data do not exist and there is no reasonable prospect of development.

THIS PARTICULAR INDICATOR IS A TYPE A.



Notes: This section will describe any peculiar features of the indicator.

Source: This is the source of the data that was used to construct the indicator.

Data Characteristics and Limitations: This section describes the methodology used in the collection of the data. It will also explain any strengths and weaknesses of the data set used in the construction of the indicator.

References

These are the materials that were used to explain the indicator.

INDICATOR USES, DEFINITIONS, AND CONCEPTS USED IN CAPRM

Indicators are useful tools for a wide variety of planning and management purposes. The capacity of individual public organizations to develop and evaluate policy is greatly enhanced by the availability of good indicator systems. Indicators can be used as a:

- Mission-based tool to support a broad evaluation of an environmental agency's performance in protecting and managing the environment;
- Means of providing information to decisionmakers;
- Foundation of measurements for structuring environmental goals;
- Basis for measuring environmental achievement and progress;
- Basis for making strategic budget decisions;
- Means of evaluating the performance of individual programs and activities;
- System to monitor the health of individual ecosystems or places;
- Structure around which to develop environmental education programs;
- Tool for disseminating information to the public; and a
- Tool to build constituent support for the agency and its programs.

The terminology associated with planning-based measurement systems is often confusing and inconsistent. A sometimes bewildering array of terms -- indicators, environmental indicators, performance measures, mission-based indicators, program performance measures, output measures, input measures, impact measures, effectiveness measures, efficiency measures, benchmarks, milestones, goals, and objectives -- are employed in a generally inconsistent and occasionally contradictory manner.

CAPRM uses definitions and concepts that PEPPS has employed in several of its indicator projects to develop an overall indicator framework. Some of this framework reflects well-known and commonly used indicator terminology and conceptual models. Other components have been developed by PEPPS in an attempt to improve the indicator process.

Definitions

The Organization for Economic Cooperation and Development (OECD) defined the basic components of indicators. These are listed below.

- **Parameter:** *A property that is measured or observed.*
- **Indicator:** *A parameter, or value derived from a parameter, which points to, provides information about, or describes the state of a phenomenon, environment, or area with a significance extending beyond that directly associated with a parameter value.*
- **Index:** *A set of aggregated or weighted parameters or indicators.*

Environment Canada defines indicators as:

> *statistics or parameters that, tracked over time, provide information on trends in the condition of a phenomenon and have significance extending beyond that associated with the properties of the statistics themselves. Environmental indicators are selected key statistics which represent or summarize a significant aspect of the state of the environment, natural resource sustainability and related human activities.*

PEPPS maintains that, fundamentally, an indicator:

- Must be explicitly measurable;
- Must reflect an important issue,
- Must be repeatedly and reliably measured over time in order to establish a trend; and
- Must have significance that is broader than the measure itself; that is to say, the measure represents a much broader issue, condition, phenomenon or circumstance than is being directly measured.

Types of Indicators

A complex environmental organization needs to measure performance at five levels:

- **Mission-Based:** All organizations exist to fulfill some fundamental purpose. Mission-based indicators measure how well and to what extent the organization is fulfilling that purpose. For environmental organizations, that purpose is to protect, enhance, and/or conserve the natural environment. Thus, mission-based indicators for such environmental organizations are called *environmental indicators*. Environmental indicators answer the fundamental questions of: is the environment becoming better or worse and what is the character of changes in the environment?
- **Policy:** Policy indicators are a specialized form of environmental indicators. While policy indicators are expressed in environmental terms, they measure environmental outcomes within the context of and as a function of broader social, economic, political, or cultural contexts and directly reflect the achievement of values that are not strictly environmental in nature. Further, policy indicators tend to be reflected across all environmental issues. Environmental justice, sustainability, and growth management are examples of common policy areas sometimes supported by indicators.
- **Program Performance:** Program performance indicators are focused on measuring the achievement of program results or outcomes. Each individual program has specific objectives it seeks to accomplish. Program performance measures document how well the program is meeting its objectives by measuring the extent to which it is producing the desired programmatic outcomes. In some cases a program performance indicator can be expressed as a direct or indirect environmental result; however, in most cases the results are expressed as programmatic outcomes.
- **Program Activity and Efficiency:** Environmental organizations need to know if their programs and activities are functioning efficiently. Program efficiency measures document how well the program is operating mechanically and what and how many outputs it is producing. They answer such questions as: are programs operating efficiently? Are programs cost-effective for the activities completed? These indicators do not demonstrate whether the program is achieving the results that its mission specifies. These indicators reflect the infamous "bean-counting" of measurement systems.
- **Administrative:** Regardless of the substantive orientation of their missions, all organizations need information on how they are performing as an organization. Administrative indicators answer such questions as: are financial management systems operating efficiently? Are the employees motivated, adequately trained and performing to expectations? Is the organization meeting its legal obligations? Administrative indicators do not measure any type of mission-based result and were not pursued in CAPRM.

All five of these categories represent important components of an organization's measurement system. For the purpose of this project, however, program performance, program activity and administrative indicators were not treated. CAPRM focuses almost exclusively on mission-based environmental indicators and, to a lesser degree, policy indicators. These two types of indicators are important because they deal with the achievement of **results**. They provide an assessment of how well we are doing - directly and indirectly - in our efforts to protect the environment and in achieving policy-based goals and objectives.

Qualification Standards

In the development of an indicator system, it is useful to list, with as much precision and comprehensiveness as possible, the specific criteria for defining an acceptable indicator. Reflected in these criteria would be such considerations as:

- The geographic scope of the indicators (e.g., national, statewide, regional, ecosystem, local);
- The acceptable types of indicators (e.g., environmental, program, administrative);
- The availability of data; and
- The manner in which the indicator will be used.

Clearly identifying such standards at the beginning of the process and consistently following them will help ensure that indicators are appropriate for the scope and purpose of the system in development.

CAPRM Indicator Qualification Standards: In the development of CAPRM indicators, the following criteria were used:

- The indicator must relate to the OPPTS mission;
- The indicator should measure an environmental or policy result;
- Performance measures will be permitted when a specific sub-issue represents a program activity (e.g., stewardship), and when the data for a sub-issue lacks environmental indicator quality data and there is a program performance measure with environmental implications;
- The indicator must reflect a global or transboundary issue of U.S. interest, or reflect an issue that is national in scope and is capable of demonstrating regional and state variability; and
- All Type A indicators must meet essential indicator selection criteria (described in the following section).

Selection Criteria

Ideally, each indicator included in the finalized indicator system should meet a series of standards designed to ensure consistently high quality. Listed below are the selection criteria employed by PEPPS in all of its indicator work. Selection criteria are of two types: essential, which are criteria an indicator must meet, and preferable, which are criteria an indicator should meet.

Essential criteria include:

- **Measurability:** The indicator measures a feature of the environment that can be quantified simply using standard methodologies with a known degree of performance and precision.
- **Data Quality:** The data supporting the indicators are adequately supported by sound collection methodologies, data management systems, and quality assurance procedures to ensure that the indicator is accurately represented. The data should be clearly defined, verifiable, scientifically acceptable, and easy to reproduce.
- **Importance:** The indicator must measure some aspect of environmental quality that reflects an issue of major importance to the region and the states in demonstrating the current and future conditions of the environment.
- **Relevance:** The indicator should be relevant to a desired significant policy goal, issue, legal mandate, or agency mission (e.g., contaminated fish fillets for consumption advisories; species of recreational or commercial value) that provides information of obvious value that can be easily related to the public and decisionmakers.
- **Representativeness:** Changes in the indicator are highly correlated to trends in the other parameters or systems they are selected to represent.

- **Appropriate scale:** The indicator responds to changes on an appropriate geographic (e.g., national, state, or regional) and/or temporal (e.g., yearly) scale.
- **Trends:** The data for the indicator should have been collected over a sufficient period of time to allow some analysis of trends or should provide a baseline for future trends. The indicator should show reliability over time, bringing to light a representative trend, preferably annual.
- **Decision support:** The indicator should provide information to a level appropriate for making policy decisions. Highly specific and special parameters, useful to technical staff, will not be of much significance to policy staff or management decisionmakers.

Preferable criteria include:

- **Results:** The indicator should measure a direct environmental result (e.g., an impact on human health or ecological conditions). Indicators expressing changes in ambient conditions or changes in measures reflecting discharges or releases are acceptable, but not preferred. Process measures (e.g., permits, compliance and enforcement activities, etc.) are not acceptable.
- **Understandability:** The indicator should be simple and clear, and sufficiently nontechnical to be comprehensible to the general public with brief explanation. The indicator should lend itself to effective and appealing display and presentation.
- **Sensitivity:** The indicator is able to distinguish meaningful differences in environmental conditions with an acceptable degree of resolution. Small changes in the indicator show measurable results.
- **Integrates effects/exposures:** The indicator integrates effects or exposure over time and space and responds to the cumulative impacts of multiple stressors. It is broadly applicable to many stressors and sites.
- **Data comparability:** The data supporting an indicator can be compared to existing and past measures of conditions to develop trends and define variation.
- **Cost effective/availability:** The information for an indicator is available or can be obtained with reasonable cost and effort and provides maximum information per unit effort.
- **Anticipation:** The indicator is capable of providing an early warning of environmental change.

Classification of Availability

PEPPS classifies all of its indicators according to their immediate availability for use into one of three types. Classifying indicators in this way clarifies the data inventory and sets directions for future growth in available indicators. The use of this availability classification allows the presentation of indicators that may not currently exist as part of the system in order show what will be needed to establish a fully functioning system. In this scheme, three types of indicators are possible. They are:

Type A: Indicators for which adequate data are available now and can be used to support the indicator without significant cost considerations. To be classified as Type A, an indicator:

- Meets all essential selection criteria and most preferred criteria;
- Is presently available for use in its present condition; and
- Can be acquired easily at little or no cost.

Type B: Indicators which are presently feasible and for which data exist but cannot be provided due to inordinate cost, analytical complexity, time limitation or legal constraints. Type B indicators are those that would be available if some barrier could be overcome.

Type C: Prospective indicators for which indicator quality data do not exist and there is no reasonable prospect of development. Type C indicators are purely prospective. The data do not exist and there is no clear intent to collect it. Type C indicators may exist conceptually as designs or as onetime studies. They reflect unmet needs for indicators of important environmental issues. There are issue areas that are data rich and for which the selection of indicators is relatively easy. In other areas, there is almost a complete lack of indicator quality data. In other cases, the indicators available are not of the highest quality and do not reflect the best way to measure a given issue. Wherever data gaps or data quality inadequacies existed, workgroup members were requested to recommend the types of indicators that should be made available to correct those deficiencies. In this process, C indicators are considered important. If measurement of all issues is to occur, then attention must focus on filling significant data gaps and improving current measures. Future growth in our ability to measure environmental results is linked to our ability to identify new and alternative measures. The specification of C indicators is the first step in meeting that need.

Pressure-State-Response

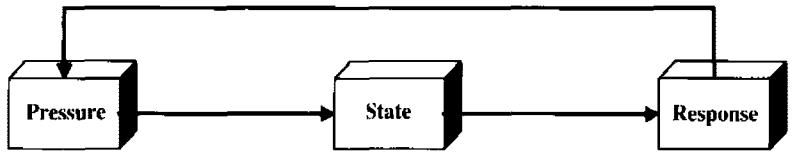
The Organization for Economic Cooperation and Development (OECD) developed a framework for organizing indicators that reflects three different, but related, types of indicators for environmental issues. They are:

- **Pressure indicators:** measures of pressures on the environment caused by human activities or natural causes.
- **State indicators:** measures of the quality of the environment, the quality of human health and the quality and quantity of natural resources.
- **Response indicators:** measures that demonstrate what and how much governments and society in general are doing to respond to environmental changes and issues.

The logic of the model is appealing. It suggests that there are pressures on environmental values (emissions, discharges, development activities, floods, volcanic eruptions etc.) that lead to changes in the state of the environment (impaired water quality, polluted air, habitat destruction, species loss, etc.). In response to these degraded environmental conditions, governments and society respond with positive or negative actions that change the character and level of pressures of the environment.

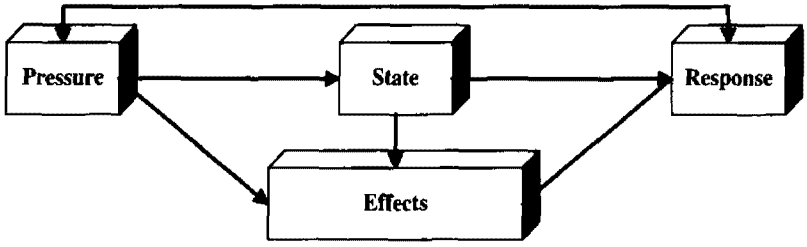
The value of this approach is that it facilitates the structuring of a comprehensive group of issue indicators. There is an implied loop from response back to pressure to show that societal responses to environmental problems continue to affect environmental values. This feedback loop is illustrated in ***Figure 1***.

Figure 1: The Pressure-State-Response Conceptual Model



Other indicator projects have added noteworthy refinements to the basic pressure-state-response (PSR) model. In 1995, the EPA Office of Policy, Planning and Evaluation (OPPE) reviewed the PSR as a conceptual model for organizing indicators. Their analysis resulted in the addition of an *effects* concept to the model. The logic of the model suggests that pressures, states, and responses all contribute to the creation of human health and ecological effects. The PSR/E model is illustrated in ***Figure 2***.

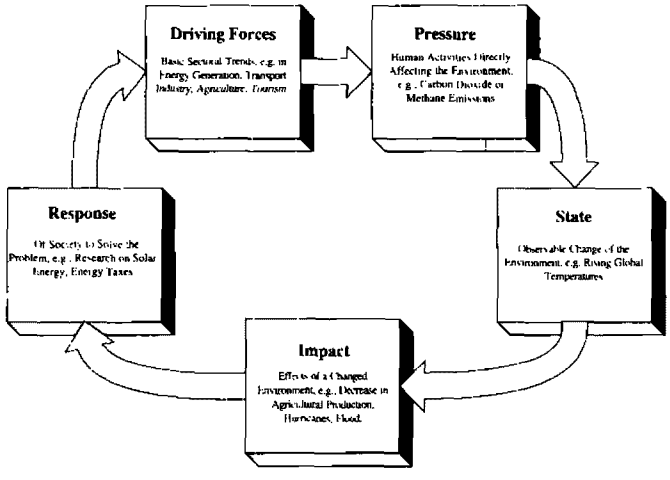
Figure 2: The Pressure-State-Response/Effects Conceptual Model



The full PSR/E model developed by the OPPE is considerably more complex and should be reviewed for additional contributions to indicator conceptualization. From the perspective of CAPRM, its principal contributions are: (1) the separation of the idea of environmental effects (impacts of changes in environmental conditions) from the state level (changes in the environment) and (2) the notion that such effects result from the joint action of pressures, environmental states and governmental and societal responses. In a political context, where there is so much emphasis on achieving results, this focus on effects as environmental end points is helpful.

Another interesting piece of conceptual work was undertaken by the European Union (EU) in the development of a group of pressure indicators . They also added some new features and refinements to the basic PSR model. In a manner similar to the EPA "effects" addition, the EU added an "impacts" category. Impacts are roughly the equivalent of effects, but the placement in the model is somewhat different. EPA viewed "effects" as being something that responded directly to all other parts of the model, while the EU interprets impacts to be continuous with pressure and state issues. The EU also added to the model the concept of driving forces, which create the pressures in the PSR/I model. The logic of their circular model suggests that driving forces create environmental pressures which cause changes in the state or condition of the environment that then cause human health and ecological impacts. Society and government responds to these impacts in a way that positively or negatively affects the driving forces which in turn affect environmental pressures, and so on. ***Figure 3*** summarizes the EU indicator model.

Figure 3: The European Union Conceptual Indicator Model



PEPPS believes that the impact/effect concept is a valuable refinement to the basic PSR model and incorporates it into the CAPRM conceptual model. While CAPRM is consistent with the EU model of pressure-state-impact-response, it does not consider driving forces as part of its current issue structure.

Hierarchy of Indicators

The Hierarchy of Indicators is a conceptual model developed by the Chesapeake Bay Program to measure the relative power of indicators employed to reflect environmental values. The ability of individual indicators to provide information varies significantly. The best indicators are those that directly measure the ultimate and most important results of environmental changes: the health of humans and wildlife. Unfortunately, there are relatively few areas where

such definitive, health-based measures are available. Where such quality indicators are not available, less direct measures must be used. ***Figure 4*** illustrates the conventional Hierarchy of Indicators.

Figure 4: Hierarchy of Indicators

Hierarchy of Indicators					
Administrative		Environmental			
1	2	3	4	5	6
Actions by Federal or State Regulatory Agency	Responses of the Regulatory Community or Society	Changes in Discharge or Emission Quantities	Changes in Ambient Conditions or in the Quantities of Natural Resources	Changes in Uptake and/or Assimilation, e.g., Body Burden, Bioaccumulation	Changes in Health, Ecology or Other Effects

Levels 1 and 2 measure administrative, bureaucratic, or activity outcomes and are, at best, only weakly associated with the capacity to measure environmental quality. Some of the environmental indicators in the CAPRM indicator system are Levels 1 or 2. They are employed only when process or program performance indicators are the best available. Such indicators are usually targeted for replacement in the long run by higher quality indicators. Some sub-issues in CAPRM reflect program concerns (e.g., Product Stewardship) and in such instances Level 1 and 2 indicators are appropriate.

Levels 3 through 6 are measures that reflect indicators of environmental performance. As the indicators progress from Level 3 to Level 6, the association of the indicator to environmental outcomes strengthens. Ideally, all indicators should be Level 6 indicators because they measure the health endpoints for human and biological systems. Future versions of the system should focus on increasing the number of Level 6 indicators.

In preparing CAPRM, a new type of indicator emerged that did not fit within the Hierarchy of Indicators structure. Through use of the Risk Screening Environmental Indicators (RSEI) project, PEPPS was able to create several indicators measuring population-based health risk. Because the ability to generate an indicator based on health risk is a recent development, it is not precisely described by any of the Levels in the conventional Hierarchy. In recognition of this new type of indicator and the opportunities for similar risk-based indicators to be created in the future, CAPRM features a new seventh Level in the Hierarchy that reflects "Changes in Human and/or Ecological Health Risk." This new Level has been placed in the sixth position, placing it only behind direct human and ecological health effects in terms of its value in describing environmental results. The revised Hierarchy is displayed in ***Figure 5***.

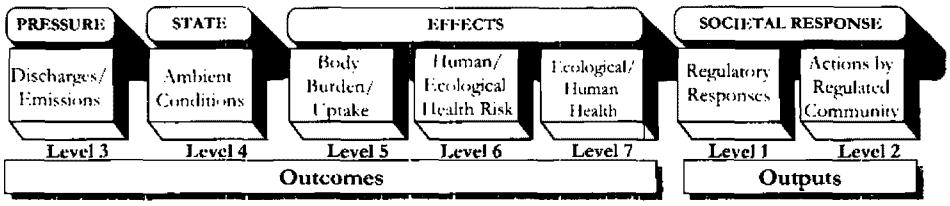
Figure 5: CAPRM Revised Hierarchy of Indicators

CAPRM Revised Hierarchy of Indicators						
Administrative		Environmental				
1	2	3	4	5	6	7
Actions by Federal or State Regulatory Agency	Responses of the Regulatory Community or Society	Changes in Discharge or Emission Quantities	Changes in Ambient Conditions or in the Quantities of Natural Resources	Changes in Uptake and/or Assimilation	Changes in Human and/or Ecological Health Risk	Changes in Health, Ecology or Other Effects

The CAPRM Model

PEPPS developed a graphic scheme for characterizing indicators according to the pressure-state-effects-response (PSER) model. This graphic scheme is included as the header of each indicator and displayed in ***Figure 6.***

Figure 6: The Pressure-State-Effects-Response Header



The CAPRM header efficiently conveys three important items of information about the indicator:

- Its position on the PSER scale;
- Its position in the Hierarchy of Indicators; and
- Whether the indicator is an output (societal response) or outcome (environmental) measure.

Users are sometimes confused by moving Level 1 and Level 2 out of numerical order in the Hierarchy of Indicators. This is done to match the governmental and societal indicators on the Hierarchy scale with the Societal Response category in the PSER model. It should be noted that the new Effects concept and the new Human and Ecological Health Risk category have been included in the header.

PRELIMINARY ASSESSMENT OF CAPRM

CAPRM II is the second version of what will continue to evolve, through successive process iterations, into a comprehensive, effective, and dynamic indicator system. CAPRM II represents the current ability of environmental data to support OPPTS environmental issues. This approach identifies the existing capacity to measure these issues and also identifies weaknesses that need to be addressed to provide high quality measures. These weaknesses form the basis of an agenda to make changes in data collection activities.

The Quality of Existing Indicators

CAPRM comprises numerous and diverse data sets; an individual analysis of each of them is beyond the scope of this document. However, a meta-analysis of data quality issues and data gaps is appropriate. With the exceptions noted below, most issues are adequately supported by existing data sets. In general, there is a significant improvement in the number and quality of indicators supporting CAPRM issues in comparison with CAPRM I. The strength and character of those indicators is of great importance to the utility and reputation of the system. However, there are many areas in which improvement can be made. Observations include:

- Of considerable importance to the validity of each indicator is the quality of the data that supports it. The data quality in CAPRM still ranges widely from excellent to poor. In general, the scientific, technical, and methodological foundations of most supporting data sets are quite good. The data sets from the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Agriculture (USDA), the United Stated Geological Service water data, and the National Atmospheric Deposition Program are among some of the quality data sets. The inclusion of new data from the Centers for Disease Control's National Exposure Study and the national cancer registry data are quality additions. Quality ecological data from the Chesapeake Bay Program and the Great Lakes Program and future data from other EPA ecological indicator initiatives will provide increasing strong supporting data. There are other data sets, however, that are not as strong and others that are considerably flawed and of limited utility.

- The data supporting indicators in CAPRM II come from a wide variety of sources, all of which have different perspectives and interests regarding chemicals and pesticides. Data from the USDA, Food and Drug Administration, Centers for Disease Control and Prevention (CDC), NOAA, Environment Canada, the U.S. Geological Survey, and several offices within the EPA are used to support CAPRM indicators.
- Emerging issues such as biotechnology and hormone disruption continue to have weak measurement support.
- There was general improvement in the quality and quantity of indicators measuring body burden, health risk, and human and ecological health impacts. However, the preponderance of CAPRM II indicators still measure emissions/discharges or ambient conditions. Some indicators continue as program measures or societal response measures. The continued improvement of the system over time will require a general upgrading of the types of indicators used.

This second version of CAPRM represents an indicator system that is based on currently existing data, much of which was not designed to support indicators. The indicators presented are, in many cases, not the ideal measurements of an issue, but reflect the best available data. Further, the development of the system is the result of rather intense research by a relatively small group of individuals on the CAPRM work group and the CAPRM staff. Broader review and participation are needed to add value to the system.

Where national-level data is weak, there are often excellent state-level data collection systems that could be used as models for national programs.The use of birth defects information from four states to create the birth defects indicator is illustrative of this approach.

CAPRM Data Gaps

The CAPRM process has treated data gaps as a serious concern. In fact, many Technical Advisory Workgroup (TAW) members expressed the opinion that the identification of data gaps and the recommendation of work to fill those gaps are as important as documenting what is currently available in the form of indicators. An effort has been made to identify the major gaps associated with each issue and to provide recommendations for future development. The following represents the major data gaps collectively identified by the TAW and PEPPS staff:

Human Health: Human and ecological health issues are the central issues in this project. If chemicals and pesticides did not have the potential to negatively affect the health of humans, animals, and plants, they would not represent an issue of any environmental significance. Such, however, is not the case since there are many known chronic and acute health effects associated with chemical and pesticide exposures and many others that are suspected and under investigation. While the indicator data available to portray relationships between chemical and pesticide exposures and human health effects have improved and will improve further in the next decade, it remains perhaps the most important area for future development. The following represent major dimensions of current data gaps.

1. **Relationship Between Chemical and Pesticide Exposures, Body Burden, and Direct Health Effects**: The greatest single shortcoming of the current human health indicators is the inability to identify with any great uncertainty the relationship between chemical and pesticides exposure and chemical and pesticide body burden, and resulting pathologies. While information on some exposures is available and high quality body burden information is increasingly available, current science cannot with any precision connect their levels to actual pathologies. Three key areas are discussed below:

    - **Hormone Disruption:** There has been increasing public concern over hormone (or endocrine) disruptors, a group of man-made chemicals that are suspected of interfering with the endocrine systems of both humans and wildlife in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system. Over the last several years, numerous studies have been performed, reviewing the health impacts of hormone disruptors. Wildlife studies

have shown associations between hormone disrupting chemicals in the environment and declining populations, thinning eggshells, morphological abnormalities, and impaired viability of offspring. In humans, scientists have hypothesized a relationship between hormone disruptors and declining sperm counts; breast, testicular, and prostate cancers; and neurological disorders, including cognitive and behavioral effects. Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health. In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm or deny that potential and characterize the effects. The program's priority is to target 15,000 high-volume chemicals (nonpolymeric chemicals with production levels exceeding 1,000,000 pounds that are potentially capable of negatively influencing human health) for screening and testing, including pesticides, commercial chemicals, and environmental contaminants. The importance of this issue and the current absence of adequate science make this issue a critical data gap.

- **Cancer:** Rising rates of cancer incidence in the U.S. are another focus of concern for the public, EPA, and the medical community. EPA identifies a number of chemicals as known or suspected carcinogens. However, the science necessary to establish clear, definite relationships between carcinogenic exposure and cancer is not sufficiently precise. While some of the increases in cancer rates, particularly hormonally related cancers, may be explained by chemical or pesticide exposure, there are too many confounding circumstances to assert any direct and precise relationship. Life style issues, inadequate understanding of genetic polymorphism, and the extended period of time between exposures and the contraction of cancer are factors that blur establishment of any direct causal link. Further confounding factors are the multi-causal and interactive effects of the potential causes of cancer. Much more cancer research is required to refine the research and to collect appropriate data to support indicators.

- **Birth Defects:** Similarly, rising birth defects rates give cause to much public concern, and like hormone disruption and cancer, chemical and pesticide exposures are raised as a partial explanation. The current research inadequately supports a clear documentation of the precise relationship between some chemical exposes and a range of birth defects. Further, the data that is presently collected is diffuse and inconsistent. Relatively few states have effective birth defects registries and the data between states is not directly comparable. There is only an incipient move to begin some sort of consistent data collection process.

2. **Improved Precision and Expanded Use of Risk Analysis.** The use of risk as a focal point for the development of human health indicators is a relatively new development. The current tools used to create such indicators - the Risk Screening Environmental Indicators (RSEI), the LifeLine Project (pesticide risk estimation), and risk estimates from the National Air Toxics Inventory — are good first steps and provide measures of environmental issues that are currently otherwise unmeasurable. These tools, however, are relatively crude and are capable only of assessing the broad trends associated with an issue. Risk assessors need to refine the application of risk assessment concepts and methods to build more effective ways to assess the risk relationship between chemical and pesticide exposures and human health impacts.

3. **Health Data Standardization:** Individual states collect considerable environmental health data that, if aggregated at the national level, would be extremely useful. The collection of birth defects information is a prime example. A number of states have birth defect registries. However, the birth defect categories are inconsistent between states, collection periods vary, and data collection processes vary between states, among other problems. Some coordination and standardization could assist greatly in providing more quality data without the necessity of mounting a completely new data collection process.

Ecological Health: While there is some high quality indicator data for some aspects of ecological health (Chesapeake Bay Program, Great Lakes Program, and the Arctic Monitoring and Assessment Program), it is an issue with many serious deficiencies. Important concerns include:

1. **Chronic and Acute Impacts on Wildlife Health:** There is a virtual absence of indicator quality data measuring the relationship between chemical and pesticide exposures and the direct health impacts of wildlife, in spite of widespread research results that suggest a wide range of wildlife are affected by chemical and pesticide contact. Of particular interest to both the TAW and to EPA is the absence of good indicator quality data on avian impacts.

2. **Impacts on Habitat:** There is considerable information regarding the discharges of chemicals and pesticides into the environment and the accumulation of key chemicals and pesticides in important habitats for a few major ecosystems. More work in a wider range of systems is scheduled for the future. Substantial areas of the U.S., however, are without much data and a full spatial assessment is not currently possible. Further, there is little indicator quality data capable of measuring the impact of chemical and pesticide contamination on the biota supported by the habitat.

3. **Development of Wildlife Risk Models:** Incipient risk models for human health (RSEI) exist and provide useful data to support a wide range of indicators. No other similar risk models have been found during this project. Both acute and chronic wildlife indicators are scheduled for the future as part of RSEI, but initiation of work is not imminent. As with human health, risk analysis indicators for wildlife health represents an important area for development.

Biotechnology: Biotechnology is an emerging issue of enormous public and scientific concern. The manipulation of genetic material has the potential to achieve enormous benefits that can profoundly improve the health of the world's population. Conversely, biotechnology has the potential to achieve profound negative environmental impacts in a variety of ways. Add the moral and religious concerns and biotechnology becomes an explosive issue. Because of its incipient nature and its relative lack of a regulatory system, there is virtually no indicator quality data capable of measuring its important dimensions. The development of good indicators of biotechnology is a major area of potential growth.

Cumulative Impact of Chemical and Pesticide Use

The United States is a nation where chemicals and pesticides are a pervasive part of everyday life. Over 70,000 chemicals and pesticides are in use and more are being added every day. Some of these chemicals are well documented, but many others are relatively undocumented in terms of their effects on human and ecological health. The regulation of these chemicals and the management of the pathways, which may expose them to the environment, vary widely. Further, the regulatory processes themselves vary widely with a number of different agencies having responsibilities for different segments of the chemical and pesticide universe. Additionally, many of the pathways of chemical and pesticide exposure are not subject to any management system. Where regulatory systems exist, there is no process to integrate data or information. As a consequence, there is only a patchwork of information regarding how chemicals and pesticides, in a total or cumulative sense, impact human and ecological health values. While understanding some of the components of chemicals and pesticides impact is helpful, until there is measurement of the cumulative impact of chemicals and pesticides, an assessment of some of the key sustainability issues cannot be fully explored. Such an indicator is not yet available, but might be worthy future development.

A suite of indicators and, perhaps eventually, an index indicator could be developed by focusing on the following areas:

- Production,
- Use,
- Exposure,
- Toxicity,
- Health Risk, and
- Health Impacts.

Knowledge of Key Chemicals:
The Toxic Substances Control Act (TSCA) has an inventory of over 70,000 chemicals that it is empowered to regulate. Excluding low volume production chemicals (approximately 25,000 chemicals produced at annual rates under 10,000 pounds) and polymeric chemicals judged to be of negligible potential health risk), about 15,000 chemicals remain on the inventory that are a concern to EPA. Within this group, particular attention is paid to a group of 3,000 to 4,000 High Production Volume Chemicals (HPV) (chemicals produced or imported at levels higher than 1,000,000 pounds per year). As of October, 2002, 540 of these (HPV) had undergone testing, and another 250 had been issued "Decision Not to Test" designations. This leaves over 14,000 chemicals in the non-polymeric inventory and at least 2,500 chemicals in the HPV inventory that have not undergone testing. The lack of knowledge concerning these chemicals remains a substantial deficiency in estimating the chemical impacts on human and ecological health.

International Chemical and Pesticide Transport
As the world economy expands an increasing recognized problem is the international transport of chemical and pesticide pollutants, and persistent, bioaccumulative toxics (PBTs) are of particular concern. More research is needed to identify how much of our pollutant load is coming from such international transport.

Ambient Accumulation of Chemicals on Land Resources
Acceptable measures of ambient chemical and pesticide pollution for air, surface water, and to a lesser degree, groundwater currently exist. However, chemical and pesticide contamination of land resources is limited to specific locations where levels are already known to be of concern, locations where some known event has occurred (e.g., a hazardous waste site). What is not known is the rate at which chemicals and pesticides are accumulating on land resources in an ambient sense. Of concern is the legacy issue measuring contribution to the sustainability of the nation.

Product Safety: A glaring data deficiency relates to the safety of products from a chemical and pesticide perspective. The lack of any significant testing program prevents the collection of any systematic data. As the U.S. becomes increasingly dependent on foreign imports of a wide range of products, this deficiency could become more important.

Cross-Media

1. **Pollution Prevention.** A focus of CAPRM II is the measurement of pollution prevention (P2). While some improvement was achieved, the measurement of P2 is still relatively weak. The lack of a centralized federal program, the lack of a common definition of what P2 is, the programmatic nature of P2 activities, and the difficulty of measuring that which does not happen are several of the impediments to measuring P2 achievements.

2. **Stewardship.** The diffuse nature of stewardship activities, the lack of any centralized program to collect data, and the incipient nature of stewardship programs make indicator development very difficult.

3. **Impacts of Voluntary Programs.** Voluntary programs managed by industries, community groups, and government are increasing important as a means of reducing chemical and pesticide contamination and exposures. Useful measurement of such activities, however, is sporadic, inconsistent, and, usually, local. Better information is needed to support indicators of this set of activities.

Tribes
One of the major data gaps identified in the first version of CAPRM is that relatively few sets of data used by federal, state, and local governments to develop indicators which have relevance to tribal organizations. The lack of such measurements inhibits the development of tribal environmental management systems and does not allow tribes the complete ability to document their achievements. Special attention needs to be paid to tribes to assess what existing data is relevant to tribal organizations and to identify alternative measurement tools capable of assisting tribes in building effective measurement systems.

Environmental Justice

Most of the indicators in the CAPRM II are relatively straightforward measurements of environmental quality. The development of environmental justice indicators adds several layers of complexity. Environmental justice indicators require not only good quality environmental data, they further require information that can be defined by ethnicity, income status, and location. These additional qualifications severely limit the availability of data capable of supporting environmental justice indicators. The development of geo-coded environmental data bases capable of being combined with critical social, economic, political, and cultural data are necessary for the development of improved environmental justice indicators.

Miscellaneous Concerns

During the course of the project several other concerns were raised:

1. **Links to Sustainability:** The TAW wanted the indicators in CAPRM II to have a clear relationship with the concept of sustainability. While it was beyond the current scope of the project, some members wanted to include a broader range of indicators dealing with power, water, and materials efficiency as a part of the project. Future versions of CAPRM might include more refined measures capable of reflecting sustainability.

2. **Leading Indicators:** Most of the indicators in CAPRM II use data that reflect measurement of past environmental conditions. Some TAW members would like to see more measures that have predictive capabilities.

3. **Risk Communication and Behavioral Change:** Risk communication is the process of providing appropriate information to the community and involving the community in decisions concerning important environmental concerns. Indicators capable of measuring the effect of such communication in terms of behavioral change are presently not available. Development of such indicators would provide a useful addition.

4. **Cost-Benefit:** Some TAW members were interested in the development of cost-benefit indicators, particularly in indicators capable of measuring the cost of marginal increments of environmental benefits associated with increased regulatory requirements.

Management and Process Issues

After working on the project diligently for three years, TAW members have expressed a number of concerns regarding the future of the CAPRM indicators.

1. **Use of the System:** Normally when PEPPS works to build an indicator system the intended use of the product is known in advance. In the case of CAPRM, there was no specific predefined use. CAPRM and CAPRM II have been developed as a general indicator system to assist states, tribes, the private sector, nonprofit entities, and the community in general in using indicators for their own needs. After investing their time and energy in this process, the TAW would like to ensure that this work will be used. The most common use mentioned was the integration of the indicator system with management systems of EPA, OPPTS, and other client groups of EPA.

2. **System Maintenance.** Indicator systems are not static; they either grow or they decay. The TAW recognizes that without some continuing maintenance of the indicators in CAPRM that the system will slowly lose its utility. Members recommended the periodic review of the indicators, adding and deleting the indicators as needed, and periodically updating the data in the indicators.

3. **Improvement of Indicator Data Quality.** Most of the indicators, with notable exceptions, are supported by data that was not intended to support indicators. Many of the indicators in this document have been mined from data sources ill-designed for indicator development. Most of the data comes from program monitoring data for specific concerns, from program reporting, and from required public reporting requirements. As a result many of the

indicators developed for this report are surrogates for more precise measures and others, because of methodological deficiencies, are marginal from a scientific perspective. Data collected specifically to support identified needs will increasingly be needed. EPA, other federal agencies, the General Accounting Office, the Office of Management and Budget, the states, tribes, and other involved parties need to identify the specific environmental issues that need to be tracked and ensure that scientifically valid and complete data capable of supporting quality indicators is collected and made accessible.

4. **Better Access to Data:** There is a lot of environmental data that might have been important to the development of indicators for CAPRM, but was, for a variety of reasons, not available. Some data is proprietary and must be purchased. Often, that data can be available if presented at high levels of aggregation. Purchasing data to support specific indicator needs might highly useful and cost effective. Data might be available but for procedural reasons, difficult to acquire. For example, it was surprisingly difficult to acquire the excellent Great Lakes Program, Chesapeake Bay Program, and Arctic Monitoring and Assessment Program data. Finally, some public data sets with great potential contain proprietary information and are difficult to access. The Toxic Substances Control Act (TSCA) details an example of such a data set.

5. **Delays in Receiving Indicator Data.** Much useful data used to support indicators has diminished value because of reporting delays. Data reports generally have a one-year delay, two-year delays are common, and three- and five-year delays are sometimes experienced. The informational value of data deteriorates over time and the longer the delay in acquiring and publishing data, the less use it has for informing current decisionmaking processes.

Future Development and Expansion of CAPRM

All good indicator systems are works in progress. Collecting indicators on a one-time basis may have some utility in establishing a snapshot of environmental conditions but unless they are reliably collected over time, they lose one of their most important attributes: the ability to shows trends in environmental values. Thus, at a minimum, indicator systems need to be updated with new data points. Indicator systems also change because the universe of important environmental issues changes. Breakthroughs in science or changes in human behavior may diminish a particular issue and register new environmental issues on the public radar. When such changes in public priorities occur, the issue structure of important environmental concerns must be modified and indicators associated with those indicators must be added or deleted accordingly. Data sources that support current indicators can also change. A data source that supports an indicator may diminish in quality or cease to be collected. Such indicators must then be removed from the system. Finally, new data opportunities arise that allow an issue to be better measured. In this situation, new indicators would need to be developed to either supplement or supplant existing indicators. For all of these reasons, indicator systems need to go through a regular program of maintenance to retain and improve their utility.

Maintenance

A maintenance and development program for CAPRM should include the following elements:

- A continuing evaluation of the document with broad stakeholder participation;
- An analysis of the evaluation to inform system edits (additions and deletions of indicators) as necessary;
- Identification of major data gaps that prevent the development of high quality indicators for each issue area;
- Incorporation of new issues and new sources of data,
- Expansion of the system to include new important policy areas and issues of concern to specific subpopulations, and,
- Periodic updates (annual or biannual) or maintenance of a real time web site version of the critical indicators.

Expansion

Once the base indicator system has been solidified, a series of enhancements can be added to provide the system greater power. Indicator subsystems could be added to support specific areas important to stakeholders. Such areas could include:

- **Data Gaps**: After three years of CAPRM, it is increasingly apparent that there are some major areas where indicator quality data is weak or nonexistent. A focused and structured study of those gaps in concert with an examination of options for closing those gaps could be useful.
- **Tribal** : Relatively few of the data sets federal, state, and local governments use to develop indicators have much relevance to tribal organizations. Special attention needs to be paid to tribes to assess what existing data is relevant to tribal organizations and to identify alternative measurement tools capable of assisting tribes in building effective measurement systems.
- **Environmental Justice**: Environmental justice is a major policy issue of considerable relevance to chemicals and pesticides. The development of an explicit set of indicators measuring societal performance vis a vis different social, economic, racial and gender groups could provide an effective tool for policy management.
- **State and Local Data**: Both versions of CAPRM have focused on national level data as the basis for indicators. Where state data has been used, it was used as a surrogate for larger scale data. The birth defects indicator is a good example. However, individual regions, states, tribes, or local government do hold unique data sets that might be capable of providing data on otherwise weakly supported issues or may provided perspectives missed by larger scale data. A structured examination of state and tribal data resources might yield results.

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SUSTAINABILITY

THE UNDERLYING THEME

SUSTAINABILITY

THE UNDERLYING ISSUE

Decades of rapid and increasingly globalized economic growth, technological advancement, and population increase have raised concerns that society is consuming resources at a rate faster than replacement or substitution can occur. There is further concern that degradation of environmental values is occurring faster than the ability to repair within the lifetime of the present generation and that a negative legacy is being created for future generations. Society's actions have been identified as being unsustainable or unsupportable: that is, they are incapable of being continued without long-term negative consequences. Increasingly, world, national, regional, and local scale organizations representing governments, economic interests, and citizens have adopted the concept of sustainability as a focus for planning and implementing activities to affect integrated economic, social, and environmental change.

Sustainability is achieved through sustainable development. A classic definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development). A sustainable society does not consume or damage resources at a rate that does not allow for the needs of those who will follow and it does not leave a legacy of pollution with which others must deal.

The Thomas Jefferson Sustainability Council has established a set of principles that summarize the concept of sustainability. The following concepts are implemented in a Sustainable Community:

- Individual Enterprise: Individual rights are respected and community responsibilities are recognized.
- Community Decision Making: All human and natural needs are respected and conflict is resolved through consensus building. The Community is a collection of diverse human and other biological interests.
- Full Benefits/Cost Accounting: Achieving social, environmental, economic, and political health has inter-generational costs and benefits which must be weighed. In a healthy society, benefits outweigh costs.
- Conservation: The integrity of the natural systems will be maintained or improved.
- Interdependence: Social, environmental, economic, and political systems are acknowledged to be interdependent at all levels.
- Stewardship/Long-Term Focus: The responsibility for future generations' social, environmental, economic, and political health is acknowledged.
- Finite Resources: The members understand there are limits to growth.

The Chemical and Pesticides Results Measures (CAPRM II) project adopts the concept of sustainability as the central theme for its work. In some way each indicator within this document contributes to the ability to assess the impact that chemicals and pesticides have — positively and negatively — on the sustainability of society and the individuals that live in it.

The environmental issues selected for CAPRM reflect this concern for sustainability:

- Human Health: How is health of the citizenry being affected by chemicals and pesticides? Are direct negative health effects attributed or potentially attributed to chemicals and pesticides declining? What are the trends in health risk

due to exposure to potentially dangerous chemicals and pesticides? What are the trends in the uptake of chemicals and pesticides into the body? What risks occur due to the inadequate control of disease vectors normally controlled by chemicals and pesticides?

- Ecological Health: What is the health of ecosystems with regard to chemicals and pesticides and are such systems improving or declining due to involvement with chemicals and pesticides? What is the long-term prognosis for important species that are sensitive to pesticides and chemicals?
- Chemical and Pesticide Safety and Use: What is the legacy of the long-term build-up of toxic chemicals and pesticides in the environment? Are the chemicals and pesticides that are being used increasingly safer to use, lessening impacts on future generations? Is the legacy of persistent bioaccumulative toxics (PBTs) being expanded or reduced? Are ways of reducing our demand for agricultural chemicals and pesticides being reduced?
- Food Safety: Is the food supply being protected from potentially dangerous chemicals and pesticides? Are effective safer pesticides being employed that offer less health risk and lower levels of long-term risk to the environment?
- Product Safety: What are the trends in the toxicity of the products used?
- Transboundary Movement of Chemicals and Pesticides: What are the trends in the regional and international sharing of chemical and pesticide pollution? What inequities are created by the distribution of such regional and international pollution?

The project also looks at the equity impacts of negative effects on special populations: children, ethnic and low-income groups, and Indian tribes. In each case there is concern that each of these groups is being differentially impacted by the distribution of exposure to potentially harmful chemicals and pesticides. A sustainable society would seek to correct those inequities.

Finally, CAPRM seeks to address two additional concepts that are closely related, if not integral, to the concept of sustainability:

- Product Stewardship: Product stewardship refers to an industrial producer taking a long-term responsibility for their products by taking actions that go beyond merely building and selling a product. Effective product stewards are now designing products and implementing actions that ensure that the products use, and the eventual recycling, reuse, or disposal, minimizes waste and protects the environment. Industry is increasingly taking responsibility for the environmental quality and impacts of its products. This may include taking steps to ensure that products are safe to use or may take a more long-term perspective by integrating concepts such as health, safety, and environmental protection into the life-cycle of products. This life-cycle analysis includes the manufacturing, marketing, distribution, use, recycling, and disposal of particular products. Product stewardship reduces pollution, reduces materials waste, saves energy and returns the spent product for reuse or recyling. All of these values contribute to sustainability.
- Pollution Prevention: The objective of pollution prevention programs is to reduce or eliminate the need to control, treat and dispose of pollutants, and to alleviate the negative health and quality of life consequences of pollution. Effective pollution prevention strategies and programs will reduce the short- and long-term stresses on the environment. It is a fundamental building block of a sustainable society.

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ENVIROMENTAL ISSUES

Environmental Issues List

Human Health

Ecological Health

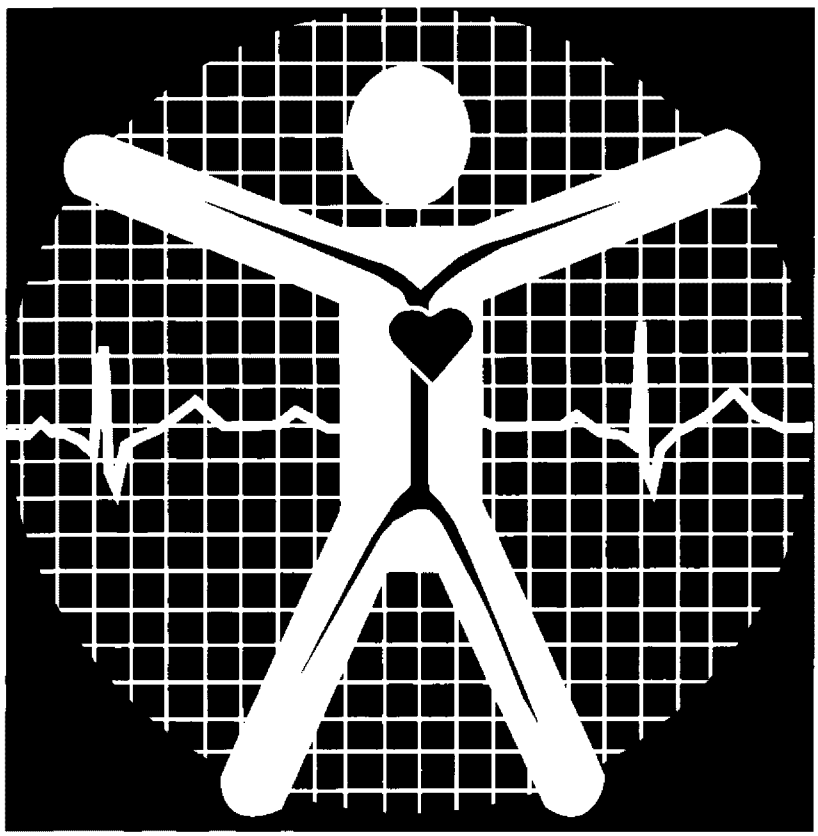
Chemical and Pesticide Safety and Use

Food Safety

Product Safety

Transboundry Movement of Chemicals and Pesticides

ENVIROMENTAL ISSUE 1: HUMAN HEALTH



List of Indicators

Pathologies Caused by Chemical or Pesticide Exposure

Cervical Cancer Incidence and Mortality

Endometrial Cancer Incidence and Mortality

Female Breast Cancer Incidence and Mortality

Ovarian Cancer Incidence and Mortality

Prostate Cancer Incidence and Mortality

Thyroid Cancer Incidence and Mortality

Testicular Cancer Incidence and Mortality

Incidence of Asthma

Number of Fatal and Non-Fatal Poisonings due to Pesticide Exposure

Number of Fatal and Non-Fatal Poisonings due to Chemical Exposure

Occupational Incidence of Respiratory Conditions due to Toxic Agents

Occupational Incidence of Poisoning

Number of Occupational Chemical and Pesticide-Related Injuries and Illnesses

Chronic Human Health Risk Index for Toxic Releases

Acute Human Health Risk Index for Toxic Releases

Chronic Human Health Risk for Releases of Carcinogenic Chemicals

Chronic Human Health Risk for Releases of Developmental Toxins

Body Burden of Toxic Substances

Metal Levels in People Ages 6 Years and Older

Blood Lead Levels in Peoples Ages 6 Years and Older

List of Indicators Continued

Blood Mercury Levels in Women of Childbearing Age

Levels of Organophosphate Pesticide Metabolites in People Ages 6-59 Years

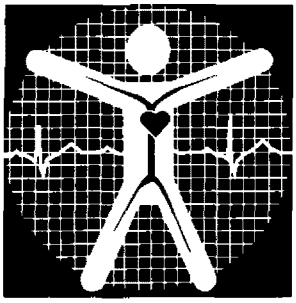
Levels of Phthalate Metabolites in People Ages 6 and Older

Occupational Lead Exposure

Reported Cases of Vector-Borne Diseases

Number of Fish and Wildlife Advisories

Environmental Issue 1: Human Health



There are over 70,000 chemicals currently in use in the U.S. and the U.S. Department of Agriculture has reported that over the last 10 years approximately 270 active ingredients have been used in pesticides. Of great concern to many people is how those chemicals affect their health and quality of life. EPA has accepted the importance of understanding these chemicals and pesticides and their effects on human health as a major driver of their policies and programmatic activities.

From an environmental perspective, chemicals and pesticides are important because they have a potential acute and chronic effect on human and biological health. If chemicals and pesticides did not have this association with human and biological health, much of the reason for EPA's existence would be gone and the need for this indicator system would be eliminated. In a sense, virtually all of the indicators in the document are included because of the inadequacy of available data to directly measure health effects fully. If the relationship between human and biological health effects could be adequately measured, all of the indicators that look at programs, discharges and ambient conditions could be dispensed with.

However, the measurement of chemical and pesticide associations to health outcomes is not supported by sufficient science to support indicator development. The data systems required to measure the association between chemicals and chronic and acute health effects are only now being constructed. The National Report on Human Exposure to Environmental Chemicals and the National Children's Study, along with a myriad of new and ongoing medical studies, are projects that will begin to yield increasingly valuable and complete information about the relationship between chemical exposures and direct health effects. In the interim, there is information capable of supporting useful surrogate measures.

The Human Health issue is divided into five sub-issues for which existing and potential measurement systems are identified. The sub-issues are: (1) pathologies and direct health impacts, (2) health risk, (3) body burden, (4) public health, and (5) subsistence diet.

Issue Dimensions

Pathologies and Direct Health Impacts

The most direct and compelling human health indicators would be those that would measure the direct physical relationship between chemical and pesticide exposure and physiological health effects. Evidence suggests relationships between exposure to toxic chemicals and cardiovascular disorders, developmental disorders, endocrine system dysfunction, gastrointestinal or liver dysfunction, weakening of the immune system, kidney failure, musculoskeletal disease, neurological and behavioral dysfunction, interference with sexual function or the ability to reproduce, respiratory system dysfunction, and skin or sense organ dysfunction might exist.

Unfortunately, the science and the data needed to support such direct relationships are not fully available. Many pathologies have multiple causes and interactive effects with nonchemical factors that prevent measurement of the contribution of specific chemical exposures to specific health effects. For most chemicals, it is unknown precisely what long-term effects they will have on human health. For those chemicals about which some effects are known, long-term risks are not well understood. The National Children's Study is initiating new data collection processes that may produce the evidence necessary to establish such relationships. This project will examine the effects of environmental influences, including chemical bioassay data, on the health and development of more than 100,000 children, following them from before birth

until age 21. This project will have the explicit benefit of allowing bioassay information to be related to health and pathology outcomes. When such relationships are established, then long-term tracking through indicators can occur.

While a wide range of health effects might have associations with chemical and pesticide exposure, the indicators presented here focus on pathologies with suspected relationships: cancer, birth defects, and asthma.

Health Risk

A potential intermediate measurement of the impact of chemicals on human health is the estimation of the change in risk associated with increases or decreases in chemical exposure. While the concept of risk is thoroughly integrated into the culture of environmental protection agencies and risk-based analysis is increasingly employed to make environmental decisions, risk-based data sets suitable for indicator development have not existed until recently. The Risk Screening Environmental Indicators project at the EPA permits an estimation of unanchored human health risk resulting from modeled exposure to Toxics Release Inventory chemicals. This tool is used cautiously to support a variety of indicators in this documents that cannot be provided with any other source.

Body Burden

Of particular concern are toxic chemicals that persist in the environment, bioaccumulate in human and animal tissues, and result in negative health effects. Such chemicals - known as persistent bioaccumulative toxics (PBTs) - are worthy of special consideration because of the serious health risk they pose. The measurement of bioaccumulation of these substances does not measure direct health effects, but it is a good surrogate measure. The National Report on Human Exposure to Environmental Chemicals being developed by the Centers for Disease Control and Prevention provides annual, high-quality biomonitoring data for 116 important chemical constituents associated with health issues.

A second major future source of biomonitoring information is the previously mentioned National Children's Study. Current planning would include chemicals and pesticides that pass through the body as well as those which tend to bioaccumulate.

Public Health

Chemicals and pesticides are used to manage diseases through the control of infectious organisms. When such chemical agents are ineffective, a variety of public health effects can result. Hospital disinfectants that inadequately control bacteria can lead to a rise in secondary infections. Ineffective insecticides can lead to increases in mosquito borne diseases (eg., equine encephalitis, malaria, and West Nile) or tick borne diseases.

Subsistence Diet

There are populations of individuals and families in the U. S. that - for reasons of personal preference, life style, or economic necessity - have diets that place them at higher risk of chemical and pesticide exposure. Individuals who catch and eat fish or other seafood as a major component of their diet are at risk of consuming high levels of PBTs. For example, the Inuits of North America, while distantly removed from any significant source of direct pollution, have very high levels of PBTs in their blood and tissue. This is attributed to their status as an end-of-the-food-chain consumer, whose diet is almost solely composed of seafood and marine mammals that are effective concentrators of fat-soluble toxic chemicals. Similarly, individuals who grow their own vegetables and apply their own pesticides may have an additional risk of chemical exposure if they are not well-trained in the use of such products.

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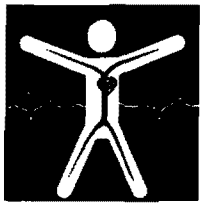
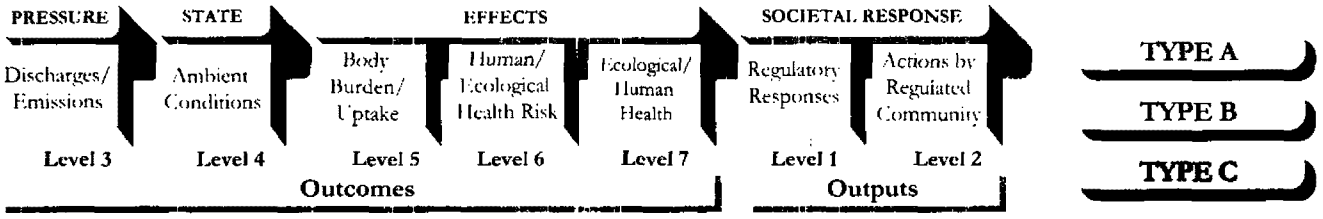


HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Pathologies Caused by Chemical or Pesticide Exposure

The ideal measurement of the human health impact of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The development of such indicators may soon be possible. In conjunction with the U.S. Department of Health and Human Services and the U.S. Environmental Protection Agency, the development of a National Children's Study (NCS) is presently underway. The NCS will examine medical outcomes and body burden data collected from a cohort of over 100,000 children. The cohort will be followed from early gestation to the age of 21. Analysis of the data will permit the identification of causal relationships between chemical exposure and specific medical outcomes. The confirmation of such relationships, however, will take many years due to the lengthy scientific process of data analysis, results validation or replication, and peer review.

Pilot studies will begin in fiscal year 2002-03 and the full study will begin in fiscal year 2004-05. The study is projected to conclude in fiscal year 2027-28.

The NCS, however, by concluding the monitoring when the cohort reaches age 21 may be missing an opportunity to considerably expand knowledge of chemical exposure and health effects well into adulthood. By continuing the cohort study indefinitely or until death, information could be collected that could be used to conclusively establish the relationship between chemical exposure and the character and timing of medical outcomes across the entire life span.

Reference

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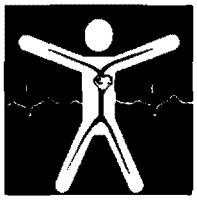
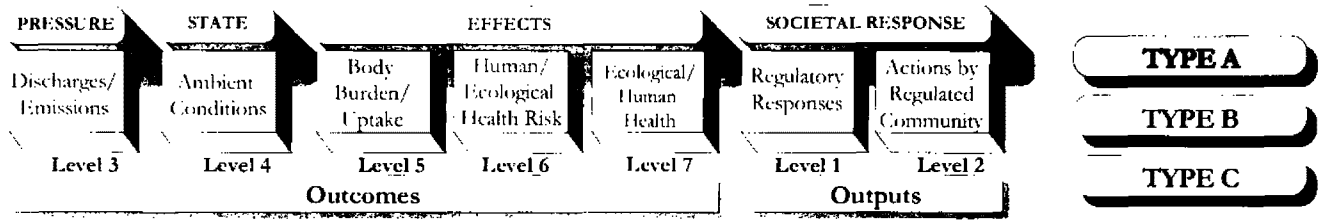


HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Cervical Cancer Incidence and Mortality

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA). Cervical cancer is part of a group of such cancers, which have been identified by the U.S. EPA as having a potential association with chemical exposure.

Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a). A malignant tumor that forms in the cervix, the lower part of the uterus, is called cervical cancer. Symptoms of cervical cancer include abnormal vaginal bleeding or discharge and pain during intercourse (NCI, 2002a). However, during the first stages of cervical cancer, often there are no symptoms. Tests used to detect and diagnose cervical cancer include pelvic exams, pap tests, colposcopies, and biopsies. Treatments include surgery, radiation therapy, and chemotherapy. Although the causes of cervical cancer are not known, women with certain conditions, such as a family history of cervical cancer, low physical activity, being over age 50, or infection with any of the following sexually transmitted diseases: human papillomavirus (HPV), HIV, and chlamydia, have an increased risk of developing the disease. Cigarette smoking also increases a woman's risk of developing cervical cancer by exposing the body to carcinogenic chemicals that can damage the DNA of cells in the cervix.

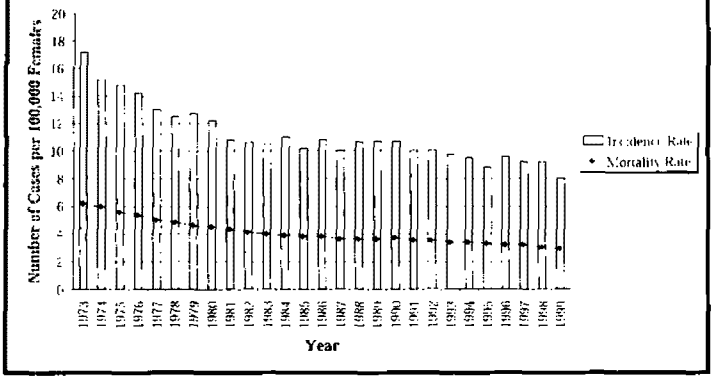
A risk factor that may additionally contribute to cervical cancer incidence is exposure to diethylstilbestrol (DES), a synthetic form of estrogen that was used to prevent complications during pregnancy from the 1940s to 1971. Exposure to other hormonally active agents may also be a risk factor for cervical cancer. Scientists have hypothesized a relationship between hormonally active agents and reproductive cancers, birth defects, neurological disorders, and other negative health effects. The endocrine system guides the "development, growth, reproduction, and behavior of human beings and animals" (U.S. Environmental Protection Agency, 2001). Hormonally active agents are a group of man-made chemicals that are suspected of interfering with human endocrine systems in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system (U.S. EPA, 2001).

Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health (U.S. EPA, 1997). In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm that potential and characterize the effects (U.S. EPA, 2000). The program's priority is to target 15,000 high-volume chemicals for screening and testing, including pesticides, commercial chemicals and environmental contaminants (U.S. EPA, 1997).

About 15,000 American women are diagnosed with cervical cancer each year (NCI, 2002a). Cervical cancer incidence and mortality in the U.S. has declined over the past thirty years mostly due to the use of the pap test to detect abnormal cells before they become cancerous (American Cancer Society, 2001). The following charts show trends in cervical cancer incidence and mortality in the U.S., as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics.

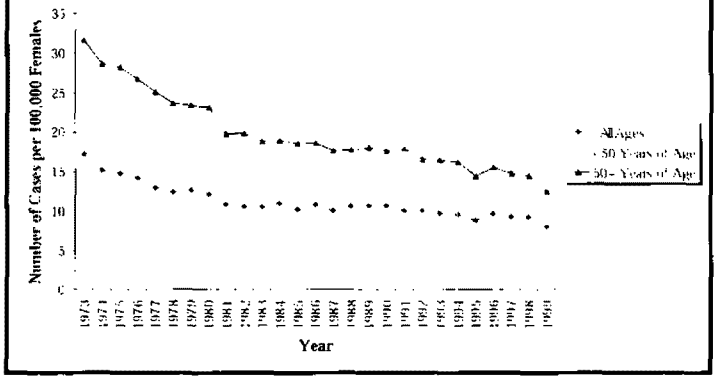
- From 1973 to 1999, cervical cancer incidence rates per 100,000 people decreased from 17.2 to 8.0.
- Mortality rates decreased from 6.2 to 2.9.

Cervical Cancer Incidence and Mortality Rates, 1973-1999



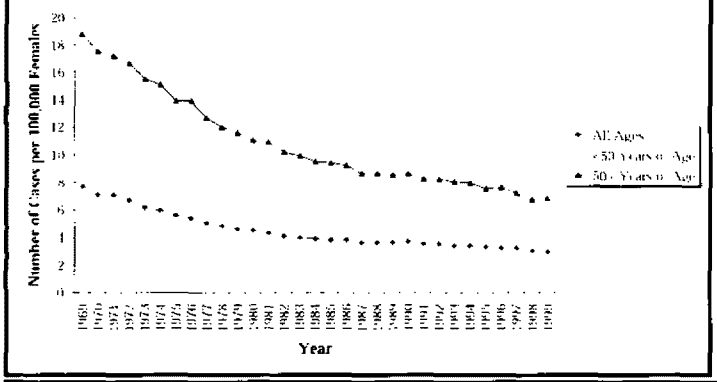
- From 1973 to 1999, the highest cervical cancer incidence rates per 100,000 people were seen in women 50 and older.
- Incidence rates decreased in the overall population, as well as in each age group.

Cervical Cancer Incidence Rates by Age, 1973-1999



- From 1969 to 1999 the highest cervical cancer mortality rates per 100,000 people were seen in women 50 and older.
- Mortality rates decreased in the overall population, as well as in each age group.

Cervical Cancer Mortality Rates by Age, 1969-1999



Source: National Cancer Institute (NCI). Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002, http://seer.cancer.gov/canques/ (30 January 2003).

Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Data is collected from 11 population-based cancer registries and three supplemental registries, which cover approximately 26 percent of the U.S. population. The registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle Puget Sound, Utah, Los Angeles, San Jose-Monterey, Alaska, Arizona, and certain rural counties in Georgia. The population used in the SEER study may not be a complete representation of the general U.S. population due to the fact that it tends to be somewhat more urban and has a larger proportion of foreign born persons than the general population.

Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age adjusted to the 2000 U.S. standard million population by 5 year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age adjusted rate is a weighted average of the age specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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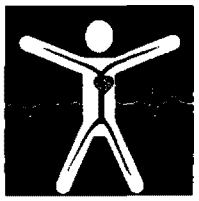
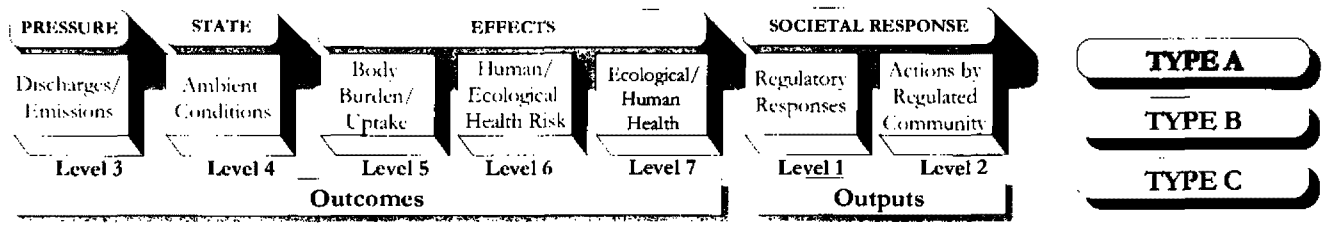


HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Endometrial Cancer Incidence and Mortality

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA). Endometrial cancer is part of a group of such cancers, which have been identified by the U.S. EPA as having a potential association with chemical exposure.

Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a). A malignant tumor that forms from the endometrium, the inner lining of the uterus, is called endometrial cancer. Symptoms of endometrial cancer include abnormal vaginal bleeding, pain during urination or intercourse, and pain in the pelvic area (NCI, 2002a). Tests used to detect and diagnose endometrial cancer include pelvic exams, pap tests, ultrasounds, biopsies, and D&C (dilation and curettage). Treatments include surgery, radiation therapy, and hormonal therapy. Although the causes of endometrial cancer are not known, women with certain conditions, such as a family or personal history of ovarian, breast, colon, or rectum cancers, prior pelvic radiation, obesity, diabetes, high blood pressure, low physical activity, or being over age 50, have an increased risk of developing the disease.

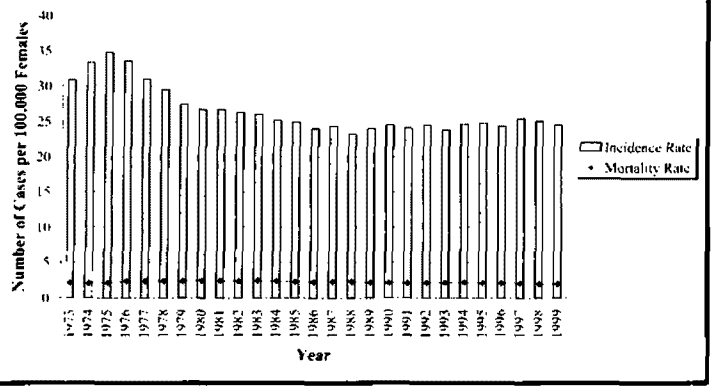
Risk factors that may additionally contribute to endometrial cancer incidence include prolonged or increased exposure to estrogen, exposure to tamoxifen, a drug used to treat breast cancer that has estrogen-like effects on the uterus (NCI, 2002a), and exposure to diethylstilbestrol (DES), a synthetic form of estrogen that was used to prevent complications during pregnancy from the 1940s to 1971. Exposure to other hormonally active agents may also be a risk factor for endometrial cancer. A woman may prolong or increase her exposure to estrogen in a number of ways, including hormone replacement therapy, never having children, and having a high-fat diet (because some of the body's estrogen is made in fatty tissue) (NCI, 2002a). Scientists have hypothesized a relationship between hormonally active agents and endometrial, breast, and ovarian cancers, birth defects, neurological disorders, and other negative health effects. The endocrine system guides the "development, growth, reproduction, and behavior of human beings and animals" (U.S. Environmental Protection Agency, 2001). Hormonally active agents are a group of man-made chemicals that are suspected of interfering with human endocrine systems in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system (U.S. EPA, 2001).

Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health (U.S. EPA, 1997). In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm that potential and characterize the effects (U.S. EPA, 2000). The program's priority is to target 15,000 high-volume chemicals for screening and testing, including pesticides, commercial chemicals and environmental contaminants (U.S. EPA, 1997).

Endometrial cancer is the most common cancer of the female reproductive system (NCI, 2002b). The following charts show trends in endometrial cancer incidence and mortality in the U.S., as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics.

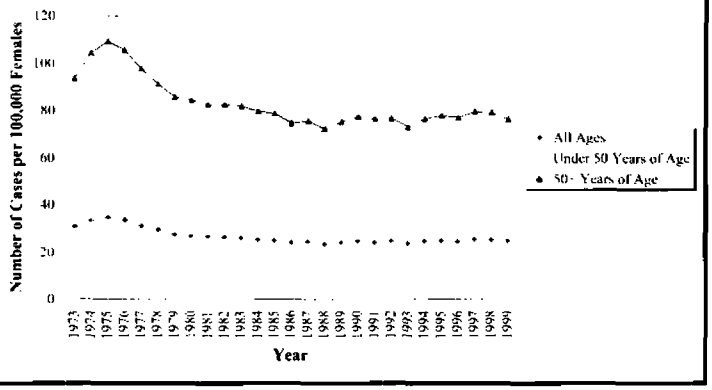
- From 1973 to 1999, endometrial cancer incidence rates per 100,000 people decreased from 30.9 to 24.6.
- Mortality rates decreased from 2.2 to 2.0.

Endometrial Cancer Incidence and Mortality Rates, 1973-1999



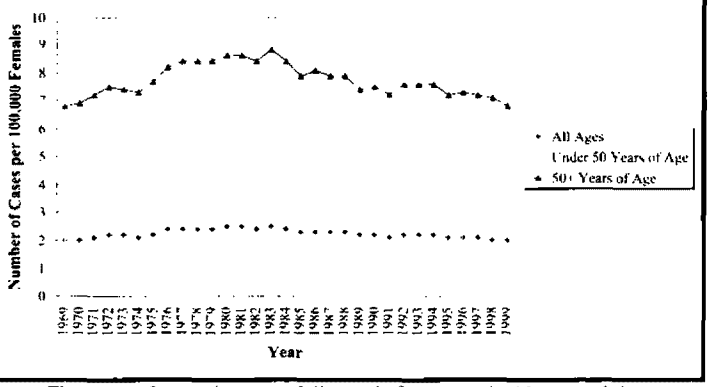
- From 1973 to 1999, the highest endometrial cancer incidence rates per 100,000 people were seen in women 50 and older.

Endometrial Cancer Incidence Rates by Age, 1973-1999



- From 1969 to 1999 the highest endometrial cancer mortality rates per 100,000 people were seen in women 50 and older.

Endometrial Cancer Mortality Rates by Age, 1969-1999



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Source: National Cancer Institute (NCI). Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002, http://seer.cancer.gov/canques/ (30 January 2003).

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Data is collected from 11 population-based cancer registries and three supplemental registries, which cover approximately 26 percent of the U.S. population. The registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, San Jose-Monterey, Alaska, Arizona, and certain rural counties in Georgia. The population used in the SEER study may not be a complete representation of the general U.S. population due to the fact that it tends to be somewhat more urban and has a larger proportion of foreign-born persons than the general population.

Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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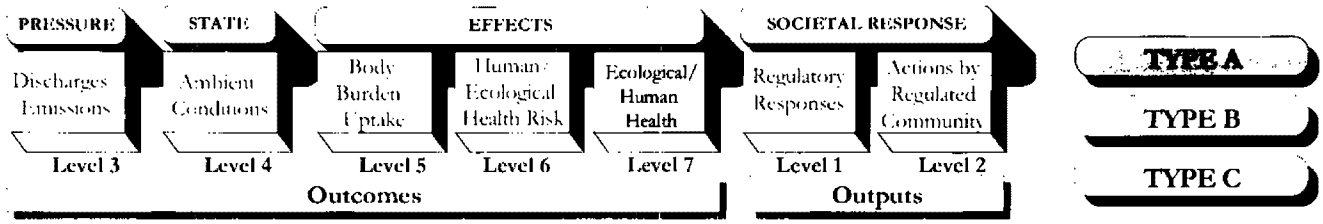
HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Female Breast Cancer Incidence and Mortality

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA). Female breast cancer is part of a group of such cancers, which have been identified by the U.S. EPA as having a potential association with chemical exposure.

Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a). A malignant tumor that forms in the breast is called breast cancer. While breast cancer can occur in men, most cases are seen in women. This indicator's focus is breast cancer in women. However, during the first stages of breast cancer, often there are no visible symptoms. As a tumor grows, women may observe a lump in or near the breast or underarm, change in breast size or shape, nipple inversion or discharge other than breast milk, change in breast skin such as redness, scaliness, dimpling, or irritation (American Cancer Society, 2001). Breast cancer is detected by breast exams and mammograms. Treatments include surgery, radiation therapy, chemotherapy, and hormonal therapy. Early detection and treatment are essential for saving the breast and the woman's life.

Although the causes of breast cancer are not known, women with certain conditions, such as a personal or family history of breast cancer, have an increased risk of developing the disease. Women who are over 50, have a mutated gene, were exposed to radiation during radiation therapy before age 30, drink alcohol, are overweight, have low physical activity, or have a high fat diet are more likely to develop breast cancer (NCI, 2002b).

Risk factors that may additionally contribute to the recent increase in breast cancer incidence include prolonged exposure to estrogen and exposure to diethylstilbestrol (DES), a synthetic form of estrogen that was used to prevent complications during pregnancy from the 1940s to 1971. Exposure to other hormonally active agents may also be a risk factor for breast cancer. Scientists have hypothesized a relationship between hormonally active agents and breast, testicular, and prostate cancers, birth defects, neurological disorders, and other negative health effects (Krimsky, 2001). The endocrine system guides the "development, growth, reproduction, and behavior of human beings and animals" (U.S. EPA, 2001). Hormonally active agents are a group of man-made chemicals that are suspected of interfering with human endocrine systems in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system (U.S. EPA, 2001).

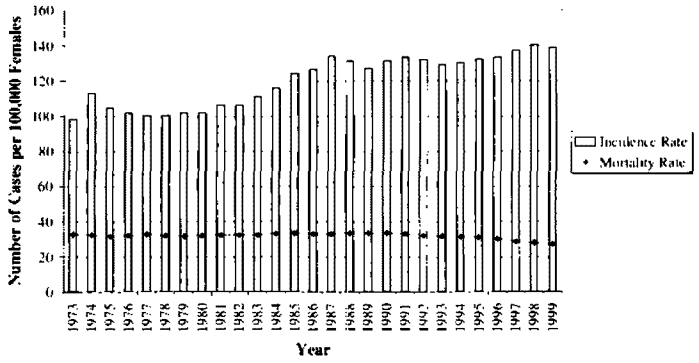
Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health (U.S. EPA, 1997). In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm that potential and characterize the effects (U.S. EPA, 2000). The program's priority is to target 15,000 high-volume chemicals for screening and testing, including pesticides, commercial chemicals and environmental contaminants (U.S. EPA, 1997).

Breast cancer is the second most common type of cancer in American women; skin cancer being the most common. An estimated one in eight women will get breast cancer in her life (NCI, 2002b). Approximately 180,000 women in the U.S. are diagnosed with breast cancer each year and the number is rising (NCI, 2002a). While the reason for the increase is not yet known, it is suspected that some can be accounted for by better, earlier detection and increasing exposure to hormonally active agents in recent years. The following chart shows trends in

breast cancer incidence and mortality in the U.S., as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics.

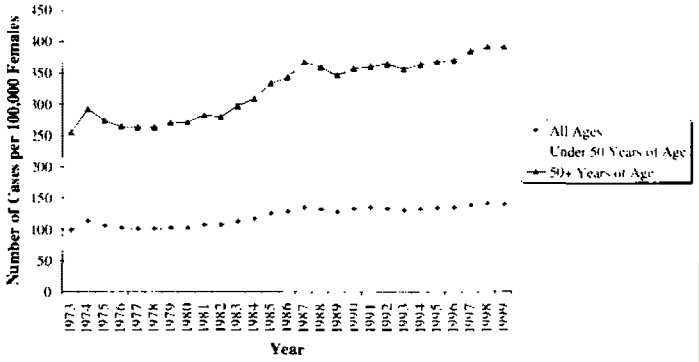
- From 1973 to 1999, female breast cancer incidence rates per 100,000 people increased from 98.5 to 139.1.
- Mortality rates decreased from 32.3 to 27.0.

Female Breast Cancer Incidence and Mortality Rates, 1973-1999



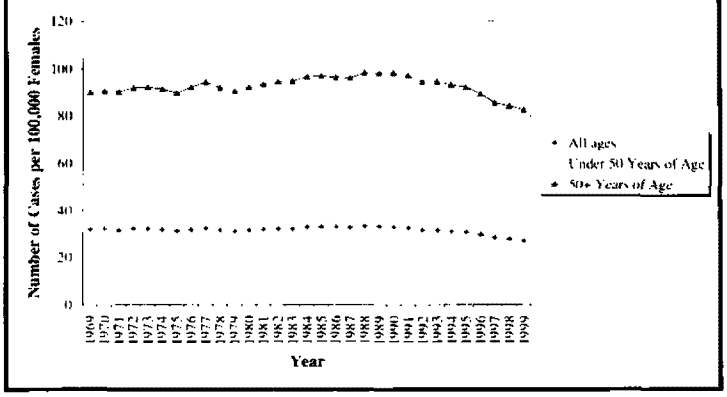
- From 1973 to 1999, female breast cancer incidence rates per 100,000 people increased in the overall population, as well as in each age group. The largest increase and the most cases were seen in women 50 and older.

Female Breast Cancer Incidence Rates by Age, 1973-1999



- From 1969 to 1999 the highest female breast cancer mortality rates per 100,000 people were seen in women 50 and older.

Female Breast Cancer Mortality Rates by Age, 1969-1999



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Source: National Cancer Institute (NCI). Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002. http://seer.cancer.gov/canques/ (30 January 2003).

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Data is collected from 11 population-based cancer registries and three supplemental registries, which cover approximately 26 percent of the U.S. population. The registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, San Jose-Monterey, Alaska, Arizona, and certain rural counties in Georgia. The population used in the SEER study may not be a complete representation of the general U.S. population due to the fact that it tends to be somewhat more urban and has a larger proportion of foreign-born persons thant heg eneralp opulation.

Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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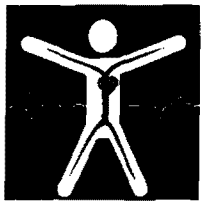
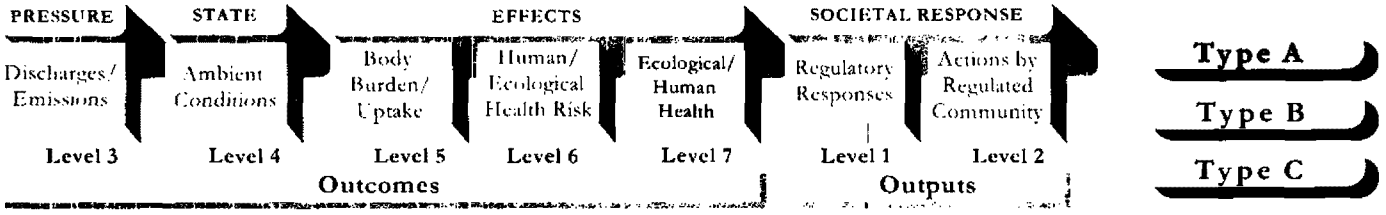


HUMAN HEALTH

PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Ovarian Cancer Incidence and Mortality

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA). Ovarian cancer is part of a group of cancers that have been identified as having a potentially close association with chemical exposure.

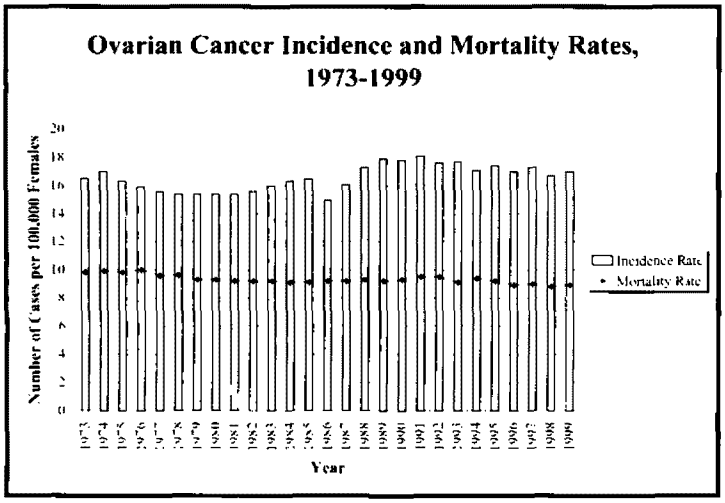
Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a). A malignant tumor that forms in one of the ovaries, a pair of organs in the female reproductive system that produce eggs and hormones, is called ovarian cancer. Symptoms of ovarian cancer include abdominal discomfort and/or pain, nausea, diarrhea, frequent urination, loss of appetite, and abnormal weight changes or vaginal bleeding (NCI, 2002a). However, during the first stages of ovarian cancer, often there are no symptoms. Tests used to detect and diagnose ovarian cancer include pelvic exams, ultrasounds, blood tests, CT (computed tomography) scans, and biopsies. Treatments include surgery, chemotherapy, and radiation therapy. Although the causes of ovarian cancer are not known, women with certain conditions, such as a family or personal history of ovarian, breast, or colon cancers, low physical activity, or are over age 65, have an increased risk of developing the disease. Some studies suggest an increased risk of ovarian cancer in women who have regularly used talc on the genital area. The correlation between talc use and ovarian cancer may be due to the fact that "in the past, talcum powder was sometimes contaminated with asbestos," which is a known carcinogen (American Cancer Society, 2001).

A risk factor that may additionally contribute to the increase in ovarian cancer incidence over the past thirty years is prolonged exposure to estrogen and/or fertility drugs. Exposure to other hormonally active agents may also be a risk factor for ovarian cancer. Scientists have hypothesized a relationship between hormonally active agents and ovarian, breast, and endometrial cancers, birth defects, neurological disorders, and other negative health effects. The endocrine system guides the "development, growth, reproduction, and behavior of human beings and animals" (U.S. Environmental Protection Agency, 2001). Hormonally active agents are a group of man-made chemicals that are suspected of interfering with human endocrine systems in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system (U.S. EPA, 2001).

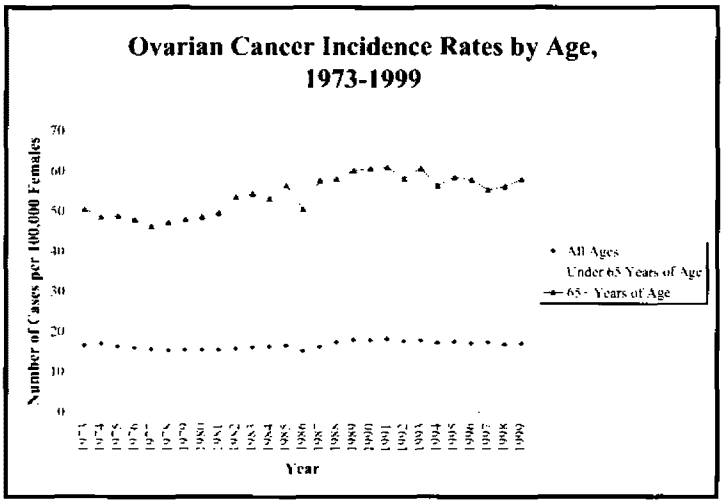
Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health (U.S. EPA, 1997). In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm that potential and characterize the effects (U.S. EPA, 2000). The program's priority is to target 15,000 high-volume chemicals for screening and testing, including pesticides, commercial chemicals and environmental contaminants (U.S. EPA, 1997).

Approximately one in every fifty-seven American women will develop ovarian cancer (NCI, 2002a). The following charts show trends in ovarian cancer incidence and mortality in the U.S., as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics.

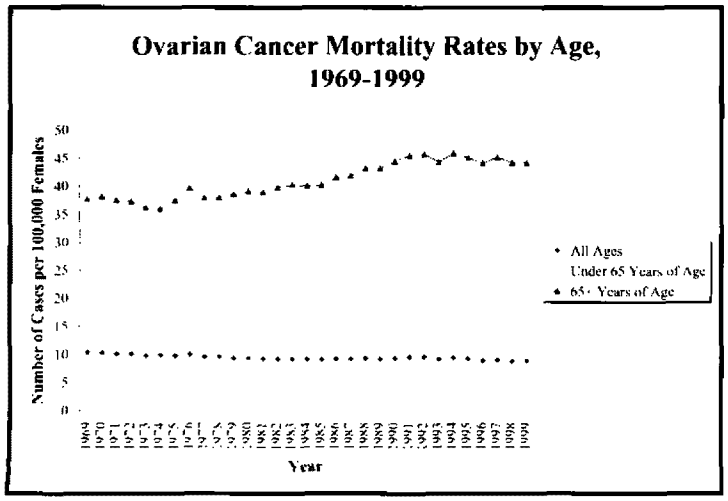
- From 1973 to 1999, ovarian cancer incidence rates per 100,000 people increased from 16.5 to 17.0.
- Mortality rates decreased from 9.8 to 8.9.



- From 1973 to 1999, the highest and largest increase in ovarian cancer incidence rates per 100,000 people were seen in women 65 and older.



- From 1969 to 1999 the highest ovarian cancer mortality rates per 100,000 people were seen in women 65 and older.



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Source: National Cancer Institute (NCI). Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002. 30 January 2003. Available online at: http://seer.cancer.gov/canques/

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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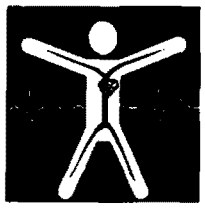
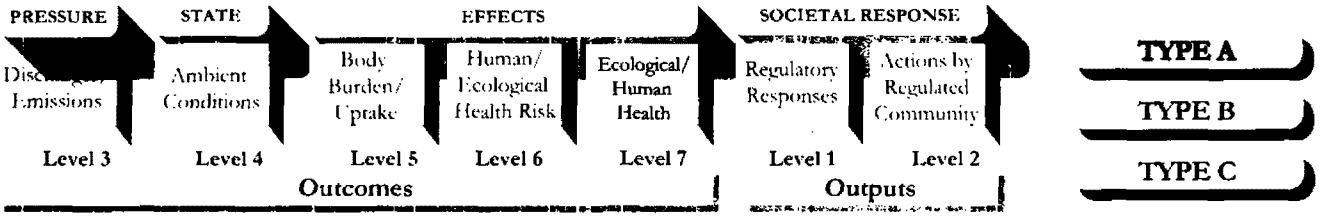
U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics. (1997). *Toxics release inventory relative risk-based environmental indicators methodology.*



HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Prostate Cancer Incidence and Mortality

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA). Prostate cancer is part of a group of cancers that have been identified as having a potentially close association with chemical exposure.

Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a). A malignant tumor that forms in the prostate, a male reproductive gland, is called prostate cancer. Symptoms of prostate cancer include urinating often, difficulty or pain urinating, and recurrent pain in the back, hips, or pelvis. However, during the first stages of prostate cancer, often there are no symptoms. Tests used to detect and diagnose prostate cancer include digital rectal exams, prostate-specific antigen (PSA) blood tests, and biopsies. Treatments include surgery, radiation therapy, and hormonal therapy. Although the causes of prostate cancer are not known, men with certain conditions, such as a family history of prostate cancer, a high fat diet, low physical activity, or are over age 50, have an increased risk of developing the disease.

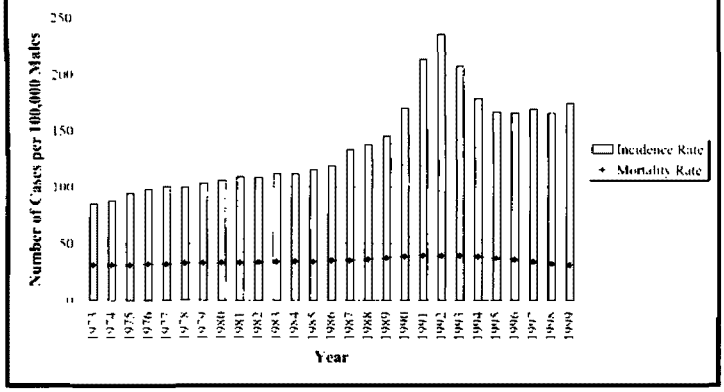
Risk factors that may additionally contribute to the recent increase in prostate cancer incidence include higher levels of certain hormones, such as androgens (male hormones) and estrogen (American Cancer Society, 2001) and exposure to diethylstilbestrol (DES), a synthetic form of estrogen that was used to prevent complications during pregnancy from the 1940s to 1971. Exposure to other hormonally active agents may also be a risk factor for prostate cancer. Scientists have hypothesized a relationship between hormonally active agents and prostate, testicular, and breast cancers, birth defects, neurological disorders, and other negative health effects (Krimsky, 2001). The endocrine system guides the "development, growth, reproduction, and behavior of human beings and animals" (U.S. Environmental Protection Agency, 2001). Hormonally active agents are a group of man-made chemicals that are suspected of interfering with human endocrine systems in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system (U.S. EPA, 2001).

Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health (U.S. EPA, 1997). In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm that potential and characterize the effects (U.S. EPA, 2000). The program's priority is to target 15,000 high-volume chemicals for screening and testing, including pesticides, commercial chemicals and environmental contaminants (U.S. EPA, 1997).

Prostate cancer is the second most common type of cancer in American men; skin cancer being the most common. While the reason for the increase in prostate cancer incidence over the past thirty years is not yet known, it is suspected that some can be accounted for by better, earlier detection and increasing exposure to hormonally active agents in recent years. The following charts show trends in prostate cancer incidence and mortality in the U.S., as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics.

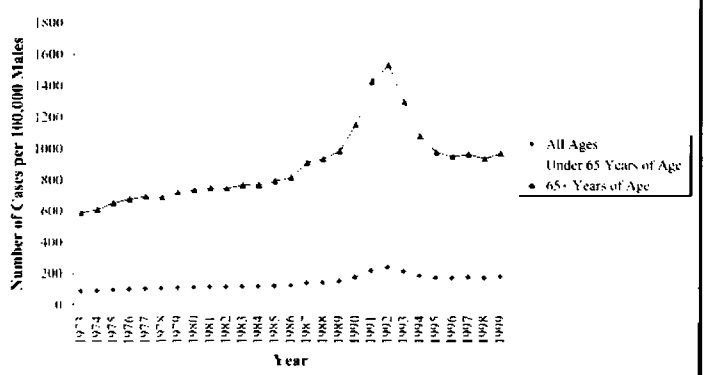
- From 1973 to 1999, prostate cancer incidence rates per 100,000 people increased from 85.3 to 174.8.
- The peak in incidence rates in the early 1990's is likely due to the introduction of the PSA blood test as a method of detecting the disease (National Cancer Institute, 2002b).
- Mortality rates also peaked in the early 1990's at about 39.0 after increasing from 31.1 in 1973.
- Mortality rates decreased to 31.1 in 1999.

Prostate Cancer Incidence and Mortality Rates, 1973-1999



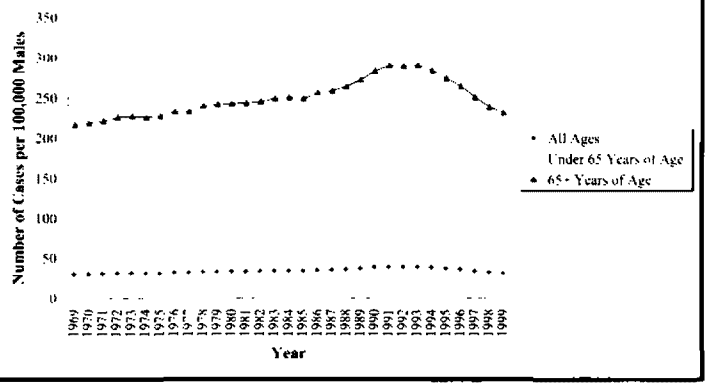
- From 1973 to 1999, prostate cancer incidence rates per 100,000 people increased in the overall population, as well as in each age group. The largest increase and the most cases were seen in men 65 and older.

Prostate Cancer Incidence Rates by Age, 1973-1999



- From 1969 to 1999 the highest prostate cancer mortality rates per 100,000 people were seen in men 65 and older.

Prostate Cancer Mortality Rates by Age, 1969-1999



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Source: National Cancer Institute (NCI). Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002, http://seer.cancer.gov/canques/ (30 January 2003).

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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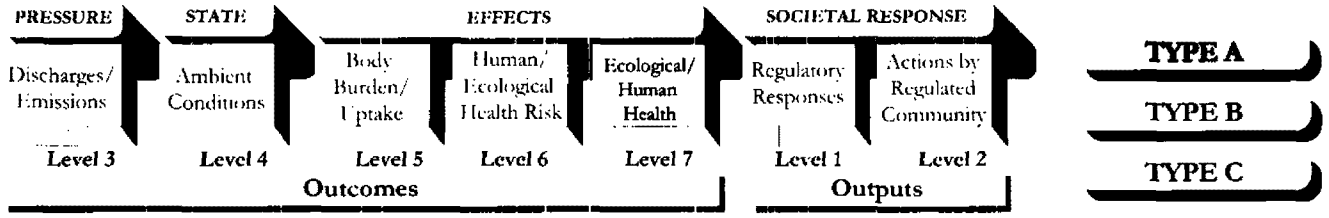


Indicator: Thyroid Cancer Incidence and Mortality

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA). Thyroid cancer is part of a group of cancers that have been identified as having a potentially close association with chemical exposure.

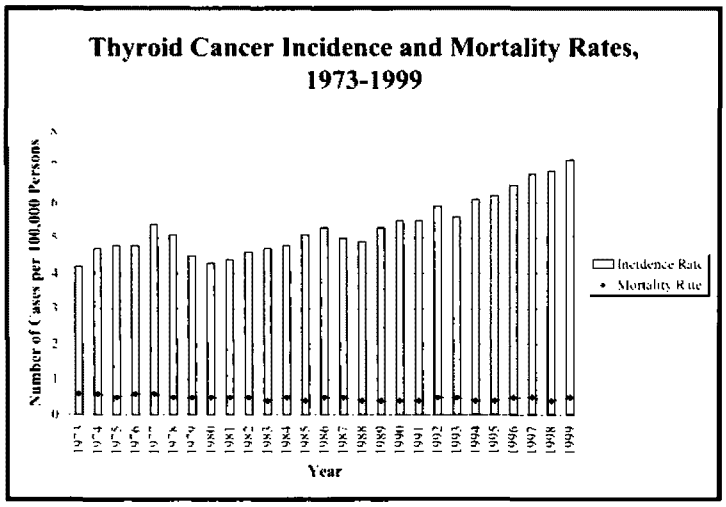
Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors or nodules, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a). A malignant nodule that forms in the thyroid, a gland in the neck that produces hormones as part of the endocrine system, is called thyroid cancer. Symptoms of thyroid cancer include a lump in the front of the neck, difficulty speaking, swallowing, or breathing, and throat or neck pain (NCI, 2002a). However, during the first stages of thyroid cancer, often there are no symptoms. Tests used to detect and diagnose thyroid cancer include blood tests, ultrasounds, and biopsies. Treatments include surgery, radioactive iodine, hormone treatment, external radiation, or chemotherapy (NCI, 2002a). Although the causes of thyroid cancer are not known, people with certain conditions, such as exposure to high radiation levels, a low iodine diet, low physical activity, or are over age 65, have an increased risk of developing the disease.

Exposure to hormonally active agents may also be a risk factor for thyroid cancer. Scientists have hypothesized a relationship between hormonally active agents and certain cancers, birth defects, neurological disorders, and other negative health effects. The endocrine system guides the "development, growth, reproduction, and behavior of human beings and animals" (U.S. Environmental Protection Agency, 2001). Hormonally active agents are a group of man-made chemicals that are suspected of interfering with human endocrine systems in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system (U.S. EPA, 2001).

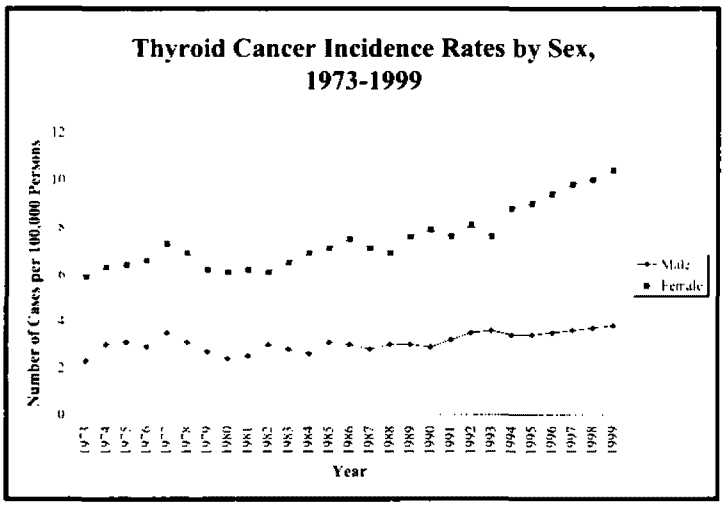
Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health (U.S. EPA, 1997). In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm that potential and characterize the effects (U.S. EPA, 2000). The program's priority is to target 15,000 high-volume chemicals for screening and testing, including pesticides, commercial chemicals and environmental contaminants (U.S. EPA, 1997).

In the U.S., over 11,000 people are diagnosed with thyroid cancer each year. Thyroid cancer is two to three times more common in American women than men (NCI, 2002a). The following charts show trends in thyroid cancer incidence and mortality in the U.S., as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics.

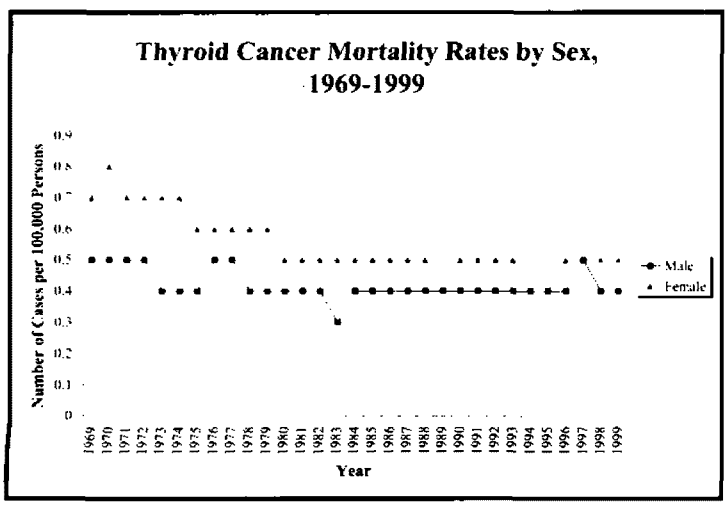
- From 1973 to 1999, thyroid cancer incidence rates per 100,000 people increased from 4.2 to 7.2.
- Mortality rates decreased from 0.6 to 0.5.



- From 1973 to 1999, female thyroid cancer incidence rates per 100,000 people increased from 5.9 to 10.4.
- Male thyroid cancer incidence rates increased from 2.3 to 3.8.



- From 1969 to 1999, female thyroid cancer mortality rates per 100,000 people decreased from 0.7 to 0.5.
- Male thyroid cancer mortality rates decreased from 0.5 to 0.4.



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Source: National Cancer Institute (NCI). Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002, http://seer.cancer.gov/canques/ (30 January 2003).

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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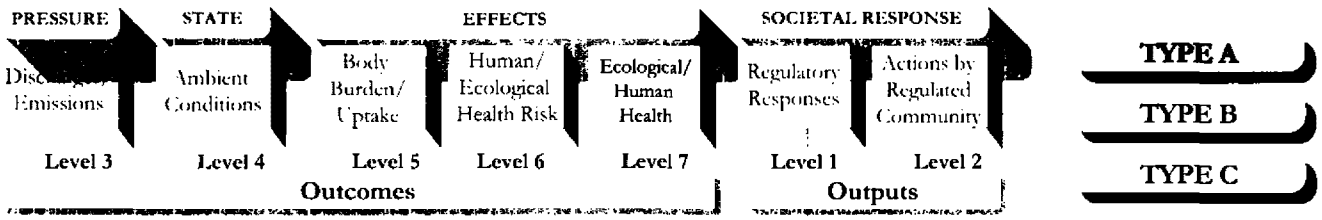


Indicator: Testicular Cancer Incidence and Mortality

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA). Testicular cancer is part of a group of cancers that have been identified as having a potentially close association with chemical exposure.

Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a). A malignant tumor that forms in one of the testicles, a pair of male sex glands that produce sperm and hormones, is called testicular cancer. Symptoms of testicular cancer include pain, swelling, or a lump in either testicle and mild aching in the lower abdomen or groin (NCI, 2002a). Tests used to detect and diagnose testicular cancer include blood tests, ultrasounds, and biopsies. Treatments include surgery, radiation therapy, and chemotherapy. They are highly effective at curing testicular cancer, which may explain the recent decrease in mortality rates. Although the causes of testicular cancer are not known, men with certain conditions, such as a family or personal history of testicular cancer, undescended or abnormally developed testicle(s), low physical activity, or are between the ages of 15 and 40, have an increased risk of developing the disease (NCI, 2001a). However, it is likely that some disorder other than the undescended testicle(s) themselves is responsible for increasing the testicular cancer risk and causing the testicle(s) not to descend (American Cancer Society, 2001).

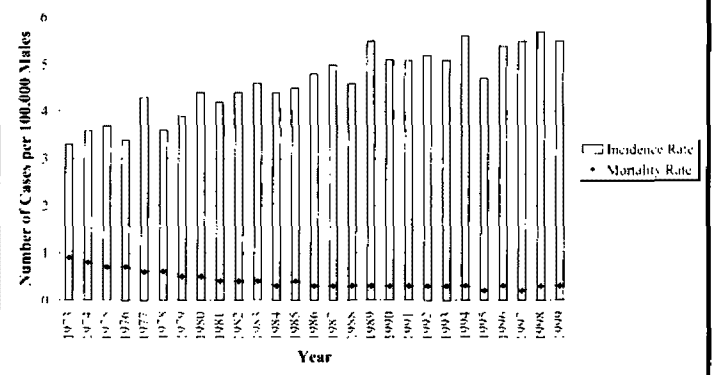
A risk factor that may additionally contribute to the recent increase in testicular cancer incidence is exposure to diethylstilbestrol (DES), a synthetic form of estrogen that was used to prevent complications during pregnancy from the 1940s to 1971. Exposure to other hormonally active agents may also be a risk factor for testicular cancer. Scientists have hypothesized a relationship between hormonally active agents and testicular, prostate, and breast cancers, birth defects, neurological disorders, and other negative health effects (Krimsky, 2001). The endocrine system guides the "development, growth, reproduction, and behavior of human beings and animals" (U.S. Environmental Protection Agency, 2001). Hormonally active agents are a group of man-made chemicals that are suspected of interfering with human endocrine systems in a number of ways, including mimicking natural hormones, blocking the effects of hormones, and stimulating or inhibiting the endocrine system (U.S. EPA, 2001).

Further studies are needed to determine a causal relationship between human exposure to certain chemicals and endocrine disruption resulting in an adverse effect on human health (U.S. EPA, 1997). In an effort to better understand the effect of certain chemicals on the endocrine system, the EPA has developed a screening program known as, the Endocrine Disruptor Screening Program (EDSP). This program is designed to identify and evaluate the hazard potential of endocrine disrupting chemicals through a two-tiered approach. Tier 1 screening will identify substances which have the potential to interact with the endocrine system, and Tier 2 testing will confirm that potential and characterize the effects (U.S. EPA, 2000). The program's priority is to target 15,000 high-volume chemicals for screening and testing, including pesticides, commercial chemicals and environmental contaminants (U.S. EPA, 1997).

Testicular cancer is the most common type of cancer in males between the ages of 15 and 35 (NCI, 2002a). While the reason for the increase in testicular cancer incidence over the past thirty years is not yet known, it is suspected that some can be accounted for by increasing exposure to hormonally active agents in recent years. The following charts show trends in testicular cancer incidence and mortality in the U.S., as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics.

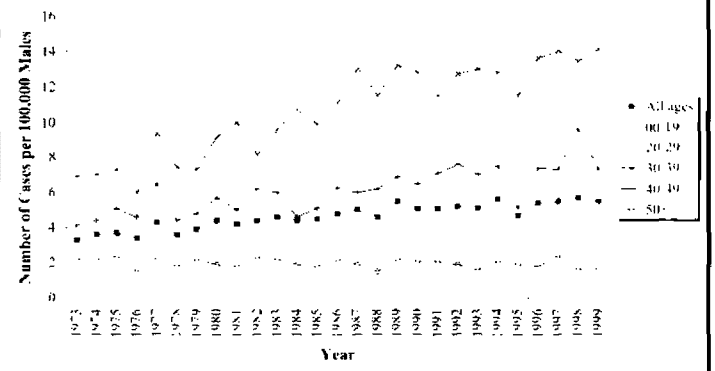
- From 1973 to 1999, testicular cancer incidence rates per 100,000 people increased from 3.3 to 5.5.
- Mortality rates decreased from 0.9 to 0.3.

Testicular Cancer Incidence and Mortality Rates, 1973-1999



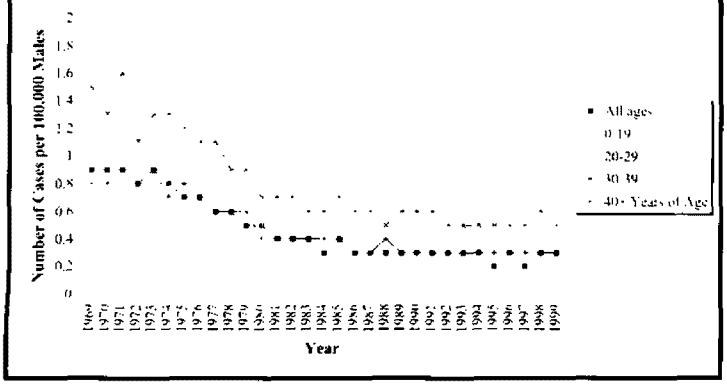
- From 1973 to 1999, testicular cancer incidence rates per 100,000 people increased in the overall population, as well as in each age group, except for men 55 and older.
- The largest increase occurred in men aged 15-44.
- The highest incidence rates were for men aged 15-44.

Testicular Cancer Incidence Rates by Age Group, 1973-1999



- From 1969 to 1999 the highest testicular cancer mortality rates per 100,000 people were seen in men aged 30-39 and 20-29.

Testicular Cancer Mortality Rates by Age Group, 1969-1999



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Source: National Cancer Institute (NCI). Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002, http://seer.cancer.gov/canques/ (30 January 2003).

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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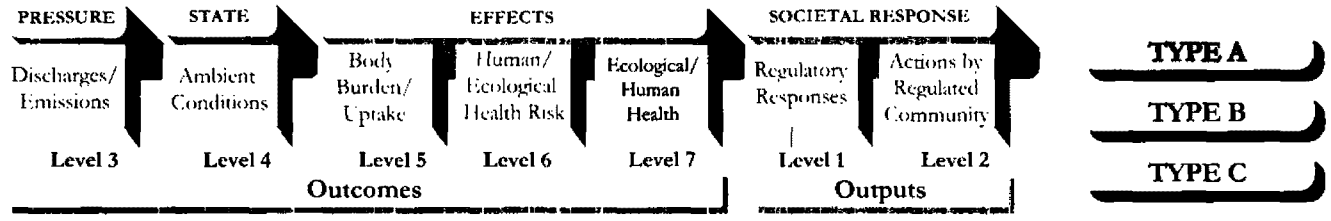


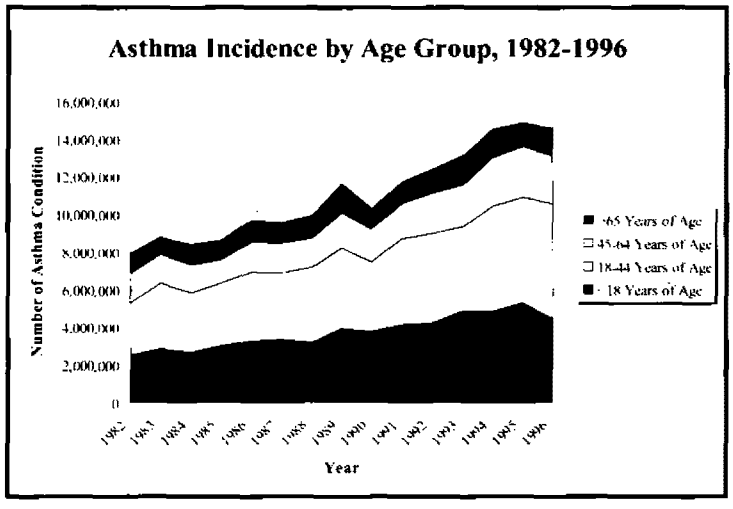
Indicator: Incidence of Asthma

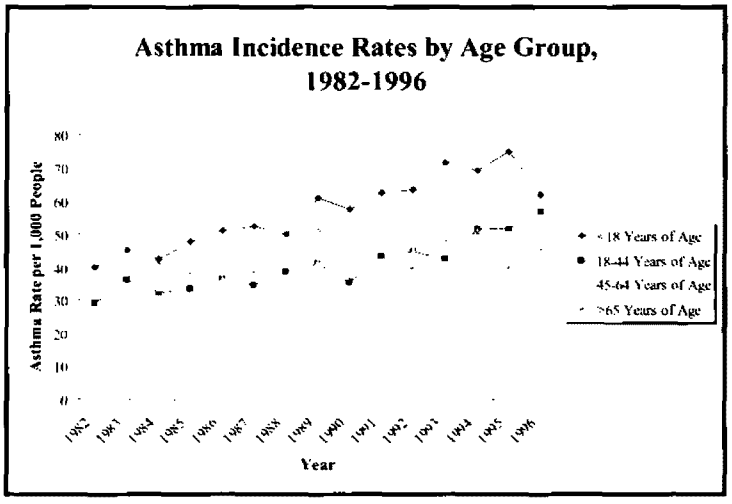
Asthma is a chronic lung disease characterized by airway inflammation and obstruction in which symptoms include wheezing, coughing, and shortness of breath (Mannino, Homa, Pertowski, Ashizawa, Nixon, Johnson, Ball, Jack, & Kang, 1998). Asthma may be caused or triggered by "familial, infectious, allergenic, socioeconomic, psychosocial, and environmental factors" (Mannino et al., 1998, p. 1). Although there is no cure for asthma, it can be treated with anti-inflammatory agents (inhaled steroids) and bronchodilators. Another way to control asthma is to avoid environmental triggers such as allergens, viruses, tobacco smoke, particulate matter, certain chemicals, and other indoor and outdoor air pollutants (Centers for Disease Control and Prevention, 2002). With good management, people with asthma may gain control over the disease. An estimated 25% of children with asthma show no symptoms when they become adults (American Lung Association, 2002). However, damage to the lungs due to asthma may become irreversible if the condition persists for a long period of time and is insufficiently treated (Mannino et al., 1998).

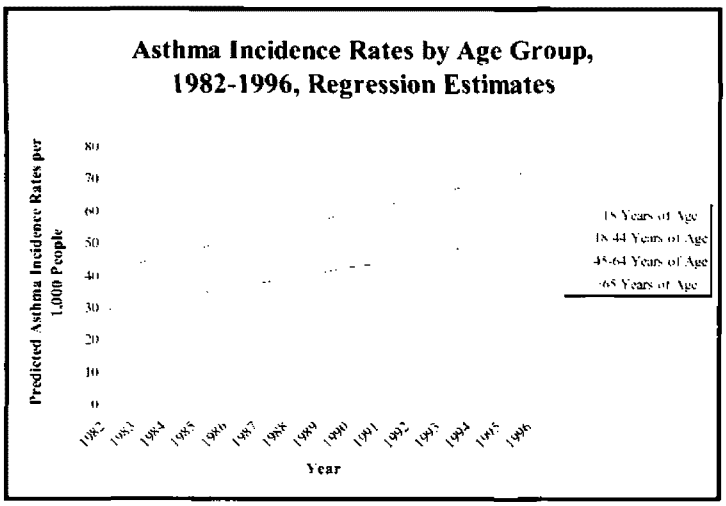
Asthma affects nearly 15 million Americans, more than 5 percent of the U.S. population. The scope of the health care problem caused by asthma lies not only in the large number of Americans with the disease, but also in the limitations that asthma imposes on daily activities, such as school, work, sports, and recreation. Asthma is the leading cause of school absenteeism for children and a common cause of work absenteeism for adults.

The following charts show trends in asthma incidence in the U.S., as measured in the National Health Interview Survey between 1982 and 1999. Due to the use of a new design in the Survey in 1997, asthma incidence rates prior to 1997 cannot be compared with later rates.

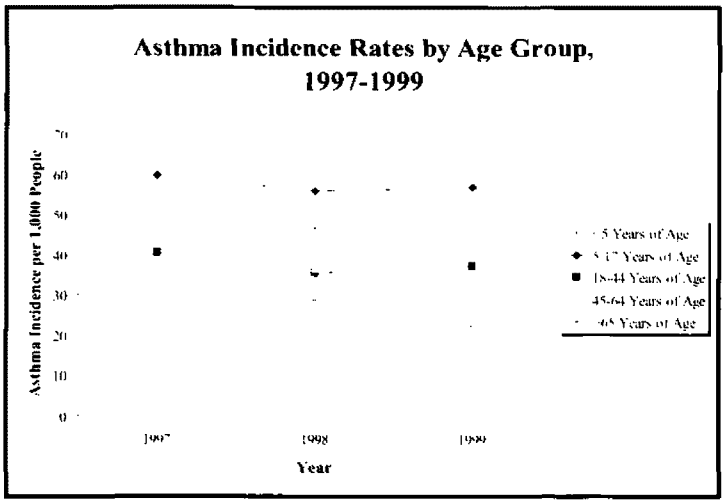
- From 1982 to 1996, asthma incidence rates per 1,000 people increased in the overall population, as well as in each age group.
- From 1983 to 1996, children under 18 consistently had the highest asthma incidence rates.
- From 1982 to 1996, asthma incidence rates for children under 18 have increased at a faster rate than for all other age groups.

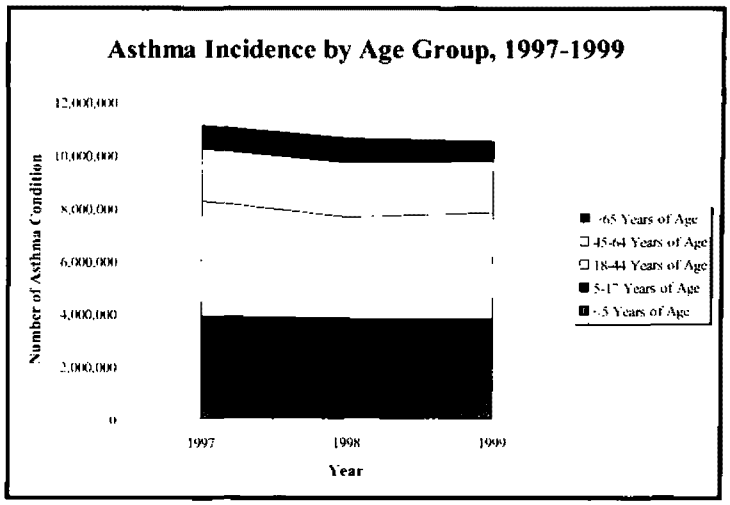






- From 1997 to 1999, there was a small decline in asthma incidence rates in the overall population. However, more data points are needed to establish an overall trend.
- Children aged 5-17 consistently had the highest asthma incidence rates per 1,000 people.
- Children under 5 had the second highest asthma incidence rates.
- People over 65 had the lowest asthma incidence rates.





Note: An asthma condition was defined as answering yes to "Have you EVER been told by a doctor or other health professional that you had asthma?" and "During the past 12 MONTHS, have you had an episode of asthma or asthma attack?"

Source: National Center for Health Statistics, National Health Interview Survey, 1982-1996, 1997-1999 as reported in the Trends in Asthma Morbidity and Mortality, February 2002 by the American Lung Association.

Scale: Asthma incidence data is at the national level and is not available at the state or local level.

Data Characteristics and Limitations: These estimates are based on a sample. Therefore, they may differ from the figures that would be obtained from a census of the population. Each data point is an estimate of the true population value and is therefore subject to sampling variability. Estimates of sampling variability were not available. Due to the use of a new design in the National Health Interview Survey in 1997, asthma incidence rates prior to 1997 cannot be compared with later rates.

References :

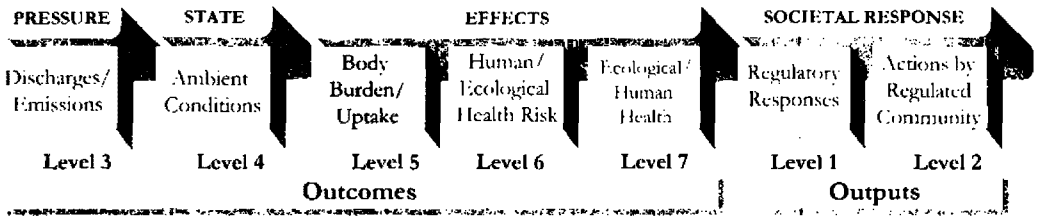
American Lung Association. (2002). Asthma. 17 December 2002. Available online at: http://www.lungusa.org/asthma/

Centers for Disease Control and Prevention. (2002). Asthma. 17 December 2002. Available online at: http://www.cdc.gov/nceh/airpollution/asthma/

Mannino, D.M., Homa, D.M., Pertowski, C.A., Ashizawa, A., Nixon, L.L., Johnson, C.A., Ball, L.B., Jack, E., & Kang, D.S. Centers for Disease Control and Prevention. (April 24, 1998). Surveillance for asthma - United States, 1960-1995. *Morbidity and Mortality Weekly, 47(SS-1)*, 1-28. 17 December 2002. Available online at: http: www.cdc.gov/epo/mmwr/preview mmwrhtml/00052262.htm.

National Center for Health Statistics, National Health Interview Survey, 1982-1996, 1997-1999 as reported in the Trends in Asthma Morbidity and Mortality, February 2002 by the American Lung Association. 17 December 2002. Available online at: http://www.lungusa.org/data/asthma/ASTHMAdt.pdf

HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



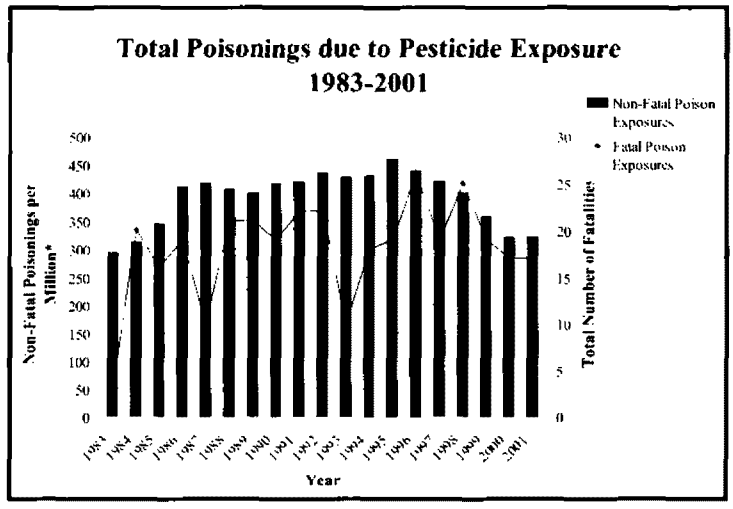
Indicator: Number of Fatal and Non-Fatal Poisonings Due to Pesticide Exposure

The American Association of Poison Control Centers (AAPCC) administers the Toxic Exposure Surveillance System (TESS), the only comprehensive poisoning surveillance database in the United States. TESS is a cumulative database, with data dating back to its inception in 1983, of poison exposure cases. These cases are poison exposures reported by telephone to one of the AAPCC's regional poison control centers.

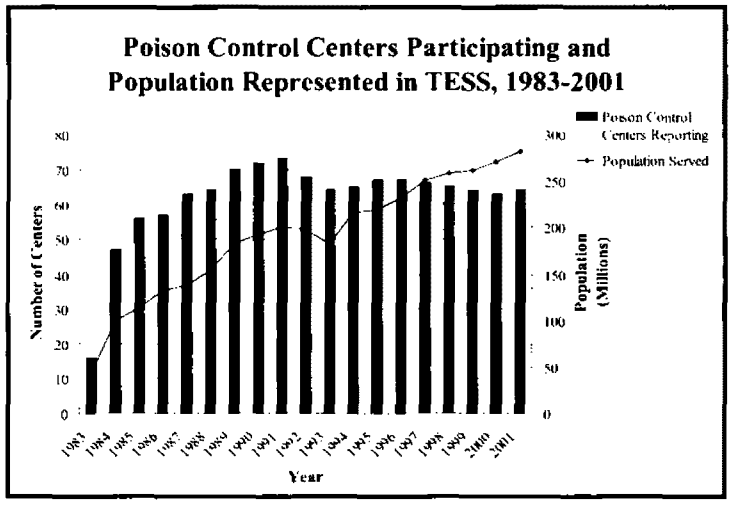
For each reported exposure, the gender, age and location of each caller is recorded. The locational site of exposure, substance(s) involved, reason for and route of exposure are also recorded for each case. To complete the profile of the poison exposure case, the medical outcome and intervention (type of decontamination and/or therapy) are also documented.

Each year, the AAPCC reports that pesticides are one of the substances most frequently involved in poison exposures and in fatal poison exposures. The chart displays poisonings due to pesticide exposure per million people and total fatalities for the years 1983-2001.

- The number of non-fatal poisonings gradually rose to a peak of 460 per million people annually in 1995. Since that time, the trend has continued to decrease with each subsequent year.
- The total number of fatalities due to pesticide exposure fluctuates annually, but has remained below 30 deaths per year.



*Per million people in the population serviced by participating poison control centers



Source: Annual Report of the AAPCC TESS published in the American Journal of Emergency Medicine, 1984-2002.

Scale: Data are available on the national level. States are not comparable due to variations in Poison Control Center participation.

Data Characteristics and Limitations: The cumulative AAPCC database contains 22.6 million human poison exposure cases for the reporting years 1983-2001. Each year, the AAPCC publishes an annual report of select releases of TESS data in the September issue of the American Journal of Emergency Medicine. Since 1983, TESS has grown dramatically, with increases in the number of participating poison centers and population served by those centers (refer to chart below).

Annual changes in the number of human poison exposure cases may reflect changes in participation and reporting of cases may not be accurate due to self-reporting. Pesticides may not be the cause of all poisonings because the sources of exposures were not verified.

To control for the increase in annual reporting, the reported indicator is the number of non-fatal poisoning cases due to pesticide exposure per million people in the serviced population.

The following TESS categories of products are reflected in the number of pesticide exposures in the indicator data series: fungicides, herbicides, insecticides/pesticides, moth repellents, and rodenticides.

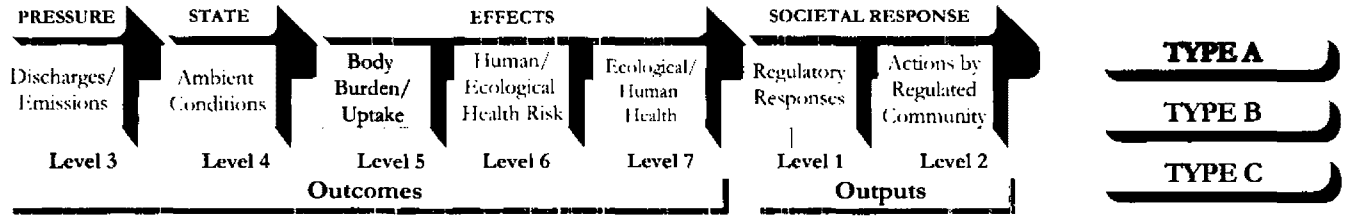
A noteworthy limitation of the TESS data is that diagnoses are not established, except in cases of known ingestion. The health effects associated with the poison exposure are reported and not proven through thorough investigation (Wagner).

References

Annual Report of the AAPCC TESS published in the American Journal of Emergency Medicine, 1984-2002.

Telephone conversation with Dr. Sheldon Wagner, Clinical Toxicologist, Department of Environmental and Molecular Toxicology, Oregon State University

HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



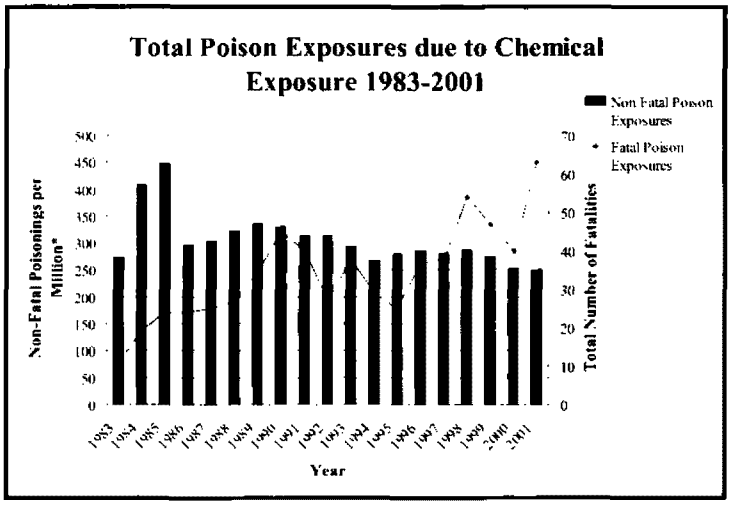
Indicator: Number of Fatal and Non-Fatal Poisonings Due to Chemical Exposure

The American Association of Poison Control Centers (AAPCC) administers the Toxic Exposure Surveillance System (TESS), the only comprehensive poisoning surveillance database in the United States. TESS is a cumulative database, with data dating back to its inception in 1983, of poison exposure cases. These cases are poison exposures reported by telephone to one of the AAPCC's regional poison control centers.

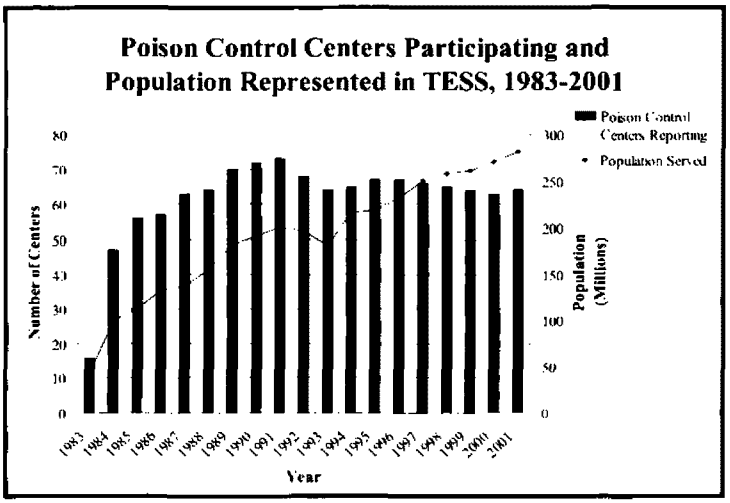
For each reported exposure, the gender, age and location of each caller is recorded. The locational site of exposure, substance(s) involved, reason for and route of exposure are also recorded for each case. To complete the profile of the poison exposure case, the medical outcome and intervention (type of decontamination and/or therapy) are also documented.

Each year, the AAPCC reports that chemicals are one of the substances most frequently involved in poison exposures and in fatal poison exposures. The chart displays poisonings due to chemical exposure per million people and total fatalities for the years 1983-2001.

- Over the past two years, the trend of non-fatal poisions due to chemical exposure has decreased slightly. However, for the most part, the number of non-fatal poisonings due to chemical exposure has remained stable, ranging between 250-330 poisonings per million people annually.
- The total number of fatalities due to chemical exposure fluctuates annually, but has usually remained below 50 deaths per year.



*Per million people in the population serviced by participating poison control centers



Source: Annual Report of the AAPCC TESS published in the American Journal of Emergency Medicine, 1984-2002.

Scale: Data are available on a national level. States are not comparable due to variations in Poison Control Center participation.

Data Characteristics and Limitations: The cumulative AAPCC database contains 27 million human poison exposure cases for the reporting years 1983-2001. Each year, the AAPCC publishes an annual report of select releases of TESS data in the September issue of the American Journal of Emergency Medicine. Since 1983, TESS has grown dramatically, with increases in the number of participating poison centers and population served by those centers (refer to chart below).

Annual changes in the number of human poison exposure cases may reflect changes in participation and reporting of cases may not be accurate due to self-reporting. Chemicals may not be the cause of all poisonings because the sources of exposures were not verified.

To control for the increase in annual reporting, the reported indicator is the number of non-fatal poisoning cases due to chemical exposure per million people in the serviced population.

The following TESS categories of products are reflected in the number of chemical exposures in the indicator data series: chemicals and heavy metals.

A noteworthy limitation of the TESS data is that diagnoses are not established, except in cases of known ingestion. The health effects associated with the poison exposure are reported and not proven through thorough investigation (Wagner).

References

Annual Report of the AAPCC TESS published in the American Journal of Emergency Medicine, 1984-2002.

Telephone conversation with Dr. Sheldon Wagner, Clinical Toxicologist, Department of Environmental and Molecular Toxicology, Oregon State University

HUMAN HEALTH
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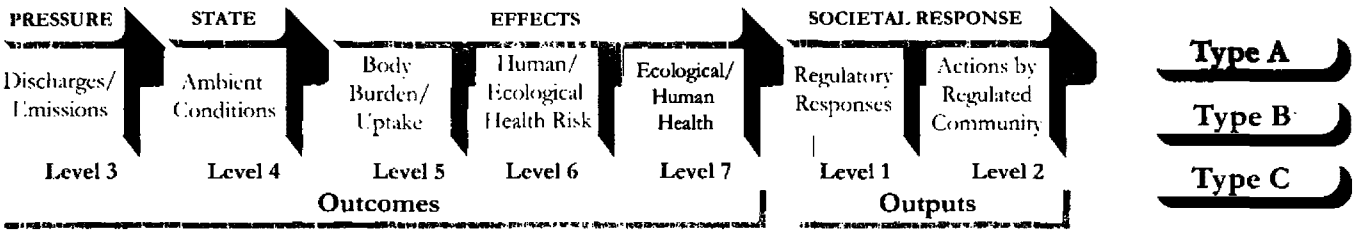


Indicator: Occupational Incidence of Respiratory Conditions due to Toxic Agents

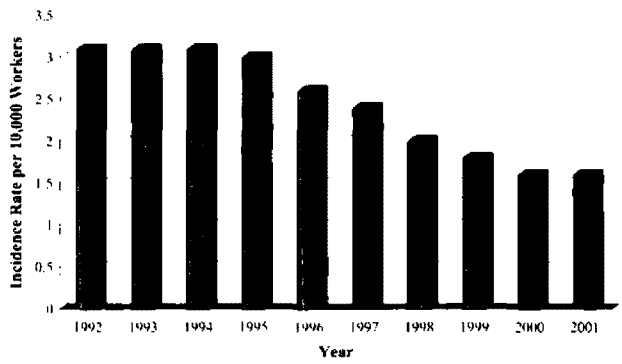
Occupational safety is a particular concern to employees such as agricultural and manufacturing workers who work with toxic chemicals on a regular basis. Since these types of workers come into contact with toxic agents often, they face a greater risk of injury and illness. One of the main pathways to exposure is inhalation. A number of respiratory conditions can develop as a result of toxic agents. Some of the respiratory conditions that may develop include allergic and irritant asthma, chronic bronchitis, and reactive airways dysfunction (an asthma-like syndrome). Other examples include: pneumonitis, pharyngitis, rhinitis or acute congestion due to chemicals, dusts, gases, or fumes.

Due to the adverse health impacts it is important to monitor the occupational incidence of respiratory conditions due to toxic agents. Data used to develop this indicator was taken from annual survey data collected by the U.S. Bureau of Labor Statistics (BLS) for their annual Survey of Occupational Injuries and Illnesses (SOII). It tracks the nonfatal occupational incidence of respiratory conditions due to toxic agents between 1992 to 2001.

The following chart shows a decreasing trend in the nonfatal occupational incidence of respiratory conditions due to toxic agents since 1992. Not seen in the chart are the following:

- Between 1992 and 2001, the occupational incidence of repiratory conditions due to toxic agents has decreased 48%.
- In 1997, 37% of the cases of respiratory conditions due to toxic agents were attributed to the manufacturing industry.

Occupational Incidence of Respiratory Conditions Due to Toxic Agents, 1992-2001



Notes: The incidence rate represents the number of illnesses per 10,000 full-time workers and was calculated as the number of illnesses divided by the total hours worked by all employees during the calendar year. The product of these two numbers is then multiplied by 20,000,000.

Source: Survey of Occupational Injuries and Illnesses (SOII), U.S. Bureau of Labor Statistics' Injuries, Illnesses and Fatalities (IIF) program. http://www.bls.gov/iif/ (December 16, 2002).

Scale: Data is available nationally, as well as for selected participating states

Data Characteristics and Limitations: The annual Survey of Occupational Injuries and Illnesses (SOII) is a surveillance system in which employer reports are collected by the BLS from private industry establishments. A two-part survey is conducted and provides estimates for the United States and separately for participating states. Part 1, which has been collected since 1972, provides estimates of the number and incidence of injuries and illnesses by Standard Industrial Classification (SIC) and does not provide data regarding the type or nature of injury or illness. Part 2, which was added to the survey in 1992, provides estimates of demographic characteristics of workers with injuries and illnesses involving time away from work. Part 2 also provides data on the type, nature, and circumstances of the injuries and illnesses. The data presented here is from Part 2 of the Survey.

Illnesses reported to SOII are those most easily and directly related to workplace activity. Diseases that develop over a long period or that have workplace associations that are not immediately obvious are overwhelmingly under recorded in SOII. Since data is only reported for the private industry, a large

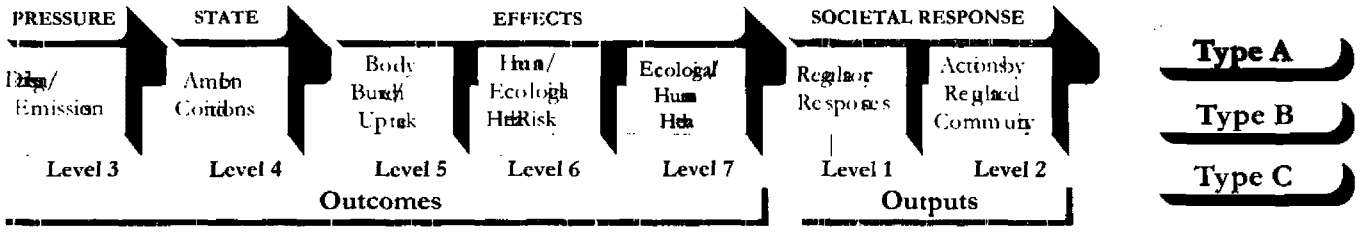
segment of the U.S. workforce - public workers are not described adequately. Also not described are the self-employed and farms with fewer than 11 employees.

References

U.S. Bureau of Labor Statistics. 2002. *Injuries, illnesses and fatalities (IIF) program.* December 16, 2002. Available online at: http://www.bls.gov/iif/.

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health. 2000. *Worker Health Chartbook, 2000.* December 16, 2002. Available online at: http: www2.cdc.gov chartbook CDplem Chartbk0.htm.

HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



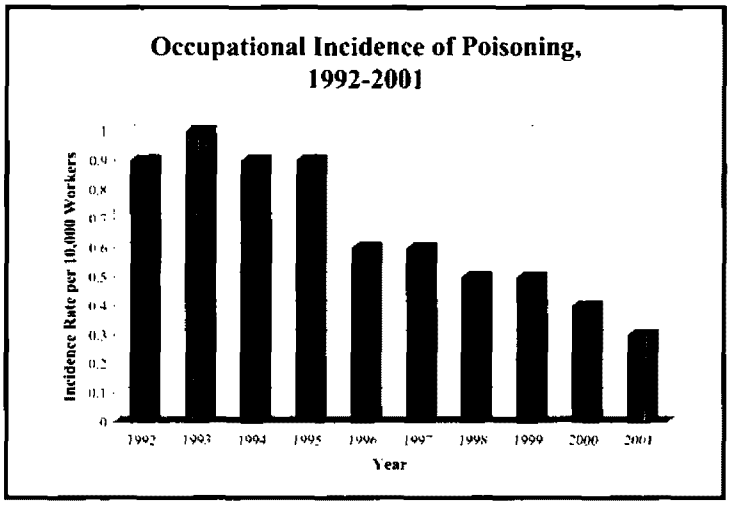
Indicator: Occupational Incidence of Poisoning

Chemical and pesticide safety in the workplace is a critical issue of concern for agricultural and industrial workers due to their increased exposure to toxic chemicals and pesticides. Since these types of workers come into contact with chemical and pesticides often, they face a greater risk of developing illnesses caused by poisoning. Poisoning cases as defined by the Survey of Occupational Injuries and Illnesses (SOII) include exposures to heavy metals, toxic gases, organic solvents, pesticides, and other substances (such as formaldehyde). These poisonous substances can be released into the air and be absorbed by workers through their skin, by breathing them in and by ingestion. Specific health effects will vary based on the type and amount of poison come into contact with.

Due to the potential acute and chronic health risks associated with poisons found in the workplace, it is important to monitor the number of occupational illnesses attributed to these substances. Data used to develop this indicator was taken from the U.S. Bureau of Labor Statistics' (BLS) annual Survey of Occupational Injuries and Illnesses (SOII). It tracks the number of nonfatal occupational illnesses due to poisoning between 1992 to 2001.

The following chart shows a decreasing trend for the incidence of occupational poisoning between 1992 and 2001.

- Overall the trend for the number of nonfatal occupational incidence of poisoning has shown a decreasing trend, ranging from 0.9 in 1992 to 0.3 in 2001.
- In 1997, 55% of the cases of respiratory conditions due to toxic agents were attributed to the manufacturing industry.



Notes: The incidence rate represents the number of illnesses per 10,000 full-time workers and was calculated as the number of illnesses divided by the total hours worked by all employees during the calendar year. The product of these two numbers is then multiplied by 20,000,000.

Source: Survey of Occupational Injuries and Illnesses (SOII), U.S. Bureau of Labor Statistics' Injuries, Illnesses and Fatalities (IIF) program, http://www.bls.gov/iif (December 16, 2002).

Scale: Data is available nationally, as well as for selected participating states

Data Characteristics and Limitations: The annual Survey of Occupational Injuries and Illnesses (SOII) is a surveillance system in which employer reports are collected by the BLS from private industry establishments. A two-part survey is conducted and provides estimates for the United States and separately for participating states. Part 1, which has been collected since 1972, provides estimates of the number and incidence of injuries and illnesses by Standard Industrial Classification (SIC) and does not provide data regarding the type or nature of injury or illness. Part 2, which was added to the survey in 1992, provides estimates of demographic characteristics of workers with injuries and illnesses involving time away from work. Part 2 also provides data on the type, nature, and circumstances of the injuries and illnesses. The data presented here is from Part 2 of the Survey.

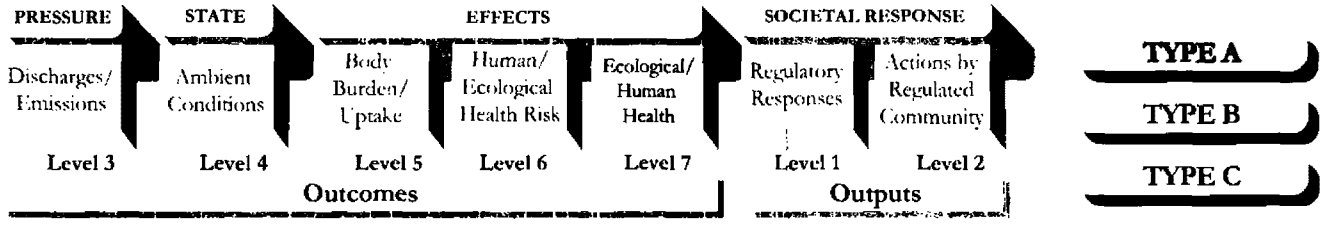
Illnesses reported to SOII are those most easily and directly related to workplace activity. Diseases that develop over a long period or that have workplace associations that are not immediately obvious are overwhelmingly under recorded in SOII. Since data is only reported for the private industry, a large segment of the U.S. workforce – public workers are not described adequately. Also not described are the self-employed and farms with fewer than 11 employees.

References

U.S. Bureau of Labor Statistics. 2002. *Injuries, illnesses and fatalities (IIF) program.* December 16, 2002. Available online at: http://www.bls.gov/iif/.

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health. 2000. *Worker Health Chartbook, 2000.* December 16, 2002. Available online at: http://www2.cdc.gov/chartbook/CDplem/Chartbk0.htm.

HUMAN HEALTH
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Number of Occupational Chemical and Pesticide-Related Injuries and Illnesses

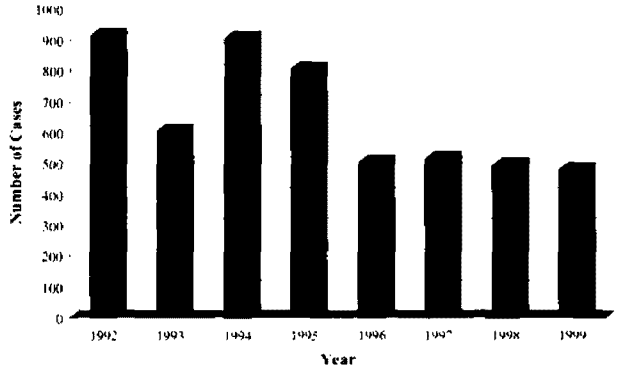
Occupational safety is a particular concern to employees such as agricultural and manufacturing workers who work with chemicals and pesticides on a regular basis. Since these types of workers come into contact with chemical and pesticides often, they face a greater risk of injury and illness. Toxic chemicals and pesticides can be released into the air and absorbed by workers through their skin, inhalation, and ingestion. Specific health effects will vary based on the amount and type of chemical and pesticide the worker has come in contact with.

One national database used to monitor occupational safety is the Survey of Occupational Injuries and Illnesses (SOII), maintained by the Bureau of Labor Statistics. SOII collects information about chemical and pesticide poisonings associated with lost workdays in private industry. Lost workday cases are defined as those which involve days away from work, or days of restricted work activity, or both. In the case of this indicator the source of injury or illness can be attributed to chemicals and pesticides.

The following charts show the number of occupational chemical and pesticide-related injuries and illnesses between 1992 and 1999.

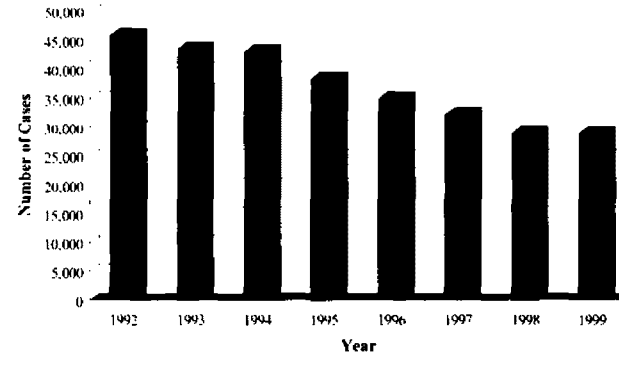
- Between 1992 and 1999, the annual number of illnesses and injuries related to pesticides ranged from 914 in 1992 to 480 in 1999. Most of these illnesses were associated with exposure to insecticides.
- Since 1992, the number of chemical-related illnesses and injuries has decreased by 37%.

Number of Occupational Pesticide-Related Injuries and Illnesses, 1992-1999



Notes: A pesticide-related illnesses includes the following pesticide categories: insecticides, herbicides and defoliants, fumigants, fungicides, and rodenticides.

Number of Occupational Chemical-Related Illnesses and Injuries, 1992-1999



Notes: Chemicals reported here includes all chemicals and chemical products.

Source: SOII [2001], Bureau of Labor Statistics

Scale: Data is available nationally, as well as for selected participating states

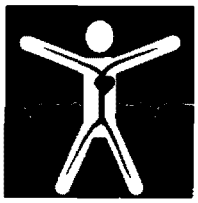
Data Characteristics and Limitations: The annual Survey of Occupational Injuries and Illnesses (SOII) is a surveillance system in which employer reports are collected by the BLS from private industry establishments. A two-part survey is conducted and provides estimates for the United States and separately for participating states. Part 1, which has been collected since 1972, provides estimates of the number and incidence of injuries and illnesses by Standard Industrial Classification (SIC). Part 2, which has been added to the survey in 1992, provides estimates of demographic characteristics of workers with injuries and illnesses involving time away from work. Part 2 also provides data on the circumstances of the injuries and illnesses with time away from work.

Illnesses reported to SOII are those most easily and directly related to workplace activity. Diseases that develop over a long period or that have workplace associations that are not immediately obvious are overwhelmingly under recorded in SOII. Since data is only reported for the private industry, a large segment of the U.S. workforce public workers are not described adequately. Also not described are the self-employed and farms with fewer than 11 employees.

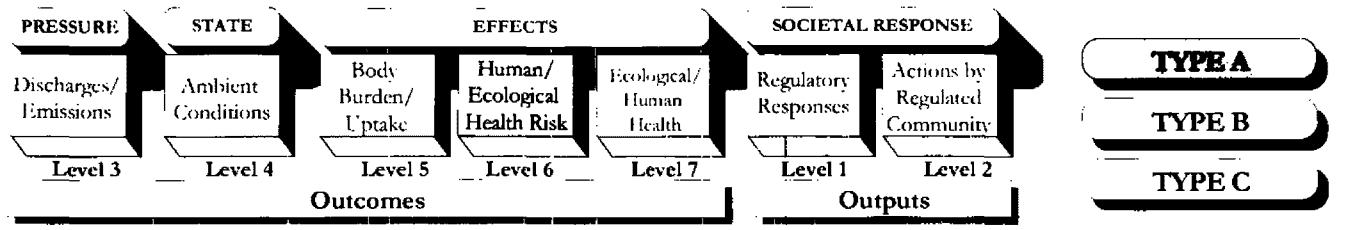
References:

U.S. Bureau of Labor Statistics. 2001. *Safety and Health Statistics: Industry Injury and Illness Data 1999.* 17 December 2002. Available online at: http://stats.bls.gov/oshsum99.htm

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health. 2000. *Worker Health Chartbook, 2000.* 17 December 2002. Available online at: http://www2.cdc.gov/chartbook/CDplem/Chartbk0.htm



HUMAN HEALTH
HEALTH RISK



Indicator: Chronic Human Health Risk Index for Toxic Releases

The ideal measurement of the human health impacts of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating data that, for each chemical: reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the chronic human health risk posed by a toxic chemical release or waste stream can be estimated.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unitless measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the chronic health risk measures were adjusted to create a chronic health risk index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the chronic health risk estimate for the baseline year was adjusted to equal a value of 100; subsequent estimates less than or greater than 100 indicate a decrease or increase in the chronic health risk posed by toxic chemical releases and wastes, respectively. In a broad sense, this indicator reflects whether human populations in the U.S. are at a higher or lower risk of adverse health effects from environmental toxics than they were in previous years.

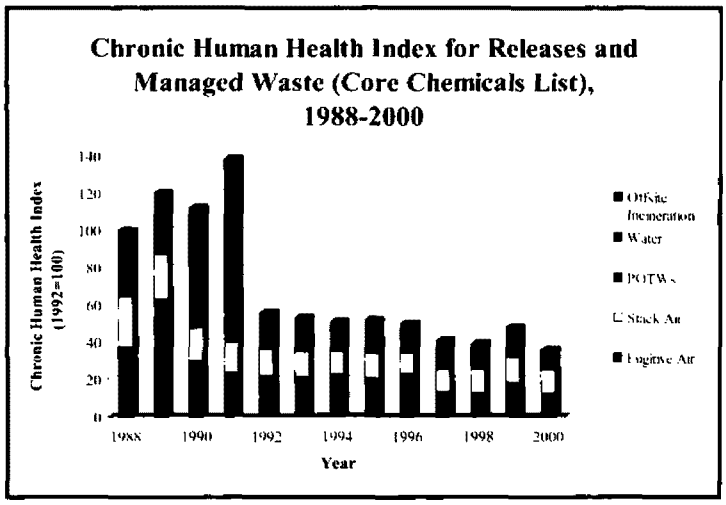
Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total health risk of the entire population. It can be inferred, however, as a measure of the relative gains the U.S. is making in reducing the chronic health risk posed by toxic chemicals.

There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

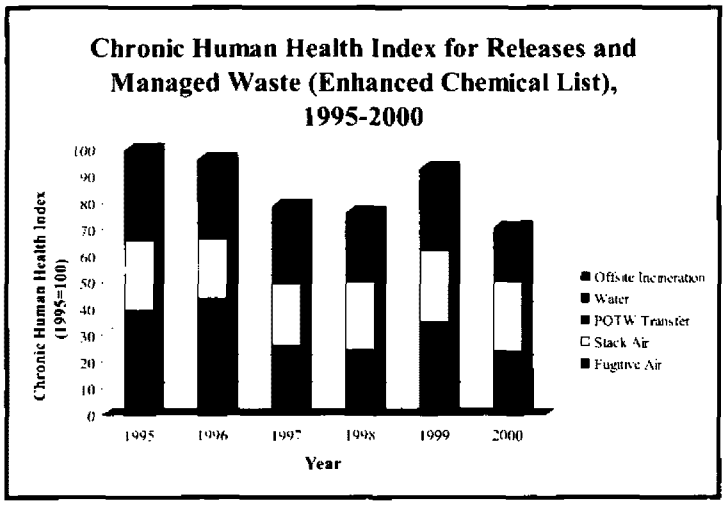
Two different subsets of TRI data are reflected in the presented charts. The first chart reflects data for a core list of chemicals that were reported every year from 1988 to 2000. The second chart reflects data for an enhanced list of chemicals that have been reported every year from 1995 to 2000.

- The chart shows that the chronic human health risk index for the core chemicals list decreased from 100 points in 1988 to 36 points in 2000.
- The chart shows that the chronic human health risk index for the enhanced chemicals list decreased from 100 points in 1995 to 71 points in 2000.

- Releases to air, releases to water and transfers to wastewater treatment facilities (POTWs) account for most of the chronic human health risk index (for both the core and enhanced chemicals lists).



Note: The large risk in 1991 is likely due to a release of 144,000 pounds of Nickel to a wastewater treatment facility in Los Angeles, which resulted in drinking water exposure to 3.9 million people.



Source: **Risk Screening Environmental Indicators,** Computer queries of national summary data prepared January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: *The Toxics Release Inventory (TRI) is capable of providing rich* information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

References

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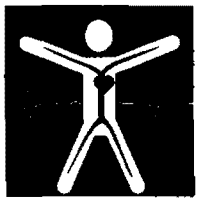

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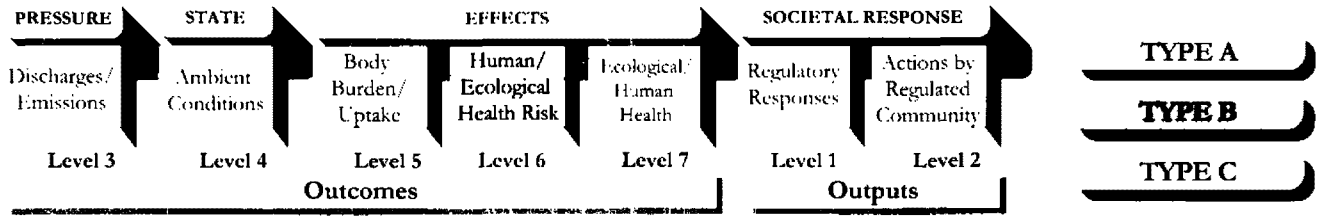

Indicator: Acute Human Health Risk Index from Toxic Releases

The ideal measurement of the human health impacts of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The Toxics Release Inventory (TRI) is a database of reported toxic chemical releases into the environment. TRI data are commonly used as a measure of toxic exposure. TRI data are normally reported by volume of release of a specific chemical. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of health risk posed by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators represent an analytical expansion of TRI by incorporating data that, for each chemical: reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the human health risk posed by a toxic chemical release can be estimated.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unitless measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the health risk measures would be adjusted to create a health risk index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the health risk estimate for the baseline year would be adjusted to equal a value of 100; subsequent estimates less than or greater than 100 would indicate a decrease or increase in the health risk posed by toxic chemical releases, respectively.

In a broad sense, this indicator would reflect whether human populations in the U. S. are at a higher or lower risk of adverse health effects from environmental toxics than they were in previous years.

Currently, the Risk Screening Environmental Indicators can produce estimates for only chronic (long-term) health risk. Next on the research schedule is the development of a methodology for estimating acute (short-term) health risk. Current expectations are that an acute health risk model will be available within two years.

Since TRI includes only a subset of chemicals to which people are exposed, this indicator would not be a complete measure of the total acute health risk of the entire population. It may be inferred, however, as a measure of the relative gains the U.S. is making in reducing the acute health risk posed by toxic chemicals.

There are, however, efforts to move the TRI toward comprehensive coverage. This past year, the TRI was expanded to include the reporting of releases from seven new economic sectors -- electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. By the time this prospective indicator is available, the expanded reporting will provide a more complete and accurate reflection of the scope and impact of chemical releases to the environment.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and cannot reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) represent an attempt to capitalize on the extensive chemical inventory that constitutes TRI and to introduce flexibility and manipulability of the inventory by introducing new data elements. These new data elements allow estimations of toxicity, fate, and size and distribution of the receptor population for a toxic chemical release. The RSEI model integrates estimated toxicity scores for individual chemicals and chemical categories with a measure of exposure potential based upon reported multi-media release and transfer data and the size of the potentially exposed general population. The result is a screening level, risk-related perspective for relative comparisons of chemical releases. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection.

The data elements that will be used to construct this indicator are:

- Air Releases
  - Fugitive Air Releases
  - Stack Air
- Water Releases
  - Direct water
  - POTW Transfers
- Land Releases
  - Onsite Landfill
  - Land Treatment/Application/Farming
  - Surface Impoundment
  - Other Land Disposal
  - Other Landfills

Underground injection treatment was not included among the releases to land due to the very small health risk posed by injection.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

References

2000 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics. August 2000. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. 31 January 2003. Available online at: http://www.epa.gov/tri/tridata/tri00/index.htm.

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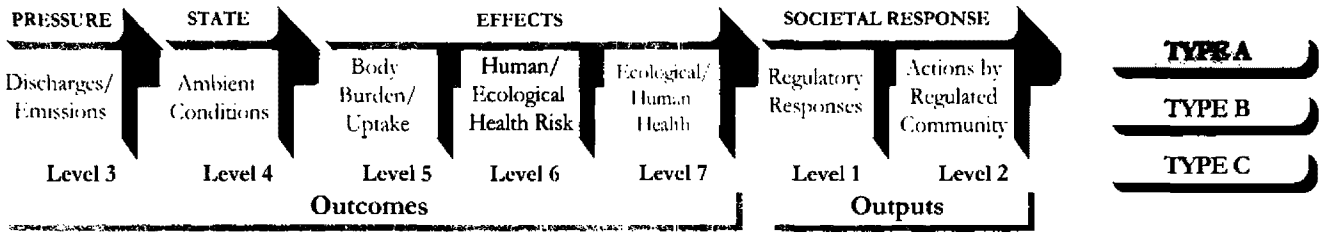


Indicator: Chronic Human Health Risk Index for Releases of Carcinogenic Chemicals

Carcinogens are toxic substances that may cause or induce the growth of cancerous tumors in humans and animals. Depending on the length and level of exposure, cancer caused by chemicals may develop many years after the exposure occurs. The U.S. Environmental Protection Agency currently conducts risk assessment studies on known carcinogens such as benzene, asbestos, and butatdiene (U.S. EPA, 2002). Other known carcinogens include the fumes of metals such as cadmium, nickel, and chromium, which can cause lung cancer (Environmental Defense, 2002).

The ideal measurement of the human health impacts of carcinogenic chemical releases would involve indicators capable of causally linking toxic exposure to specific cancers in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected carcinogenic chemicals, measures of ambient concentrations of carcinogenic chemicals, and measures of the releases of carcinogenic chemicals into the environment.

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating data that, for each chemical, reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the chronic human health risk posed by a carcinogenic chemical release or waste stream can be estimated.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unit-less measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the chronic health risk measures were adjusted to create a chronic health risk index. It is conventional to present unit-less data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the chronic health risk estimate for the baseline year was adjusted to equal a value of 100; subsequent estimates less than or greater than 100 indicate a decrease or increase in the chronic health risk posed by carcinogenic chemical releases and wastes, respectively. In a broad sense, this indicator reflects whether human populations in the U.S. are at a higher or lower risk of adverse health effects from carcinogenic chemicals than they were in previous years.

Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total health risk of the entire population. It can be inferred, however, as a measure of the relative gains the U.S. is making in reducing the chronic health risk posed by toxic chemicals.

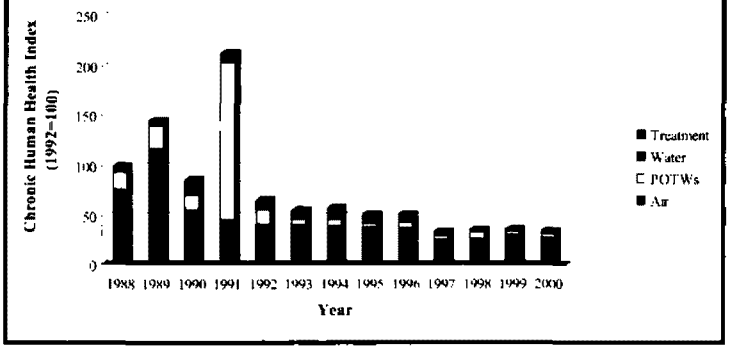
There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much

more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Two different subsets of TRI data are reflected in the presented charts. The first chart reflects data for a core list of carcinogenic chemicals that were reported every year from 1988 to 2000. The second chart reflects data for an enhanced list of carcinogenic chemicals that have been reported every year from 1995 to 2000.

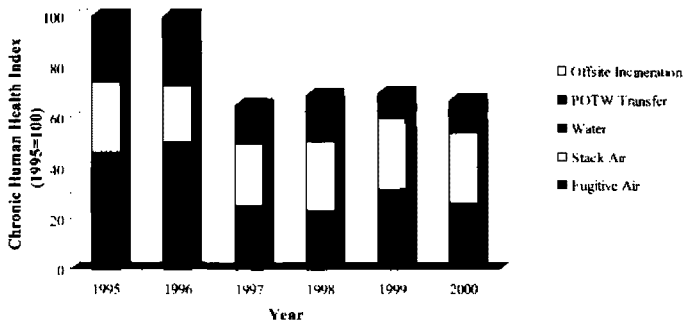
- The chart shows that the chronic human health risk index for the core carcinogenic chemicals list decreased from 100 points in 1988 to 36 points in 1999.
- The chart shows that the chronic human health risk index for the enhanced carcinogenic chemicals list decreased from 100 points in 1995 to 62 points in 1999.
- Releases to air, releases to water and transfers to wastewater treatment facilities (POTWs) account for most of the chronic human health risk index (for both the core and enhanced chemicals lists).

Chronic Human Health Risk Index for Releases and Managed Waste of Carcinogens (Core Chemicals List), 1992-2000



Note: The large risk in 1991 is likely due to a release of 144,000 pounds of Nickel to a wastewater treatment facility in Los Angeles, which resulted in drinking water exposure to 3.9 million people.

Chronic Human Health Risk Index for Releases and Managed Waste of Carcinogens (Enhanced Chemicals List), 1995-2000



Source: Risk Screening Environmental Indicators, Custom computer queries of national summary data prepared by January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection.

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: off-site incineration, off-site landfill, POTW (publicly owned treatment works) transfers, direct water releases, stack air releases and fugitive air releases. Releases to land, underground injection, disposal, recycling, energy recovery and treatment operations are estimated to pose very small risks (i.e., an index score less than 1), such that they would not be visible in graphic representation. Therefore, they are not included in this indicator.

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

References

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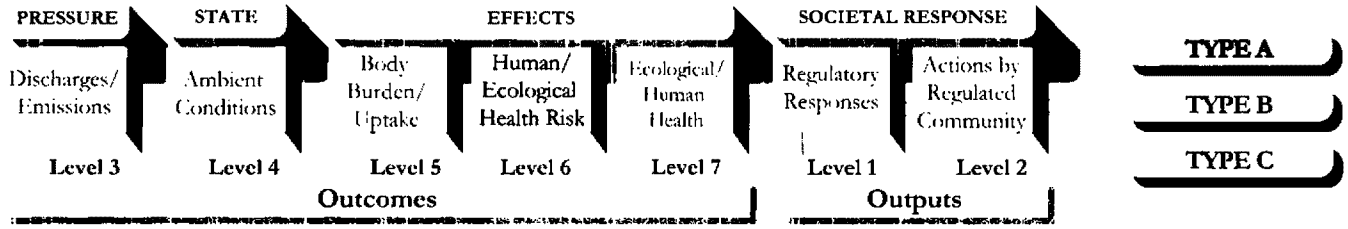


Indicator: Chronic Human Health Risk Index for Releases of Developmental Toxins

Developmental toxins are substances that may cause negative physical and mental health effects such as birth defects and attention deficit hyperactivity disorder (National Environmental Trust, 2000). Developmental toxins can affect a developing child through prenatal exposure, paternal exposures, or postnatal exposures. Prenatal exposure to mercury, for example, can disrupt the development of or kill the fetus (Environmental Defense, 2002). Paternal exposure to developmental toxins such as vinyl chloride can cause sterility, birth defects, and fetal death (Environmental Defense, 2002). Postnatal exposure to developmental toxins can also negatively affect the development of the child.

The ideal measurement of the human health impacts of developmental toxic releases would involve indicators capable of causally linking toxic exposure to specific cancers in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected developmental and neurological toxins, measures of ambient concentrations of developmental and neurological toxins, and measures of the releases of developmental and neurological toxins into the environment.

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating data that, for each chemical, reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the chronic human health risk posed by a developmental or neurological toxin release or waste stream can be estimated.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unit-less measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the chronic health risk measures were adjusted to create a chronic health risk index. It is conventional to present unit-less data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the chronic health risk estimate for the baseline year was adjusted to equal a value of 100; subsequent estimates less than or greater than 100 indicate a decrease or increase in the chronic health risk posed by developmental and neurological toxin releases and wastes, respectively. In a broad sense, this indicator reflects whether human populations in the U.S. are at a higher or lower risk of adverse health effects from developmental and neurological toxins than they were in previous years.

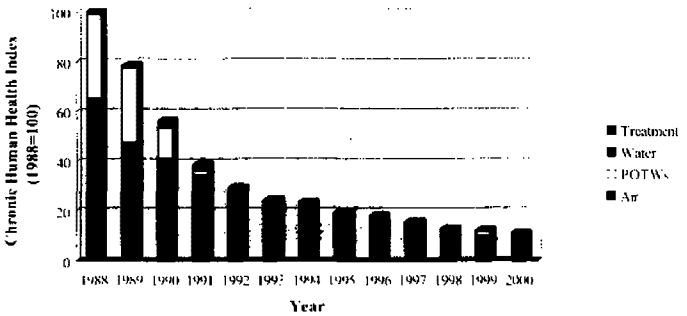
Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total health risk of the entire population. It can be inferred, however, as a measure of the relative gains the U.S. is making in reducing the chronic health risk posed by toxic chemicals.
There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated

into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

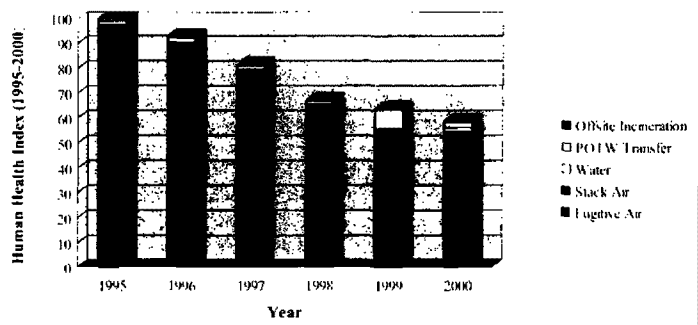
A list of known and suspected developmental and neurological toxins was developed by the National Environmental Trust (2000) based on chemicals in the TRI. This list was used to produce the following charts. Two different subsets of TRI data are reflected in these charts. The first chart reflects data for a core list of developmental and neurological toxins that were reported every year from 1988 to 2000. The second chart reflects data for an enhanced list of developmental and neurological toxins that have been reported every year from 1995 to 2000.

- The chart shows that the chronic human health risk index for the core developmental toxins list decreased from 100 points in 1988 to 11 points in 2000.
- The chart shows that the chronic human health risk index for the enhanced developmental and neurological toxins list decreased from 100 points in 1995 to 58 points in 2000.

Chronic Human Health Index for Releases and Managed Waste of Developmental Toxics (Core Chemicals List), 1988-2000



Chronic Human Health Index for Releases and Managed Waste of Developmental Toxics (Enhanced Chemicals List), 1995-2000



Source: Risk Screening Environmental Indicators. Custom computer queries of national summary data prepared by January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection.

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: off-site incineration, off-site landfill, POTW (publicly owned treatment works) transfers, direct water releases, stack air releases and fugitive air releases. Releases to land, underground injection, disposal, recycling, energy recovery and treatment operations are estimated to pose very small risks (i.e., an index score less than 1), such that they would not be visible in graphic representation. Therefore, they are not included in this indicator.

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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1999 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, February 2002. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. 14 January 2003. Available online at: http://www.epa.gov/tri/.

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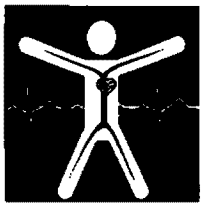
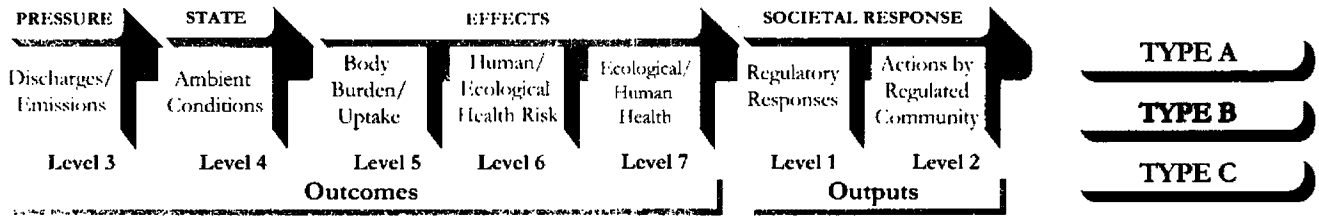
Toxics Release Inventory Relative Risk-Based Environmental Indicators Methodology. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, June 1997.

User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators may be viewed or downloaded at http://www.epa.gov/opptintr/rsei/. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov).



HUMAN HEALTH
BODY BURDEN



Indicator: Body Burden of Toxic Substances

The ideal measurement of the human health impact of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The Second National Report on Human Exposure to Environmental Chemicals (2003) will provide an ongoing assessment of the U.S. population's exposure to environmental chemicals using biomonitoring. The Report provides exposure information for people participating in the Centers for Disease Control and Prevention's (CDC's), National Health and Nutrition Examination Survey (NHANES) for 1999-2000. This data will establish the baseline for these chemical levels in future years and future data will also be released in two-year groups. The Report presents levels of 116 environmental chemicals measured in the U.S. population.

The 116 chemicals included in the Report belong to one of the following chemical groups:

- metals
- polycyclic aromatic hydrocarbons
- tobacco smoke
- phthalates
- polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls
- polychlorinated biphenyls
- phytoestrogens
- organophosphate pesticides
- organochlorine pesticides
- carbamate pesticides
- herbicides
- pest repellents and disinfectants

Indicators for metals, phthalates, and organophosphates have been developed and detailed descriptions are provided in this updated Chemical and Pesticides Results Measures document.

Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http: www.cdc.gov/exposurereport/ (4 March 2003).

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

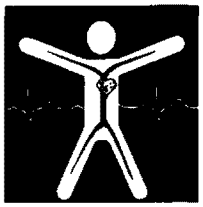
Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.

It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

Reference

Centers for Disease Control and Prevention. (2003). *Second National Report on Human Exposure to Environmental Chemicals*. 4 March 2003. Available online at: http://www.cdc.gov/exposurereport/



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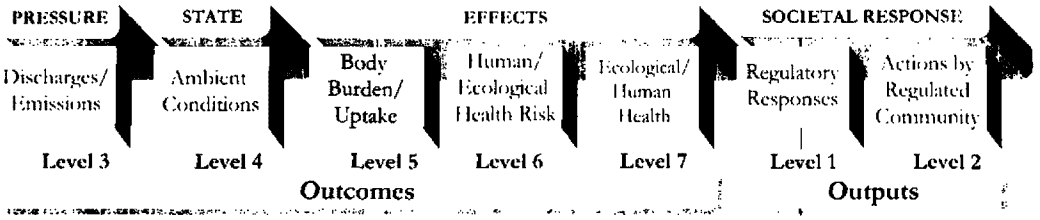
BODY BURDEN



Indicator: Metal Levels in People Ages 6 Years and Older

Toxic metals are present in our air, water, soil and food supply as a byproduct of our industrialized society. Exposure to metals may exhibit obvious and classical symptoms of poisoning. Chronic low-level exposure can lead to a wide array of problems, such as: memory loss, depression, irritability, and learning deficit, exposure also can result in physical manifestations such as liver and kidney dysfunctions, fatigue, infertility, gout, hypertension and headache (Filidei, 2002). Some metals have been extensively researched and the sources, toxicity levels and the effects have been well documented. Others have been less documented and research is being conducted to determine at what levels various health effects will occur. The exposure limit for these metals vary according to the length of time a person is exposed and the effects experienced:

- **Cobalt** - Low levels of cobalt are naturally present in air, water, and food and have both beneficial and harmful effects on health. At low levels, it is part of Vitamin B12, which is essential for good health; at high levels, it may harm the lungs. The Occupational Safety and Health Administration (OSHA) have set a limit of 0.1 mg/m^3 of cobalt in workplace air for an 8-hour workday, 40-hour workweek according to The Agency for Toxic Substances and Disease Registry (ASTDR, 2002).

- **Cadmium** - The general population is exposed to cadmium from breathing cigarette smoke or eating cadmium contaminated foods. OSHA limits workplace air to 100 µg/m^3 for cadmium fumes and 200 µg/m^3 as cadmium dust. High levels of cadmium damages the lungs, can cause kidney disease, and may irritate the digestive tract (ASTDR, 2002).

- **Thallium** - OSHA has set a limit of 0.1 mg/m^3 for thallium in workplace air. Other forms of exposure to thallium occur mainly from eating food, smoking cigarettes or living near hazardous waste sites containing thallium. Breathing high levels of thallium may result in effects on the nervous system, while ingesting high levels results in vomiting, diarrhea, temporary hair loss and effects on the nervous system, lungs, heart, liver, and kidneys. The National Institute for Occupational Safety and Health (NIOSH) has recommended that a thallium level of 15 mg/m^3 be considered dangerous as this level of exposure is likely to cause permanent health problems or death (ASTDR, 2002).

- **Tungsten** - Exposure to tungsten is normally through inhalation, ingestion, skin and or eye contact. The symptom usually includes irritation of eyes, skin, respiratory system; diffuse pulmonary fibrosis; loss of appetite, nausea, cough and blood changes. NIOSH has recommended an exposure limit of 5 mg/m^3 for a 10-hour workday, 40-hour workweek (NIOSH Pocket Guide to Chemical Hazards, 2002).

- **Antimony** - Antimony exposure mostly occurs in the workplace or from skin contact with soil at hazardous waste sites. OSHA has set an occupational exposure limit of 0.5 mg/m^3 of antimony in workplace air for an 8-hour workday, 40-hours per week. Breathing high levels of antimony for a long time can irritate the eyes and lungs, and can cause problems with the lungs, heart, and stomach (ASTDR, 2002).

- **Uranium** - Exposure to uranium is normally by inhalation, ingestion, skin and/or eye contact. Symptoms include dermatitis, kidney damage and blood changes. OSHA has set the limits for uranium in breathing air for an 8-hour workday, 40-hour workweek at 0.05 mg/m^3 for soluble uranium dust and 0.25 mg/m^3 for insoluble uranium dust (ASTDR, 2002).

- **Barium** - Exposure to barium can occur from drinking contaminated water or breathing barium contaminated air. Ingesting high levels of barium can cause problems with the heart, stomach, liver, kidneys, and other organs. OSHA has set an occupational exposure limit

of 0.5 milligrams of soluble barium compounds per cubic meter of air for an 8-hour workday, 40-hour workweek. NIOSH currently recommends that a level of 50 mg/m^3 be considered immediately dangerous because at this level barium is likely to cause permanent health problems and even death (ASTDR, 2002).

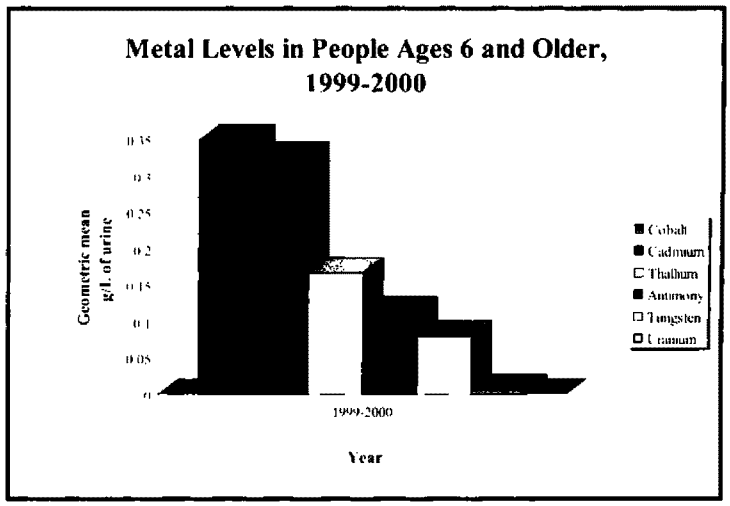
- **Cesium** - Stable and radioactive cesium can enter the body from contaminated food, water, air, or from contact with the skin. When you eat, drink, breathe, or touch things containing cesium compounds that can easily be dissolved in water, cesium enters your blood and is carried to all parts of your body (Agency for Toxic Substances and Disease Registry, 2002). Exposure to large amounts of radioactive cesium could cause the cells in your body to become damaged from the radiation that might penetrate your entire body. One might also experience acute radiation syndrome, which includes such effects as nausea, vomiting, diarrhea, bleeding, coma, and even death (ASTDR, 2002).

- **Molybdenum** - Exposure to Molybdenum is normally through inhalation, ingestion, skin and/or eye contact. Information on the effect of molybdenum on humans is limited; most available research information is on animals. OSHA has recommended an exposure limit of 15 mg/m^3 for an 8-hour workday, 40-hour workweek (NIOSH Pocket Guide to Chemical Hazards, 2002).

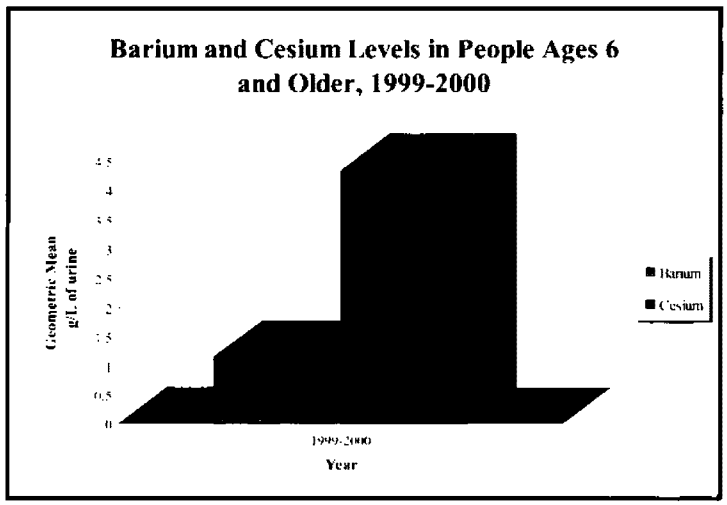
Because of the multiple pathways for metal exposure and the potential adverse health effects associated with exposure, it is important to monitor the body burden of different metals. This indicator tracks metal levels using the Second National Report on Human Exposure to Environmental Chemicals conducted by the Centers for Disease Control and Prevention (CDC) (2003). The Report will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals.

The following charts show national average urine levels in people ages six and older of cobalt, cadmium, thallium, tungsten, antimony, uranium, barium, cesium and molybdenum for 1999 to 2000. This data will establish the baseline for these metal levels in future years and future data will also be released in two-year groups. Each metal is grouped with other metals of similar scale for effective graphing.

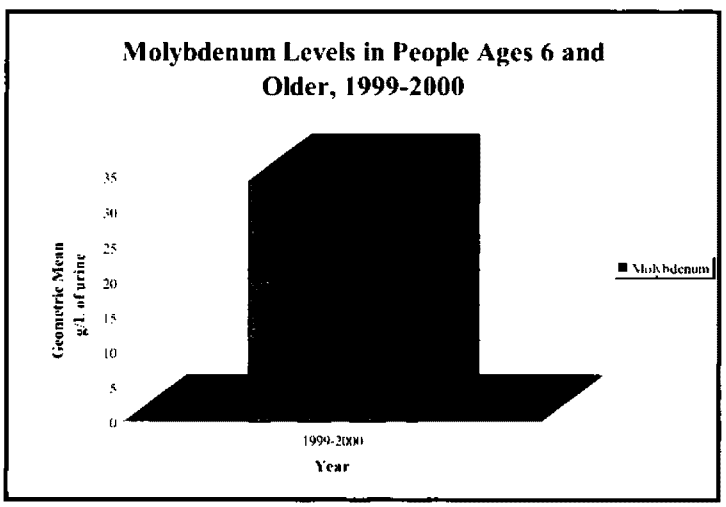
- Cobalt - 0.35 g/L, Cadmium - 0.326 g/L, Thallium - 0.167 g/L, Tungsten - 0.081 g/L, Antimony - 0.114 g/L, Uranium 0.007 - g/L



- Barium - 1.15 g/L, Cesium - 4.34 g/L



- Molybdenum - 34.3 g/L



Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.

It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

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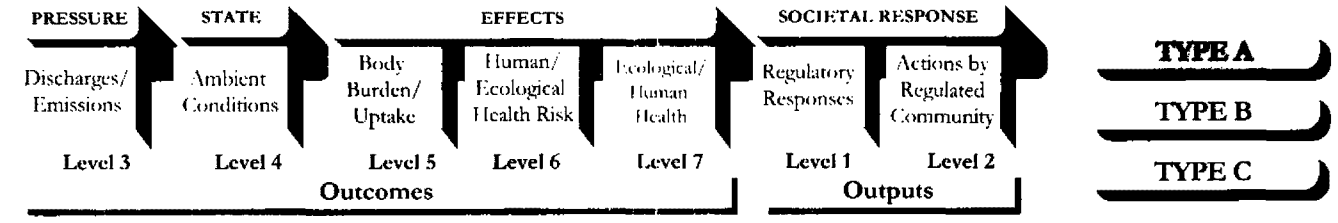
HUMAN HEALTH
BODY BURDEN



Indicator: Blood Lead Levels in People Ages 6 Years and Older

The hazardous effects of lead on human health have been well researched and established. Lead can affect almost every organ and system in the body and cause both acute and chronic health problems. The most sensitive system to lead in the body is the central nervous system. In adults, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead also damages kidneys and the immune system. Lead may cause anemia, abortion, or damage to the male reproductive system. Several chemical compounds of lead such as, lead acetate and lead phosphate are suspected carcinogens based on studies in animals; however there is inadequate evidence to clearly determine lead's carcinogenicity in humans (U.S. Dept. of Health and Human Services 1993).

Humans are exposed to lead through a number of sources. The most common sources of lead exposure include:

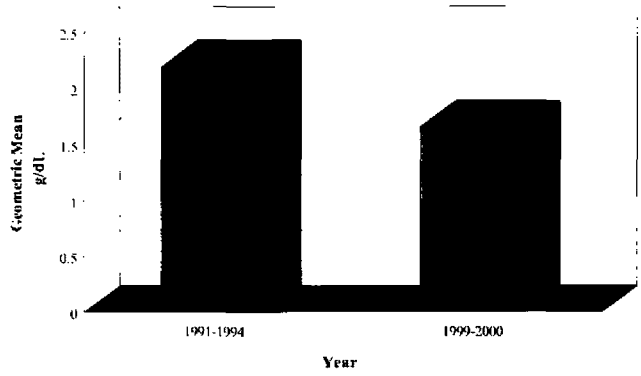
- Breathing workplace air (lead smelting, refining, and manufacturing industries);
- Drinking water that comes from lead pipes or lead soldered fittings;
- Breathing or ingesting contaminated soil, dust, air, or water near waste sites;
- Breathing tobacco smoke;
- Eating contaminated food grown on soil containing lead or food covered with lead-contaminated dust;
- Breathing fumes or ingesting lead from hobbies that use lead (leaded-glass, ceramics).

Because of the multiple pathways for lead exposure and the potential adverse health effects associated with exposure, it is important to monitor lead body burden. This indicator tracks blood lead levels using the Centers for Disease Control and Prevention's (CDC's) Second National Report on Human Exposure to Environmental Chemicals (2003) and National Health and Nutrition Examination Survey (NHANES). The Report will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals.

The following chart shows trends in blood lead levels of people ages 6 years and older, from 1991 to 2000. Blood lead levels of 25 g/dL and above are considered to be elevated levels. Blood lead levels have been decreasing partly due to the restrictions on lead in gasoline, ceramic products, paints for residential use, and solder used on food cans.

- From 1991-1994 to 1999-2000, the geometric mean blood lead level in people ages 6 and older, decreased 25%.
- The geometric mean blood lead level in people ages 6 and older from 1999 to 2000 was 1.66 g/dL.

Blood Lead Levels in People Ages 6 Years and Older, 1991-1999



Notes: g/dL = micrograms per deciliter of blood

Source for 1999-2000 Data: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Source for 1991-1994 Data: The NHANES as reported by Pirkle, J.L., Kaufmann, R.B., Brody, D.J., Hickman, T., Gunter, E.W., & Paschal, D.C.

(1998, November). Exposure of the U.S. population to lead, 1991-1994. Environmental Health Perspectives, 106(11), 745-750.

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.

It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

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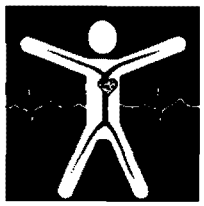
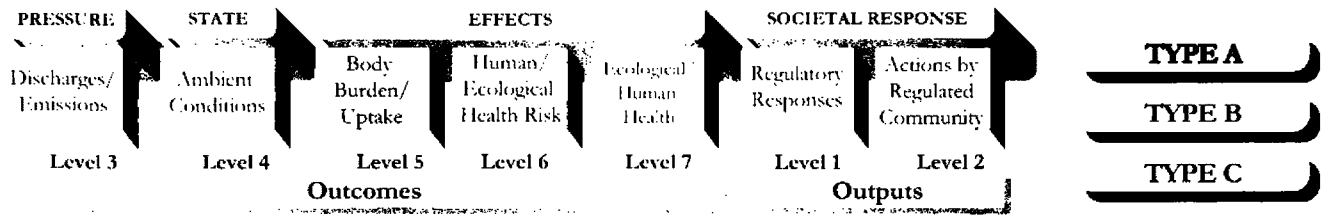


HUMAN HEALTH
BODY BURDEN



Indicator: Blood Mercury Levels in Women of Childbearing Age

Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at certain levels, may damage the brain, kidneys, and developing fetus. Mercury exposures to women of childbearing age are of great concern because the fetus is highly susceptible to adverse effects. Mercury in the mother's body passes to the fetus and can pass to a nursing infant through breast milk. Mercury's harmful effects that may be passed from the mother to the developing fetus include brain damage, mental retardation, lack of coordination, blindness, seizures, and an inability to speak.

Due to the adverse human health affects associated with mercury and the multiple pathways for exposure, it is important to monitor mercury levels. This indicator was developed to track blood mercury levels in females ages 16 to 49 using the Second National Report on Human Exposure to Environmental Chemicals conducted by the Centers for Disease Control and Prevention (CDC) (2003). The Report will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals.

The following bullet shows the national average blood mercury level in women of childbearing age (ages 16 to 49) for 1999 to 2000. This datum will establish the baseline for blood mercury levels in future years and future data will also be released in two-year groups.

- The geometric mean blood mercury level for women of childbearing age was 1.02 µg/L for 1999-2000.

Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.

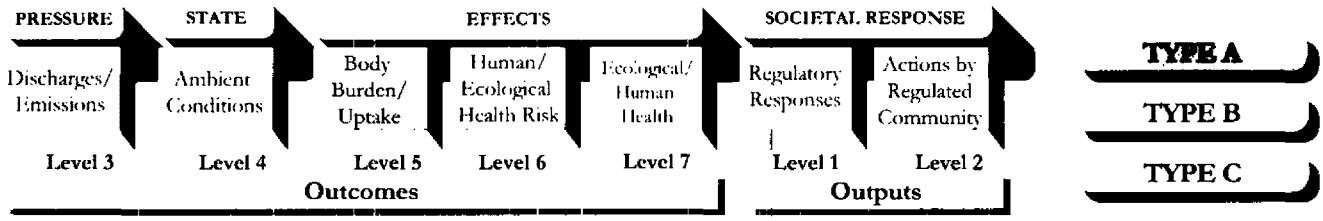
It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

References

Centers for Disease Control and Prevention. (2003). *Second National Report on Human Exposure to Environmental Chemicals.* 4 March 2003. Available online at: http://www.cdc.gov/exposurereport/

Centers for Disease Control and Prevention. "Blood and Hair Mercury Levels in Young Children and Women of Childbearing Age U.S., 1999" *Morbidity and Mortality Weekly Report.* 29 January 2003. Available online at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5008a2.htm

HUMAN HEALTH
BODY BURDEN



Indicator: Levels of Organophosphate Pesticide Metabolites in People Ages 6-59 Years

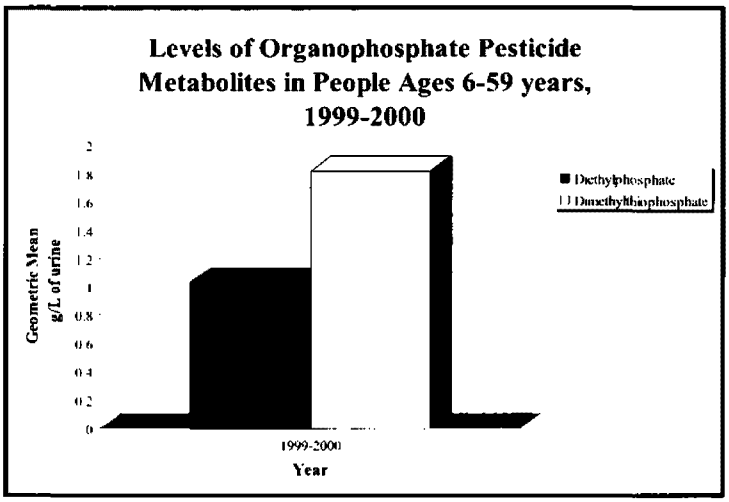
Organophosphate pesticides are widely used on many food crops, as well as in residential and commercial buildings, and for ornamental plants and lawn care. They account for nearly one-half of insecticides used in the U.S., with approximately 60 million pounds applied to U.S. agricultural crops annually. Some of the characteristics that have lead to their widespread use include, their ability to control a variety of insect pests; they are relatively inexpensive; and for the most part, insects have not developed resistance to them.

Organophosphates have a common mechanism of toxicity – they all affect the nervous system by reducing the ability of cholinesterase, an enzyme, to deactivate the chemical acetylcholine, a neuro-transmitter that transfers impulses across nerves and to muscles. Such cholinesterase inhibition allows nerve impulses to remain active longer than they should resulting in overstimulation of the nervous system, causing such symptoms as weakness and sometimes paralysis at higher levels of exposure. Acute toxic effects may include headaches, nausea, dizziness, anxiety and restlessness. While the acute effects of organophosphates are well documented and generally understood, the chronic effects are less certain.

People may be exposed to organophosphates routinely in several ways – through the diet, in drinking water, around the home, and while applying these pesticides. Since organophosphates are widely used and they are known to pose risks of acute and chronic toxicity to both humans and wildlife, it is important to monitor exposure to them.

This indicator provides measurements for urinary metabolites of organophosphate pesticides in people ages 6-59 for 1999-2000, as reported by the Second National Report on Human Exposure to Environmental Chemicals conducted by the Centers for Disease Control and Prevention (CDC) (2003). The Report will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals. This data will establish the baseline for these organophosphate levels in future years and future data will also be released in two-year groups.

While further research is needed to determine whether the metabolite levels reported here are of concern for human health, this information is useful for providing a reference range so that physicians and researchers can determine whether people have been exposed to higher levels of organophosphate pesticides than those experienced in the general population.



Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination

are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.

It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

References

Centers for Disease Control and Prevention. (2003). *Second National Report on Human Exposure to Environmental Chemicals*. 4 March 2003. Available online at: http://www.cdc.gov/exposurereport/

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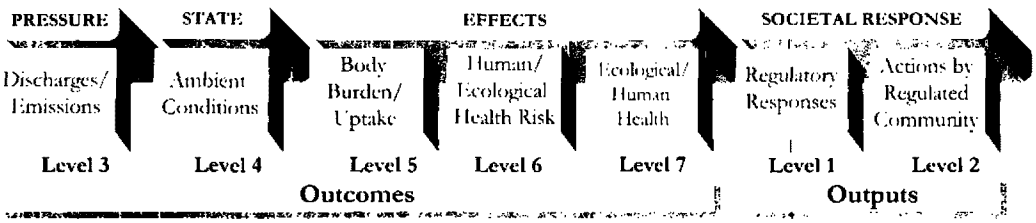
HUMAN HEALTH
BODY BURDEN



Indicator: Levels of Phthalate Metabolites in People Ages 6 and Older

Phthalates are industrial chemicals commonly found in many consumer products including, vinyl flooring and wall covering, detergents, lubricating oils, solvents, food packaging, and personal care products such as soaps, shampoos, hair sprays and nail polish. Other phthalates are used in flexible plastics like blood bags, tubing or children's toys, and in some pharmaceutical and pesticide formulations. Animal studies have found that some phthalates given at very high doses to animals during pregnancy produce birth defects among offspring. Continuous exposure to phthalates at high levels can also affect reproduction rates, the nervous system, and as well, potentially cause cancer.

Due to these potentially dangerous impacts on human health, it is important to monitor phthalate levels. This indicator tracks phthalate levels in humans using the Second National Report on Human Exposure to Environmental Chemicals conducted by the Centers for Disease Control and Prevention (CDC) (2003). The Report will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals.

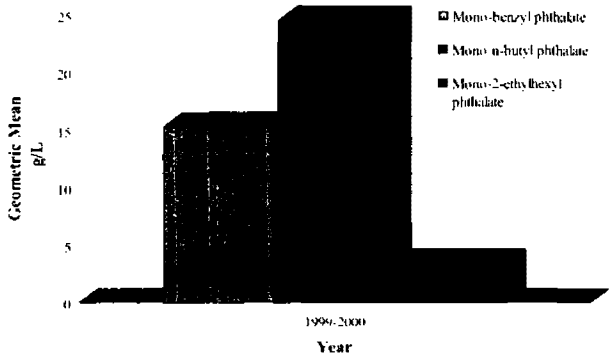
Finding a measurable amount of one or more phthalate metabolites in urine does not mean that the level of one or more phthalates causes an adverse health effect.

Whether phthalates at the levels of metabolites reported here are a cause for health concern is not yet known; more research is needed. These levels of phthalate metabolites in urine provide physicians with a reference range so that they can determine whether people have been exposed to higher levels of phthalates than those experienced in the general population. These data will also assist scientists in planning and conducting research on phthalate exposure and health effects.

The following chart and bullet show national average urine levels in people ages six and older of phthalates for 1999 to 2000. This data will establish the baseline for these phthalate levels in future years and future data will also be released in two-year groups.

- The average mono-ethyl phthalate urine level was 179 g/L for 1999-2000.

Urine Levels of Phthalate Metabolites in People Aged 6 Years and Older, 1999-2000



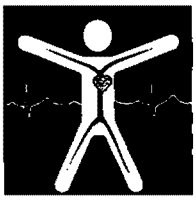
Notes: Samples for Mono-cyclohexyl phthalate, mono-isononyl phthalate, and mono-n-octyl phthalate were found to be below the limit of detection of the analytical method.

Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

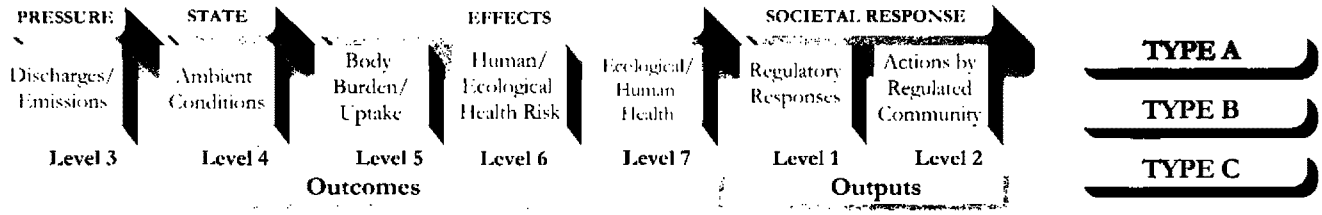
Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.



HUMAN HEALTH
BODY BURDEN



Indicator: Occupational Lead Exposure

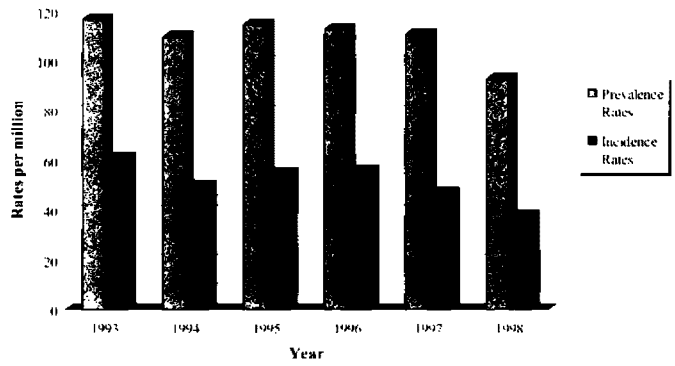
Between 90 and 95 percent of adults with elevated blood lead levels are exposed occupationally. In 2001, 125 out of one million adults in the U.S. had an elevated blood lead level, which is defined as 25 g of lead per dL of blood (U.S. Department of Health and Human Services, 2000). Occupational exposure to lead occurs via inhalation of lead-containing dust and fumes as well as ingestion from contact with lead-contaminated surfaces. High-risk industries and occupations for lead exposure include: radiator repair shops, battery recycling operations, and construction-related jobs such as bridge repair and home remodeling. Workers exposed to lead can experience anemia, nervous system dysfunction, kidney problems, hypertension, decreased fertility, and increased miscarriages. Workers can also bring lead home from their workplace and unknowingly expose their families.

Due to the adverse health impacts caused by lead exposure, it is important to monitor occupational blood lead levels. This indicator tracks occupational lead exposure by using data from the Adult Blood Lead Epidemiology and Surveillance (ABLES) program. State ABLES programs collect blood lead level data from local health departments and state reporting laboratories. ABLES defines an adult as a person aged 16 or older and an elevated blood lead level (BLL) in an adult as greater than or equal to 25 g/dL, although BLL reporting thresholds vary among the states.

The following charts show the prevalence (all cases reported that year) and/or incidence (new cases only) rates for elevated blood lead levels of adults from 1993 to 1998 and from 1998 to 2001.

- From 1993 to 1998, prevalence rates for BLLs of 25 g/dL or greater have decreased by 19% since 1995.
- In 1998 about 11,000 U.S. workers were reported by the ABLES states to have blood lead levels greater than or equal to 25 g/dL. This number is known to be an underestimate because many lead-exposed workers do not have routine blood lead level testing.

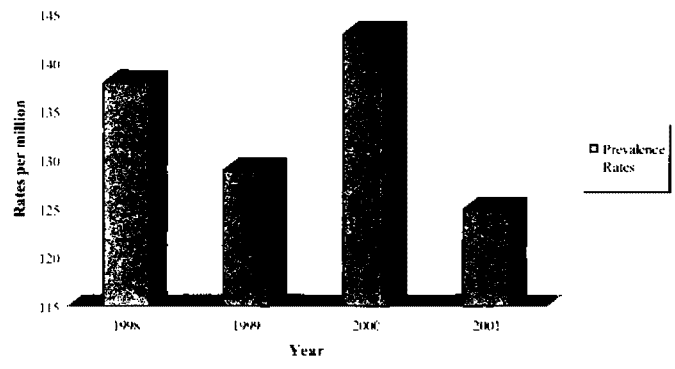
Prevalence and Incidence Rates of Adults Aged 16-64 with Elevated BLLs, 1993-1998



Notes: Prevalence rates are based on all persons reported in a given year. Incidence rates are based on new cases reported in a given year.

- From 1998 to 2001, prevalence rates for BLLs of 25 g/dL or greater decreased, however, more data points are needed to establish a trend.

Prevalence Rates of Employed Adults Aged 16 & Older with Elevated BLLs, 1998-2001



Source of 1993-1998 data: ABLES (1999), as reported in the Worker Health Chartbook 2000, compiled by the National Institute for Occupational Safety and Health (NIOSH), Center for Disease Control (CDC).

Source of 1998-2000 data: Centers for Disease Control and Prevention (2002), "Adult Blood Lead Epidemiology and Surveillance United States, 1998-2001. *Morbidity and Mortality Weekly Report 51(ss-11).*

Scale: ABLES data is available for the twenty-seven states that participated in this program from 1993 to 1998 and the 25 states that participated from 1998 to 2001.

Data Characteristics and Limitations: Occupational lead exposure data for this indicator come from State registries that report adult blood lead levels. Data are compiled by NIOSH in the Adult Blood Lead Epidemiology Survey (ABLES). All ABLES data are subject to certain limitations and, as with state-specific prevalence data, may not convey a true picture of workplace lead exposure. Variation in the number of persons with BLLs greater than or equal to 25 g/dL reported quarterly and annually to ABLES may reflect changes in 1) year-to-year efforts of participating states and lead-using industries within them to identify lead-exposed workers and to prevent new exposures; 2) occupational exposures to lead; 3) compliance with OSHA requirements regarding blood lead monitoring; and 4) workforce size in lead-using industries. Variations in reporting might result from changes in staffing and funding in state-based surveillance programs, interstate differences in worker BLL testing by lead-using industries, or random variations.

References

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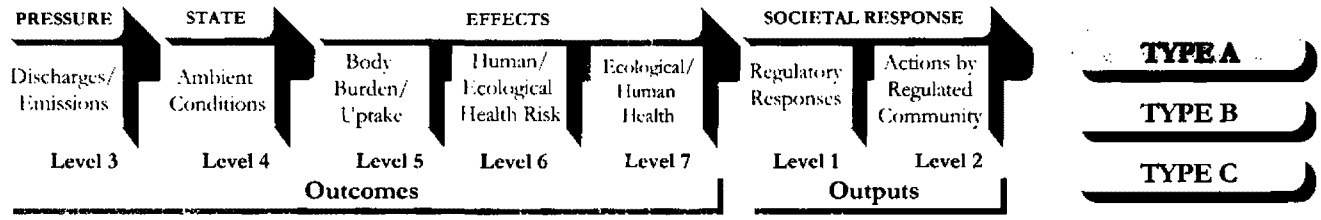
HUMAN HEALTH
PUBLIC HEALTH



Indicator: Reported Cases of Vector-Borne Diseases

A vector-borne disease is an infectious agent that is transmitted to humans by insect or rodent pests. Since the 1960s, the transmission of these diseases has been prevented with the use of vaccines and the application of pesticides. Vector-borne diseases are more prevalent outside of the United States, in countries with tropical environments and/or limited public health resources. However, many of these diseases are imported into the United States through immigration and international travel. Malaria (mosquito-borne) is the most common imported vector-borne disease: approximately 1,000 suspected malaria cases are imported into the U.S. each year (Gubler 1998). Certain vector-borne diseases are also endemic to the U.S., including West Nile virus, (mosquito-borne), Lyme disease (tick-borne), encephalitis (mosquito-borne), and Rocky Mountain spotted fever (tick-borne).

In recent years, the U.S. has witnessed focal epidemics of different strains of encephalitis and Lyme disease. Indeed, scientists have detected a resurgence in vector-borne diseases in many areas around the world (Gubler 1998). The reasons for this resurgence include: the development of pesticide-resistance in certain vectors; changes in public health policy; and human activities such as urban sprawl and deforestation. This indicator tracks the incidence of vector-borne diseases in the U.S. Trends of increasing incidence would imply the need for environmental health interventions, such as increasing pesticide applications or developing safer and more effective pesticides for vector control.

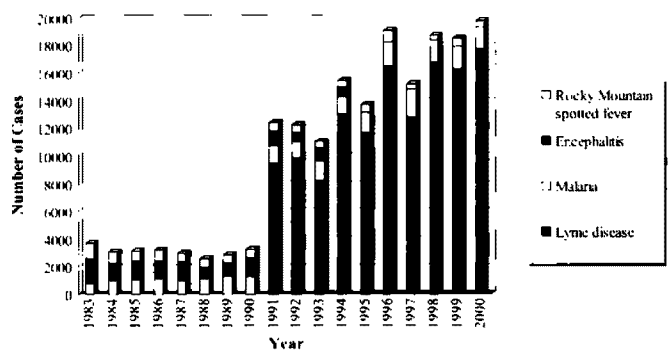
The West Nile virus is a new area of emphasis in preventing vector-borne diseases. Since 2001, the Centers for Disease Control and Prevention (CDC) has collected human and animal West Nile virus infection data through ArboNET, a web-based, surveillance data network, and state and local public health agencies. Data are published weekly in the CDC's *Morbidity and Mortality Weekly Report (MMWR)* and are available at the county, state, and national levels. Due to extreme variance in state participation and values, no chart of West Nile virus data is presented.

- In 2001, 66 human cases of West Nile virus disease were reported from 39 counties in 10 states (CDC, 2002b).
- From January 1, 2002 to November 26, 2002, 3,737 human cases of West Nile virus disease were reported from 39 states and the District of Columbia (CDC, 2002a).

The following chart depicts the annual number of reported cases of Lyme disease, encephalitis, malaria and Rocky Mountain spotted fever from 1983 to 2000.

- The number of reported cases of Rocky Mountain spotted fever has decreased by 56% since 1983.
- The incidence of malaria displays a rising trend in the 1990s, with 1560 reported cases in 2000.
- Since national surveillance began in 1991, the incidence of Lyme disease has increased by nearly 87%, with 17,730 reported cases in 2000.
- National surveillance of encephalitis ended in 1994, at which time it displayed a trend of decreasing incidence.

Reported Cases of Vector-Borne Diseases, 1983-2000



Notes: Since 1995, the national incidence of encephalitis has not been tracked by the Center for Disease Control and Prevention (CDC); it is no longer classified as a notifiable disease. National summary data for Lyme disease is not available before 1991.

Source: CDC Summary of Notifiable Diseases for the U.S., 2000

Scale: Data are available on the local, county, state and national levels.

Data Characteristics and Limitations: A notifiable disease is one for which frequent and timely information about individual cases is considered necessary for the prevention and control of the disease. Cases of notifiable diseases are reported by state and local health units to the CDC Division of Public Health Surveillance and Informatics through the National Electronic Telecommunications System for Surveillance (NETSS). The reporting of notifiable diseases is mandated by state and federal law.

It must be noted that the annual national summary figures for notifiable diseases probably under-represent the actual incidences. Persons with diseases that are clinically mild (e.g., salmonellosis) might not seek medical care from a health care provider. Also, differences in case definition or the introduction of new diagnostic tests can affect disease reporting, independent of the true incidence of disease.

Data are reported annually in the CDC *Morbidity and Mortality Weekly Report* at the state and national level and by age, sex, race/ethnicity of the case.

References

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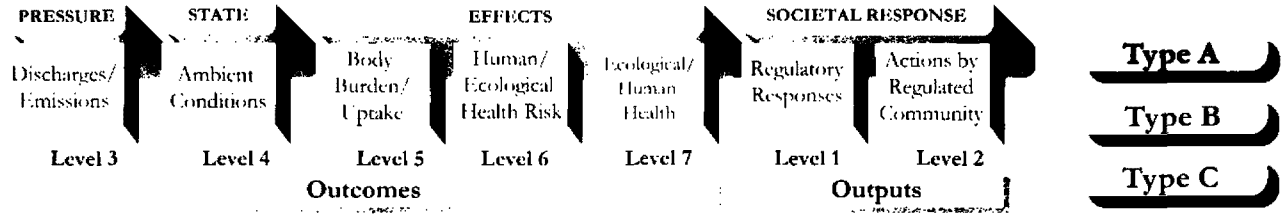
HUMAN HEALTH
SUBSISTENCE DIET



Indicator: Number of Fish and Wildlife Advisories

To protect their citizens from health risks associated with the consumption of contaminated fish and wildlife, states, the national territories and Native American Tribes issue consumption advisories. These advisories inform the public of the existence of high levels of chemical contaminants in local fish and wildlife. They suggest that consumption of such fish and wildlife from specific water bodies or water body types be restricted or avoided. Five types of advisories can be issued:

1. Restricted Consumption - General Population. Chemical contamination is less severe and consumption by the general public should be limited.

2. Restricted Consumption Sensitive Populations. Chemical contamination is less severe and consumption by sensitive populations should be limited.

3. No Consumption Sensitive Subpopulation. Chemical contamination poses a health risk to sensitive subpopulations (children, pregnant women, nursing mothers).

4. No Consumption - General Population. Chemical contamination creates a health risk to the general public.

5. Commercial Fishing Ban. This advisory prohibits commercial harvesting and sale of identified species of fish, shellfish, and wildlife from designated water bodies.

This indicator measures trends in the number of issued fish advisories. Persistent bioaccumulative toxic (PBT) chemicals - mercury, PCBs, chlordane, dioxins, and DDT - were at least partially involved in 99% of all advisories. Accordingly, this indicator becomes an indirect measure of the dietary exposure to PBTs of populations who follow a subsistence diet and consume disproportionate amounts of fish and wildlife. Such groups include: low-income people who fish and hunt for their own food, Native American Tribes who have historically been high-volume consumers of fish and wildlife, and individuals who make the lifestyle choice to eat fish and wildlife in quantity.

The following charts display the trends in the number of issued fish advisories from 1993 to 2000. Since 1993, the number of issued advisories of all types has increased.

- The largest increases have been for sensitive populations. Between 1993 and 2000, no consumption advisories for sensitive populations increased 155% and advisories for restricted consumption for sensitive populations increased by 162%.

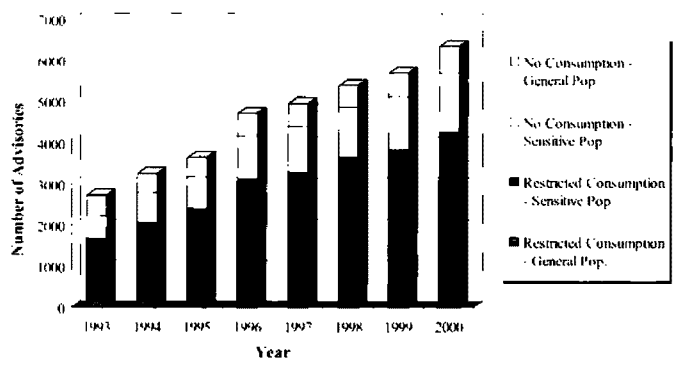
- The trend of no consumption advisories for the general population has remained relatively stable.

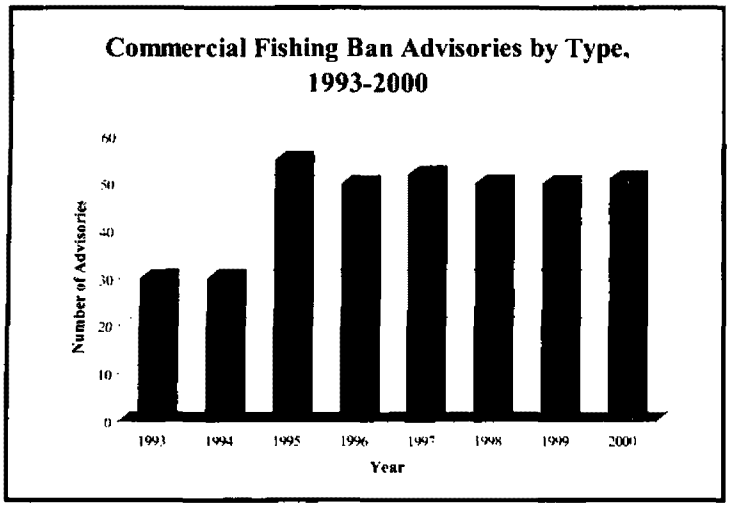
Not reflected in the charts are the following facts:

- The water bodies under restriction represent 15.8% of the nation's total lake acres and 6.8% of the nation's total river miles. All of the Great Lakes and their connecting waters and 58.9% of U.S. coastal waters are under advisory.

- Advisories increased over the six-year period for mercury, PCBs, and DDT, but decreased for dioxins and chlordane.

Fish and Wildlife Advisories by Type, 1993-2000





Source: National Listing of Fish and Wildlife Advisories (NLFWA), National Fish and Wildlife Contamination Program. EPA Office of Science and Technology

Scale: Data are available at the state, regional, and national levels.

Data Characteristics and Limitations: Included in the NLFWA database is information regarding:

1. species and size range of fish and/or wildlife,
2. chemical contaminants specified in the advisory,
3. geographic location of the advisory,
4. lake acreage or river miles included in the advisory, and
5. the population for which the advisory was issued.

From 1994 onward, maps can be generated at the national, regional, and state level for any combination of database components. Database versions following 1996 have the additional capacity to provide information on the percentage of water bodies in each state under advisory and the percentage of water assessed. From 1998 onward, the database includes information on fish tissue residue data for 16 states.

References

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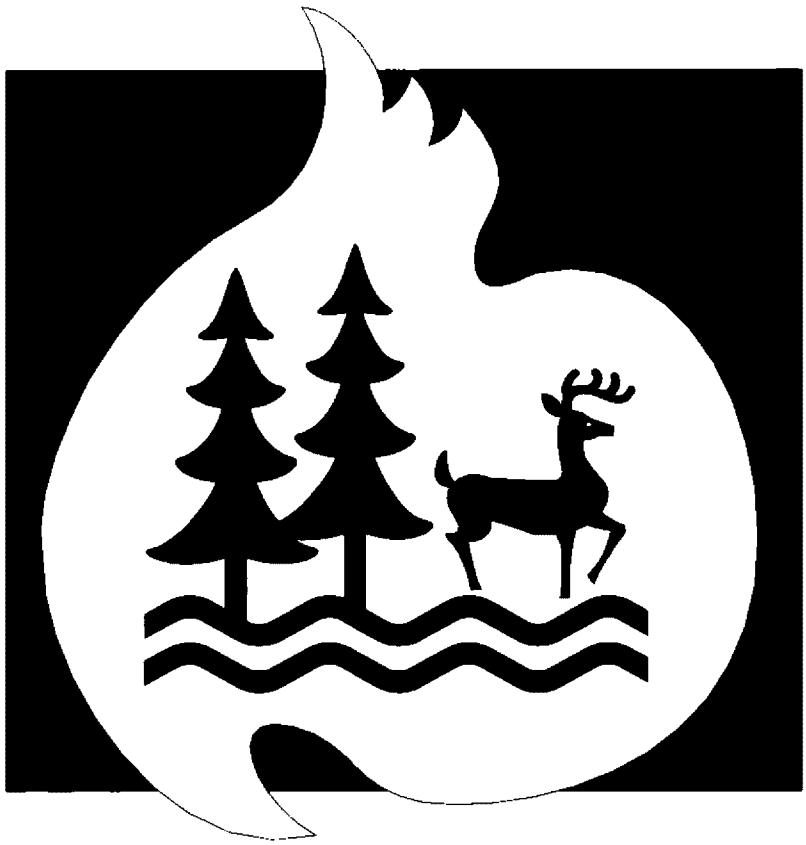
ENVIROMENTAL ISSUE 2: ECOLOGICAL HEALTH



List of Indicators

Chronic and Acute Ecological Health Risk From Toxic Releases

Number of Terrestrial and Aquatic Incidents and Associated Mortalities from the 15 Pesticides Causing the Most Wildlife Mortalities

Great Lakes Ecosystem

External Anomalies in Brown Bullhead Fish from the Great Lakes

PCB Levels in Herring Gull Eggs from the Great Lakes

DDE Levels in Herring Gull Eggs from the Great Lakes

Mirex Levels in Herring Gull Eggs from the Great Lakes

Dieldrin Levels in Herring Gull Eggs from the Great Lakes

Hexachlorobenzene Levels in Herring Gull Eggs from the Great Lakes

Concentrations of Total DDE in Bald Eagle Eggs from the Great Lakes

Concentrations of Total PCBs in Bald Eagle Eggs from the Great Lakes

Contaminants in Snapping Turtle Eggs from the Great Lakes

Contaminants in Colonial Nesting Waterbirds

PAH Concentrations in Offshore Waters of the Great Lakes

Dieldrin Concentrations in Offshore Waters of the Great Lakes

Concentrations of Atrazine in Lake Michigan

Concentrations of PCBs in Lake Michigan

Concentrations of Mercury in Lake Michigan

Concentrations of Trans-Nonachlor in Lake Michigan

Arsenic Loadings to the Great Lakes

Lead Loadings to the Great Lakes

Chesapeake Bay Ecosystem

Bald Eagle Population Count in the Chesapeake Bay Ecosystem

Contaminants in Maryland Oyster Tissue

List of Indicators Continued

Kepone in Finfish Tissue in the Chesapeake Bay Ecosystem

Tributyltin Concentration Levels in the Chesapeake Bay Ecosystem

Copper Concentration Levels in the Sediments of the Chesapeake Bay Ecosystem

Concentrations of Lead and Copper in Precipitation of the Chesapeake Bay Ecosystem

Benzo[a]pyrene Concentration in the Sediments of the Chesapeake Bay Ecosystem

Industry Reported Releases and Transfers of Chesapeake Bay Toxics of Concern

Industry Reported Releases and Transfers of Chemical Contaminants in the Chesapeake Bay

Releases and Transfers of Chemical Contaminants from Federal Facilities in the Chesapeake Bay Region

Cropland Acres Under Integrated Pest Management in the Chesapeake Bay Ecosystem

Pesticide Container Recycling Programs in the Chesapeake Bay Ecosystem

Pesticide Collection and Disposal Programs in the Chesapeake Bay Ecosystem

Mid-Atlantic Integrated Assessment Program (MAIA)

PCB Levels in Mid-Atlantic Estuarine Blue Crabs

Concentrations of PCBs in Mid-Atlantic Estuarine Sediments

Mid-Atlantic Highlands Assessment Program (MAHA)

Western Pilot Study

San Francisco Bay and San Joaquin River-Delta Ecosystem

Estuarine and Great Lakes Program

National Coastal Assessment (Coastal 2000)

Environmental Issue 2: Ecological Health

Most commonly, when people think about chemical contamination, they focus on human health concerns. However, the health of wildlife, natural plant communities, and, indeed, the health of entire ecosystems, are profoundly affected by toxic chemicals and pesticides. Toxic chemicals and pesticides can affect wildlife and ecosystems at several levels. Large doses of sufficiently toxic chemicals and pesticides can have acute, short-term effects resulting in high mortality rates. Similarly, they may disrupt the food chain by selectively eliminating certain species necessary as a food supply to other organisms. Chemical contamination may weaken wildlife species, diminishing their ability to compete and survive. Over longer periods of time, chemicals and pesticides, at relatively low doses, can have serious developmental impacts on wildlife that may have long-term affects on the survivability of whole species. At the highest level, chemical contamination can have broad, systematic effects across large, integrated ecosystems like the Everglades, the Great Lakes, and the Chesapeake Bay.

Issue Dimensions

Flora and Fauna Impacts

The use or release of pesticides and toxic substances affects not only human health, but wildlife as well. The rapid growth in the use of pesticides, beginning in the 1960's and continuing to the present, has been accompanied by an increase in wildlife impacts. The use of DDT, in particular, was associated with declines in bald eagles, peregrine falcons, and brown pelicans. All of these bird species are predators that reaped the impacts of biomagnified DDT loadings. DDT caused the thinning of egg shells and diminished the ability of eggs to survive. New pesticides were developed to avoid the persistence of organochlorides, a class of pesticides that includes DDT. These replacement pesticides, however, while less persistent, can also be more acutely toxic to wildlife in the near term. The effect of pesticides on fauna that serve as food supply for others can reduce the ability of higher species to compete and survive.

Potentially more damaging on ecological health are the long-term effects of chemical and pesticide exposure. While some pesticides may cause near immediate death, others may lead to a decline in health that will eventually lead to sickness, death, and species decline. As with humans, pesticides and toxic chemicals can disrupt development processes in wildlife. Such disruption can result in a variety of effects to include behavior changes, physical deformities, sexual and reproductive dysfunction, and offspring mortality. Weakened wildlife may become easier prey or lose their ability to adapt to environmental changes.

Preliminary information suggests that most pesticide-related avian mortalities result from pesticides used on corn, grapes, rice, alfalfa, and from golf courses and home/lawn pesticides. Herbivorous waterfowl, followed by raptors, appear to be most impacted. In the aquatic environment, fish appear to be most commonly reported in terms of mortalities, followed by aquatic invertebrates, reptiles, and amphibians.

Of particular concern are endangered species in the U.S. At present, there are 735 species of plants and 496 species of animals listed as threatened or endangered. Given their small numbers, chronic or acute pesticide or toxic chemical impacts can be particularly damaging.

Major Ecosystem Functioning

The presence of toxic substances and pesticides has the potential to disrupt the functioning of whole ecosystems. An example of a major ecosystem affected by chemical pollution can be found in Florida's Everglades where mercury from

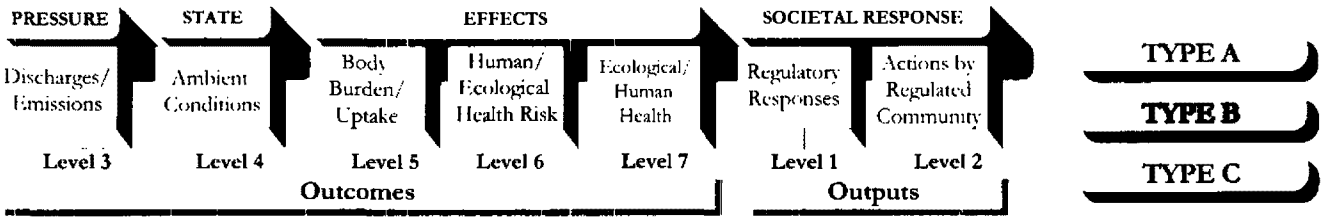
national and international air deposition, stormwater runoff, and from the disturbance of mercury-bearing peat has significant environmental impacts on the system. Additional research demonstrates that an international deposition pathways provides the crucial additional increment of mercury. Mercury from Europe, and maybe even China is being borne to Florida where an unusual confluence of international airflows is leading to an unusual mercury deposition process. Through the process of biomagnification, mercury is being concentrated up the food chain and is beginning to have systemwide effects on wildlife.

The Great Lakes Program has focused heavily on the role of chemical contaminants. For years the Great Lakes were the recipient of huge amounts of chemicals and pesticides and the effects on wildlife were systematic and devastating. To manage the restoration of the Great Lakes the Great Lakes Program and Environment Canada have jointly prepared a series of excellent ecological indicators.

Similarly, the Chesapeake Bay suffered from long-term loading of chemicals from urban runoff and atmospheric deposition. The Chesapeake Bay Program has identified toxic chemical contamination as one of the four top stresses on the Bay. To support restoration efforts the program has developed 18 chemically-based indicators and have an additional 3 indicators under development. These indicators support a goal-driven, result-based management system that is a model for ecosystem management.

Projects now underway in other areas of the country are also looking at chemical impacts. The Mid-Atlantic Integrated Assessment (MAIA), the Mid-Atlantic Highlands Assessment Program (MAHA), the San Francisco Bay and San Joaquin River Delta Ecosystem Program, the Western Pilot Study, the National Coastal Assessment, and the Estuarine and Greats Lakes Program (EAGLES) all have chemical contamination related elements. In several years when all of these projects are fully functioning, the assessment and monitoring of chemical and pesticide related health effects and contamination on a national scale will be possible.

ECOLOGICAL HEALTH
FLORA AND FAUNA IMPACTS



Indicator: Chronic and Acute Ecological Health Risk From Toxic Releases

At present there is little that is known about the direct relationship between chemical or pesticide exposure and ecological health effects that can be expressed in indicator terms. Common measures intended to demonstrate chemical effects on plants and animals include mortality estimates or reports associated with chemical or pesticide exposure or bioassay or body burden assessment.

Currently, the Risk Screening Environmental Indicators Program at the U.S. Environmental Protection Agency can produce estimates of chronic human health risk resulting from exposure to toxic chemicals. These estimates are generated by applying toxicity weights to each chemical among the releases found in the Toxic Release Inventory (TRI) and by modeling the fate of the chemicals and receptor population impacts to produce an estimate of chronic human health risk. In another 18 months, a modeling process capable of estimating acute human health effects may be in place.

On the development horizon for the Risk Screening Environmental Indicators Program is the expansion of the modeling process to include estimates of chronic and acute ecological health risk resulting from exposure to TRI chemical releases. At present, relatively little work has been done on the development of the required models. Current expectations, however, are that the model will function only in the aquatic environment. Assuming maintenance of effort, the indicators could be available in 3-4 years.

Notes: The Toxic Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, is capable only of reporting the pounds of chemicals released or transferred and cannot reflect human or ecological health impacts. The Risk Screening Environmental Indicators project represents an attempt to capitalize on the extensive chemical inventory that constitutes TRI along with the flexibility and manipulability of the system by introducing additional data elements to the system that allow assessments of toxicity, fate, and size of receptor population. These modes integrate estimated toxicity scores for individual chemicals and chemical categories with a measure of exposure potential based upon reported multi-media release and transfer data and the size of the potentially exposed general, non-worked population. The result is a screening level, risk-related perspective for relative comparisons of chemical releases. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Data Characteristics and Limitations: A significant means by which chemicals enter into the ambient environment is through their release to air, water, and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases at the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air steam, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the subsurface placement in a well. Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

Also included in TRI are a variety of transfers of toxic chemicals. Transfers include amounts transferred off site for recycling, energy recovery, treatment, and disposal.

There are several limitations of the Toxic Release Inventory data. First, the TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees, and those that do not meet the chemical thresholds, are not required to file reports. Prior to 1998, non-manufacturing sectors included were also not required to report. As of 1998, electric utilities, coal mining metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are additionally required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Secondly, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and completeness. Thirdly, there is an 18-month lag in time from when data are collected and current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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1998 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 2000. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. 31 January 2003. Available online at: http://www.epa.gov/triinter/tridata/tri98/pdr/index.htm.

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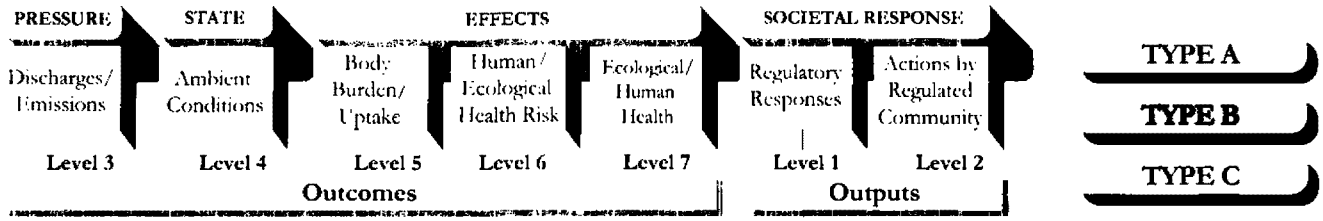
Toxics Release Inventory Relative Risk-Based Environmental Indicators Methodology, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, June 1997.

User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators, may be viewed or downloaded at http://www.epa.gov/opptintr/rsei. 31 January 2003. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov.)

ECOLOGICAL HEALTH
FLORA AND FAUNA IMPACTS



Indicator: Number of Terrestrial and Aquatic Incidents and Associated Mortalities from the 15 Pesticides Causing the Most Wildlife Mortalities

As part of their response to the requirements of the Government Performance and Results Act (GPRA), OPPTS must set and measure goals relating to their performance in achieving major dimensions of their mission. One of the areas they identified as important is their success in protecting wildlife from the effects of pesticides. Consequently, they are presently in the process of utilizing an internally collected and maintained data set -- the Ecological Incident Information System (EIIS) – to develop an indicator designed to measure pesticide-related mortality incidents and total mortalities.

They are in the process of developing an indicator that measures mortality incidents and mortalities for the 15 pesticides most commonly causing the most mortalities. The information for the indicator is being provided by the EIIS. Currently, this database contains over 3,000 incidents reported by public agencies from around the nation. At present, data are available only for aquatic systems and birds.

The pesticides under preliminary consideration are: carbofuran, diazinon, azinphos-methyl, chlorpyrifos, endosulfan, terbufos, fenthion, brodifacoum, parathion, methyl parathion, atrazine, profenofos, famphur, 2,4-D, and permethrin.

Summaries of EIIS data collected to date are found in the attached tables. To date, the database contains 695 incidents of aquatic mortality events caused by pesticides. Of these, 57% were caused by just four of the listed pesticides: azinphos-methyl, chlorpyrifos, endosulfan, and terbufos.

For avian species, there are over 1160 incidents in the database. Two insecticides carbofuran and diazinon are associated with 55% of all incidents.

Data Characteristics and Limitations: The data set is still preliminary in its development. The information is received from a variety of different organizations from across the nation and very uneven in quality. The certainty of each incident is quite low. Furthermore, wildlife mortalities are surely under-reported. The data should not be treated as a definitive count of wildlife mortalities, but more like a sample.

References

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Table 1. Leading Pesticides Causing Aquatic Organism Mortalities in the United States

Active Ingredient	Number of aquatic incidents in EIIS	Uses associated with majority of incidents
Azinphos-methyl	226	sugarcane and cotton
chlorpyrifos	110	termiticide use
endosulfan	98	agricultural areas, lettuce, tobacco, tomato, potato
terbufos	85*	corn
toxaphene	37	cotton (95% of incidents occurred between 1970 and 1989)
atrazine	30	corn (only 8 of these incidents listed as probable)
methyl parathion	26	cotton (one fish kill involved 20 to 30 million fish)
profenofos	23	cotton
2,4-D	22	agricultural areas
permethrin	20	termiticide, home lawn, corn
pentachlorophenol	18	wood preservation
Subtotal	695	

Table 2. Leading Pesticides Causing Avian Mortalities in the United States

Active Ingredient	Number of avian incidents in EIIS		Aggregate Number of Carcasses Reported	Uses associated with majority of incidents
	Total	Probable*		
carbofuran	352	241	12,341	grapes, corn, alfalfa (most granular uses canceled in 1991)
diazinon	267	165	4434	lawns and turf (golf course use canceled in 1989)
chlordane	70			termiticide (use canceled in 1987)
fenthion***	58	47	5545	avicide use, mosquito control
chlorpyrifos	57	37		termiticide, lawn and turf
brodifacoum	47**	47		rodent control
parathion	45		2457	small grains, sunflower, alfalfa
famphur	31			livestock
Total	927			

* probable includes incidents that were convincingly linked to pesticide use and not linked to pesticide misuse.
**total includes recently received incidents not yet entered into EIIS
*** avicide use voluntarily canceled on 3/1/99; use will be replaced by starlicide

Indicator: Great Lakes Ecosystem

The Great Lakes ecosystem represents an important and unique ecosystem. It is the largest system of fresh water in the world and provides many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and Canadian government. Long-term monitoring is necessary to track the progress of these initiatives.

Since 1994, the EPA and Environment Canada (EC) have held a biennial conference, called the "State of the Lakes Ecosystem Conference" (SOLEC). The purpose of these conferences is to focus on the Great Lakes ecosystem and to identify the great forces affecting it. Each of the four conferences held to date have led to the production of a state of the lakes report.

From the beginning, the conferences and the work done between conferences has focused energy on the development of indicator frameworks and indicators capable of describing environmental conditions in the Great Lakes. At the 1998 SOLEC conference, 79 candidate indicators were identified for eventual development and harmonization. These indicators were arrayed across six core groups. At SOLEC 2000, 25 of the indicators were selected for display with data and trends. They represent the first group of SOLEC indicators released for use. Shown below are the six core groups and those indicators included in the initial 79 candidate indicators reflecting pesticide and toxic chemical concerns that are ready for use now. The remaining indicators related to pesticide and chemical interests are not shown here since they are to be developed and released over the next several SOLEC conferences.

1. Nearshore and Open Water Indicators

- Deformities, Eroded Fins, Lesions and Tumors in Nearshore Fish
- Contaminants in Colonial Nesting Waterbirds
- Atmospheric Deposition of Toxic Chemicals
- Toxic Chemical Concentrations in Offshore Waters

2. Coastal Wetland Indicators

- Contaminants in Snapping Turtle Eggs

3. Nearshore Terrestrial Indicators

- Contaminants Affecting Productivity of Bald Eagles

4. Human Health Indicators

- Chemical Contaminants in Edible Fish Tissue
- Drinking Water Quality
- Air Quality

5. Land Use Indicators

- Brownfield Redevelopment

6. Societal Indicators

This indicator system creates an excellent framework for ecosystem indicator systems and serves as a model for other ecosystem indicator developers. Because of the cooperation between Canada and the U.S., the system further provides an example of an indicator-driven transboundary environmental management system that is well worth studying.

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Bertram, Paul and Nancy Stadler-Salt. 2000. *Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4.* State of the Lakes Ecosystem Conference.

Environment Canada SOLEC Web Site. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

Stadler-Salt, Nancy and Paul Bertram. 2000. Implementing Indicators: Draft for Discussion at SOLEC 2000.

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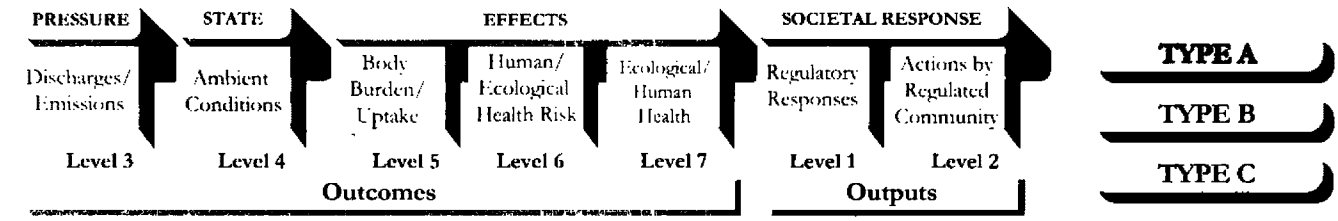

Indicator: External Anomalies in Brown Bullhead Fish from the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

This indicator assesses the prevalence of external anomalies in brown bullhead from the Great lakes. This type of indicator is useful in identifying near shore areas that have populations of benthic fish exposed to contaminated sediments. The presence of contaminated sediments at Areas of Concern (AOCs) has been linked to increases in the incidences of external anomalies in benthic fish species, such as brown bullhead and white suckers. The presence of these anomalies may be associated with specific families of chemicals.

Notes: Data are not provided by date of publication.

Source: "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000." October 2000.

Scale: The Great Lakes and its watersheds.

Data Characteristics and Limitations: N/A

References

Bertram, Paul, and Stadler-Salt, Nancy. "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4." State of the Lakes Ecosystem Conference, March 2000.

Environment Canada SOLEC. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

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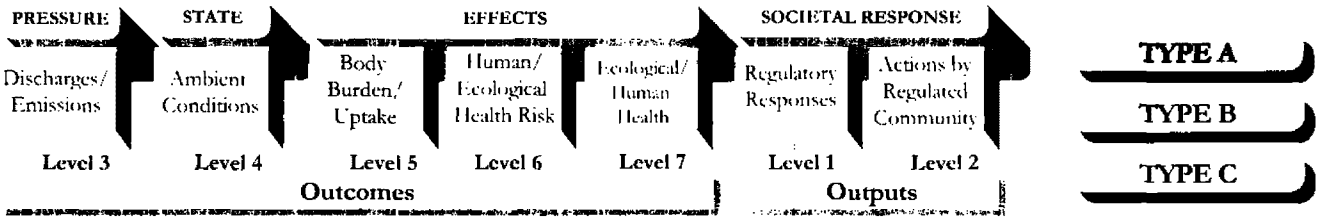


Indicator: PCB Levels in Herring Gull Eggs from the Great Lakes

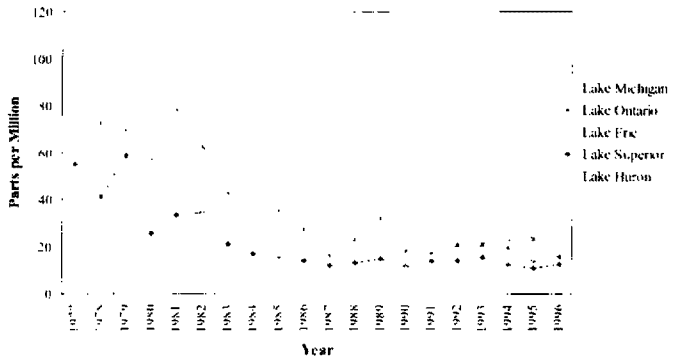
The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

This indicator measures PCB levels in herring gull eggs from each of the Great Lakes. PCBs are a small family of industrial compounds that are environmentally persistent and bioaccumulative. They are good representatives for many of the toxic organic compounds from human-originated sources and are well suited for long-term ambient monitoring. It is important to track the levels of PCBs in herring gull eggs because they have been linked to developmental deformities in birds (Francis 1994). Due to the nature of this chemical, its toxicity to wildlife, and the status of the herring gull as a major indicator species for the Great Lakes, this indicator provides a good measure of the environmental quality of the Great Lakes ecosystem.

The chart displays the PCB levels in herring gull eggs at sampled sites from each of the Great Lakes from 1977 to 1996.

- Over the past 20 years, levels of PCBs in herring gull eggs have dropped considerably from an average of 80.1 ppm in 1977 to 15.4 ppm in 1996.
- Since 1978, Lake Huron has consistently had the lowest levels of PCBs in herring gull eggs, with only 10 ppm in 1996.
- There were "spikes" in the PCB levels in herring gull eggs in the beginning of the 1980's and again in 1989.

PCB Levels in Herring Gull Eggs from the Great Lakes, 1977-1996



Notes: Parts per million in whole egg samples, wet weight. For Lake Michigan in 1979, 1981, and 1993, data were not available. For these years, the levels of PCBs were assumed to be the average of the levels for the years immediately before and after (i.e., 1978 and 1980, 1980 and 1982, 1992 and 1994). Data for Lake Michigan for 1996 are based on only one count per sampling site.

Source: Environment Canada, Canadian Wildlife Service, and Canada Centre for Inland Waters. Data are found in the 1996 report of the Council on Environmental Quality.

Scale: The Great Lakes and its watersheds.

Data Characteristics and Limitations: The measurement of contaminant levels in herring gull eggs is one of the longest running wildlife monitoring programs for contaminants in the world. Data are available annually dating back to 1974.

References

"Contaminants in Herring Gull Eggs from the Great Lakes: 25 Years of Monitoring Levels and Effects." 31 January 2003. Available online at: http://www.on.ec.gc.ca/wildlife/factsheets/fs_herring_gulls-e.html

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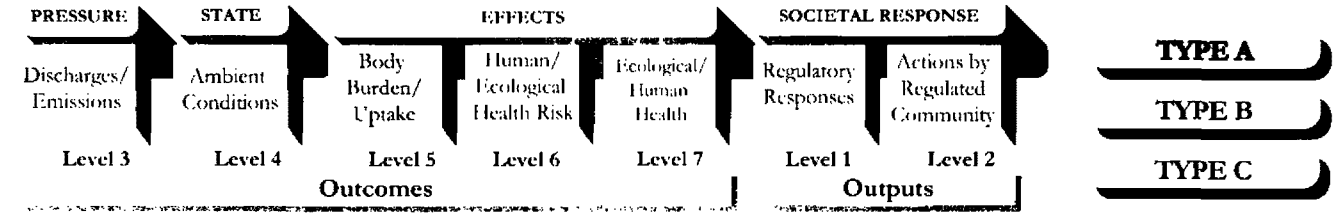


Indicator: DDE Levels in Herring Gull Eggs from the Great Lakes

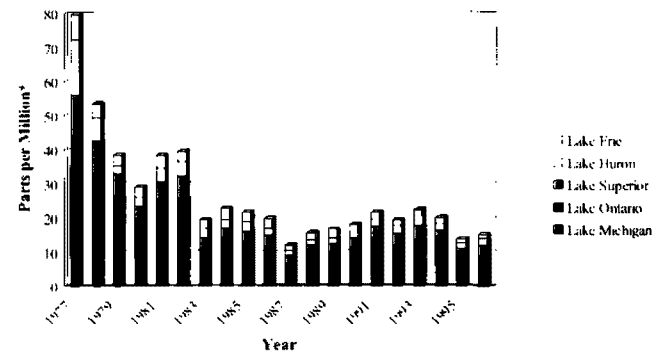
The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

This indicator measures DDE levels in herring gull eggs from each of the Great Lakes. DDE is the breakdown product of the banned pesticide DDT. Because DDE is persistent and bioaccumulative it is a good representative for pesticide pollutants in the lakes and well-suited for long-term ambient monitoring. It is important to track the levels of DDE in herring gull eggs because DDE has been linked to hormone disruption, reproductive failure, and eggshell thinning in birds (Newman 1998). Because of the nature of this chemical, its toxicity to wildlife, and the status of the herring gull as a major indicator species for the Great Lakes, this indicator provides a good measure of the environmental quality of the Great Lakes ecosystem.

The chart displays the DDE levels in herring gull eggs at sampled sites from each of the Great Lakes for 1977 to 1996.

- Over the past 20 years, levels of DDE in herring gull eggs have dropped considerably: from an average of 16 ppm in 1977 to 3 ppm in 1996.
- Lake Erie has consistently had the lowest levels of DDE in herring gull eggs, with only 1.25 ppm in 1996.
- Lake Michigan has consistently had the highest levels of DDE in herring gull eggs, with 6.1 ppm in 1996.

DDE Levels in Herring Gull Eggs from the Great Lakes, 1977-1996



Notes: *Parts per million in whole egg samples, wet weight. For Lake Michigan in 1979, 1981 and 1993, data were not available. For these years, the levels of DDE were assumed to be the average of the levels for the years immediately before and after (i.e., 1978 and 1980, 1980 and 1982, 1992 and 1994). Data for Lake Michigan for 1996 are based on only one count per sampling site.

Source: Environment Canada, Canadian Wildlife Service and Canada Centre for Inland Waters. Data found in the 1996 report of the Council on Environmental Quality.

Data Characteristics and Limitations: The measurement of contaminant levels in herring gull eggs is one of the longest running wildlife monitoring programs for contaminants in the world. Data is available annually dating back to 1974.

References

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ECOLOGICAL HEALTH
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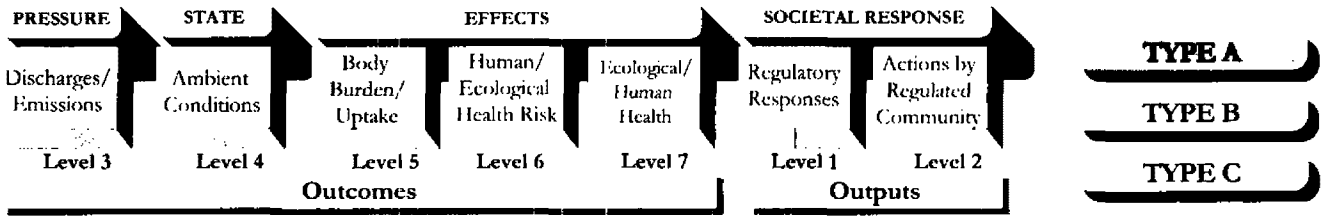


Indicator: Mirex Levels in Herring Gull Eggs from the Great Lakes

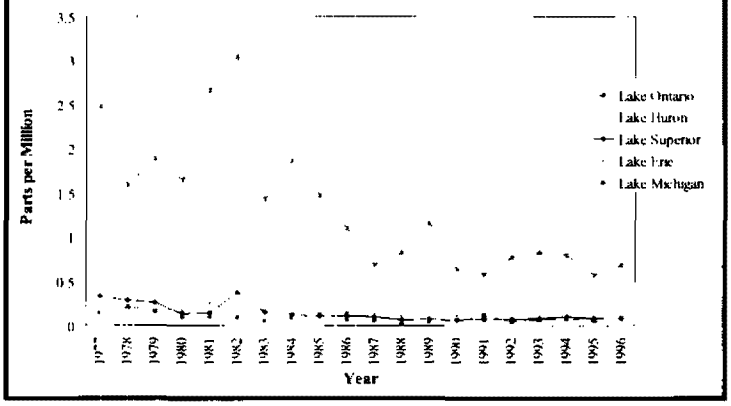
The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA, and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

This indicator measures mirex levels in herring gull eggs from each of the Great Lakes. Mirex was used as an insecticide to control fire ants, and also as a fire retardant in plastics, rubber, paint, paper, and electrical goods. Since 1978, the EPA has canceled all uses of mirex. Mirex is a persistent, bioaccumulative, and toxic (PBT) pollutant targeted by the EPA. Thus, it is well suited for long-term ambient monitoring. It is important to track the levels of mirex in herring gull eggs because it has been linked to harmful effects in birds and other wildlife. Due to the nature of this chemical, its toxicity to wildlife and humans, and the status of the herring gull as a major indicator species for the Great Lakes, this indicator provides a good measure of the environmental quality of the Great Lakes ecosystem.

The chart displays the mirex levels in herring gull eggs at sampled sites from each of the Great Lakes from 1977 to 1996.

- Over the past 20 years, levels of mirex in herring gull eggs have dropped considerably from an average of 0.77 ppm in 1977 to 0.21 ppm in 1996.
- Since 1978, Lake Ontario has consistently had the highest levels of mirex in herring gull eggs, with 0.68 ppm in 1996.

Mirex Levels in Herring Gull Eggs from the Great Lakes, 1977-1996



Notes: Parts per million in whole egg samples, wet weight. For Lake Michigan in 1979, 1981, and 1993, data were not available. For these years, the levels of mirex were assumed to be the average of the levels for the years immediately before and after (i.e., 1978 and 1980, 1980 and 1982, 1992 and 1994). Data for Lake Michigan for 1996 are based on only one count per sampling site.

Source: Environment Canada, Canadian Wildlife Service, and Canada Centre for Inland Waters. Data are found in the 1996 report of the Council on Environmental Quality.

Scale: The Great Lakes and its watersheds.

Data Characteristics and Limitations: The measurement of contaminant levels in herring gull eggs is one of the longest running wildlife monitoring programs for contaminants in the world. Data are available annually dating back to 1974.

References

"Contaminants in Herring Gull Eggs from the Great Lakes: 25 Years of Monitoring Levels and Effects." 31 January 2003. Available online at: http://www.on.ec.gc.ca/wildlife/factsheets/fs_herring_gulls-e.html

Environmental Quality Along the American River. The 1996 Report of the Council on Environmental Quality.

EPA OPPTS fact sheet on mirex. 31 January 2003. Available online at: http://www.epa.gov/opptintr/pbt/mirex.htm

ECOLOGICAL HEALTH
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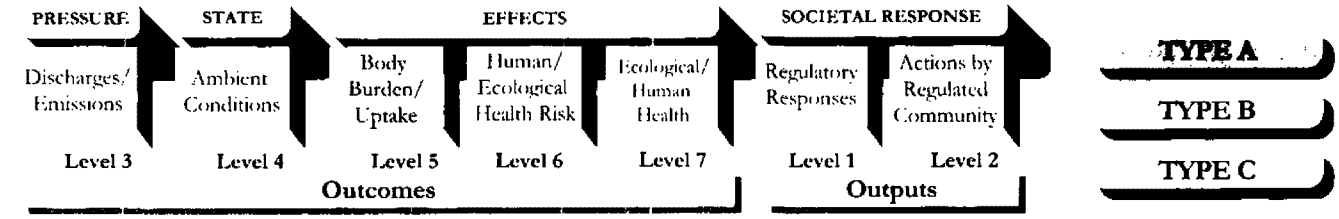


Indicator: Dieldrin Levels in Herring Gull Eggs from the Great Lakes

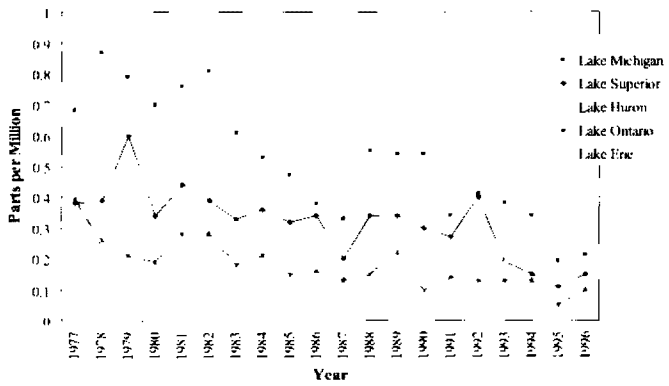
The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA, and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

This indicator measures dieldrin levels in herring gull eggs from each of the Great Lakes. Dieldrin is a persistent, bioaccumulative, and toxic (PBT) pollutant targeted by the EPA. It is an organochlorine insecticide, so most of its uses have been banned in Canada and the U.S. Thus, it is well suited for long-term ambient monitoring. It is important to track the levels of dieldrin in herring gull eggs because it has been linked to harmful effects in birds and other wildlife. Due to the nature of this chemical, its toxicity to wildlife and humans, and the status of the herring gull as a major indicator species for the Great Lakes, this indicator provides a good measure of the environmental quality of the Great Lakes ecosystem.

The chart displays the dieldrin levels in herring gull eggs at sampled sites from each of the Great Lakes from 1977 to 1996.

- Over the past 20 years, levels of dieldrin in herring gull eggs have dropped considerably from an average of 0.48 ppm in 1977 to 0.13 ppm in 1996.
- Since 1978, Lake Michigan has consistently had the highest levels of dieldrin in herring gull eggs, with 0.21 ppm in 1996.
- There were "spikes" in the dieldrin levels in herring gull eggs in the beginning of the 1980's and again in the early 1990's.

Dieldrin Levels in Herring Gull Eggs in the Great Lakes, 1977-1996



Notes: Parts per million in whole egg samples, wet weight. For Lake Michigan in 1979, 1981, and 1993, data were not available. For these years, the levels of dieldrin were assumed to be the average of the levels for the years immediately before and after (i.e., 1978 and 1980, 1980 and 1982, 1992 and 1994). Data for Lake Michigan for 1996 are based on only one count per sampling site.

Source: Environment Canada, Canadian Wildlife Service, and Canada Centre for Inland Waters. Data are found in the 1996 report of the Council on Environmental Quality.

Scale: The Great Lakes and its watersheds.

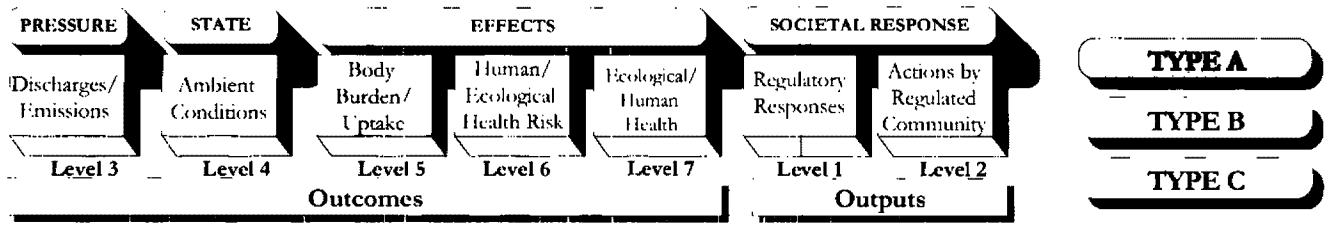
Data Characteristics and Limitations: The measurement of contaminant levels in herring gull eggs is one of the longest running wildlife monitoring programs for contaminants in the world. Data are available annually dating back to 1974.

References

"Contaminants in Herring Gull Eggs from the Great Lakes: 25 Years of Monitoring Levels and Effects." 31 January 2003. Available online at: http://www.on.ec.gc.ca/wildlife/factsheets/fs_herring_gulls-e.html

Environmental Quality Along the American River. The 1996 Report of the Council on Environmental Quality.

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



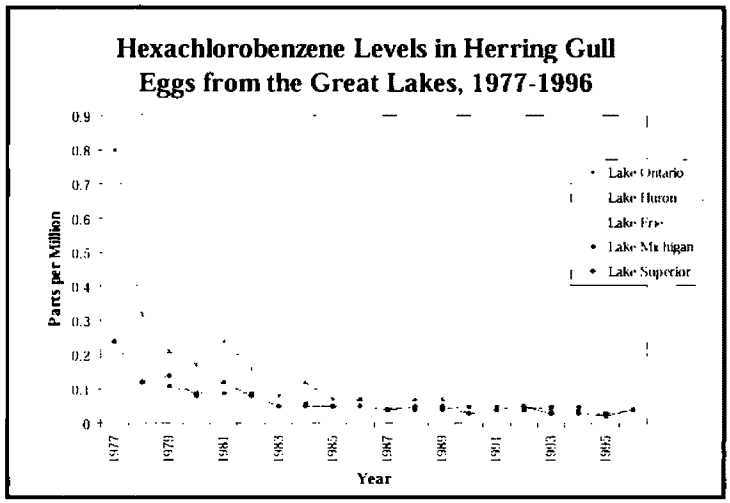
Indicator: Hexachlorobenzene Levels in Herring Gull Eggs from the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA, and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

This indicator measures hexachlorobenzene (HCB) levels in herring gull eggs from each of the Great Lakes. Past uses of HCB include its use as a fungicide, in making ammunition and fireworks, and in manufacturing synthetic rubber. HCB is a persistent, bioaccumulative, and toxic (PBT) pollutant targeted by the EPA. Thus, it is well suited for long-term ambient monitoring. It is important to track the levels of HCB in herring gull eggs because it has been linked to harmful effects in birds and other wildlife. Due to the nature of this chemical, its toxicity to wildlife and humans, and the status of the herring gull as a major indicator species for the Great Lakes, this indicator provides a good measure of the environmental quality of the Great Lakes ecosystem.

The chart displays the HCB levels in herring gull eggs at sampled sites from each of the Great Lakes from 1977 to 1996.

- Over the past 20 years, levels of HCB in herring gull eggs have dropped considerably from an average of 0.4 ppm in 1977 to 0.04 ppm in 1996.
- Since the mid-1980's, the levels of HCB in herring gull eggs have been similar across all of the Great Lakes.



Notes: Parts per million in whole egg samples, wet weight. For Lake Michigan in 1979, 1981, and 1993, data were not available. For these years, the levels of HCB were assumed to be the average of the levels for the years immediately before and after (i.e., 1978 and 1980, 1980 and 1982, 1992 and 1994). Data for Lake Michigan for 1996 are based on only one count per sampling site.

Source: Environment Canada, Canadian Wildlife Service, and Canada Centre for Inland Waters. Data are found in the 1996 report of the Council on Environmental Quality.

Scale: The Great Lakes and its watersheds.

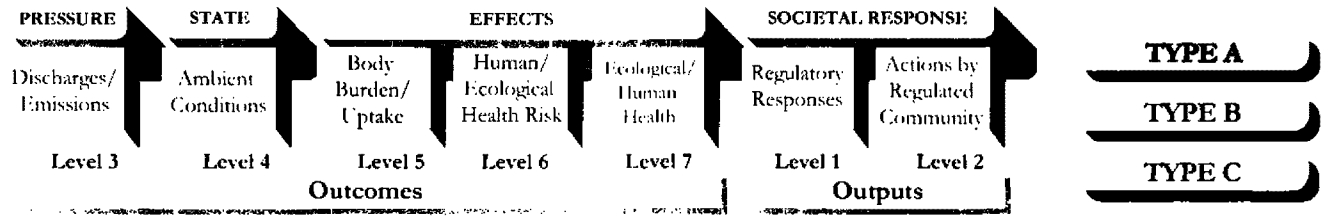
Data Characteristics and Limitations: The measurement of contaminant levels in herring gull eggs is one of the longest running wildlife monitoring programs for contaminants in the world. Data are available annually dating back to 1974.

References

"Contaminants in Herring Gull Eggs from the Great Lakes: 25 Years of Monitoring Levels and Effects." 31 January 2003. Available online at: http://www.on.ec.gc.ca/wildlife/factsheets/fs_herring_gulls e.html

Environmental Quality Along the American River. The 1996 Report of the Council on Environmental Quality.

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Concentrations of Total DDE in Bald Eagle Eggs from the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

One of the pollutants under study is DDE. DDE is the breakdown product of the banned pesticide DDT and it is environmentally persistent and bioaccumulative. For this reason, it is a good representative of the toxic organic compounds from anthropogenic sources and it is well-suited for long-term monitoring.

This indicator tracks the concentration of DDE in Bald Eagle eggs. Monitoring the concentration of DDE is important because DDE has been linked to hormone disruption, reproductive failure, and eggshell thinning in birds (Newman 1998).

Notes: Data not provided by date of publication.

Source: "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000." October 2000. SOLEC Web Site: http: www.on.ec.gc.ca/solec/implementing2000-e.html

Scale: The Great Lakes and their watersheds

Data Characteristics and Limitations: N/A

References

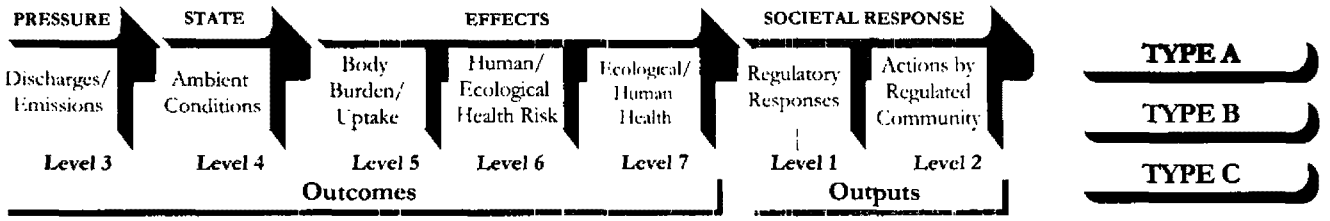
Bertram, Paul, and Stadler-Salt, Nancy, "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4," State of the Lakes Ecosystem Conference, March, 2000.

Environment Canada SOLEC Web Site. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

Newman, Michael C. 1998. *Fundamentals of Ecotoxicology*. Michigan: Ann Arbor press.

U.S. EPA SOLEC Web Site. 31 January 2003. Available online at: http://www.epa.gov/grtlakes/solec

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Concentrations of Total PCBs in Bald Eagle Eggs from the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

One of the pollutants under study are polychlorinated biphenyls (PCBs). PCBs are a small family of industrial compounds that are environmentally persistent and bioaccumulative. PCBs comprise a variety of common substances which display a range of physical and chemical properties (Francis 1994). For these reasons, they are good representatives of the toxic organic compounds from anthropogenic sources and are well-suited for long-term monitoring.

This indicator tracks the concentration of PCBs in Bald Eagle eggs. Monitoring the concentration of PCBs is important because they have been linked to developmental malformations in birds (Francis 1994).

Notes: Data not provided by date of publication.

Source: "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000." October 2000. SOLEC Web Site: http://www.on.ec.gc.ca/solec/implementing2000-e.html

Scale: The Great Lakes and their watersheds

Data Characteristics and Limitations: N/A

References

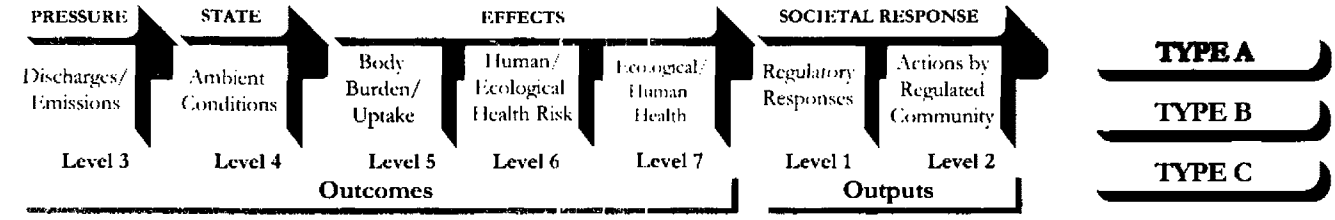
Bertram, Paul, and Stadler-Salt, Nancy, "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4," State of the Lakes Ecosystem Conference, March, 2000.

Environment Canada SOLEC Web Site. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

Francis, B. Magnus. 1994. Toxic Substances in the Environment. New York: John Wiley &Sons.

U.S. EPA SOLEC Web Site. 31 January 2003. Available online at: http://www.epa.gov/grtlakes/solec

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Contaminants in Snapping Turtle Eggs from the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

The State of the Lakes Ecosystem (SOLEC) conferences are hosted by the U. S. Environmental Protection Agency and Environment Canada on behalf of the two Countries every two years in response to the binational Great Lakes Water Quality Agreement. The conferences are intended to provide a forum for exchange of information on the ecological condition of the Great Lakes and surrounding lands. The SOLEC process views the ecosystem in terms of the state or "health" of the living system and its underlying physical, chemical and biological components. Human health is considered to be part of the living system. SOLEC conferences are intended to focus on the state of the Great Lakes ecosystem and the major factors impacting it rather than the status of programs needed for its protection and restoration. This is done through the use of environmental indicators. The SOLEC indicators are intended to provide an umbrella or overarching set which provide a general system wide overview.

One of the SOLEC indicator tracks contaminant concentrations in snapping turtle eggs from the Great Lakes. Snapping turtles are ideal candidates as indicators of wetland health due to their sedentary nature, their ability to accumulate high levels of contaminants over their long life span, and their position as top predators in the food chain.

Notes: Data not provided by date of publication.

Source: "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000," October 2000. SOLEC Web Site: http://www.on.ec.gc.ca/solec/implementing2000-e.html

Scale: The Great Lakes and their watersheds

Data Characteristics and Limitations: N/A

References

Bertram, Paul, and Stadler-Salt, Nancy, "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4," State of the Lakes Ecosystem Conference, March, 2000.

Environment Canada SOLEC Web Site. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

U.S. EPA SOLEC Web Site. 31 January 2003. Available online at: http://www.epa.gov/grtlakes/solec

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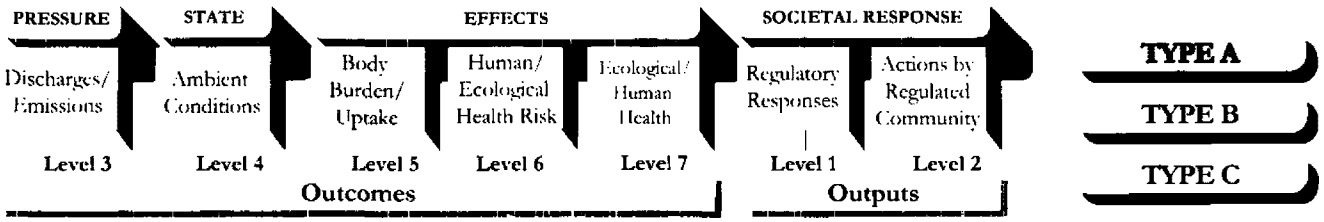

Indicator: Contaminants in Colonial Nesting Water Birds

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA, and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

The indicator, contaminants in colonial nesting water birds, will measure present chemical concentration levels and trends, as well as ecological and physiological endpoints in colonial birds, such as gulls, terns, cormorants, and/or herons. This information will help assess the impact of contaminants on the health of the water bird populations. Of particular concern is the physiology and breeding characteristics of the water birds. This indicator will serve to be exceptionally valuable since water birds are at the top of the aquatic food web of predators in the Great Lakes ecosystem. Thus, they bioaccumulate contaminants to the greatest concentration and they breed in all the Great Lakes. This will allow for easy comparisons among the lakes.

The main objective of examining colonial water birds on the Great Lakes is to note at what point there is no difference in the chemical and biological parameters between colonial water birds from the Great Lakes and those off the Great Lakes. This will be essential in recognizing when the clean-up goal has been achieved.

Notes: Data not provided by date of publication.

Source: "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000," October 2000.

Scale: The Great Lakes and its watersheds.

Data Characteristics and Limitations: N/A

References

Bertram, Paul, and Nancy Stadler-Salt. "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4." State of the Lakes Ecosystem Conference, March 2000.

Environment Canada SOLEC. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

U.S. EPA SOLEC. 31 January 2003. Available online at: http://www.epa.gov/grtlakes/solec

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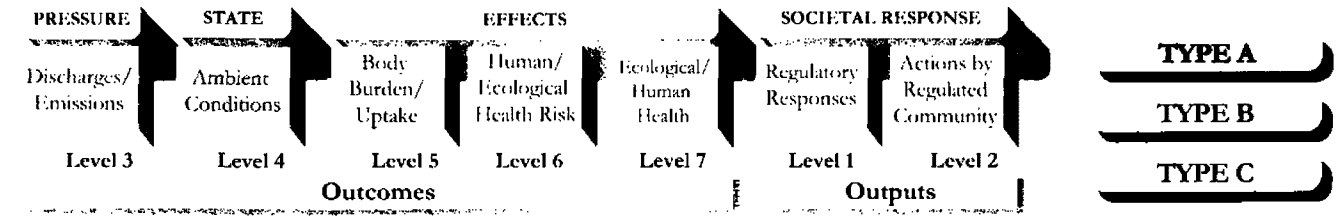

Indicator: PAH Concentrations in Offshore Waters of the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

Polycyclic aromatic hydrocarbons (PAHs) are a group of over one hundred different chemicals that are formed during the incomplete burning of coal, oil, gas, garbage, or other organic substances like tobacco and charbroiled meat. PAHs enter water through discharges from industrial and wastewater treatment plants. Once in water, they do not dissolve easily, but stick to solid particles and settle to the bottom of lakes and rivers. It is important to monitor the levels of PAHs in the environment because animal tests show that PAHs affect reproduction by causing higher rates of birth defects and lower birth rates. They can also cause harmful effects on the skin, body fluids, and the ability to fight diseases after both short- and long-term exposure. The Department of Health and Human Services has determined that some PAHs are expected carcinogens.

This indicator tracks the concentrations of PAHs in offshore waters of the Great Lakes.

Notes: Data not provided by date of publication.

Source: "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000," October 2000. SOLEC Web Site: http://www.on.ec.gc.ca/solec/implementing2000-e.html

Scale: The Great Lakes and their watersheds

Data Characteristics and Limitations: N/A

References

Bertram, Paul, and Stadler-Salt, Nancy, "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4," State of the Lakes Ecosystem Conference, March, 2000.

Environment Canada SOLEC Web Site. 31 January 2003. Available online at: http: www.on.ec.gc.ca solec intro.html

U.S. EPA SOLEC Web Site. 31 January 2003. Available online at: http: www.epa.gov grtlakes solec

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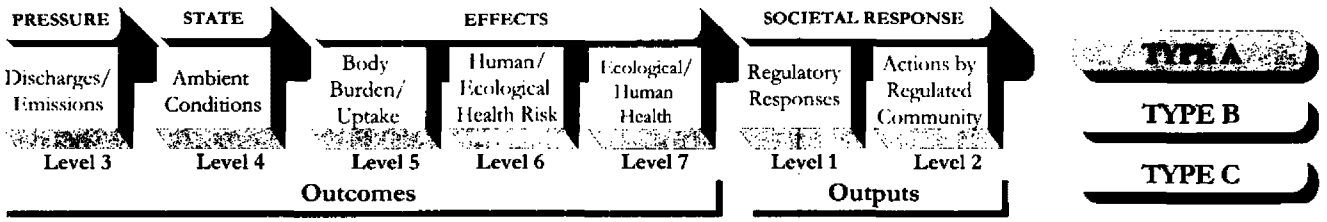

Indicator: Dieldrin Concentrations in Offshore Waters of the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

Dieldrin is an organochlorine insecticide; most of its uses have been banned in Canada and the United States. It is a persistent, bioaccumulative, and toxic pollutant (PBT) targeted by the EPA, making it well-suited for long-term ambient monitoring. It is important to track the concentrations of dieldrin in the environment because it has been linked to harmful effects in birds and other wildlife, including liver damage and immuno-suppression. The EPA considers dieldrin to be a probable carcinogen in humans.

This indicator tracks the concentrations of dieldrin in offshore waters of the Great Lakes.

Notes: Data not provided by date of publication.

Source: "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000," October 2000. SOLEC Web Site: http://www.on.ec.gc.ca/solec/implementing2000-e.html

Scale: The Great Lakes and their watersheds

Data Characteristics and Limitations: N/A

References

Bertram, Paul, and Stadler-Salt, Nancy, "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4," State of the Lakes Ecosystem Conference, March, 2000.

Environment Canada SOLEC Web Site. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

U.S. EPA SOLEC Web Site. 31 January 2003. Available online at: http://www.epa.gov/grtlakes/solec

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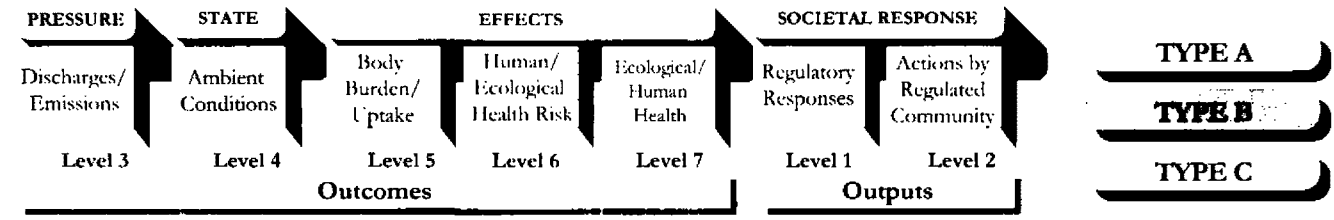

Indicator: Concentrations of Atrazine in Lake Michigan

Lakes are unique ecosystems that act as "pollutant sinks." For instance, a drop of water entering Lake Michigan today will remain in Lake Michigan for an average of 100 years before it either evaporates or washes into Lake Huron through the Straits of Mackinaw. To study the pollution of Lake Michigan, the EPA Great Lakes National Program Office (GLNPO) began the Lake Michigan Mass Balance (LMMB) project in 1994. A mass balance study is based on the simple principle that the amount of a pollutant entering an ecosystem should equal the amount of that pollutant exiting, persisting, or chemically changed in that ecosystem. Using this mass balance model, the loading, transport, and fate of four chemical pollutants in Lake Michigan are being studied.

One of the pollutants under study is atrazine. Atrazine is the most widely used herbicide in corn and sorghum production in the U.S. In 1999, 54.7 million pounds of active ingredient of atrazine were applied to 68.3 million acres of corn. These treated acres represent 70% of all corn acres in the U.S. (USDA NASS 2000). Because of its widespread use, atrazine is presently a good representative compound for less persistent herbicides. However, since the use of atrazine is declining, in the future it will be necessary to track the loading, transport, and fate of new pesticide compounds on the market.

Monitoring the ambient concentration of atrazine and tracking its transport and fate are important since it has been identified by the EPA as a potential human carcinogen. Atrazine is a restricted-use compound; however, its sale and purchase is more strictly regulated in some states than in others.

Notes: Data not provided by date of publication.

Source: EPA Lake Michigan Mass Balance Study.

Scale: Lake Michigan and its watersheds.

Data Characteristics and Limitations: The complete set of data from the LMMB project is not yet available. The data are currently undergoing verification and validation, however, select subsets of data have already been made available.

The results of the LMMB project constitute a discrete data set. It has not been stated whether the EPA Great Lakes National Program Office will continue tracking the concentrations of transported atrazine in Lake Michigan. Continued tracking would support the OPPTS objective and also the EPA's Lake Wide Management Plan (LaMP 2000) for Lake Michigan.

References

EPA Lake Michigan Mass Balance. 31 January 2003. Available online at: http://www.epa.gov/glnpo/lmmb/index.html

U.S. Department of Agriculture National Agricultural Statistics Service. Agricultural Chemical Usage, Field Crop Summary 1999. Released May 2000.

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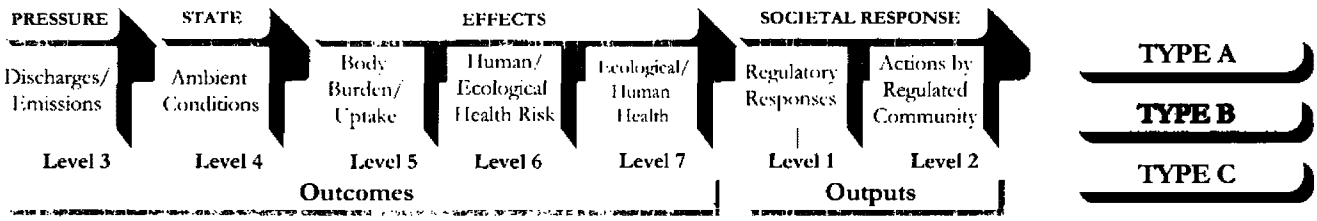
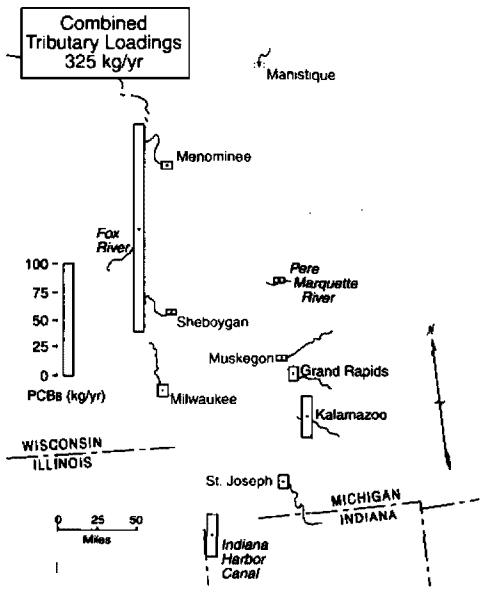


Indicator: Concentrations of PCBs in Lake Michigan

Lakes are unique ecosystems that act as "pollutant sinks." For instance, a drop of water entering Lake Michigan today will remain in Lake Michigan for an average of 100 years before it either evaporates or washes into Lake Huron through the Straits of Mackinaw. To study the pollution of Lake Michigan, the EPA Great Lakes National Program Office (GLNPO) began the Lake Michigan Mass Balance (LMMB) project in 1994. A mass balance study is based on the simple principle that the amount of a pollutant entering an ecosystem should equal the amount of that pollutant exiting, persisting, or chemically changed in that ecosystem. Using this mass balance model, the loading, transport, and fate of four chemical pollutants in Lake Michigan are being studied.

One of the pollutants under study is polychlorinated biphenyl (PCB). PCBs are a small family of industrial compounds that are environmentally persistent and bioaccumulative. PCBs comprise a variety of common substances that display a range of physical and chemical properties. For these reasons, they are good representatives for many of the toxic organic compounds from human-originated sources and are well suited for long-term ambient monitoring.

Monitoring the ambient concentration of PCBs and tracking their transport and fate are important since PCBs have been identified by the EPA as a bioaccumulative chemical of concern (BCC). PCBs have been linked to reproductive problems in turtles (Bergeron et al. 1994), developmental malformations in birds (Francis 1994), and found to reduce the photosynthetic activity of plants (Doust et al. 1994). Although the EPA has restricted the widespread use of PCBs, the compounds are legally allowed in some electrical transformers and small capacitors found in fluorescent lamps, televisions, and other appliances.



Notes: Data not provided by date of publication.

Source: EPA Lake Michigan Mass Balance Study.

Scale: Lake Michigan and its watersheds.

Data Characteristics and Limitations: The complete set of data from the LMMB project is not yet available. The data are currently undergoing verification and validation, however, select subsets of data have already been made available. The figure above graphically depicts average annual PCB loadings into Lake Michigan from April 1994 through October 1995.

The results of the LMMB project constitute a discrete data set. It has not been stated whether the EPA Great Lakes National Program Office will continue tracking the concentrations of transported atrazine in Lake Michigan. Continued tracking would support the OPPTS objective and also the EPA's Lake Wide Management Plan (LaMP 2000) for Lake Michigan.

References

Bergeron, J.M. et al. "PCBs as environmental estrogens." Cited in Fundamentals of Ecotoxicology. Michael C. Newman. Ann Arbor: Sleeping Bear Press, 1998.

Doust, J.L. et al. "Biological Assessmention of Aquatic Pollution." Cited in Fundamentals of Ecotoxicology. Michael C. Newman. Ann Arbor: Sleeping Bear Press. 1998.

EPA Lake Michigan Mass Balance. 31 January 2003. Available online at: http://www.epa.gov/glnpo/lmmb/index.html

Francis. B. Magnus. 1994. Toxic Substances in the Environment. New York: John Wiley & Sons.

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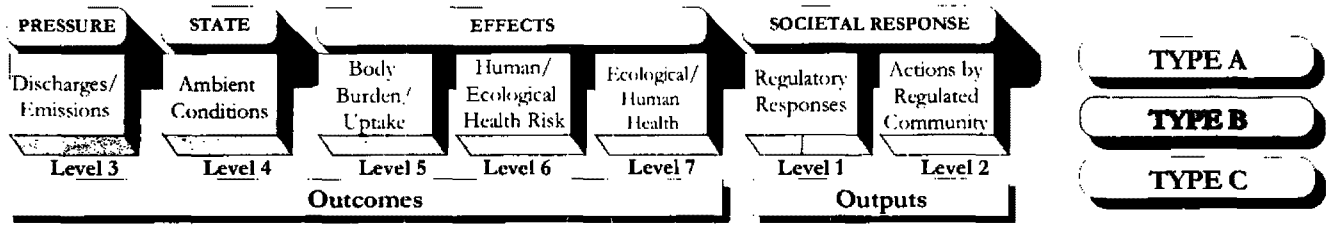
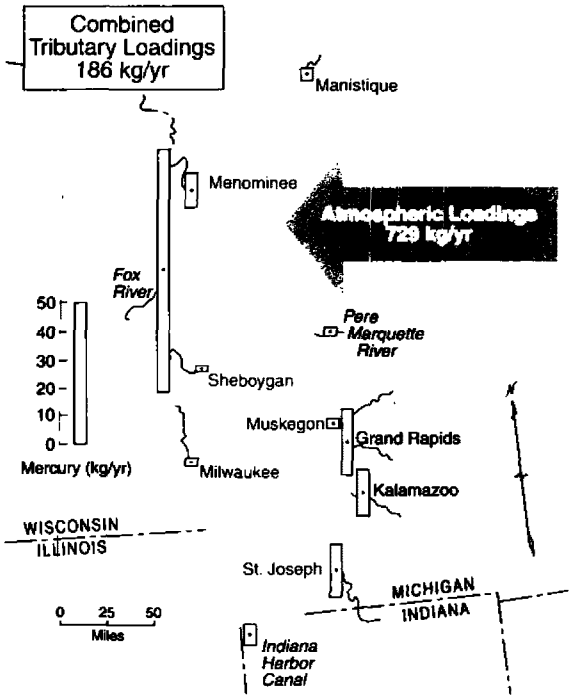


Indicator: Concentrations of Mercury in Lake Michigan

Lakes are unique ecosystems that act as "pollutant sinks." For instance, a drop of water entering Lake Michigan today will remain in Lake Michigan for an average of 100 years before it either evaporates or washes into Lake Huron through the Straits of Mackinaw. To study the pollution of Lake Michigan, the EPA Great Lakes National Program Office (GLNPO) began the Lake Michigan Mass Balance (LMMB) project in 1994. A mass balance study is based on the simple principle that the amount of a pollutant entering an ecosystem should equal the amount of that pollutant exiting, persisting, or chemically changed in that ecosystem. Using this mass balance model, the loading, transport, and fate of four chemical pollutants in Lake Michigan are being studied.

One of the pollutants under study is mercury. Mercury is a naturally occurring metal that commonly used in many consumer products, such as batteries, barometers, thermometers, switches and fluorescent lamps. Releases of mercury in the environment occur naturally and as a result of human activity. The EPA estimates that about 11,000 metric tons of mercury are released annually to the air, soil, and water through human activity. In media, mercury has been found to be persistent and bioaccumulative.

Monitoring the ambient concentration of mercury and tracking its transport and fate are important because mercury is a known neurotoxicant (Francis 1994). Mercury compounds are highly poisonous to most organisms and have been identified as human developmental toxicants (ibid.).



Notes: Data not provided by date of publication.

Source: EPA Lake Michigan Mass Balance Study.

Scale: Lake Michigan and its watersheds.

Data Characteristics and Limitations: The complete set of data from the LMMB project is not yet available. The data are currently undergoing verification and validation, however, select subsets of data have already been made available. The figure above graphically depicts average annual mercury loadings into Lake Michigan from April 1994 through October 1995.

The results of the LMMB project constitute a discrete data set. It has not been stated whether the EPA Great Lakes National Program Office will continue tracking the concentrations of transported mercury in Lake Michigan. Continued tracking would support the OPPTS objective and also the EPA's Lake Wide Management Plan (LaMP 2000) for Lake Michigan.

References

EPA Lake Michigan Mass Balance. 31 January 2003. Available online at: http://www.epa.gov/glnpo/lmmb/index.html

Francis, B. Magnus. 1994. Toxic Substances in the Environment. New York: John Wiley & Sons.

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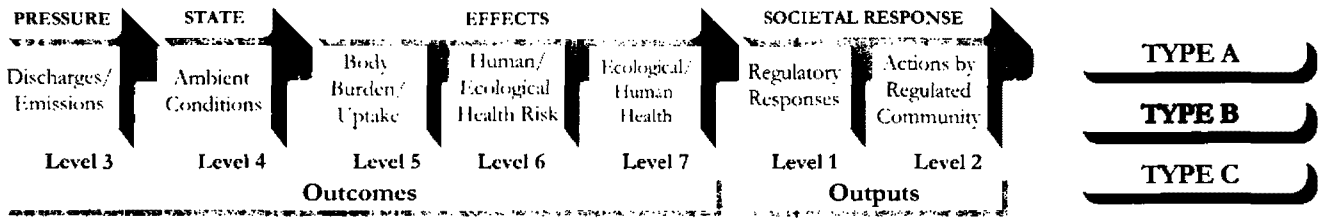
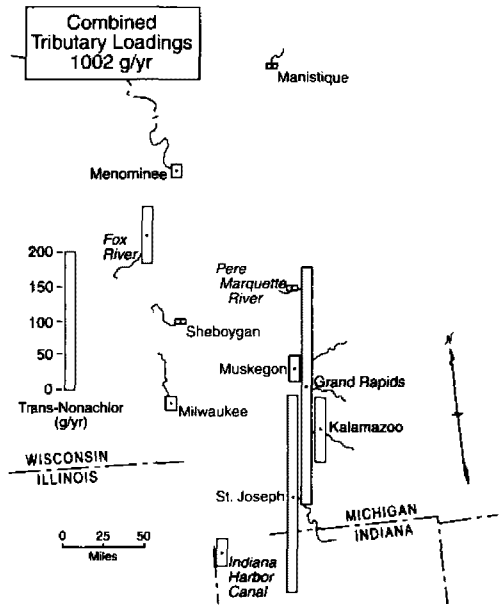


Indicator: Concentrations of Trans-Nonachlor in Lake Michigan

Lakes are unique ecosystems that act as "pollutant sinks." For instance, a drop of water entering Lake Michigan today will remain in Lake Michigan for an average of 100 years before it either evaporates or washes into Lake Huron through the Straits of Mackinaw. To study the pollution of Lake Michigan, the EPA Great Lakes National Program Office (GLNPO) began the Lake Michigan Mass Balance (LMMB) project in 1994. A mass balance study is based on the simple principle that the amount of a pollutant entering an ecosystem should equal the amount of that pollutant exiting, persisting, or chemically changed in that ecosystem. Using this mass balance model, the loading, transport, and fate of four chemical pollutants in Lake Michigan are being studied.

One of the pollutants under study is trans-nonachlor. Trans-nonachlor is a constituent compound of chlordane. Chlordane is a chlorinated hydrocarbon that was originally registered as a pesticide in 1948; however, the EPA canceled all commercial use of chlordane in 1988. Especially in aquatic environments, chlordane is persistent and bioaccumulative. Trans-nonachlor is the most bioaccumulative compound of the chlordanes exceeding human health guidelines in fish tissue. For this reason, it is a good representative of the cyclodiene class of pesticides.

Monitoring the ambient concentration of cyclodiene pesticides (via the proxy measure of trans-nonachlor) and tracking their transport and fate are important since cyclodienes are known neurotoxicants (Francis 1994). Cyclodienes have been linked to fish kills, chronic poisoning of applicators, and behavioral abnormalities and cancers in mammals (ibid.).



Notes: Data not provided by date of publication.

Source: EPA Lake Michigan Mass Balance Study.

Scale: Lake Michigan and its watersheds.

Data Characteristics and Limitations: The complete set of data from the LMMB project is not yet available. The data are currently undergoing verification and validation, however, select subsets of data have already been made available. The figure above graphically depicts average annual trans-nonachlor loadings into Lake Michigan from April 1994 through October 1995.

The results of the LMMB project constitute a discrete data set. It has not been stated whether the EPA Great Lakes National Program Office will continue tracking the concentrations of trans-nonachlor in Lake Michigan. Continued tracking would support the OPPTS objective and also the EPA's Lake Wide Management Plan (LaMP 2000) for Lake Michigan.

References

EPA Lake Michigan Mass Balance. 31 January 2003. Available online at: http://www.epa.gov/glnpo/lmmb/index.html

Francis, B. Magnus. 1994. Toxic Substances in the Environment. New York: John Wiley & Sons.

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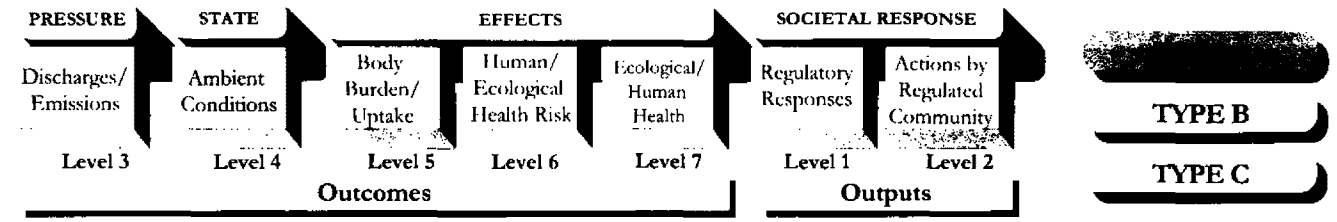


Indicator: Arsenic Loadings to the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA, and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

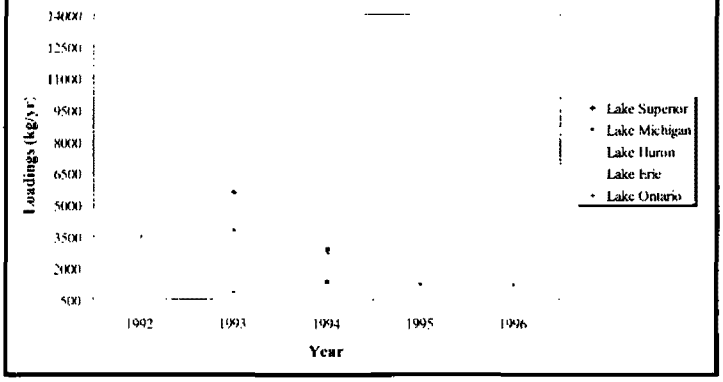
The Integrated Atmospheric Deposition Network (IADN) was created under the U.S.-Canada Great Lakes Water Quality Agreement for the purpose of identifying airborne toxic substances, identifying their sources, and estimating their deposition to the Great Lakes. The IADN measures the loadings of atmospheric contaminants into the Lakes through wet deposition, dry deposition, and gas exchange.

One of the chemicals of concern is arsenic. Arsenic is an element that occurs in the earth's crust. Accordingly, there are natural sources of exposure, including the weathering of rocks, the erosion of depositing arsenic in water bodies, and the uptake of the metal by animals and plants. People may also be exposed to industrial sources, as arsenic is used in semiconductor manufacturing, petroleum refining, wood preservatives, animal feed additives, and herbicides. Arsenic can combine with other elements to form inorganic and organic arsenicals. In general, inorganic arsenicals are considered more toxic than the organic forms. While food contains both inorganic and organic arsenicals, primarily inorganic forms are present in water. Exposure to arsenic at high levels poses a serious health risk because it is a known human carcinogen. In addition, it has been reported to affect the vascular system in humans and is associated with the development of diabetes.

This indicator tracks the amount of arsenic (kg/yr) being loaded into the Great Lakes through wet and dry deposition from 1992 to 1996.

- Lake Huron has the highest levels of arsenic loadings of any of the five Great Lakes.
- After an initial decrease from 1992 to 1995, arsenic loadings increased in 1996 to 5,600 kg/yr in Lake Huron.

Atmospheric Loadings of Arsenic into the Great Lakes, 1992-1996



Notes: Loadings reflect the sum of wet and dry deposition into the lakes. A missing value means that a loading could not be calculated, not that no loading occurred. This measure does not take into account the size differences among the Great Lakes.

Source: Environment Canada and the EPA. *Atmospheric Deposition of Toxic Substances to the Great Lakes: IADN Results to 1996.*

Scale: The Great Lakes and its watersheds.

Data Characteristics and Limitations: The IADN monitoring system comprises five master stations (one at each Great Lake) and fourteen satellite stations. Several instruments are grouped at each site to collect air and rain samples. In IADN, three deposition processes are considered: wet deposition by precipitation, dry particle deposition by sedimentation, and net diffusive gas exchange. These processes account for the effects of air to water absorption and water to air volatilization. The data reported in this indicator reflect work from the first phase of IADN, which was conducted from 1990 to 1996. The second phase of IADN, preliminary data from which are not yet available, is scheduled to run until 2004. No major changes to IADN are anticipated.

References

Bertram, Paul and Nancy Stadler-Salt. "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4." State of the Lakes Ecosystem Conference, March 2000.

Environment Canada SOLEC. 2001. 31 January 2003. Available online at: http://www.on.ec.gc.ca/solec/intro.html

Stadler-Salt, Nancy and Paul Bertram. "State of the Lakes Ecosystem Conference 2000 Implementing Indicators: Draft for Discussion at SOLEC 2000." October 2000.

U.S. EPA OPPT. 2001. 31 January 2003. Available online at: http://www.epa.gov/opptintr/lead/

U.S. EPA SOLEC. 2001. 31 January 2003. Available online at: http://www.epa.gov/grtlakes/solec/

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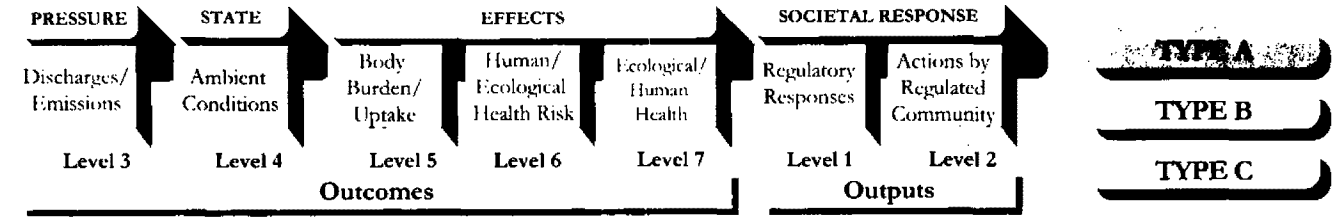


Indicator: Lead Loadings to the Great Lakes

The Great Lakes compose an important and unique ecosystem. They represent the largest system of fresh water in the world and provide many economic and ecological benefits to the surrounding areas. The Great Lakes basin, which includes the lakes and over 290,000 square miles of land that drains into them, supports concentrated industry and agriculture for the U.S. and Canada. These activities have taken their environmental toll on the Great Lakes as sewage, fertilizer and pesticide run-off, and industrial wastes have deteriorated water quality. In response to this, there have been many pollution prevention and clean-up efforts sponsored by local governments, the EPA, and the Canadian government. Long-term monitoring is necessary to track the progress of these initiatives and to prevent any further degradation of the Great Lakes ecosystem.

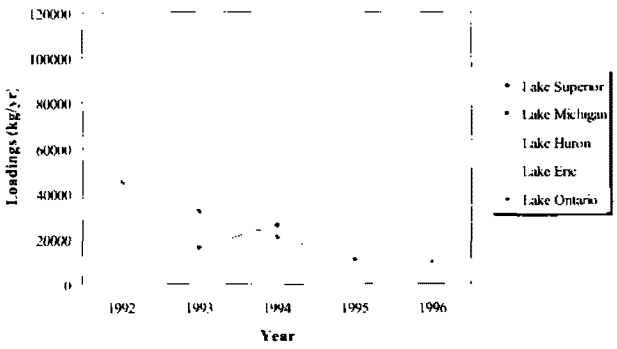
The Integrated Atmospheric Deposition Network (IADN) was created under the U.S.-Canada Great Lakes Water Quality Agreement for the purpose of identifying airborne toxic substances, identifying their sources, and estimating their deposition to the Great Lakes. The IADN measures the loadings of atmospheric contaminants into the Lakes through wet deposition, dry deposition, and gas exchange.

Lead is a highly toxic metal that produces a range of adverse health effects, particularly in young children. Exposure to excessive levels of lead can cause brain damage, affect a child's growth, damage kidneys, impair hearing, cause vomiting, headaches, appetite loss, and behavioral problems. In adults, lead poisoning can lead to increased blood pressure, digestive problems, kidney damage, nerve disorders, sleep disorders, muscle and joint pain, and mood disorders.

This indicator measures the amount of lead (kg/yr) being loaded into the Great lakes through wet and dry deposition from 1992 to 1996.

- Lake Huron has the highest level of lead deposition of all five Great Lakes.
- After an initial decrease from 1992 to 1995, lead deposition rose to 31,000 kg/yr in lake Huron.
- Lead deposition in lake Ontario has been decreasing since 1992.

Atmospheric Loadings of Lead into the Great Lakes, 1992-1996



Notes: Loading reflects the sum of wet and dry deposition into the lakes. A missing value means that a loading could not be calculated, not that no loading occurred. This measure does not take into account the size differences among the Great Lakes.

Source: Environment Canada and the EPA. *Atmospheric Deposition of Toxic Substances to the Great Lakes: IADN Results to 1996.*

Scale: The Great Lakes and its watersheds.

Data Characteristics and Limitations: The IADN monitoring system comprises five master stations (one at each Great Lake) and fourteen satellite stations. Several instruments are grouped at each site to collect air and rain samples. In IADN, three deposition processes are considered: wet deposition by precipitation, dry particle deposition by sedimentation, and net diffusive gas exchange. These processes account for the effects of air to water absorption and water to air volatilization. The data reported in this indicator reflect work from the first phase of IADN, which was conducted from 1990 to 1996. The second phase of IADN, preliminary data from which are not yet available, is scheduled to run until 2004. No major changes to IADN are anticipated.

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Bertram, Paul and Nancy Stadler-Salt. "Selection of Indicators for Great Lakes Basin Ecosystem Health: Version 4." State of the Lakes Ecosystem Conference, March 2000.

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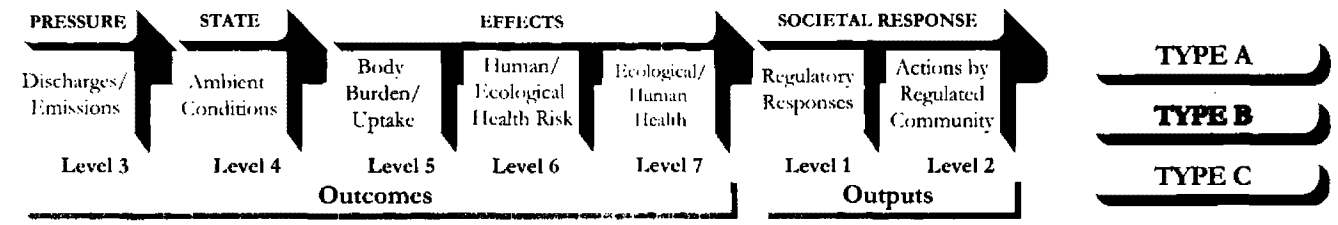

Indicator Set: Chesapeake Bay Ecosystem

The Chesapeake Bay is the United States' largest estuary and. with over 3,600 species of plants and animals, a highly diverse, complex, and productive led to the creation in 1983 of the initial Chesapeake Bay Agreement. ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The goal of this partnership was to focus on the restoration of the Bay and its living resources.

Over its 17 years of operation, this partnership has created a model ecosystem planning and management system firmly based in measurable goals, monitoring, and adaptive management. At the core of their efforts is an extensive system of environmental indicators that thoroughly document and measure every significant aspect of the Bay's health. These indicators are used to support a broad system of goals, management activities, and public information. It may be the premier example of an ecosystem management system currently operating in the United States.

The Program has identified 4 top stresses on the Bay:

- Excess nutrients
- Toxic chemical contaminants
- Air pollution
- Landscape changes

From the perspective of chemicals and pesticides, the current indicators list includes:

- Bald Eagle Population Count
- Industry Reported Releases and Transfers of Chemical Contaminants
- Industry Reported Releases and Transfers of Chesapeake Bay Toxics of Concern
- Releases and Transfers of Chemical Contaminants from Federal Facilities
- Cropland Acres Under Integrated Pest Management
- Pesticide Collection and Disposal Programs
- Pesticide Container Recycling Programs
- Kepone in Finfish Tissue
- Declines in Maryland Oyster Tissue Contaminants
- Tributyltin Concentration Levels
- Trends in Rainfall Metals Concentrations
- Copper Concentrations in Sediments
- Copper Concentrations in Sediments
- Benzo[a] pyrene Concentrations in Sediments

This array of indicators provides a solid foundation for describing the chemical contaminants condition of the Bay. Awaiting completed/awaiting approval or revision approval are the following indicators:

- Ambient Toxicity in the Chesapeake Bay, Water Column Data
- Ambient Toxicity in the Chesapeake Bay, Sediments Data
- Chesapeake Bay Ambient Toxicity Index for Sediments

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. EPA 903-99-014. CBP/TRS 223/99, July 1999. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

Toxics Indicators List. 31 January 2003. Available online at: http://www.chesapeakebay.net/status/t_index.htm

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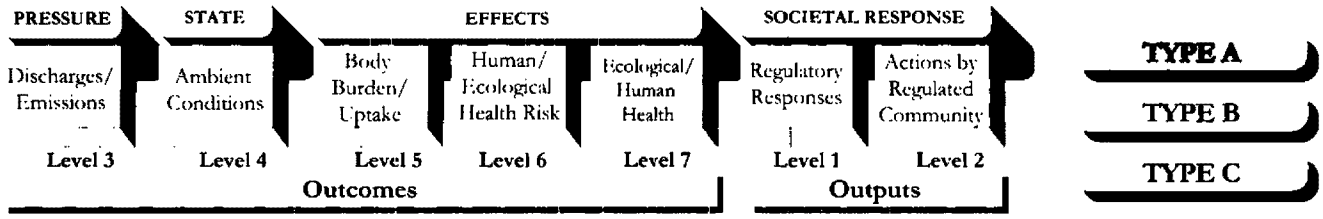


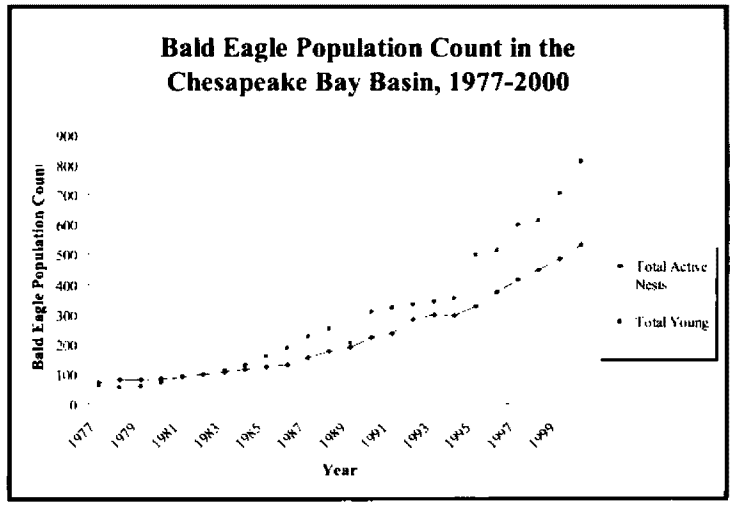
Indicator: Bald Eagle Population Count in the Chesapeake Bay Ecosystem

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

As many as 3,000 pairs of bald eagles once inhabited the Chesapeake Bay region. Their numbers declined dramatically due to habitat destruction, shooting, and contamination by DDT and other chemicals. DDT contamination caused the eggshells to become brittle, and fewer young were hatched. In 1977, only 72 nests were found in the entire Chesapeake watershed. With the ban on DDT in 1972, along with other habitat improvements, the bald eagle has made a comeback. The bald eagle was officially down listed from endangered to threatened in July of 1995.

This indicator measures the number of fledgling bald eagles and active nests in the Chesapeake Bay basin from 1977 to 2000.

- The number of active nests in the basin increased from 72 in 1977 to 533 in 2000.
- The number of fledging eagles in the basin increased from 63 in 1977 to 813 in 2000.



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: The totals from 1977 to 1999 include only the Maryland, Pennsylvania, and Virginia portions of the Chesapeake Bay basin. The total for 2000 includes those portions and the Washington D.C. portion. 2000 was the first year that an active nest and a fledgling were reported for the Washington D.C. portion of the basin.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and *Measures in the Chesapeake Bay System*. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

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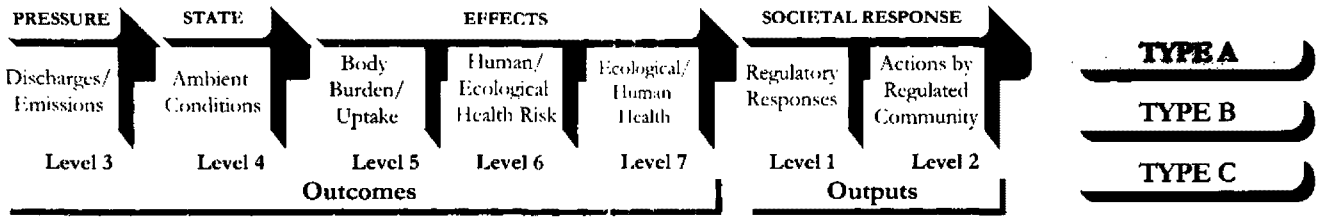


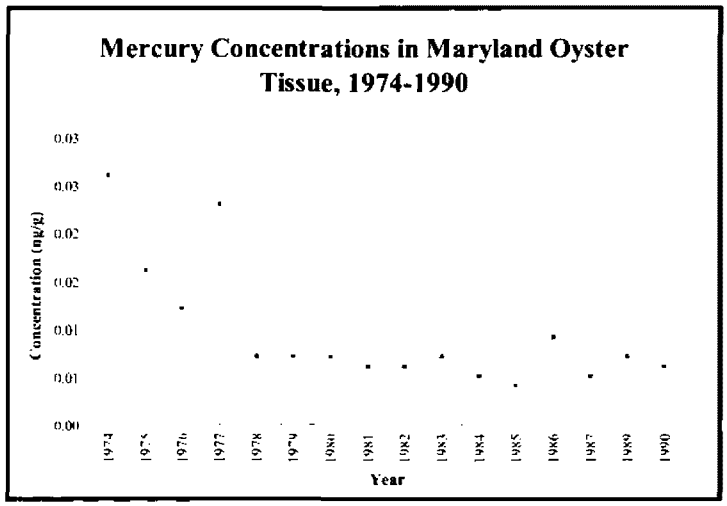
Indicator: Contaminants in Maryland Oyster Tissue

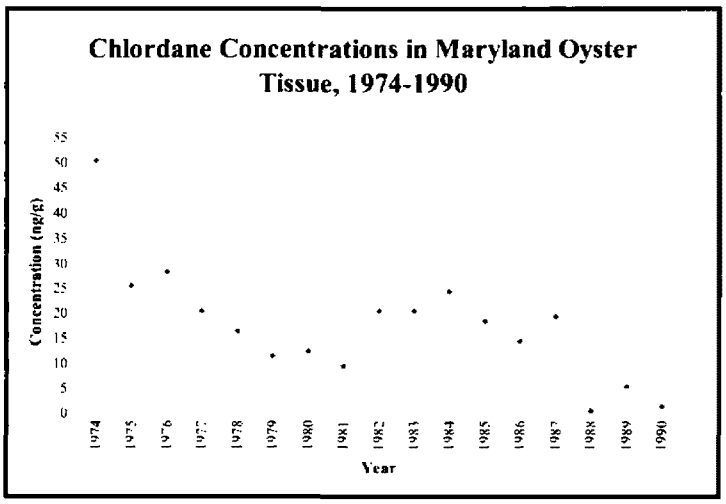
The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

Mercury and chlordane are measured in oyster tissue from the Maryland portion of the Chesapeake Bay mainstream. These are metals that are persistent, toxic, and bioaccumulative pollutants. They affect the water quality and the health of fish and wildlife in the Chesapeake Bay ecosystem. They can also affect human health through the ingestion of contaminated food sources.

This indicator measures mercury and chlordane concentrations in Maryland oyster tissue from 1974 to 1990.

- Mercury concentrations in oyster tissue have decreased 77% between 1974 and 1990.
- Chlordane concentrations in oyster tissue have decreased 98% between 1974 and 1990. Chlordane levels were below the detectable levels in 1990.





Source: The Chesapeake Bay Program.

Notes: In 1990, chlordane levels were below detectable levels.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: Data after 1990 are not presently available.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. *Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System.* 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

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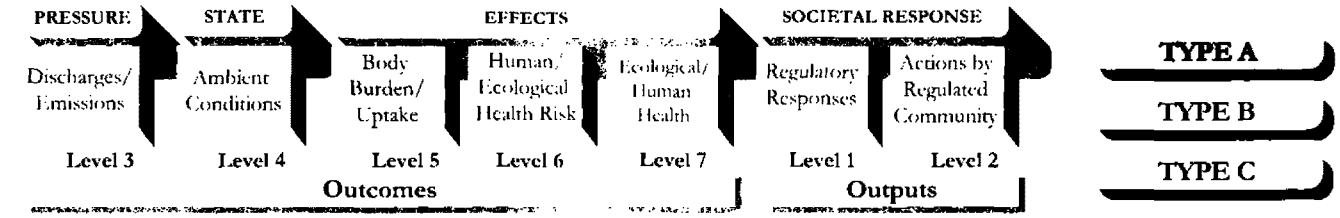


Indicator: Kepone in Finfish Tissue in the Chesapeake Bay Ecosystem

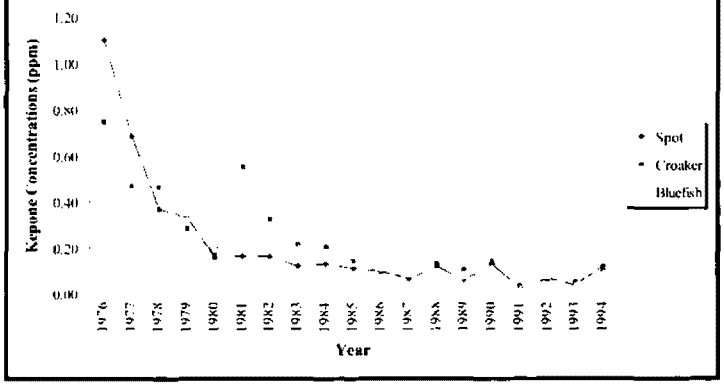
The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

Kepone is a toxic organochlorine insecticide formerly used in ant and roach traps. Its use has been banned because it is a suspected endocrine disruptor. An estimated 90,720 kg of kepone was released to the environment through atmospheric emissions, wastewater discharges, and bulk-disposal of off-specification batches. In 1975, sections of the James River and its tidal tributaries were closed to commercial and sport fishing because of kepone contamination exceeding FDA specifications. This fishing ban has since been lifted, but fish consumption advisories are still in effect for the James and its tributaries up to the fall line at Richmond, Virginia.

This indicator measures kepone in finfish tissue from Spot, Croaker, and Bluefish taken from the James River from 1976 to 1994.

- Kepone concentration levels have decreased below the Food and Drug Administration Action Level of 0.3 ppm for all three species of fish. However, a few sampled fish are still found to have levels above 0.3 ppm, which is why the consumption advisory remains in effect.

Kepone Concentrations in Finfish Tissue, 1976-1994



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: Data after 1994 are not presently available.

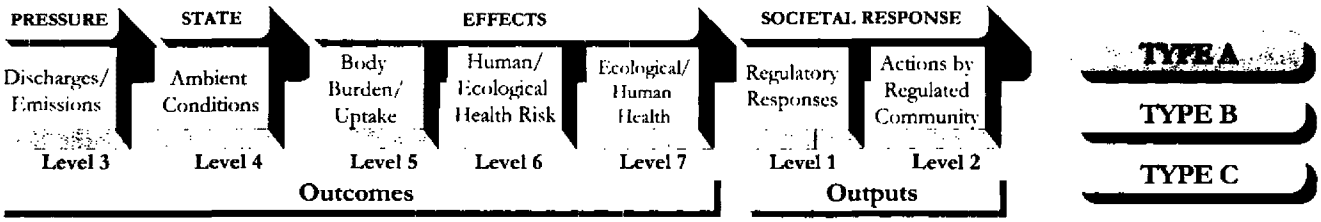
References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

Endocrine Disruptor Screening Program. 2001. EPA: Office of Science Coordination and Policy. 31 January 2003. Available online at: http://www.epa.gov/oscpmont/oscpendo/whatis.htm

U.S Environmental Protection Agency. 1999. *Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System.* 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Tributyltin Concentration Levels in the Chesapeake Bay Ecosystem

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

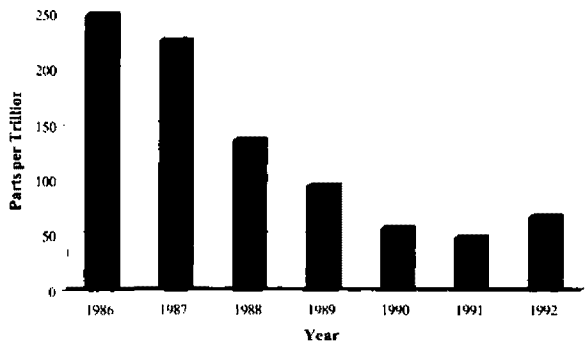
Tributyltin (TBT) is an ingredient in anti-fouling paints that was commonly used by boaters to keep boat hulls free of barnacles, algae, and other marine organisms. In time, TBT in the paint leaches into the surrounding waters. TBT is associated with the curling of oyster shells into a ball form instead of a flatter shape. TBT is also toxic to other bay life forms such as plankton and mollusks. A national restriction on the use of TBT in antifouling paints was enacted in 1988, but TBT is still found in the environment. The International Commercial Fleet still uses TBT, but the ships move almost all the time, so the leachate has few local effects. It is also legal to use TBT on aluminum-hulled boats or commercial vessels over 27 meters; as well as on motor outdrives and crab pots.

This indicator measures the TBT concentrations at a marina in Hampton Roads, Virginia from 1986 to 1992, and at four stations in Sarah Creek, Virginia from 1986 to 1991. Virginia has a chronic Water Quality Standard for TBT in estuarine waters of 1 part per trillion (ppt). Though generally declining, the recorded concentrations in Hampton Roads and Sarah Creek are still high enough to pose a risk to certain Bay organisms such as plankton and mollusks.

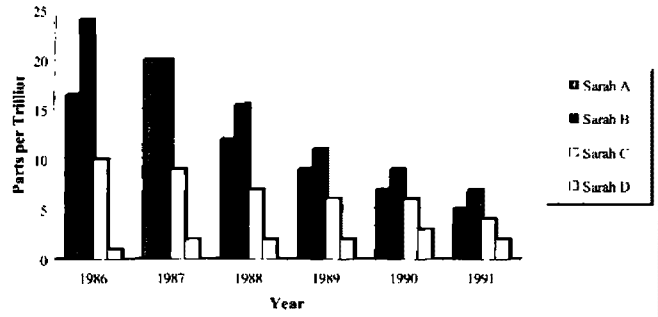
- Between 1986 and 1992, there was an overall decrease in TBT levels of 73% at the Hampton Roads, Va. testing site. However, there was an 18 ppt increase in TBT levels between 1991 and 1992.

- Overall, TBT levels at the Sarah Creek, Va. sites have decreased between 1986 and 1991. However, there was a slight increase in TBT levels at testing station D.

Tributyltin Water Column Concentration Levels at Hampton Roads, Va., 1986-1992



Tributyltin Water Column Concentration Levels at Four Stations in Sarah Creek, Va., 1986-1991



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
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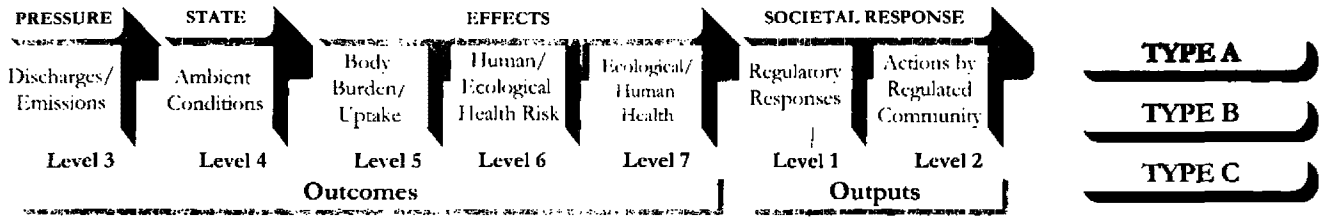


Indicator: Copper Concentration Levels in the Sediments of the Chesapeake Bay Ecosystem

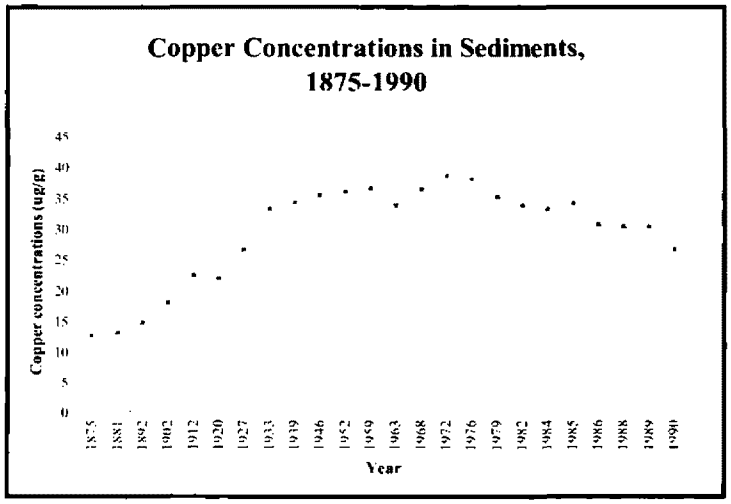
The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

Sediments are a major reservoir for metals and organic chemical contaminants because these chemicals bind to particles. Sediment concentrations are, therefore, typically higher than they are in the water column. Changes in physical or chemical characteristics of the sediment environment or the overlying water column can cause these sediment-bound chemicals to be released back into the water column.

Copper originates from domestic wastes as well as direct industrial discharge. Urban stormwater runoff, atmospheric deposition, industrial and municipal point source discharges, and shoreline erosion contribute metals, pesticides, and other organic chemical contaminants to the sediments of the bay and its tributaries. Excessive copper ingestion is associated with impaired digestive functioning in humans.

This indicator measures copper concentrations in sediment cores from the Chesapeake Bay Mainstream from 1875 to 1990. The goal of the Chesapeake Bay Program is to reduce sediment copper concentrations to a level below where there are no adverse effects on living resources. The Threshold Effect Level for copper is 18.7 ug/g. While the copper concentrations are declining, they still remain high enough to pose a health risk.

- Copper concentrations in sediments have increased 113% between 1875 and 1990. However, the levels have been decreasing since 1972.



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

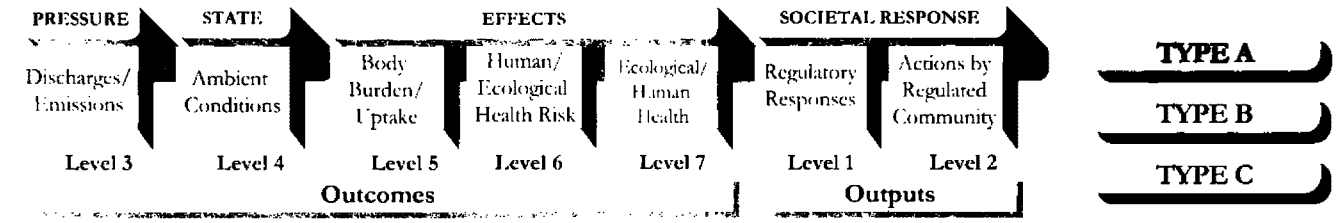
Data Characteristics and Limitations: Scientists used sediment cores to establish long-term trends by finding background or baseline concentrations in the deeper sections of the cores and constructing a chronology of sediment contamination by analyzing the shallower and more recently deposited sediment. Sediment copper levels are not available only for all years; however, overall trends can be extrapolated from the years that are available.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Concentrations of Lead and Copper in Precipitation of the Chesapeake Bay Ecosystem

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

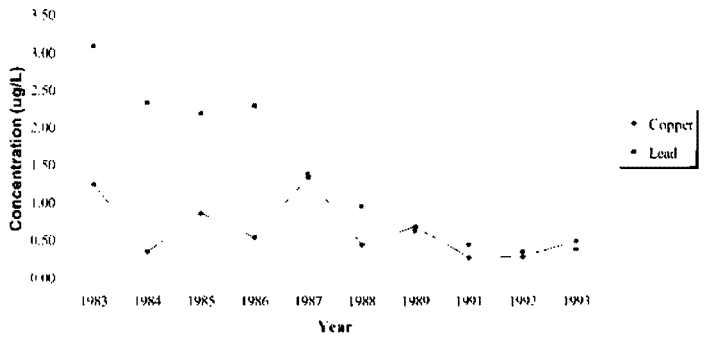
Copper originates from domestic wastes, as well as direct industrial discharge. Excessive copper ingestion is associated with impaired digestive functioning in humans, although small amounts of copper are necessary for survival.

Lead can affect almost every organ and system in the body. The most sensitive is the central nervous system, particularly in children. Lead also damages the kidneys and immune system. In adults, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may also cause anemia, abortion, and damage to the male reproductive system. Lead acetate and lead phosphate are suspected carcinogens based on studies in animals; however, there is inadequate evidence to clearly determine lead's carcinogenicity in humans (U.S. Dept. of Health and Human Services, 1993).

This indicator measures copper and lead concentrations in rainfall from the Lewes Delaware atmospheric deposition monitoring station from 1983 to 1993.

- Lead concentrations have decreased 88% between 1983 and 1993.
- Copper concentrations have increased 47% between 1991 and 1993.

Concentrations of Lead and Copper in Precipitation of the Chesapeake Bay Ecosystem, 1983-1993



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: The data for years after 1993 are unavailable, but the trend for that time period can be extrapolated from the remaining data points.

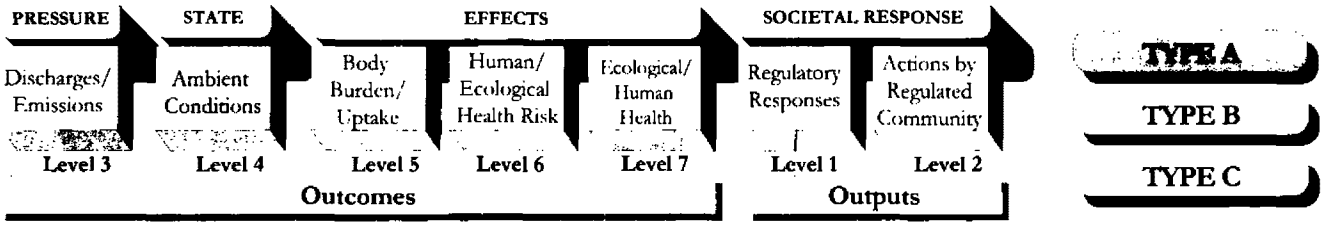
References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR). 1993. "ATSDR ToxFAQs: Lead." 31 January 2003. Available online at: www.atsdr.cdc.gov/toxfaq.html

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Benzo[a]pyrene Concentration Levels in the Sediments of the Chesapeake Bay Ecosystem

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

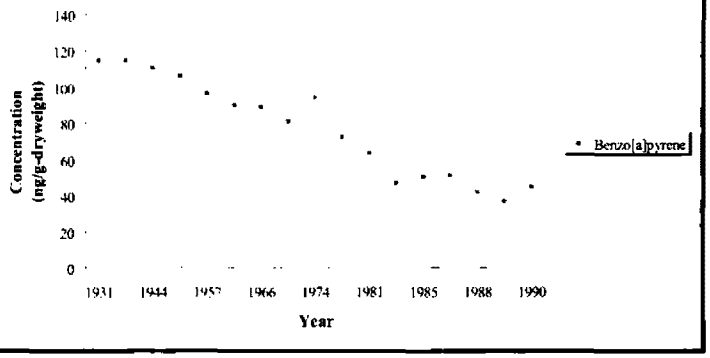
Sediments are a major reservoir for metals and organic chemical contaminants because these chemicals bind to particles. Binding can occur during urban stormwater runoff, atmospheric deposition, industrial and municipal point source discharges, shoreline erosion of metals in pesticides, and other organic chemical contaminants to the sediments of the bay and its tributaries.

Benzo[a]pyrene is one of a group of organic chemicals known as polynuclear aromatic hydrocarbons or PAHs. They are naturally formed in small quantities by plants and microbial organisms. However, human activities, such as wood burning, iron and steel production, motor vehicle emissions, and the burning of fossil fuels to generate power, are all significant sources of PAH contamination. The U.S. Department of Health and Human Services has determined that benzo[a]pyrene causes cancer when applied to the skin of laboratory animals. It has also been determined to cause reproductive difficulties, such as birth defects and low birth weight.

This indicator measures the concentration of benzo[a]pyrene in sediment cores from the mid-Chesapeake Bay Mainstream from 1931 to 1990. In 1878, the pre-industrial revolution base level concentration was 1.9 ng/g-dry weight. The goal of the Chesapeake Bay Program is to maintain sediment concentration levels below the Threshold Effect Level of 88.8 ng/g-dry weight.

- Overall, benzo[a]pyrene concentrations are declining. However, current levels are still twenty times higher than the 1878 base level.

Benzo[a]pyrene Concentrations in the Sediments of the Chesapeake Bay Ecosystem, 1931-1990



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: Scientists used sediment cores to establish long-term trends by finding background or baseline concentrations in the deeper sections of the cores and constructing a chronology of sediment contamination by analyzing the shallower and more recently deposited sediment. Measurements are only available for select years; however, overall trends can be extrapolated from the available data.

References

Agency for Toxic Substances and Disease Registry. 2001. 31 January 2003. Available online at: http://www.atsdr.cdc.gog/ToxProfiles/Phs8805.html

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S. Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
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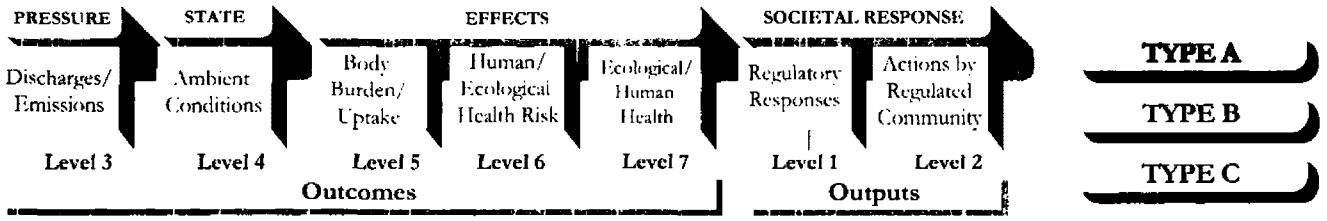


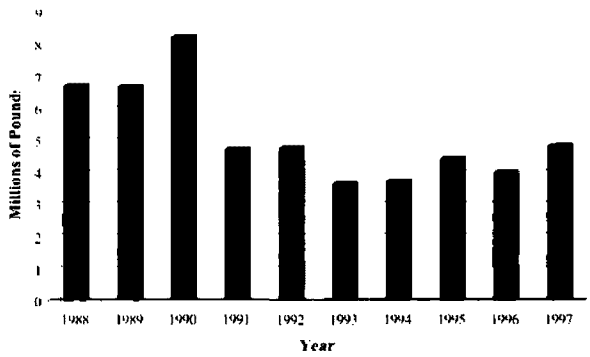
Indicator: Industry Reported Releases and Transfers of Chesapeake Bay Toxics of Concern

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

This indicator tracks industry reported releases and transfers of Chesapeake Bay Toxics of Concern (TOCs) reported in the Toxics Release Inventory (TRI) from 1988 to 1997. The TRI is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. The goal of the Chesapeake Bay Program is to have a reduction in releases and transfers of TOCs from Bay basin industries of 75% between 1988 and 2000. The toxics of concern included in this measurement are cadmium, cadmium compounds, chlordane, copper, copper compounds, chromium, chromium compounds, lead, lead compounds, mercury, naphthalene, and polychlorinated biphenyls. However, chlordane and mercury were not released by any facility between 1988 and 1997.

- Industries in the Chesapeake Bay Basin decreased the releases and transfers of toxics of concern by 29% between 1988 and 1997.
- Despite this overall decrease, the releases and transfers of toxics of concern were over a million pounds per year greater in 1997 than in 1993.

Industry Reported Releases and Transfers of Toxics of Concern, 1988-1997



Source: Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: Releases refer to air, water, and land; off-site transfers include transfers to wastewater treatment plants or disposal sites, and transfers off-site for treatment. These data do not include transfers for energy recovering or recycling which have been reported since 1991. Also, excluded are releases off-site to underground injection and on-site releases to underground injection. Data from any industrial facility required to report between 1988 and 1997 are included, even if the facility was not required to report every year. Data from federal facilities are not included in this indicator. Releases of TOC's over time appear highly variable due to the fact that these data represent a subset of Toxics Release Inventory (TRI) data and, therefore, can be driven by the actions of only a few facilities. For example, in 1997 approximately ten facilities had releases of over 100,000 lbs.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
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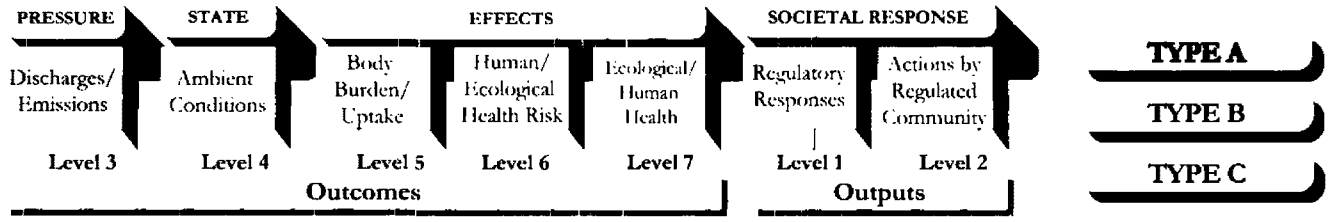


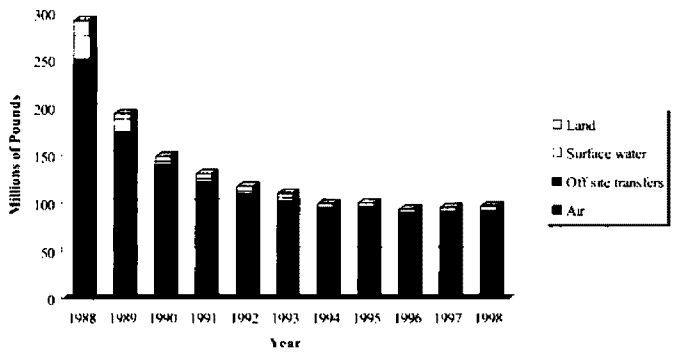
Indicator: Industry Reported Releases and Transfers of Chemical Contaminants in the Chesapeake Bay

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

This indicator tracks industry reported releases and transfers of Toxics Release Inventory (TRI) from 1988 to 1998. The TRI is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. The goal of the Chesapeake Bay Program is to have a 65% decrease in releases and transfers of chemical contaminants between 1988 and 2000.

- Industries in the Chesapeake Bay Basin decreased the releases and transfers of toxics of concern by 67% between 1988 and 1998.

Industry Reported Releases and Transfers of Chemical Contaminants, 1988-1998



Source: Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: Releases refer to air, water, and land; off-site transfers include transfers to wastewater treatment plants or disposal sites, and transfers off-site for treatment. These data do not include transfers for energy recovering or recycling which have been reported since 1991. Also, excluded are releases off-site to underground injection and on-site releases to underground injection. Data from any industrial facility required to report between 1988 and 1997 are included, even if the facility was not required to report every year. Data from federal facilities are not included in this indicator. Releases of TOCs over time appear highly variable due to the fact that these data represent a subset of Toxics Release Inventory (TRI) data and, therefore, can be driven by the actions of only a few facilities. For example, in 1997 approximately ten facilities had releases of over 100,000 lbs.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
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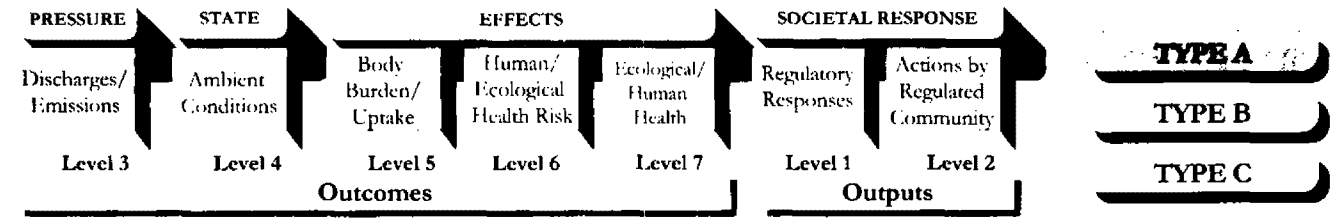
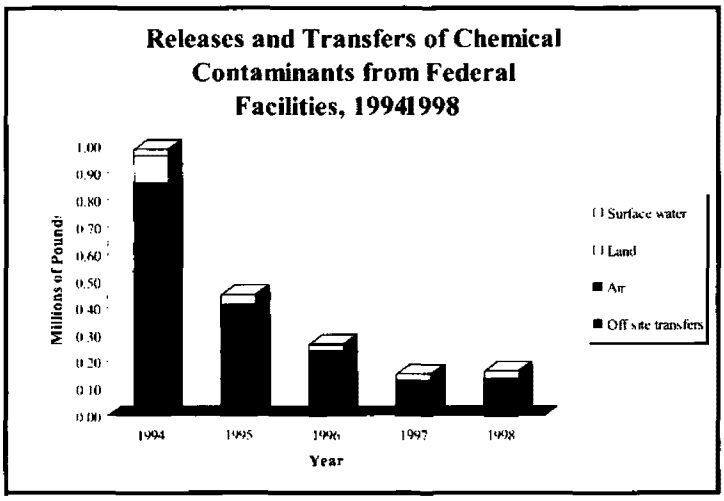


Indicator: Releases and Transfers of Chemical Contaminants from Federal Facilities in the Chesapeake Bay Region

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

This indicator tracks releases and transfers of Toxics Release Inventory (TRI) chemical contaminants from federal facilities between 1994 and 1998. The TRI is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. The goal of the Chesapeake Bay Program is to achieve a 75% voluntary reduction in releases and transfers of chemical contaminants from federal facilities in the basin.

- Federal facilities in the Chesapeake Bay basin reduced releases and transfers of chemical contaminants 83% between 1994 and 1998.



Source: Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: Releases refer to air, water, and land; off-site transfers include transfers to wastewater treatment plants or disposal sites, and transfers off-site for treatment. These data do not include transfers for energy recovering or recycling which have been reported since 1991. Also, excluded are releases off-site to underground injection and on-site releases to underground injection. Included in the data are all chemicals that have been consistently reported in the Toxics Release Inventory (TRI) between 1994 and 1998. Any chemicals that were delisted during this time period have been removed from the indicator. Similarly, new chemicals added to the TRI since 1994 are not included.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. 31 January 2003. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

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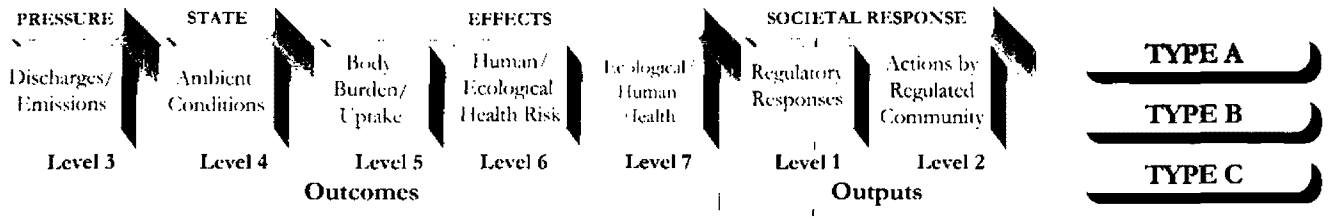


Indicator: Cropland Acres Under Integrated Pest Management in the Chesapeake Bay Ecosystem

The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

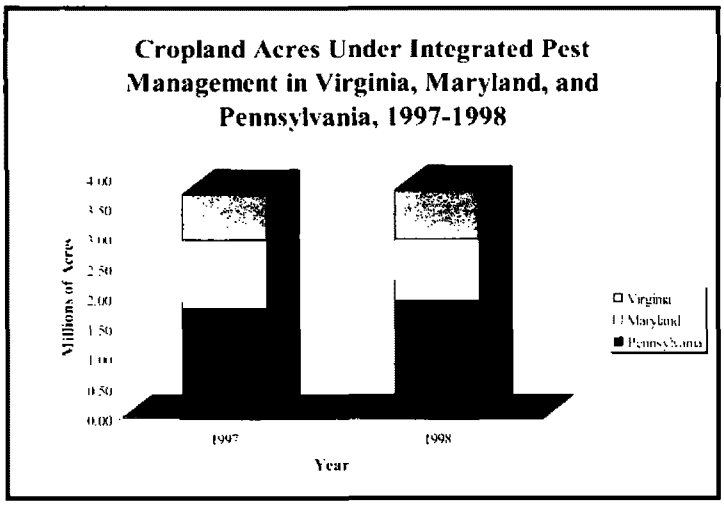
The U.S. Environmental Protection Agency (EPA) defines integrated pest management (IPM) as "the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property, and the environment." Proponents of IPM believe that it offers the best opportunity to reduce environmental and human health risk resulting from exposure to pesticides, to protect and conserve natural resources, to make farming more profitable, and to provide high-quality and safe foods and agricultural products.

The U. S. Department of Agriculture (USDA) has identified four general components of IPM:

- Prevention. Prevention may encompass a variety of techniques, but the central purpose is to prevent the infestation of the pest. A few examples of prevention include the use of pest-free seeds and transplants, the use of disease resistant varieties, and the maintenance of high levels of field and equipment sanitation.
- Avoidance. Avoidance is used where some level of infestation may exist, but serious problems can be avoided through appropriate practices. Crop rotation, the use of trap crops, selective planting, and the use of plants whose maturity dates precede the development of pest populations are examples of avoidance.
- Monitoring. Monitoring involves surveying and scouting conditions to determine what needs to be done rather than routinely applying pesticides.
- Suppression. Suppression involves utilizing a variety of cultural, physical, biological, and chemical pesticides techniques to prevent or eliminate pests.

The more acreage of farmland in the U.S. that is under IPM, the less direct usage of chemical pesticides there will be. The goal of the Chesapeake Bay Program is to establish voluntary IPM practices on 75% of all agricultural, recreational, and public lands within the basin by the year 2000. This indicator measures the number of cropland acres under IPM in the Chesapeake Bay Basin in 1997 and 1998.

- In 1998, IPM was practiced on 79% of the cropland surveyed. This is a total of 3.82 million acres.



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Notes: In 1997, an Agronomic Crop Survey was developed and administered by the CBP in order to better quantify the acreage of cropland on which IPM practices are conducted. Approximately 4.85 million acres were surveyed in 1998.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

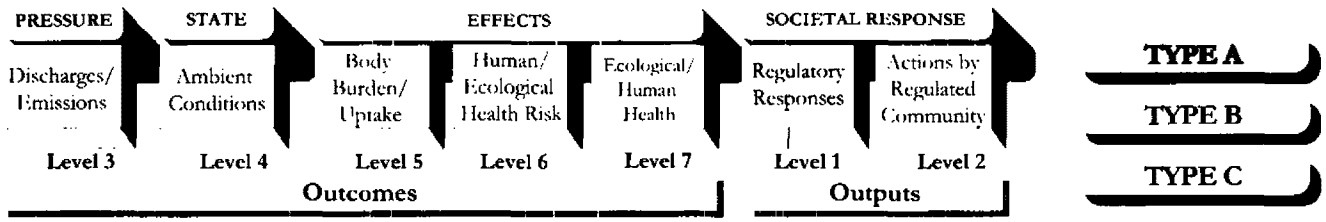
Report on Integrated Pest Management and Related Activities Supported by the United States Department of Agriculture. Submitted to the House Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriation Committee, May 18, 1998.

U.S. Department of Agriculture, National Agricultural Statistics Service. *Pest Management Practices, 1998 Summary.* 31 January 2003. Available online at: http://usda.mannlib.cornell.edu/reports/nassr/other/pest/pestan99.pdf

U.S Environmental Protection Agency. 1999. Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System. Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

U.S. Environmental Protection Agency. *Integrated Pest Management.* 31 January 2003. Available online at: http://www.epa.gov/pesticides/food/ipm.htm

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Pesticide Container Recycling Programs in the Chesapeake Bay Ecosystem

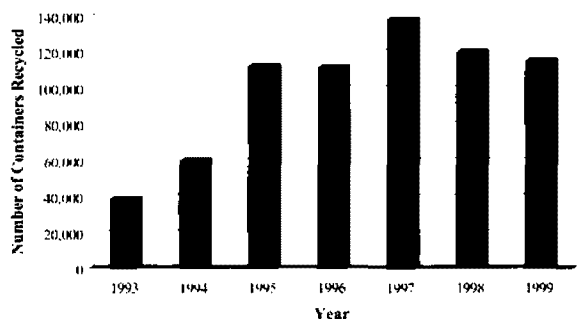
The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

The pesticide container recycling programs in the Chesapeake Bay watershed are carried out through the State Departments of Agriculture working with localities in Maryland, Pennsylvania, and Virginia. The containers accepted for recycling in these programs include all non-refillable, high-density plastic containers. Containers must be triple-rinsed by the owners and the rinsate returned to pesticide sprayers for use in subsequent applications. Containers accepted through the programs are chipped, bagged, and checked for contaminants. In some programs, the material is used to make pallets used by chemical manufacturers for stacking boxes.

This indicator measures the number of pesticide containers recycled through the recycling programs in Maryland, Pennsylvania, and Virginia from 1993 to 1999.

- The number of pesticide containers being recycled had an overall increase of 66% between 1993 and 1999.
- There has been a 17% decrease in the number of containers being recycled between the peak years of 1997 and 1999.

Pesticide Containers Recycled in Programs of Maryland, Pennsylvania, and Virginia, 1993-1999



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

U.S Environmental Protection Agency. 1999. *Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System.* Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

ECOLOGICAL HEALTH
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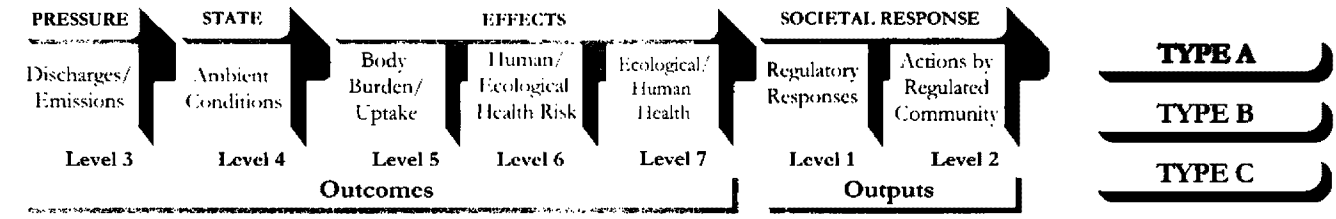


Indicator: Pesticide Collection and Disposal Programs in the Chesapeake Bay Ecosystem

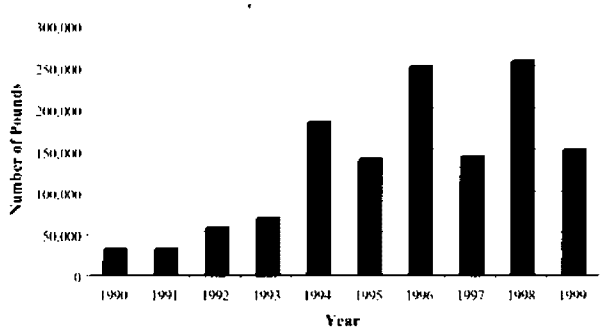
The Chesapeake Bay is the United States' largest estuary and, with over 3,600 species of plants and animals, a highly diverse, complex, and productive ecosystem. Within its 64,000-acre watershed are over 100,000 streams and tributaries that flow into the Bay. By the 1970's, development around the Bay had reached such proportions that water resources had been severely polluted and biological resources of all types were declining rapidly. Spurred by the passage of the federal Clean Water Act, civic and governmental action led to the creation in 1983 of the initial Chesapeake Bay Agreement. This agreement created a partnership among Maryland, Pennsylvania, Virginia, the District of Columbia, the U.S. Environmental Protection Agency, and the Chesapeake Bay Commission. The purpose of this partnership is to focus on the restoration of the Bay and its living resources.

The pesticide collection and disposal programs in the Chesapeake Bay watershed are carried out through the State Departments of Agriculture working with Cooperative Extension Services in Maryland, Pennsylvania, and Virginia. To be cost effective, the programs target only jurisdictions that show a significant amount of cropland acreage. Unwanted pesticides are collected by contractors who dispose of the material at EPA approved disposal sites.

This indicator measures the pounds of pesticides collected and disposed by programs in the Maryland, Pennsylvania, and Virginia watersheds of the Chesapeake Bay region from 1990 to 1999.

- The amount of pesticides collected and disposed in the Chesapeake Bay region increased 79% between 1990 and 1999.
- Despite this overall increase, the amount of pesticides collected and disposed decreased 41% between 1998 and 1999.

Total Pounds of Pesticides Collected and Disposed in Programs of Maryland, Pennsylvania, and Virginia, 1990-1999



Source: The Chesapeake Bay Program.

Scale: The Chesapeake Bay and its watersheds.

Data Characteristics and Limitations: Programs in all three states serve agricultural producers, commercial agricultural applicators, and pesticide dealers. Only programs in Maryland and Pennsylvania serve homeowners. The amount of pesticides collected annually varies depending on usage, regulatory concerns, and other related factors.

References

Chesapeake Bay Program. 31 January 2003. Available online at: http://www.chesapeakebay.net/index.htm

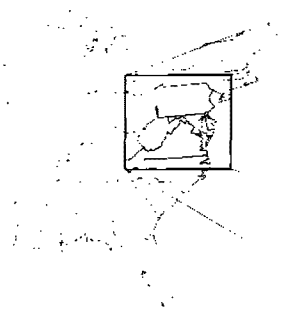
U.S Environmental Protection Agency. 1999. *Environment Outcome-Based Management: Using Environmental Goals and Measures in the Chesapeake Bay System.* Available online at: http://www.chesapeakebay.net/pubs/indpub/indpub.htm

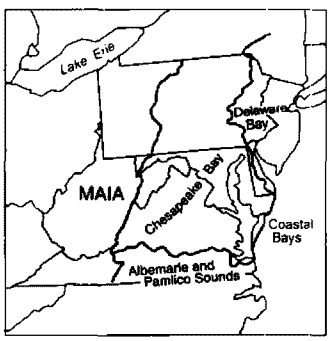
Indicator Set: Mid-Atlantic Integrated Assessment Program (MAIA)

The Mid-Atlantic region of the United States is a diverse area with major land forms ranging from estuaries to coastal plains to mountains. It is also an area with many areas of dense population that place considerable stress on environmental values.

Region 3 and the Office of Research and Development (ORD) of the U.S. Environmental Protection Agency are working jointly on an ecosystem-based evaluation of this region and its watersheds. This evaluation is called the Mid-Atlantic Integrated Assessment (MAIA) program. The program will draw upon the resources of a number of other local, state and federal programs to assemble a regional environmental monitoring assessment system capable of meeting a range of scientific, planning and management needs. Through its partners, a rich array of data is available to develop measurement tools. Such partners include: the Environmental Monitoring and Assessment Program (EMAP), the mid Atlantic Highlands Assessment, the National Biological Service's Gap Analysis Program, the Chesapeake Bay Program, the Delaware Estuary Program, the Virginia Coastal Bays Program, the U.S. Geological Survey's National Water Quality Assessment Program, the Forest Service's Forest Inventory and Analysis Program, and the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program.

The study area will include all of Pennsylvania, Maryland, Delaware, Virginia, West Virginia, and the District of Columbia, and parts of New Jersey, New York, and North Carolina.





Data Characteristics and Limitations: Seventeen data sets are being assembled for estuaries that deal with a range of physical, chemical, and biological measures. Chemically-related data sets include:

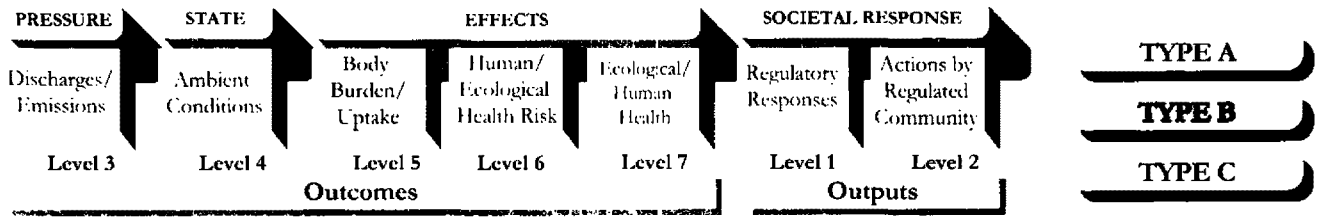
- Sediment toxicity,
- Sediment chemistry (91 chemical constituents, total metals, AVS, SEMS, butylins, PAHs, PCBs, and pesticides),
- Fish tissue chemistry (metals, PAHs, PCBs, organochlorine pesticides), and
- Sediment toxicity in streams.

Specific indicators have yet to be developed, but the near-term potential for this program to provide a strong system is good. As data from other activities, such as the Chesapeake Bay Program, are integrated into this system, MAIA could become a source of many high quality indicators capable of defining chemical impacts in the area.

Reference

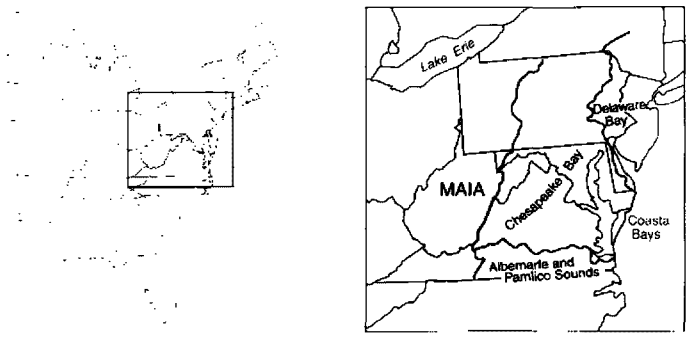
Mid-Atlantic Integrated Assessment Program (MAIA) website. Available online at: http://www.epa.gov/emap/maia/

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: PCB Levels in Mid-Atlantic Estuarine Blue Crabs

The presence of toxic substances and pesticides has the potential to disrupt the functioning of entire ecosystems. In the past, tracking chemical loadings on an ecosystem-wide basis was not common. However, many ecosystem-wide monitoring programs are now underway. An example of this is the Mid-Atlantic Integrated Assessment (MAIA). MAIA is a research, monitoring, and assessment program whose main objective is to develop high-quality scientific information on the condition of the natural resources of the Mid-Atlantic region of the eastern United States. The study area includes all of Pennsylvania, Maryland, Delaware, Virginia, West Virginia, and the District of Columbia, and parts of New Jersey, New York, and North Carolina. The Mid-Atlantic is a diverse area with major ecosystems ranging from estuaries to coastal plains to mountains. It is also an area with many areas of dense population that place considerable stress on ecological resources.



Source: U.S. Environmental Protection Agency.

A class of pollutants introduced into the environment through run-off from urbanized areas is the PCBs. Due to their nature, they are of particular concern in the Mid-Atlantic region. PCBs are a small family of industrial compounds that are environmentally persistent and bioaccumulative (Francis 1994). PCBs have been linked to reproductive problems in turtles (Bergeron et al. 1994), developmental malformations in birds (Francis 1994), and reductions in the photosynthetic activity of plants (Doust et al. 1994). They are good representatives for many of the toxic organic compounds from anthropogenic sources since they comprise a variety of common substances that display a range of physical and chemical properties. This also makes them well suited for long-term ambient monitoring. This indicator measures PCB levels in blue crabs from estuaries in the Mid-Atlantic region.

At this time, Blue Crab data are currently available for the Carolinian Provinces from 1994 to 1997. Data from other provinces are in the process of being added to the database. However, summary data files are not available for the MAIA. The available data are disaggregated according to province, chemical, and testing station. Due to the analytical complexity required to summarize this data in a manner that would lend itself to presentation as an indicator, this indicator is considered to be a Type B.

Data Characteristics and Limitations: Region 3 and the Office of Research and Development (ORD) of the U.S. Environmental Protection Agency are working jointly on an ecosystem-based evaluation of this region and its watersheds - the Mid-Atlantic Integrated Assessment (MAIA). The program draws upon the resources of a number of other local, state, and federal programs to assemble a regional environmental monitoring assessment system capable of meeting a range of scientific, planning, and management needs. Through its partners a rich array of data is available to develop measurement tools. Such partners include: the Environmental Monitoring and Assessment Program (EMAP), the mid Atlantic Highlands Assessment, the National Biological Service's Gap Analysis Program, the Chesapeake Bay Program, the Delaware Estuary Program, the Virginia Coastal Bays Program, the U.S. Geological Survey's National Water Quality Assessment Program, the Forest Service's Forest Inventory and Analysis Program, and the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program. Specific indicators have yet to be developed, but the near-term potential for this program to provide a strong system is good.

References

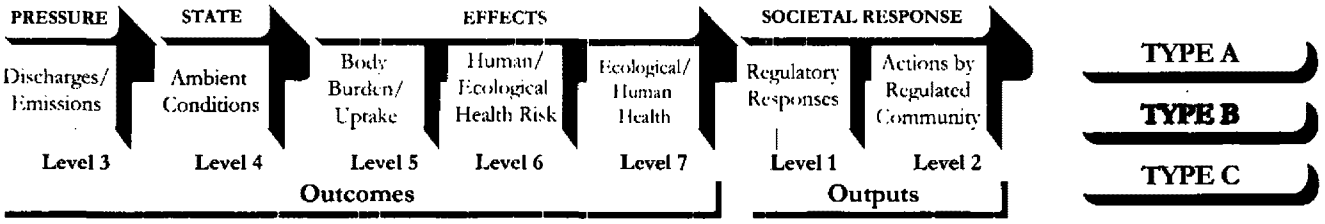
Bergeron, J.M. et Al. "PCBs as Environmental Estrogens." Cited in *Fundamentals of Ecotoxicology*. Michael C. Newman. Ann Arbor: Sleeping Bear Press, 1998.

Doust, J.L. et Al. "Biological Assessmention of Aquatic Pollution." Cited in *Fundamentals of Ecotoxicology*. Michael C. Newman. Ann Arbor: Sleeping Bear Press, 1998.

Francis, B. Magnus. 1994. *Toxic Substances in the Environment*. New York: John Wiley & Sons.

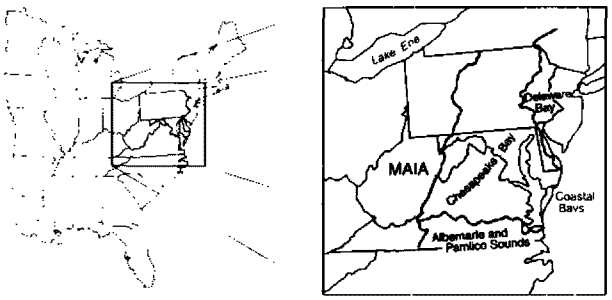
Mid-Atlantic Integrated Assessment Program (MAIA). 31 January 2003. Available online at: http://www.epa.gov/emap/maia/

ECOLOGICAL HEALTH
MAJOR ECOSYSTEM FUNCTIONING



Indicator: Concentrations of PCBs in Mid-Atlantic Estuarine Sediments

The presence of toxic substances and pesticides has the potential to disrupt the functioning of entire ecosystems. In the past, tracking chemical loadings on an ecosystem-wide basis was not common. However, many ecosystem-wide monitoring programs are now underway. An example of this is the Mid-Atlantic Integrated Assessment (MAIA). MAIA is a research, monitoring, and assessment program whose main objective is to develop high-quality scientific information on the condition of the natural resources of the Mid-Atlantic region of the eastern United States. The study area includes all of Pennsylvania, Maryland, Delaware, Virginia, West Virginia, and the District of Columbia, and parts of New Jersey, New York, and North Carolina. The Mid-Atlantic is a diverse area with major ecosystems ranging from estuaries to coastal plains to mountains. It is also an area with many areas of dense population that place considerable stress on ecological resources.



Source: U.S. Environmental Protection Agency.

A class of pollutants introduced into the environment through run-off from urbanized areas is the PCBs. Due to their nature, they are of particular concern in the Mid-Atlantic region. PCBs are a small family of industrial compounds that are environmentally persistent and bioaccumulative (Francis 1994). PCBs have been linked to reproductive problems in turtles (Bergeron et al. 1994), developmental malformations in birds (Francis 1994), and reductions in the photosynthetic activity of plants (Doust et al. 1994). They are good representatives for many of the toxic organic compounds from anthropogenic sources since they comprise a variety of common substances that display a range of physical and chemical properties. This also makes them well suited for long-term ambient monitoring. This indicator measures PCB concentrations in estuarine sediments from the Virginian and Carolinian Provinces.

At this time, data are available for the Virginian Provinces from 1990 to 1993 and the Carolinian Provinces from 1994 to 1997. However, summary data files are not available for the MAIA. The available data are disaggregated according to province, chemical, and testing station. Due to the analytical complexity required to summarize this data in a manner that would lend itself to presentation as an indicator, this indicator is considered to be a Type B.

Data Characteristics and Limitations: Region 3 and the Office of Research and Development (ORD) of the U.S. Environmental Protection Agency are working jointly on an ecosystem-based evaluation of this region and its watersheds - the Mid-Atlantic Integrated Assessment (MAIA). The program draws upon the resources of a number of other local, state, and federal programs to assemble a regional environmental monitoring assessment system capable of meeting a range of scientific, planning, and management needs. Through its partners a rich array of data is available to develop measurement tools. Such partners include: the Environmental Monitoring and Assessment Program (EMAP), the mid Atlantic Highlands Assessment, the National Biological Service's Gap Analysis Program, the Chesapeake Bay Program, the Delaware Estuary Program, the Virginia Coastal Bays Program, the U.S. Geological Survey's National Water Quality Assessment Program, the Forest Service's Forest Inventory and Analysis Program, and the National Oceanic and Atmospheric Administration's Coastal Change Analysis Program. Specific indicators have yet to be developed, but the near-term potential for this program to provide a strong system is good.

References

Bergeron, J.M. et Al. "PCBs as Environmental Estrogens." Cited in *Fundamentals of Ecotoxicology*. Michael C. Newman. Ann Arbor: Sleeping Bear Press, 1998.

Doust, J.L. et Al. "Biological Assessmention of Aquatic Pollution." Cited in *Fundamentals of Ecotoxicology*. Michael C. Newman. Ann Arbor: Sleeping Bear Press, 1998.

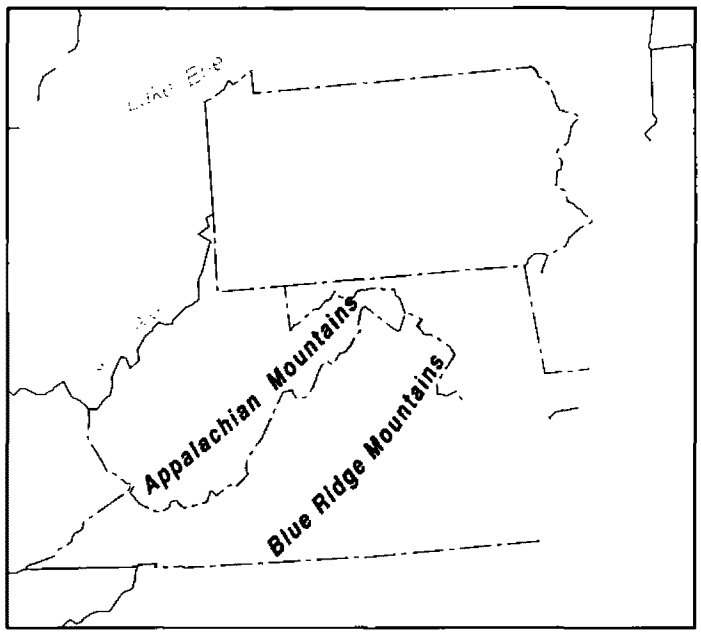
Francis, B. Magnus. 1994. *Toxic Substances in the Environment*. New York: John Wiley & Sons.

Mid-Atlantic Integrated Assessment Program (MAIA). 31 January 2003. Available online at: http://www.epa.gov/emap/maia/

Indicator: Mid-Atlantic Highlands Assessment Program (MAHA)

Region 3 and the Office of Research and Development (ORD) of the U.S. Environmental Protection Agency in cooperation with the states of Maryland, Virginia, Pennsylvania, and West Virginia, 10 other federal agencies, and the Nature Conservancy have formed an alliance to conduct a multi-year assessment of a 79,000-mile area known as the Mid-Atlantic Highlands. This alliance, known as the Mid-Atlantic Highlands Program (MAHA), is intended to assess the ecological condition of the air, water, and land resources and to identify sensitive areas and at risk biological resources.

MAHA will use a goal-based, indicator driven management system to make sound environmental decisions for the ecosystem.



Source: Environmental Protection Agency.

Data Collection and Characteristics: Data identification and collection is in process, but indicator development has not yet begun.

References

U.S. EPA Mid-Atlantic Highlands Program. 31 January 2003. Available online at: http://www.epa.gov/ecoplaces/part1/site14.html

U.S.G.S. Mid-Highlands Program (MAHA). 31 January 2003. Available online at: http://water.usgs.gov/

ECOLOGICAL HEALTH
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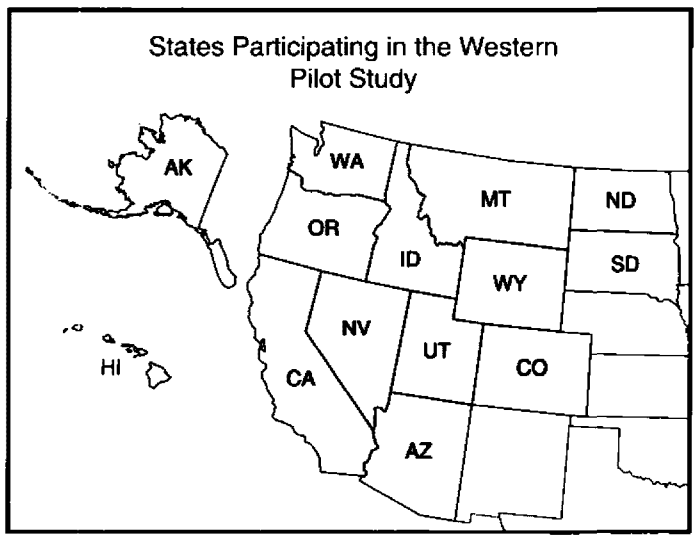
Indicator: Western Pilot Study

The Environmental Monitoring and Assessment Program (EMAP) and Regions 8, 9, and 10 of the U.S. Environmental Protection Agency (EPA) in cooperation with the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming are participating in the Western Pilot Study (WPS). This study will be conducted over a five-year period and is intended to "generate state and regional scale assessments of the condition of ecological resources in the western United States, and to identify stressors associated with the degradation of these resources." Additionally, the study will demonstrate the effective use of core monitoring, environmental monitoring, and assessment tools across large ecosystems.



Indicator Development with focus on three areas:

- Coastal Indicators. A variety of indicators will be collected that describe both biological conditions and stressors impacting western estuaries. Core EMAP coastal measures focus on three areas: water column, sediments, and fish and invertebrate trawls. Indicators of chemical and pesticide interest include:
  - Sediment chemistry
  - Sediment toxicity
  - External pathology
  - Tissue analyses
- Surface Water Indicators. Indicators that characterize biological, physical habitat, and water chemistry will be developed. At present, there are no chemical or pesticide indicators that will be developed at all sites. Depending upon resources and local applicability several indicators may be employed to include:
  - Fish tissue chemistry/toxics
  - Sediment chemistry
  - Sediment toxicity
  - Water column toxicity
- Landscape Indicators. Specific landscape indicators have not yet been developed.

Project management uses of the indicators in the Western Pilot Study include:

- Supporting the Government Performance and Results Act (GPRA).
- Providing a status and trends analysis on the area for public information purposes.
- Providing a risk assessment approach to making fundamental decisions about environmental and budgetary decisions relating to ecosystem protection.

References

EMAP Western Pilot Study. 31 January 2003. Available online at: http://www.epa.gov/emap/wpilot/

Region 8 Western Pilot Study. 31 January 2003. Available online at: http://www.epa.gov/region08/water/emap.html

Region 9 Western Pilot Study. 31 January 2003. Available online at: http://www.epa.gov/region09/water/wemap/

Region 10 Western Pilot Study. 31 January 2003. Available online at: http://yosemite.epa.gov/r10/oea.nsf/webpage/emap/?OpenDocument

Indicator: San Francisco Bay and San Joaquin River-Delta Ecosystem

The purpose of the CALFED Bay-Delta Program is to develop and implement a long-term comprehensive plan that will restore the ecological health and improve water management for the many valuable uses of the Bay-Delta System. The CALFED Bay-Delta Program is a joint effort between more than 20 state and federal agencies in managing the San Francisco Bay and San Joaquin River Bay-Delta, which will be implemented in stages throughout the next 30 years to solve California's environmental and water problems. The Bay-Delta is the largest estuary on the west coast and includes 750 plant and animal species. The program's efforts will be directed towards the achievement of four major goals: water supply reliability, water quality, ecosystem restoration, and levee system integrity.

California's Bay-Delta represents an unhealthy ecosystem where several species, such as the Chinook salmon and steelhead trout, are in decline or endangered. Additionally, demands placed on the Bay-Delta from the needs of a large population has given way to a water supply that is unreliable and of poor quality. As a result, meeting the drinking water standards and the water quality standards necessary for the long-term survival of native species is a challenging and costly task.

Listed below are several indicators being developed that relate the effects of chemicals and pesticides to the San Francisco Bay and the San Joaquin River-Delta. The completion of such indicators will contribute to the well being of numerous species and to the improvement of the water quality:

- Ecological/biological effects threshold concentrations for mercury in sediments and key organisms in the Bay-Delta estuary and its watershed
- Diazinon and chloropyrifos hazard assessment criteria
- Ecological significance of pesticide discharges
- Spatial and temporal extent of metal pollution
- Impacts of metals, such as cadmium, copper, and zinc
- Toxicity of unknown origins
- Effects of bioaccumulation of toxic substances

As the CALFED Bay-Delta Program progresses, more indicators pertinent to chemicals and pesticides may become available. The potential for this program to provide a good system for measuring chemical and pesticide impacts in the area is strong.

References

CALFED Bay-Delta Program. 31 January 2003. Available online at: http://calfed.ca.gov/

Indicator: Estuarine and Great Lakes Program

In 2000, the U.S. EPA granted authority to establish five Estuarine Indicator Research Programs, along with funding to support five years worth of development. The intent of these programs was to support the development of an environmental "suite of new, integrative indicators of ecological condition, integrity, and/or sustainability that can be incorporated into long-term monitoring programs and which will complement ORD's intramural coastal monitoring program."

Five major areas of the coastline of the United States EAGLES is intended to:

1. Develop indicators and/or procedures useful for evaluating the 'health' or condition of important coastal natural resources (e.g., lakes, streams, coral reefs, coastal wetlands, inland wetlands, rivers, estuaries) at multiple scales, ranging from individual communities to coastal drainage areas to entire biogeographical regions.

2. Develop indicators, indices, and/or procedures useful for evaluating the integrated condition of multiple resource/ecosystem types within a defined watershed, drainage basin, or larger biogeographical region of the U.S.

3. Develop landscape measures that characterize landscape attributes and that concomitantly serve as quantitative indicators of a range of environmental endpoints, including water quality, watershed quality, freshwater/estuarine/marine biological condition, and habitat suitability.

4. Develop nested suites of indicators that can both quantify the health or condition of a resource or system and identify its primary stressors at local and regional scales.

Project Websites:

Atlantic Coast Environmental Indicators Consortium. 31 January 2003. Available online at: http://www.aceinc.org/

Atlantic Slope Consortium. 31 January 2003. Available online at: http://www.asc.psu.edu/

Center for Estuarine Ecosystem Indicator Research. 31 January 2003. Available online at: http://www.bml.ucdavis.edu/peeir/

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Great Lakes Environmental Indicator Project. 31 January 2003. Available online at: http://glei.nrri.umn.edu/default/

Reference

The Estuarine and Great Lakes Program. 31 January 2003. Available online at: http://es.epa.gov/ncer/centers/eagles/

Indicator: National Coastal Assessment (Coastal 2000)

The Office of Research and Development of the U.S. Environmental Projection Agency has, along with its partners, collected extensive information from hundreds of monitoring stations along the nation's coastline. Data are available for a wide range of important coast environmental parameters to include: water column parameters, sediment chemistry and toxicity, benthic communities, demersal fish, and tissue contaminants.

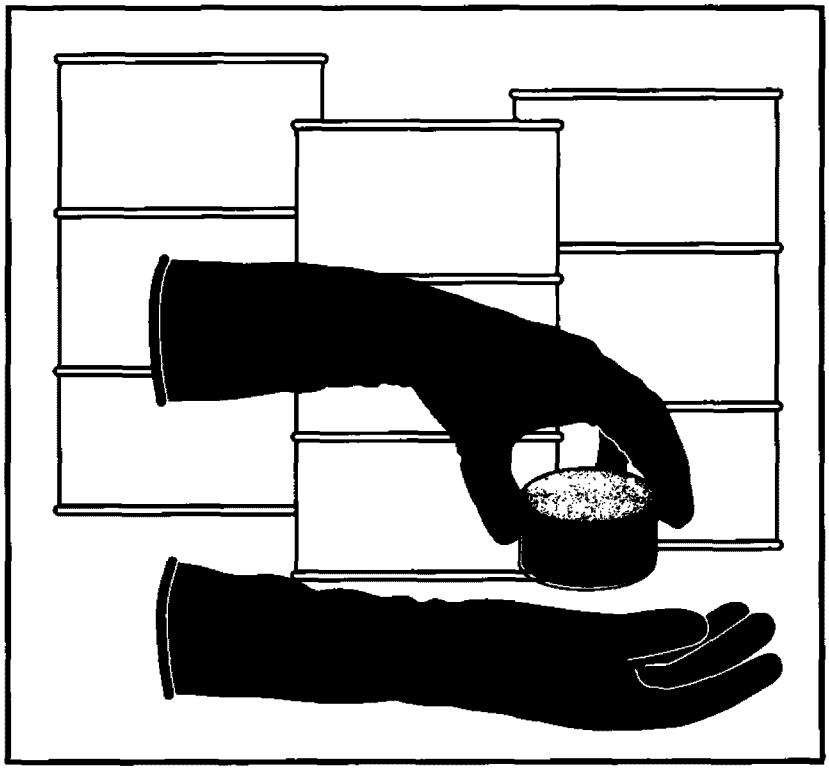
EPA is continuing this Assessment with Coastal 2000. Coastal 2000 is a five-year effort to survey the condition of the nation's coastal resources by creating an integrated, comprehensive coastal monitoring program among the coastal states.

A searchable database is available online. Over 350 chemicals and pesticides are included for water column chemistry, sediment chemistry, and fish tissue contamination.

Reference

National Coastal Assessment. 31 January 2003. Available online at: http://www.epa.gov/emap/nca/.

ENVIROMENTAL ISSUE 3: CHEMICAL AND PESTICIDE SAFETY AND USE



List of Indicators

Toxicity Index for Releases and Managed Waste

HPV Challenge Program

Average Toxicity of Pesticide Active Ingredient Applied per Acre

Pesticide Detections in Ground and Surface Water

National Emissions of Air Toxics

Number of Agricultural Acres Treated with Biopesticides

Number of Agricultural Acres Treated with Reduced Risk Pesticides

Sale of Dry Cleaning Equipment Using Safer Chemicals

Annual Pesticide Use on Select Field Crops by Pesticide Product Signal Word

Annual Pesticide Use on Select Vegetables by Pesticide Product Signal Word

Annual Pesticide Use on Select Fruits by Pesticide Product Signal Word

Chemical Bioaccumulation in Mussel Tissue

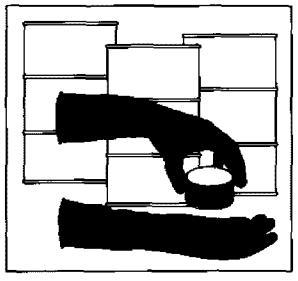
Toxicity Index for Persistent, Bioaccumulative, and Toxic Chemicals Releases

PCBs and Persistent Pesticide Detections in Fish and Bed Sediment

Number of Certified Organic Farmland Acres

Number of Acres in Integrated Pest Management

ENVIRONMENTAL ISSUE 3:
CHEMICAL AND PESTICIDE SAFETY AND USE



With over 70,000 chemicals and pesticides in use in the U.S., much of the potential health risk from those chemicals can be controlled through their proper use and management. This means eliminating or restricting the release of harmful chemicals into the environment, reducing the need for unnecessary chemicals and pesticides, ensuring that the chemicals and pesticides we use are safe and safely used, and cleaning up after ourselves when significant pollution occurs. Achievement of these ends must be placed within the context of providing adequate economic support to meet fundamental human needs, protecting important natural systems and values, and maintaining social equity in sharing the benefits and costs of society.

In early discussions, five principal issues were identified as having relevance to sustainability within the context of chemicals and pesticides: managing the toxicity of the ambient environment, providing and using safer pesticides and chemicals, improving chemical and pesticide safety, diminishing persistent bioaccumulative toxic chemicals and pesticides, and providing less chemically dependent alternative farming techniques.

Issue Dimensions

Toxicity of the Ambient Environment

Every year an additional increment of chemicals is introduced into the environment. For 2000, the Toxic Release Inventory reported total toxic releases to the environment of 7.1 billion pounds.. This amount represents only a fraction of the total chemical releases from all sources in the United States. To this must be added over 1 billion pounds of pesticides that were applied directly to the indoor and outdoor environment to control pests. These numbers, however, speak only to the United States and do not account for Europe, South America, or the exploding industriall economies of Asia. The toxicity of these chemicals, their persistence in the environment, their level of concentration, and their distribution are important concerns that have important consequences, not only for the current citizens of the U.S. and the world, but for the generations to follow.

Safer Chemicals and Pesticides

The impacts of chemical and pesticide use on everyday life have been both positive and negative. Plainly society derives enormous benefit from the use of chemicals and pesticides, and their continued use in the future is assured. Recognizing that the inappropriate use of toxic chemicals can harm human and ecological health, efforts need to be taken to continuously produce safer chemicals and promote the safe use of chemicals. To protect the environment for future generations, chemicals must be developed that have lower levels of toxicity and are generally safer for the environment.

Chemical and Pesticide Safety

Recognizing the potential for chemicals and pesticides to have acute and chronic impacts on human health, an issue of major concern is ensuring that those chemicals and pesticides are used and managed in a manner that minimizes their potential for harm. This can mean any number of things. Effective packaging, good product labeling, careful use protocols, ensuring the users of chemicals understand how they are to be used, training pesticide applicators in safe procedures, and transporting chemicals safely from location to location are all examples among many possible examples, of chemical and pesticide safety concerns.

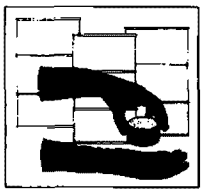
Persistent, Bioaccumulative Toxics

Of particular concern is a class of toxic chemicals that persist in the environment, bioaccumulate in human and animal tissues, and result in negative health effects. These chemicals additionally move quite easily from one media to another and are capable of moving about on a global scale. Such chemicals - known as Persistent Bioaccumulative Toxics (PBTs) - are worthy of special consideration because of the serious ongoing health risk they pose. Increases in concentrations of these substances have implications, not just for current populations, but for future populations as well. EPA's list of Priority PBTs include:

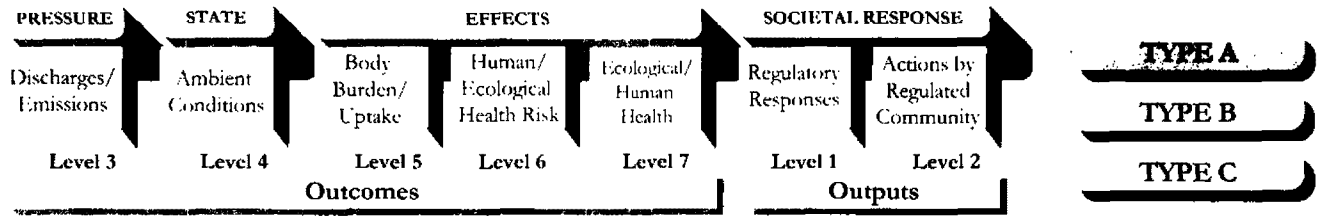
aldrin/dieldrin	DDT, DDP, DDE
mercury and its compounds	PCBs
enzo(a)pyrene	hexachlorobenzene
mirex	dioxins and furans
chlordane	alkyl-lead
octachlorostyrene	toxaphene

Alternative Farming Systems

Agricultural operations in the U.S. routinely and extensively use a variety of pesticides and herbicides. In 1997 approximately 770 million pounds of active ingredient were applied agriculturally in the U.S. The use of these chemicals has generated much public concern and scientific inquiry about how human and ecological health are affected by their use. This issue will focus on trends in farming techniques that eliminate or greatly reduce the use of agricultural chemicals.



CHEMICAL AND PESTICIDE SAFETY AND USE
TOXICITY OF THE AMBIENT ENVIRONMENT



Indicator: Toxicity Index for Releases and Managed Waste

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating a toxicity score for each chemical. The toxicity score is multiplied by the pounds of chemical released or managed in waste; the toxicity of each chemical release and waste stream can be aggregated to provide an estimate of the total toxicity of releases and managed waste for a given year.

This measure can have implications for both human and ecological health, with declining trends in the total toxicity of chemical releases and managed waste implying potential for a more healthful environment. The measure also has implications for the success of governmental pollution prevention programs and for activities conducted by the private sector to improve pollution related efficiencies.

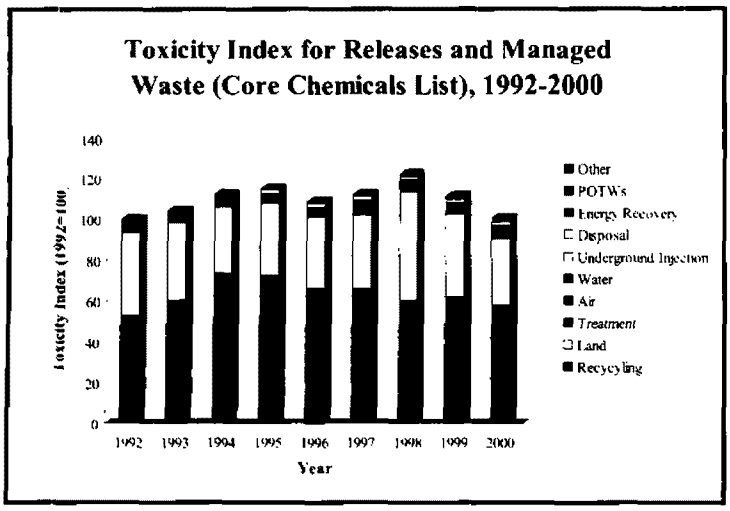
The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unitless measure of toxicity. These measures can only be interpreted relatively: to display trends and to make comparisons of toxicity over time. For this indicator, the toxicity of releases and managed waste was adjusted to create an index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the estimate of toxicity of releases and managed waste for the baseline year was adjusted to equal a value of 100; subsequent estimates reflect changes from that baseline of 100. If industries are maintaining or improving pollution efficiencies or succeeding at pollution prevention, then the index should display constant or declining trends.

Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total toxicity of releases into the environment and managed chemical waste. It can be inferred, however, as a measure of the relative gains the U.S. is making in pollution prevention and improving pollution efficiencies.

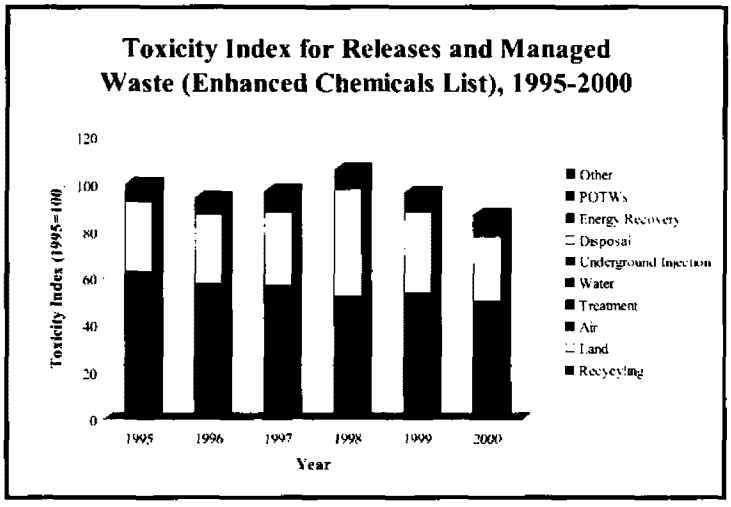
There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Two different subsets of TRI data are reflected in the presented charts. The first chart reflects data for a core list of chemicals that have been reported every year since the inception of TRI in 1988; however, the chart reflects data beginning in 1992, which is when recycling, energy recovery and treatment operations were incorporated into TRI. The second chart reflects data for an enhanced list of chemicals that have been reported every year from 1995 to 2000.

- The toxicity index for the core chemicals list shows some annual variation, and a slight overall increase through 1999 with slight reduction in the toxicity of releases and managed waste from 1999 to 2000.
- Waste recycling accounts for the vast majority (over 60%) of the toxicity index for the core chemicals list.



- Releases to land represent the second-largest share of the toxicity index for the core chemicals list; the toxicity of these releases has overall decreased slightly from 1992 to 2000.
- Overall, the chart shows that most of the toxicity represented by the core chemicals list is managed as waste, rather than released into the environment.



- The toxicity index for the enhanced chemicals list shows that the toxicity of releases and managed waste decreased from 1995 to 2000.
- Waste recycling accounts for the vast majority (over 60%) of the toxicity index for the enhanced chemicals list; however, its share of the toxicity index decreased from 1995 to 2000.
- Releases to land represent the second-largest share of the toxicity index for the enhanced chemicals list; the toxicity of these releases increased from 1995 to 2000.
- Overall, the chart shows that most of the toxicity represented by the enhanced chemicals list is managed as waste, rather than released into the environment.

Source: **Risk Screening Environmental Indicators,** Computer queries of national summary data prepared January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data

can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

References

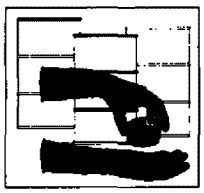
1999 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, August 2000. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. 31 January 2003. Available online at: http://www.epa.gov/tri/tridata/tri00/index.htm.

"Risk Screening Environmental Indicators," Fact Sheet, Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, October 1, 1999.

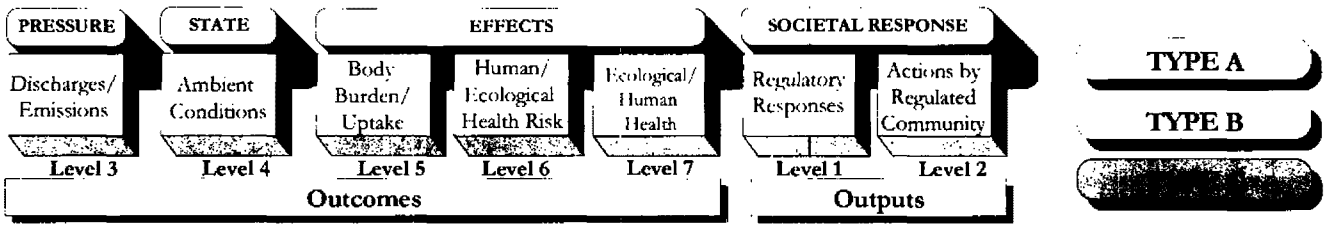
Toxics Release Inventory Relative Risk-Based Environmental Indicators Methodology, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, June 1997.

User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators are available on at: http://www.epa.gov/opptintr/rsei/. 31 January 2003. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline*(a)* epa.gov).



CHEMICAL AND PESTICIDE SAFETY AND USE
TOXICITY OF THE AMBIENT ENVIRONMENT



Indicator: HPV Challenge Program

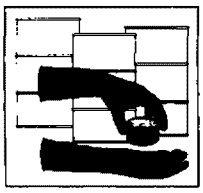
The U.S. high production volume (HPV) chemicals are those which are manufactured in or imported into the United States in amounts equal to or greater than one million pounds per year. The U.S. HPV chemicals were identified through information collected under the Toxic Substances Control Act (TSCA) Inventory Update Rule (IUR). Organic chemicals that were manufactured in, or imported into, the United States in amounts equal to or exceeding 10,000 pounds per year were subject to reporting under the TSCA IUR. Reporting is required every four years (EPA Website).

Although HPV chemicals are produced or imported in large quantities in the United States, there is little or no publicly available information regarding the potential hazards associated with most HPV chemicals. In order to obtain such information, EPA has established a data collection and development program for existing HPV chemicals. Through the HPV Initiative, which includes the voluntary HPV Challenge Program, certain international efforts, and potential rulemaking under the Toxic Substances Control Act (TSCA), basic screening level hazard data necessary to provide critical information about the environmental fate and potential hazards associated with HPV chemicals are being collected or, where necessary, developed. A primary component of this HPV Initiative is the voluntary HPV Challenge Program, which was created in cooperation with industry, environmental groups, and other interested parties, and is designed to assemble basic screening level test data on the potential hazards of HPV chemicals while avoiding unnecessary or duplicative testing. The list of HPV Challenge Program chemicals consists of all the HPV chemicals reported during the 1990 IUR reporting year. Data needs that remain unmet in the voluntary HPV Challenge Program, may be addressed through the international efforts or rulemaking. Data collected and/or developed under the HPV Initiative will provide critical basic information about the environmental fate and potential hazards associated with these chemicals which, when combined with information about exposure and uses, will allow the Agency and others to evaluate and prioritize potential health and environmental effects and take appropriate follow up action.

(Source: [OPPTS-42213; AR-201; FRL-6754-6] U.S. Environmental Protection Agency. "Data Collection and Development on High Production Volume (HPV) Chemicals." Federal Register Vol 65, No 248, 12/26/00, Notices URL: www.epa.go/chemrtk/t542213.pdf).

More than 300 companies and 101 consortia have voluntarily accepted the challenge to address the absence of and need for screening-level data for more than 2,100 HPV chemicals by 2005, with the remaining to be addressed by international and government actions. In FY 2002 EPA's HPV Challenge Program continued to make health and environmental effects screening data publicly available for more than 800 industrial and commercial chemicals, making steady progress toward the program's objective of screening existing chemicals to identify potential human and ecological hazards and risks. (Source: US EPA's FY 2002 Annual Report, 2/03. Available online at http://www.epa.gov/ocfopage/finstatement/2002ar/ar02_goal4.pdf)

Source: The US EPA HPV Voluntary Challenge Chemical List Website. 21 February 2003. Available online at http://www.epa.gov/chemrtk/hpvchmlt.htm



CHEMICAL AND PESTICIDE SAFETY AND USE
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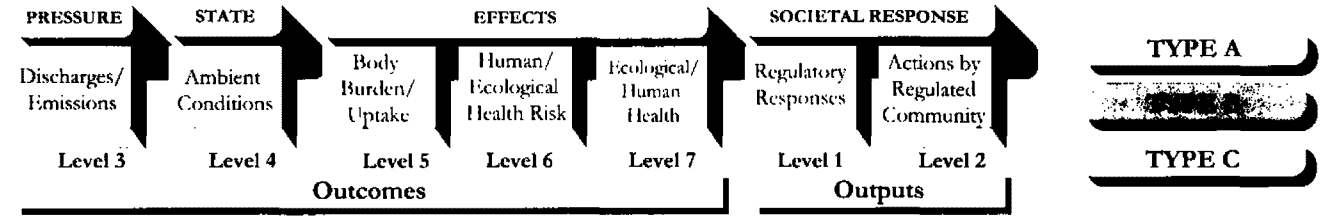
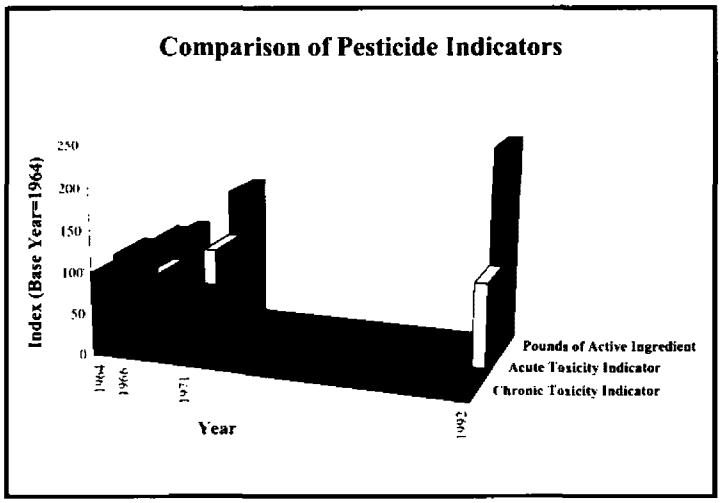


Indicator: Average Toxicity of Pesticide Active Ingredient Applied per Acre

Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems. For these reasons, it is important not only to monitor the agricultural usage of pesticides, but also to estimate the overall toxicity of the pesticides that are applied in a given year. Accurate understanding of the overall toxicity is the first step in the transition from monitoring only usage to estimating real risk to the population. While toxicity scores cannot suggest risk to humans or the environment, they can provide greater understanding of the character of pesticides that are being applied.

The figure on the right illustrates the trends that have been identified in pesticide use and toxicity since 1964. This data, which was assembled by the US Department of Agriculture's Economic Research Service, shows that while pesticide use has increased tremendously, the chronic toxicity of pesticides has remained fairly constant and acute toxicity has decreased considerably. However, the indicators compared here are less than ideal. There is a fair degree of inconsistency in the robustness of the toxicity scores that were associated with specific pesticides. For instance, the chronic toxicity scores were based on EPA Reference Doses, estimated Reference Doses from the EPA's Office of Pesticide Programs, and estimates reported by the World Health Organization. The acute toxicity scores were largely based Oral LD50 values for rats.

To develop the desired indicator it is advisable that a toxicity weighting system similar to that used by the EPA's Environmental Risk Screening Indicator (ERSI) Model be used. This modeling system has been used to calculate toxicity scores for approximately 99% of the chemicals reported under the Toxics Release Inventory. By identifying Reference Doses or Oral Slope Factors for all relevant pesticides, one could very easily calculate an estimate of average toxicity of pesticide active ingredients applied per acre. The most substantial drawback to proceeding with the development of an indicator using the ERSI methodology is the lack of a comprehensive listing of acceptable toxicity scores. Should such a list be identified, development of this indicator would be quite simple.

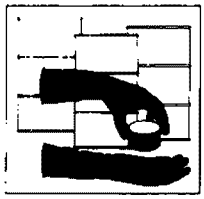


Source: USDA Economic Research Service. 1997.

Data Characteristics and Limitations: The toxicity scores that were used to develop these indicators were taken from sources that varied in their robustness. The chronic toxicity scores were based on EPA Reference Doses, estimated Reference Doses from the EPA's Office of Pesticide Programs, and estimates reported by the World Health Organization. The acute toxicity scores were largely based Oral LD50 values for rats. The data provided in this report is not provided at time intervals useful for the analysis of an indicator.

Reference:

Economic Research Service, US Department of Agriculture. *Agricultural Resources and Environmental Indicators, 1996-1997.* 10 January 2003. Available online at: http://www.ers.usda.gov/epubs/pdf/ah712/



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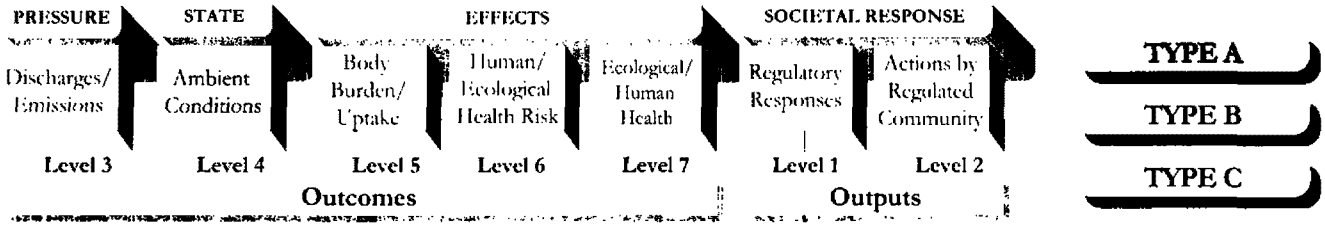


Indicator: Pesticide Detections in Ground and Surface Water

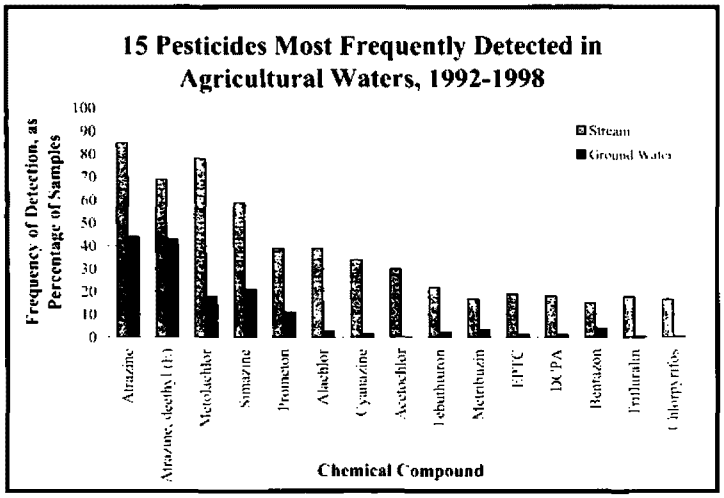
Many of the pesticides applied in agriculture, homes and gardens are environmentally transported to rivers, streams, aquifers and wells. The pesticide contamination of water supplies poses public health risks and environmental hazards to fish and wildlife. To minimize the risks to humans, aquatic life and animal life, water-quality standards and guidelines regarding the acceptable concentrations of pesticides in water are enforced by the EPA. It is important to note that these current standards do not completely eliminate risks because: concentration limits are not established for many pesticides; pesticide mixes and breakdown products are not considered; and some types of possible health effects, such as endocrine disruption, have not yet been determined.

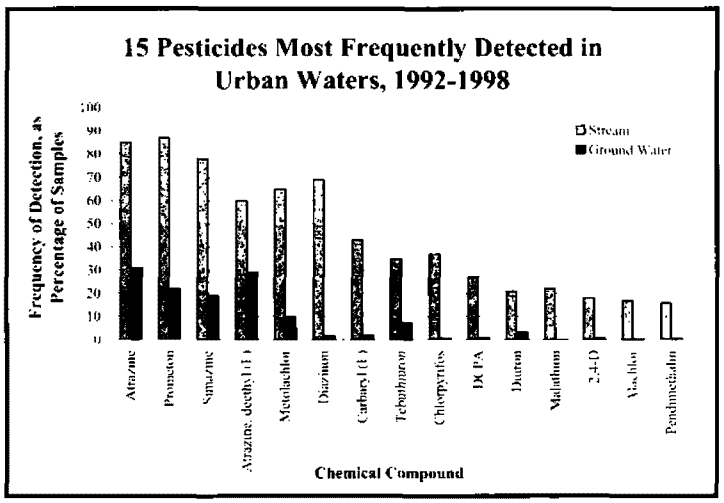
Despite the uncertainty about the health effects of long-term exposure to pesticides, it is important to monitor their concentrations in ground and surface water supplies. Tracking the trend of pesticide contamination of water reflects the degree of success of EPA's enforcement of water-quality standards and provides an estimate of the toxicity of water supplies. Moreover, the documentation of the geographic distribution of pesticide detections in water, and of the specific pesticides detected, provides useful data for researchers trying to link pesticide exposure with health effects.

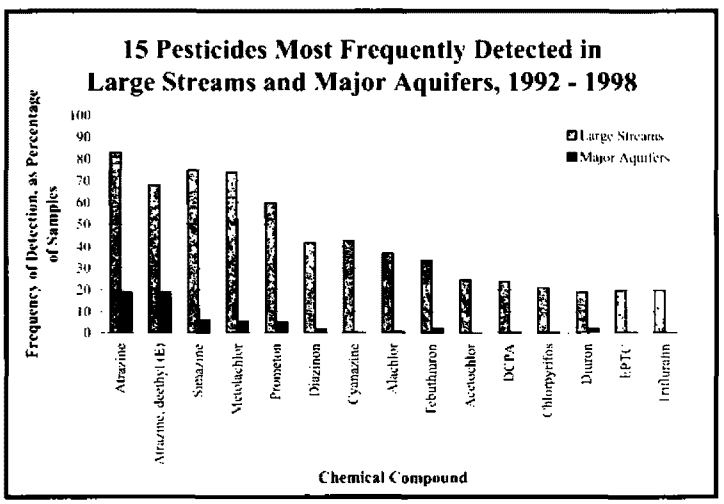
In 1992, the U.S. Geological Survey began testing samples of the nation's water sources for pesticides concentration through its National Water Quality Assessment (NAWQA) Program. The NAWQA Program focuses on 36 of the nation's major hydrologic basins (NAWQA study units), which represents water resources available to more than 60% of the population. Data collected from 1992 to 1998 constitute part of the first cycle of NAWQA and represent two-thirds of what eventually will be the national data set for pesticides in surface and ground water. The second cycle of NAWQA data collection will allow for the comparison of trends over time when study units systematically are reassessed and an increasing number of sites will have had 10 years of consistent monitoring.

The three charts show the most frequently detected pesticides in waters within agricultural areas and urban areas and in large streams and major aquifers. Key findings from the NAWQA report, which are not reflected in the charts, include:

- More than 90% of water and fish samples from all streams contained one or, more frequently, several pesticides.
- Approximately 50% of the samples of wells (including shallow ground water and aquifers) contained one or more pesticides.
- Herbicides were the most common type of pesticide found in water within agricultural areas.
- Insecticides were found to be more prevalent in water in urban areas than in agricultural areas.
- At 30% of NAWQA sampling sites, insecticide concentrations in fish exceeded guidelines for edible fish tissue.
- Although there were fewer insecticide detections than herbicide detections, insecticides exceeded drinking-water guidelines more frequently (the cancelled product dieldrin was the insecticide that exceeded guidelines in all but one of the instances).







Notes: E estimated concentration

Source: USGS, National Water Quality Assessment, Pesticide National Synthesis Project, 2001.

Scale: National and regional data available for selected hydrologic basins.

Data Characteristics and Limitations: In the NAWQA, the USGS tests for 83 pesticide compounds (76 pesticides and 7 pesticide-breakdown products). These 83 compounds account for 75% of all synthetic pesticides used in the U.S. This list includes 17 of the top 20 herbicides and 15 of the top 20 pesticides. The NAWQA study design comprises an initial 3 to 4 years of intensive study, followed by 6 to 7 years of low-level monitoring, after which intensive study resumes to evaluate any water-quality changes. At each site, fish, sediment and water samples are collected and tested for pesticide concentrations. Although NAWQA represents the broadest range of pesticides ever included in a single monitoring system, there are many pesticide compounds not accounted for. These include inorganic pesticides, biological pesticides and many pesticide breakdown products.

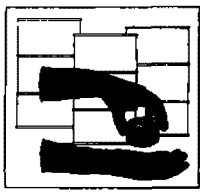
In the second cycle of studies, beginning in 2001, NAWQA will initiate assessment of three main categories of contaminants not included in the national design for the first cycle: (1) selected new pesticides with high usage in agricultural and populated areas across the Nation, and pesticide degradation products; (2) indicators of water-borne diseases in streams and ground water that are sources of drinking water and in streams that are used for water-contact recreation; and (3) total mercury and methylmercury in streams that have the greatest potential for human exposure through the consumption of fish.

References:

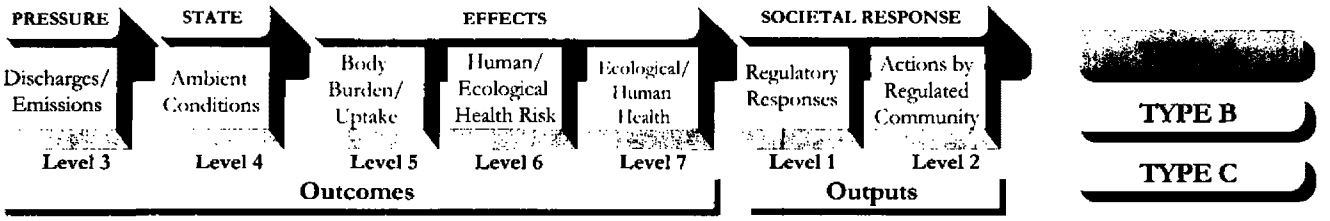
U.S. Geological Survey. 2001. *Pesticides in Ground Water: Summary Statistics; Results of the NAWQA, 1992-1998.* 10 January 2003. Available online at: http://ca.water.usgs.gov/pnsp/pestgw/

U.S. Geological Survey. 2001. *Pesticides in Streams: Summary Statistics; Results of the NAWQA, 1992-1998.* 10 January 2003. Available online at: http://ca.water.usgs.gov/pnsp/pestsw/

U.S. Geological Survey. 1999. *The Quality of Our Nation's Waters: Nutrients and Pesticides.* U.S. Geological Survey Circular 1225.



CHEMICAL AND PESTICIDE SAFETY AND USE
TOXICITY OF THE AMBIENT ENVIRONMENT



Indicator: National Emissions of Air Toxics

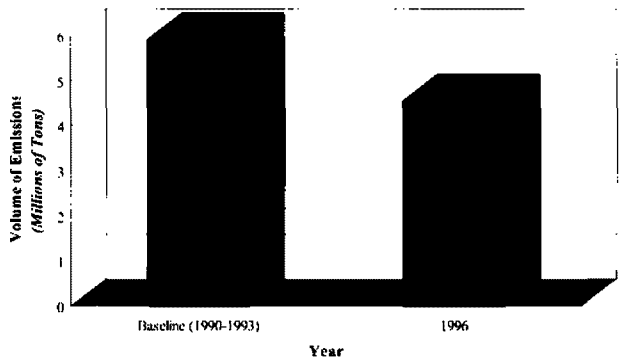
Air toxics, also referred to as hazardous air pollutants (HAPs), are pollutants that may cause adverse human health or environmental effects. Air toxics are emitted from stationary, area and mobile sources in the form of particulates or volatile organic compounds. Human health effects from air toxics are determined by the concentration of the toxics and length of exposure and may include cancer or damage to the immune system, as well as other neurological, reproductive, developmental, and respiratory problems. Although the primary exposure pathway is inhalation, exposure to some chemicals may occur through ingestion.

To monitor the emissions of air toxics, the EPA Office of Air Quality Planning and Standards (OAQPS) initiated the development of the National Toxics Inventory (NTI). The NTI is the central repository for the 188 HAPs from all human-originated sources. This database tracks emissions from four sectors: 1) major (large industrial) sources; 2) smaller area and other sources, which include smaller industrial sources, like small drycleaners and gasoline stations, as well as natural sources, like wildfires; 3) on-road mobile sources, including highway vehicles; and 4) non-road mobile sources, such as aircraft, locomotives, and construction equipment.

The chart reflects the trend in air toxics emissions from the baseline period of 1990-1993 to 1996. The baseline period comprises multiple years because it took four years to complete the initial inventory. For this reason, the 1990-1993 baseline can be interpreted to be a "snapshot" inventory in the same way that the 1996 inventory (which only took one year to complete) is. From 1996 onward, the NTI has been conducted once every three years. The next update for 1999 air toxics emissions data will be made available in 2002.

- This indicator illustrates that nationwide air toxics emissions are estimated to have decreased by approximately 23% between 1990 and 1996.

National Air Toxics Emissions: Total for 188 Toxic Air Pollutants (Baseline-1996)



Source: US EPA, National Toxics Inventory, 1999

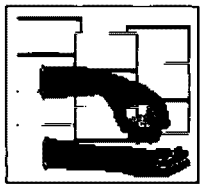
Scale: Data from NTI is available at the national level, as well as for selected state and local air agencies.

Data Characteristics and Limitations: NTI data is collected from four different sources: 1) data developed by state and local air agencies; 2) data from EPA's Emissions Standards Division, collected and developed for standards development; 3) data from existing EPA inventories, such as those developed to support requirements of the Clean Air Act; and 4) emissions reported in the Toxics Release Inventory Database and emissions that EPA generated using emission factors and activity factors. While the baseline set of data collected did not include facility or location specific information, the 1996 dataset does. This allows the NTI data to be used as input for computer air quality models. Changes in the methods used to collect and compile data from all of the relevant sources may account for some of the variation between these two data points. In addition to monitoring toxic air emissions and ambient concentrations of air toxics, the EPA has scheduled to model human exposure, and estimated health risks.

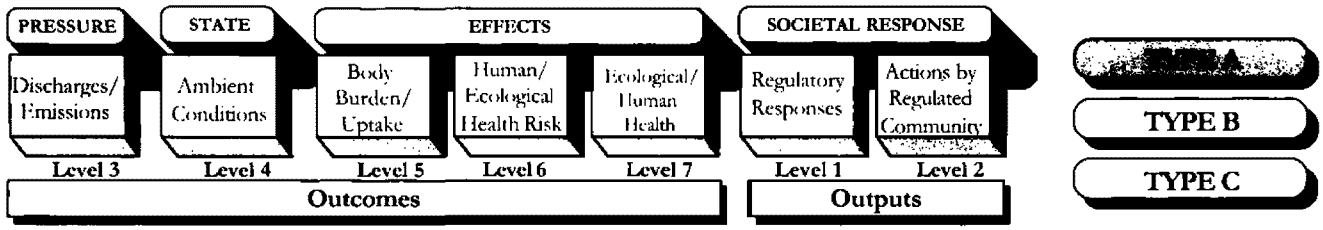
References

US Environmental Protection Agency, Office of Air Quality Planning and Standards. 2000. *Latest Findings of National Air Quality: 1999 Status and Trends*. 30 January 2003. Available online at: http://www.epa.gov/airtrends/.

US Environmental Protection Agency, Office of Air Quality Planning and Standards. *National Air Pollutant Emission Trends, 1900-1998*. Available online at: http://www.epa.gov/ttn/chief/trends/trends98/index.html



CHEMICAL AND PESTICIDE SAFETY AND USE
SAFER CHEMICALS AND PESTICIDES



Indicator: Number of Agricultural Acres Treated with Biopesticides

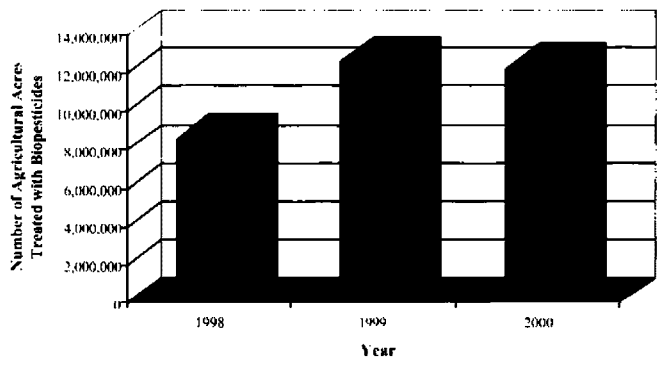
Current agricultural production has become heavily dependent on the use of agricultural pesticides to ensure that supply of agricultural commodities is consistent with demand. The potential does exist, however, for these toxic agricultural pesticides to adversely affect human and ecological health. To address this concern, the EPA has established a program designed to foster the development and use of pesticides that pose a lower health risk to the humans and the environment.

This indicator describes the use of a particular type of safer pesticide - biopesticides. Biopesticides are another type of safer pesticide derived from natural materials such as, animals, plants, bacteria, and certain minerals. Biopesticides are less harmful than conventional pesticides since they are designed to affect only one specific pest, in contrast to conventional pesticides that may affect many different organisms including birds, insects and mammals. They are also effective in small quantities and often decompose quickly, thereby decreasing exposure times and avoiding pollution problems caused by conventional pesticides (U.S. EPA 2001).

The following chart illustrates the percentage of agricultural acre treated with biopesticides between 1998 to 2000.

- The number of agricultural acres treated with biopesticides decreased slightly from 1999 to 2000 but increased overall between 1998 and 2000.
- Not reflected in the chart is the fact that biopesticides accounted for 1.4% of total agricultural pesticide use in 2000.

Number of Agricultural Acres Treated with Biopesticides, 1998-2000



Source: Doane Marketing Research, Inc. data (2001) as summarized by Edward Brandt, Office of Pesticide Programs, US EPA

Scale: County, state, and national level

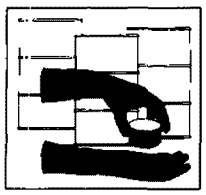
Data Characteristics and Limitations: The data that were used to construct this indicator were compiled by Doane Marketing Research, Inc. This private research company conducts interviews to estimate pesticide use on select field and row crops. To summarize use rates for reduced risk pesticides, Edward Brandt of the EPA combined the Doane use rates with crop specific assessments of whether a particular active ingredient was considered to be of reduced risk.

References:

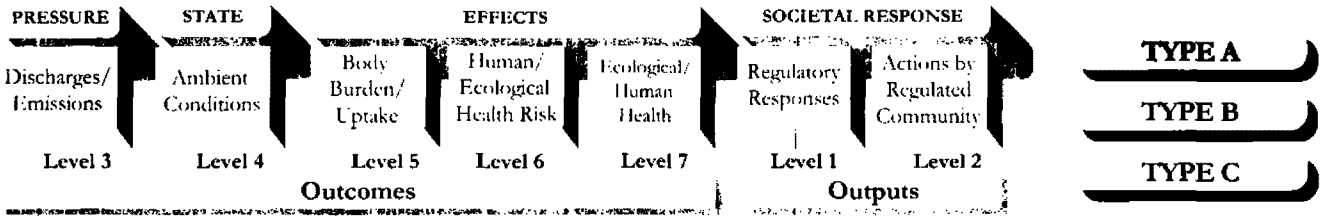
Doane Marketing Research, Inc. 2001. *AgroTrakTM: A DoaneMarkeTrakTM System Product.* 13 January 2003. Available online at: http://www.doanemr.com/row-specialty-turf/agrotrak.html

U.S. Environmental Protection Agency, Office of Pesticide Programs. 1996. *Reduced Risk, IPM and Pollution Prevention.* 13 January 2003. Available online at: http://www.epa.gov/oppfead1/fqpa/rripmpp.htm

U.S. Environmental Protection Agency, Office of Pesticide Programs. 2001. Biopesticides. 13 January 2003. Available online at: http://www.epa.gov/pesticides/citizens/biopesticides.htm



CHEMICAL AND PESTICIDE SAFETY AND USE
SAFER CHEMICALS AND PESTICIDES



Indicator: Number of Agricultural Acres Treated with Reduced Risk Pesticides

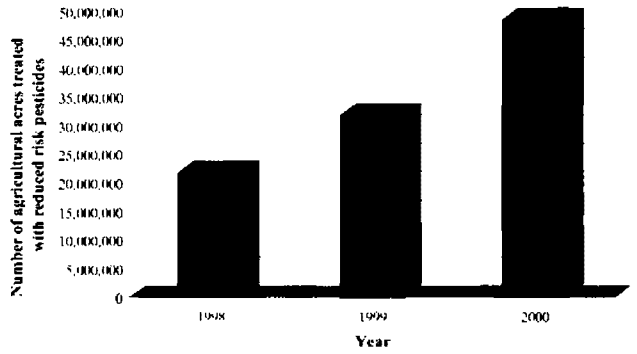
Current agricultural production has become heavily dependent on the use of agricultural pesticides to ensure that supply of agricultural commodities is consistent with demand. The potential does exist, however, for these toxic agricultural pesticides to adversely affect human and ecological health. To address this concern, the EPA has established a program designed to foster the development and use of pesticides that pose a lower health risk to the humans and the environment.

This indicator describes the use of a type of safer pesticide - reduced risk pesticides. The EPA defines a reduced risk pesticide as one which "may reasonably be expected to accomplish one or more of the following: 1) reduces pesticide risks to human health; 2) reduces pesticide risks to non-target organisms; 3) reduces the potential for contamination of valued, environmental resources; or 4) broadens adoption of Integrated Pest Management or makes it more effective." An active ingredient that is categorized as reduced risk is considered such only if it is being used for the specific application for which it was registered. For instance, a reduced risk herbicide registered for use on peanuts would not be considered reduced risk if it were used to treat winter wheat (U.S. EPA 1996).

The chart illustrates the percentage of agricultural acre treated with reduced risk pesticides between 1998 and 2000.

- The number of agricultural acres treated with reduced risk pesticides has increased from 21,775,262 acres in 1998 to 48,609,514 acres in 2000.
- Not seen in the chart is the fact that reduced risk pesticides accounted for 5.7% of total agricultural pesticide use in 2000.

Number of Acres Treated With Reduced Risk Pesticides, 1998-2000



Source: Doane Marketing Research, Inc. data (2001) as summarized by Edward Brandt, Office of Pesticide Programs, US EPA

Scale: County, state, and national level

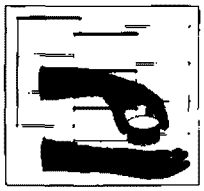
Data Characteristics and Limitations: The data that were used to construct this indicator were compiled by Doane Marketing Research, Inc. This private research company conducts interviews to estimate pesticide use on select field and row crops. To summarize use rates for reduced risk pesticides, Edward Brandt of the EPA combined the Doane use rates with crop specific assessments of whether a particular active ingredient was considered to be of reduced risk.

References:

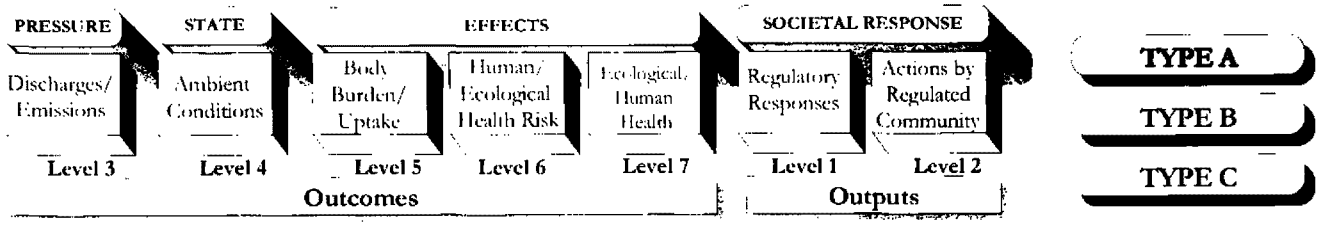
Doane Marketing Research, Inc. 2001. *AgroTrakTM: A DoaneMarkeTrakTM System Product.* 13 January 2003. Available online at: http://www.doanemr.com/row-specialty-turf/agrotrak.html

U.S. Environmental Protection Agency, Office of Pesticide Programs. 1996. *Reduced Risk, IPM and Pollution Prevention.* 13 January 2003. Available online at: http://www.epa.gov/oppfead1/fqpa/rripmpp.htm

U.S. Environmental Protection Agency, Office of Pesticide Programs. 2001. Biopesticides. 13 January 2003. Available online at: http://www.epa.gov/pesticides/citizens/biopesticides.htm



CHEMICAL AND PESTICIDE SAFETY AND USE
SAFER CHEMICALS AND PESTICIDES



Indicator: Sale of Drycleaning Equipment Using Safer Chemicals

The drycleaning industry provides garment cleaning, as well as pressing and finishing services. The process is considered dry because it uses little to no water. It does, however, use a liquid solution composed of solvents. Though estimates vary, it is generally accepted that usage of perchloroethylene, considered by the Environmental Protection Agency (EPA) to be a possible human carcinogen, still represents as much as 85% of the industry. However, the past two decades have seen a decline in total perc usage from 250 million pounds in 1986 to only 52 in 2001.

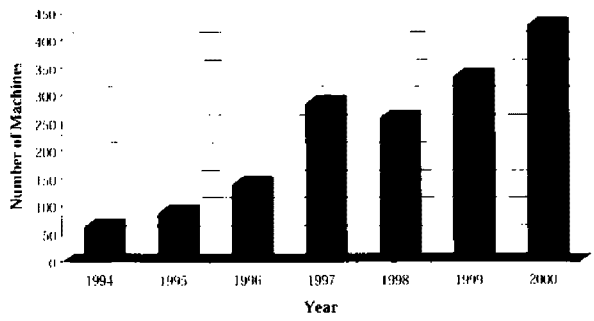
This decline is not directly related to adoption of safer chemicals, but upgrades in the early 1990's to more efficient machinery. The evolution of technology has been such that so-called first-generation drycleaning machines used 82 pounds of perc per 1,000 pounds of clothes cleaned, in contrast to the newest fourth and fifth-generation machines that use no more than 10 pounds of perc for the same amount of clothing (National Clothesline 2002).

The ideal measure would show the amount of alternative chemicals used as a result. However, because these technologies are relatively new, no such data currently exist. Instead, the EPA uses sales of environmentally preferable cleaning equipment as a measure. Environmentally preferable cleaning, as defined by the EPA, includes three processes: wetcleaning (which uses water), liquid carbon dioxide, and liquid silicone. The following charg displays an increase in the sale of equipment using these processes.

The following chart displays an increase in the sale of equipment using these processes.

> An increasing number of drycleaners are upgrading their equipment. Only 62 machines of this type were sold in 1994, versus 426 in 2000.
>
> If all machines are currently still operating, as many as 1,591 environmentally preferable machines are in use.

Sales of Environmentally Preferable Garment Cleaning Equipment in the U.S., 1994 to 2000



Source: Data from the USEPA Design for the Environment (DfE) Garment and Textile Care Partnership.

Data Characteristics and Limitations: Equipment sales data are as of March 2001.

References

"Cleaners' perc use continues decline." National Clothesline, August 2002. 30 January 2003. Available online at: http://www.natclo.com/0208/aa10.htm

E mail correspondence with Bill Linn, Professional Geologist, Florida Department of Environmental Protection.

Findings and Accomplishments of the Design for the Environment Garment and Textile Care Program. 30 January 2003. Available online at: http://www.epa.gov/opptintr/dfe/projects/garment/findings.htm

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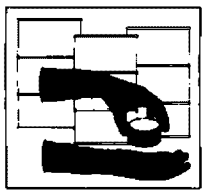
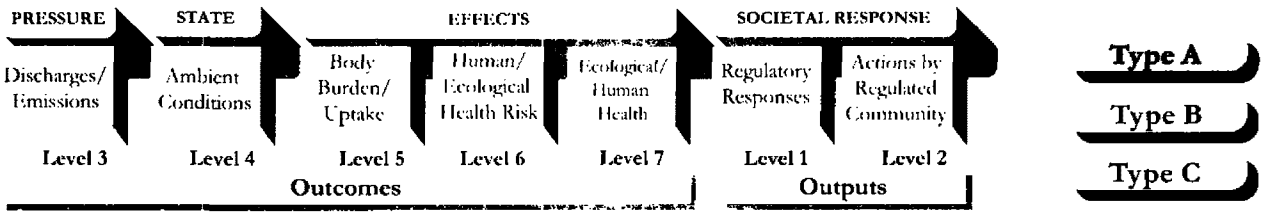
Linn, Bill. January 2002. "Chemicals Used in Drycleaning Operations." 30 January 2003. Available online at: http://www.drycleancoalition.org/chemicals/

Profile of the Fabricare Industry. International Fabricare Institute. 30 January 2003. Available online at: http://www.ifi.org/industry/industry-profile.html.

Telephone conversation with Mary Scalco, International Fabricare Institute.



CHEMICAL AND PESTICIDE SAFETY AND USE
SAFER CHEMICALS AND PESTICIDES



Indicator: Annual Pesticide Use on Select Field Crops by Pesticide Product Signal Word

Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems.

For these reasons, it is important to monitor the agricultural usage of pesticides. The U.S. Department of Agriculture (USDA) is charged with monitoring the usage of pesticides on field crops, fruits, vegetables and for livestock and general farm uses. Every year, the USDA National Agricultural Statistics Service (NASS) administers the Agricultural Resources Management Survey (ARMS) to a sample of farmers. Information on pesticide usage on field crops is obtained through this annual survey.

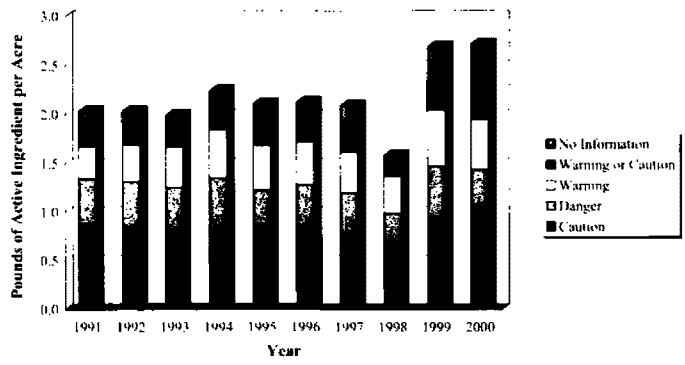
A signal word is included on the product label for all farm chemicals. The three signal words are CAUTION (slightly toxic or relatively non-toxic), WARNING (moderately toxic), or DANGER (highly toxic). Since the formulations of active ingredients can vary among products, there are instances in which an active ingredient may have more than one signal word. This indicator measures agricultural pesticide usage by pesticide product signal word. This indicator does not explicitly consider the risk to human or environmental health posed by each of the pesticides used. However, because these signal words are derived from the acute toxicity classifications of each active ingredient, they can be inferred to be proxy measures of the toxicity of pesticides applied.

- The chart shows that active ingredients with the signal word CAUTION represent the largest share of pesticide usage on field crops in the U.S. The pounds of these chemicals applied steadily decreased from 0.87 in 1991 to 0.70 in 1998. The rate increased, however, in 1999 to 0.95 lbs. per acre and in 2000 to 1.08 lbs. per acre.

- DANGER and WARNING chemicals were used at the next highest rates. The use of DANGER chemicals decreased from 0.52 lbs. per acre in 1999 to 0.36 lbs. per acre in 2000. The use of WARNING chemicals decreased from 0.57 lbs. per acre in 1999 to 0.51 lbs. per acre in 2000.

- Overall, the share of each signal word of all pesticide active ingredients applied has remained fairly constant.

Annual Pesticide Use of Select Field Crops by Pesticide Product Signal Word, 1991-2000



Notes: Select field crops include corn, upland cotton, fall potatoes, soybeans and winter wheat.

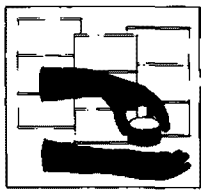
Source: USDA NASS, Field Crop Summaries for 1991-2000

Data Characteristics and Limitations: Every year, the USDA NASS administers the ARMS to a sample of farms that produce the crops of interest that particular year. Although the list of the crops of interest varies from year to year, this indicator tracks pesticide usage on the five field crops that have been surveyed every year (corn, upland cotton, fall potatoes, soybeans and winter wheat). This is to ensure comparability of the data over time. The operator of the sampled farm is personally interviewed by NASS staff to obtain information about chemical applications on the selected field. The survey and the sampling scheme are designed so that the usage estimates are statistically representative of chemical use on the targeted crops in the surveyed states. The estimates are reviewed for reliability and consistency.

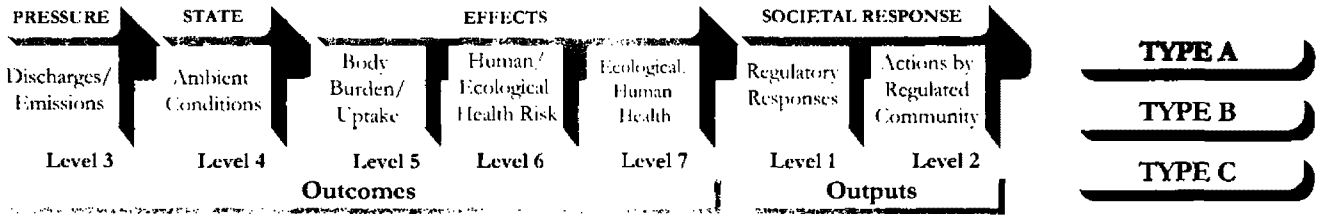
References

U.S. Department of Agriculture, National Agricultural Statistics Service (NASS), Agricultural Statistics Board. *Agricultural Chemical Usage, Field Crop Summary* (1991-2000). 7 January 2003. Available online at: http://www.usda.gov/nass.

___ 1999. *Farm Chemicals Handbook*. Willoughby: MeisterPro Publishing Co.



CHEMICAL AND PESTICIDE SAFETY AND USE
SAFER CHEMICALS AND PESTICIDES



Indicator: Annual Pesticide Use on Select Vegetables by Pesticide Product Signal Word

Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems.

For these reasons, it is important to monitor the agricultural usage of pesticides. The U.S. Department of Agriculture (USDA) is charged with monitoring the usage of pesticides on field crops, fruits, vegetables and for livestock and general farm uses. Every year, the USDA National Agricultural Statistics Service (NASS) administers the Agricultural Resources Management Survey (ARMS) to a sample of farmers. Information on pesticide usage on vegetables is obtained through this annual survey.

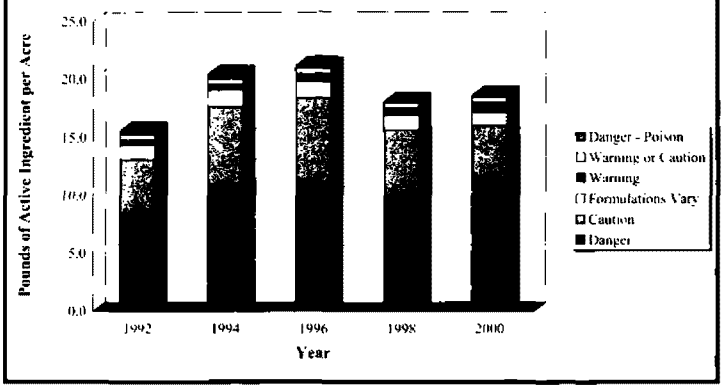
A signal word is included on the product label for all farm chemicals. The three signal words are CAUTION (slightly toxic or relatively non-toxic), WARNING (moderately toxic), or DANGER (highly toxic). Since the formulations of active ingredients can vary among products, there are instances in which an active ingredient may have more than one signal word. This indicator measures agricultural pesticide usage by pesticide product signal word. This indicator does not explicitly consider the risk to human or environmental health posed by each of the pesticides used. However, because these signal words are derived from the acute toxicity classifications of each active ingredient, they can be inferred to be proxy measures of the toxicity of pesticides applied.

The chart shows that active ingredients with the signal word DANGER represent the largest share of pesticide usage on vegetables in the U.S. The pounds of these chemicals applied steadily increased from 8.48 in 1992 to 11.23 in 1996. The rate decreased in 1998 to 9.85 lbs. per acre, but then increased again in 2000 to 11.59 lbs. per acre.

DANGER chemicals have consistently accounted for greater than 50% of all pesticide active ingredients applied.

CAUTION chemicals were applied at the next highest rate. These chemicals accounted for approximately 30% of all pesticides applied each year from 1992 to 1998. Their share decreased to approximately 24% in 2000.

Annual Pesticide Use on Select Vegetables by Pesticide Product Signal Word, 1992-2000



Notes: Select vegetables include asparagus, fresh lima beans, fresh snap beans, processing snap beans, broccoli, fresh cabbage, processing cabbage, cauliflower, celery, fresh sweet corn, processing sweet corn, fresh cucumbers, processing cucumbers, eggplant, head lettuce, other lettuce, watermelons, processing green peas, bell peppers, fresh spinach, processing spinach, strawberries, fresh tomatoes, and processing tomatoes.

Source: USDA NASS, Vegetable Summaries for 1992-2000

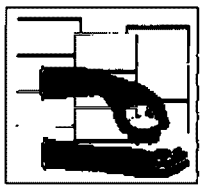
Scale: Select states are aggregated to illustrate the national situation.

Data Characteristics and Limitations: Every year, the USDA NASS administers the ARMS to a sample of farms that produce the vegetables of interest that particular year. Although the list of the vegetables of interest varies from year to year, this indicator tracks pesticide usage on the twenty-four vegetables that have been surveyed every year. This is to ensure comparability of the data over time. The operator of the sampled farm is personally interviewed by NASS staff to obtain information about chemical applications on the selected vegetable. The survey and the sampling scheme are designed so that the usage estimates are statistically representative of chemical use on the targeted vegetables in the surveyed states. The estimates are reviewed for reliability and consistency.

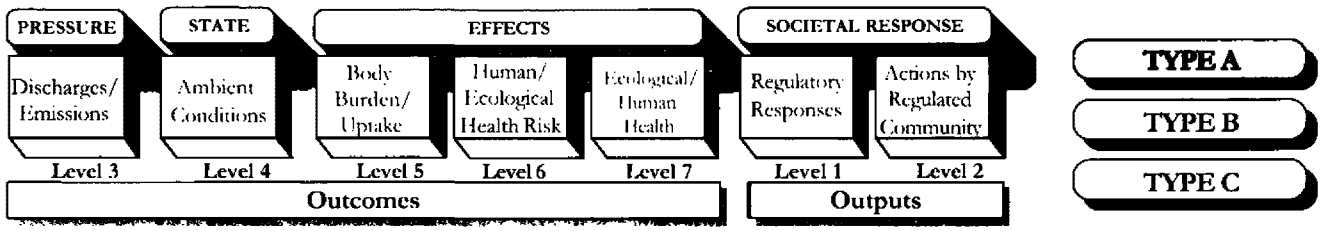
References

National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. *Agricultural Chemical Usage, Vegetable Summary* (1992-1998). 7 January 2003. Available online at: http://www.usda.gov/nass.

__ __ *Farm Chemicals Handbook*. Willoughby: MeisterPro Publishing Co., 1999.



CHEMICAL AND PESTICIDE SAFETY AND USE
SAFER CHEMICALS AND PESTICIDES



Indicator: Annual Pesticide Use on Select Fruits by Pesticide Product Signal Word

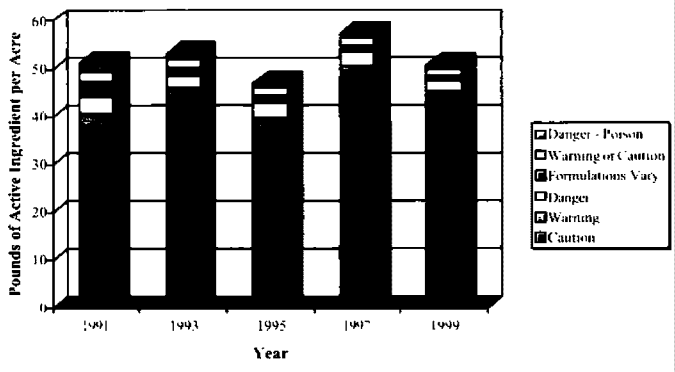
Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems.

For these reasons, it is important to monitor the agricultural usage of pesticides. The U.S. Department of Agriculture (USDA) is charged with monitoring the usage of pesticides on field crops, fruits, vegetables and for livestock and general farm uses. Every year, the USDA National Agricultural Statistics Service (NASS) administers the Agricultural Resources Management Survey (ARMS) to a sample of farmers. Information on pesticide usage on fruits is obtained through this annual survey.

A signal word is included on the product label for all farm chemicals. The three signal words are CAUTION (slightly toxic or relatively non-toxic), WARNING (moderately toxic), or DANGER (highly toxic). Since the formulations of active ingredients can vary among products, there are instances in which an active ingredient may have more than one signal word. This indicator measures agricultural pesticide usage by pesticide product signal word. This indicator does not explicitly consider the risk to human or environmental health posed by each of the pesticides used. However, because these signal words are derived from the acute toxicity classifications of each active ingredient, they can be inferred to be proxy measures of the toxicity of pesticides applied.

- The chart shows that active ingredients with the signal word CAUTION represent the largest share of pesticide usage on fruits in the U.S. The pounds of these chemicals applied has increased from 36.9 in 1991 to 42.3 in 1999.
- The percentage of CAUTION chemicals applied has increased from 72% in 1991 to 83% in 1999.
- WARNING chemicals were applied at the next highest rate. However, in 1999, they only accounted for 6% of all chemicals applied.
- The share of each other signal word of all pesticide active ingredients applied has steadily decreased from 1991 to 1999.

Annual Pesticide Use on Select Fruits by Pesticide Product Signal Word, 1991-1999



Source: USDA NASS, Fruit Summaries for 1991-1999.

Notes: Select fruits include apples, avocados, blackberries, blueberries, sweet cherries, tart cherries, grapefruit, lemons, oranges, peaches, pears, raspberries, tangelos, tangerines, and temples.

Scale: Select states are aggregated to illustrate the national situation.

Data Characteristics and Limitations: Every year, the USDA NASS administers the ARMS to a sample of farms that produce the fruits of interest that particular year. Although the list of the fruits of interest varies from year to year, this indicator tracks pesticide usage on the fifteen fruits that have been surveyed every year (apples, avocados, blackberries, blueberries, sweet cherries, tart cherries, grapefruit, lemons, oranges, peaches, pears, raspberries, tangelos, tangerines, and temples). This is to ensure comparability of the data over time. NASS staff, to obtain information about chemical applications on the selected field, personally interviews the operator of the sampled farm. The survey and the sampling scheme are designed so that the usage estimates are statistically representative of chemical use on the targeted fruits in the surveyed states. The estimates are reviewed for reliability and consistency.

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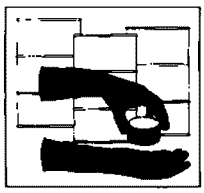
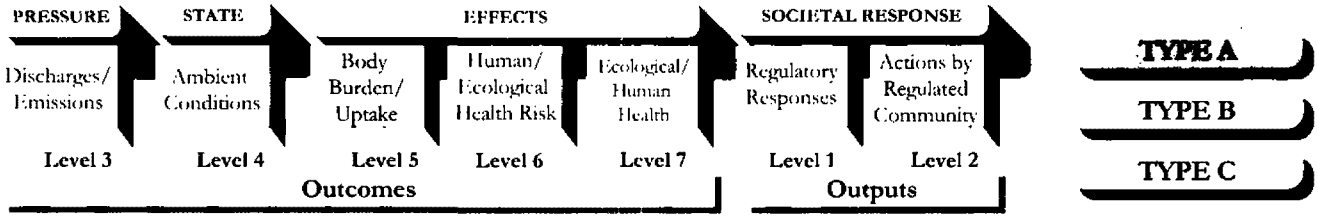


CHEMICAL AND PESTICIDE SAFETY AND USE
PERSISTENT, BIOACCUMULATIVE AND TOXIC CHEMICALS



Indicator: Chemical Bioaccumulation in Mussel Tissue

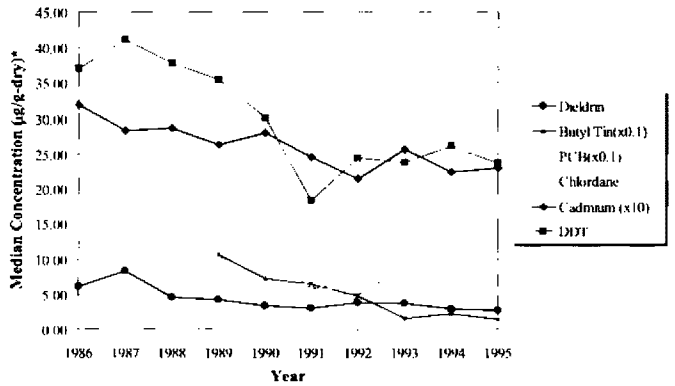
Since 1986, the National Oceanic and Atmospheric Administration (NOAA) has administered the Mussel Watch Project as part of its National Status and Trends Program. The Mussel Watch Project offers a regional and national picture of chemical contamination in estuaries, embayments and along open ocean coastline. Mussel Watch comprises chemical analyses of whole soft-parts of mussels and oysters for bioaccumulations of heavy metals and persistent chemicals known to affect human and wildlife health. The 274 Mussel Watch sites were chosen to represent large areas rather than smaller known areas of intensive chemical contamination (e.g., waste discharge points). The analysis of mollusk tissue provides an approximate measure of chemical concentrations in water and sediments and of bioaccumulation in wildlife.

NOAA prepared this indicator for use in its State of the Coastal Environment Report. The indicator reports annual median concentrations from 1986 to 1995 for the following six chemicals: cadmium, DDT, chlordane, PCBs, butyl tin compounds and dieldrin. Each of these chemicals exhibits toxic properties are conducive to long-term ambient monitoring. Chlordane, DDT and dieldrin are cancelled pesticides that are persistent, bioaccumulative and toxic (PBT) chemicals. Cadmium is a metal that is known to affect the lungs and kidneys in humans; it has also shown to be a developmental toxicant in wildlife. PCBs are a small family of industrial compounds that are environmentally persistent, bioaccumulative and have been linked to developmental deformities in birds (Francis 1994). Tributyltin is a toxic chemical targeted by the EPA and is a suspected endocrine toxicant.

The chart shows the trends in the levels of these six contaminants in mollusk tissue from 1986 to 1995 (for butyl tin, 1989-1995).

- Median concentrations of cadmium and DDT have decreased by 28% and 36%, respectively.
- Median concentrations of chlordane and dieldrin have decreased by 63% and 56%, respectively.
- Median concentrations of PCBs and butyl tin have decreased by 49% and 86%, respectively.

Levels of Selected Chemicals in Mollusk Tissue, 1986-1995



Notes: Concentrations measured in micrograms of chemical/gram of dry mollusk tissue. PCBs are measured in nanogram/gram-dry.

Source: National Oceanic and Atmospheric Administration, Mussel Watch Project.

Scale: Data are available on the regional and national levels.

Data Characteristics and Limitations: NOAA has been collecting tissue sample and analyzing them for chemical contamination since 1986 at 274 sites (current). Monitored metals and chemicals include:

Trace Metals:
Arsenic, Cadmium, Copper, Lead, Nickel, Mercury, Selenium, Zinc
Organic Compounds:
Total DDT, Total Chlordane, Total Dieldrin, Total PCBs, Total PAHs, and Total Butyl Tin.

The metal and organic compounds selected for inclusion in the indicator all experienced declines in mean concentration over the period. Other metals and chemicals showed no change.

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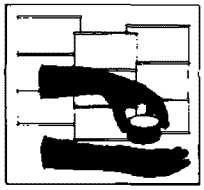
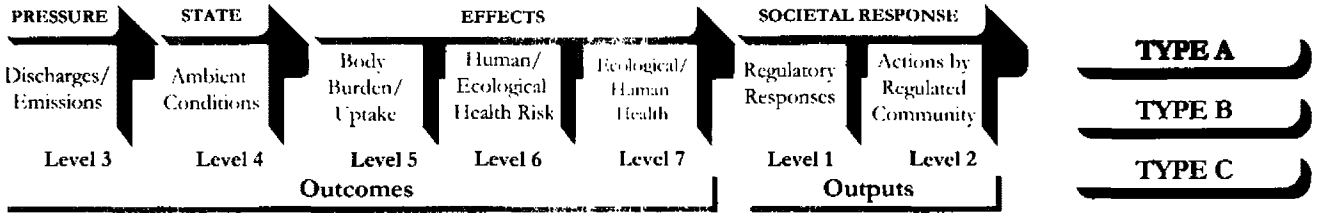


CHEMICAL AND PESTICIDE SAFETY AND USE
TOXICITY OF THE AMBIENT ENVIRONMENT



Indicator: Toxicity Index for Persistent, Bioaccumulative, and Toxic Chemical Releases

Persistent, bioaccumulative, and toxic chemicals (PBTs) are substances that slowly build up in people and the environment over time. In general, PBTs may be hazardous to human and ecological health. The hazard to human and ecological health from PBTs may occur immediately or after symptoms may begin to show in subsequent years. The U.S. Environmental Protection Agency is currently developing action plans to reduce the risk of PBTs to both human and ecological health (U.S. EPA 2002).

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating a toxicity score for each chemical. The toxicity score is multiplied by the pounds of chemical released or managed in waste; the toxicity of each chemical release and waste stream can be aggregated to provide an estimate of the total toxicity of releases and managed waste for a given year.

This measure can have implications for both human and ecological health, with declining trends in the total toxicity of chemical releases and managed waste implying potential for a more healthful environment. The measure also has implications for the success of governmental pollution prevention programs and for activities conducted by the private sector to improve pollution related efficiencies.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unitless measure of toxicity. These measures can only be interpreted relatively: to display trends and to make comparisons of toxicity over time. For this indicator, the toxicity of releases and managed waste was adjusted to create an index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the estimate of toxicity of releases and managed waste for the baseline year was adjusted to equal a value of 100; subsequent estimates reflect changes from that baseline of 100. If industries are maintaining or improving pollution efficiencies or succeeding at pollution prevention, then the index should display constant or declining trends.

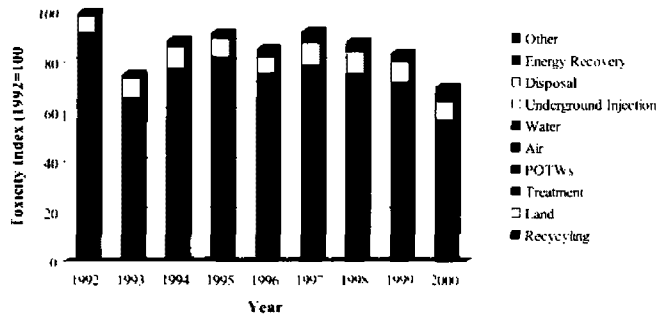
Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total toxicity of releases into the environment and managed chemical waste. It can be inferred, however, as a measure of the relative gains the U.S. is making in pollution prevention and improving pollution efficiencies.

There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Three different subsets of TRI data are reflected in the presented charts. The first chart reflects data for a core list of chemicals that have been reported every year since the inception of TRI in 1988; however, the chart reflects data beginning in 1992, which is when recycling, energy recovery and treatment operations

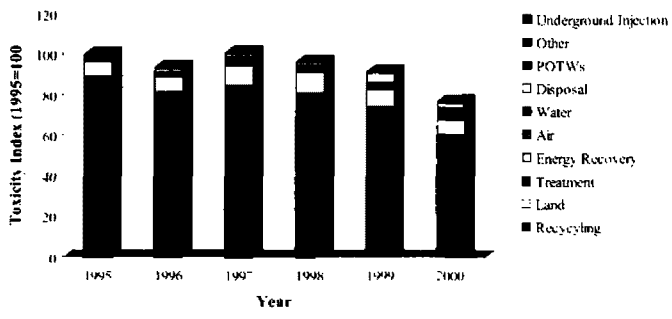
were incorporated into TRI. The second chart reflects data for an enhanced list of chemicals that have been reported every year from 1995 to 2000. The third chart reflects the expansion of the TRI in1998 which added the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal.

Toxicity Index for Releases and Managed Waste of Persistent Bioaccumulative Toxic Chemicals (Core Chemicals List), 1992-2000



- The toxicity index for the core chemicals list shows some annual variation, and a decrease overall from 100 in 1992 to 70 in 2000.
- Waste recycling accounts for the vast majority (over 80%) of the toxicity index for the core chemicals list.

Toxicity Index of Release and Managed Waste for Persistent Bioaccumulative Toxic Chemicals (Enhanced Chemicals List), 1995-2000



- The toxicity index for the enhanced chemicals list shows some annual variation, and a decrease overall from 100 in 1995 to 77 in 2000.
- Again, waste recycling and other management methods account for the majority of the risk from PBTs.

Source: **Risk Screening Environmental Indicators,** Computer queries of national summary data prepared February 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening

Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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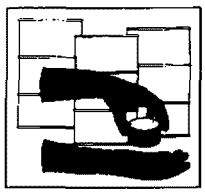
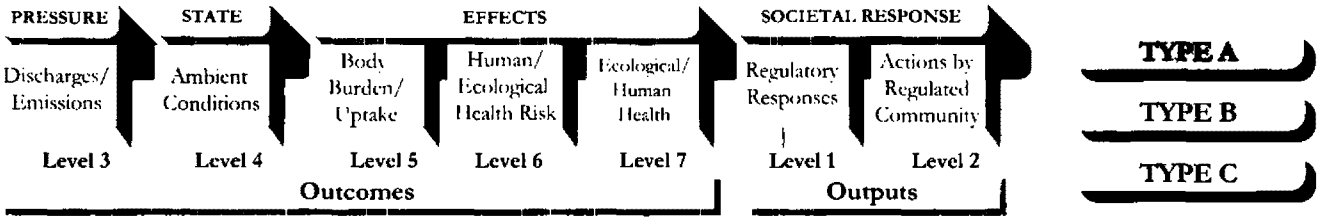
Toxics Release Inventory Relative Risk-Based Environmental Indicators Methodology, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, June 1997.

User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators are available on at: http://www.epa.gov/opptintr/rsei/. 31 January 2003. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov).



CHEMICAL AND PESTICIDE SAFETY AND USE
PERSISTENT, BIOACCUMULATIVE, AND TOXIC CHEMICALS



Indicator: PCBs and Persistent Pesticide Detections in Fish and Bed Sediment

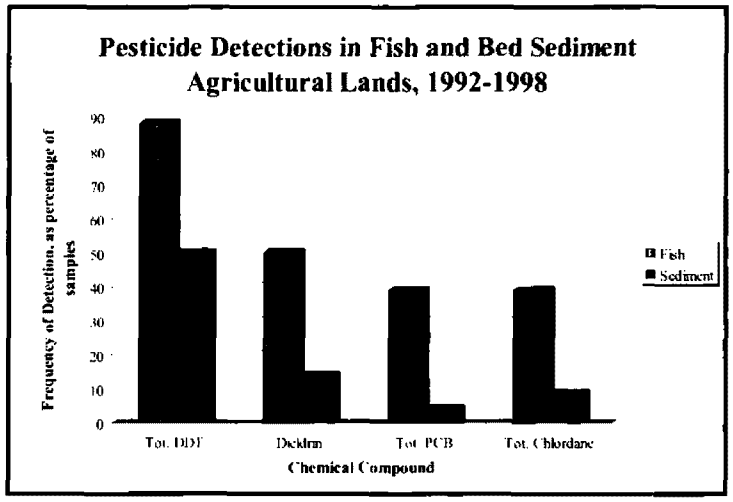
While many of the harmful pesticides historically used for agriculture are no longer used in the U.S. today, evidence of them can still be detected in air, precipitation, soil, sediment, and biota. A group of pesticides known as the organochlorine (OC) pesticides are particularly well known for their persistence in the environment due to their hydrophobicity (low water solubility). Most OC pesticides were canceled or restricted during the 1970's because of potential human and wildlife health effects, their tendency to bioaccumulate, and their ability to persist in the environment (U.S. EPA 1990). In general, OC pesticides have moderate to high chronic toxicity, are associated with developmental and/or reproductive effects in animal studies, and many are also considered to be probable human carcinogens (Nowell and others, 1999). PCBs, an industrial contaminant of high concern, is often included in persistent chemical analyses because its physical and chemical properties are similar to those of the OC pesticides, so that it too, tends to accumulate in bed sediment and biota.

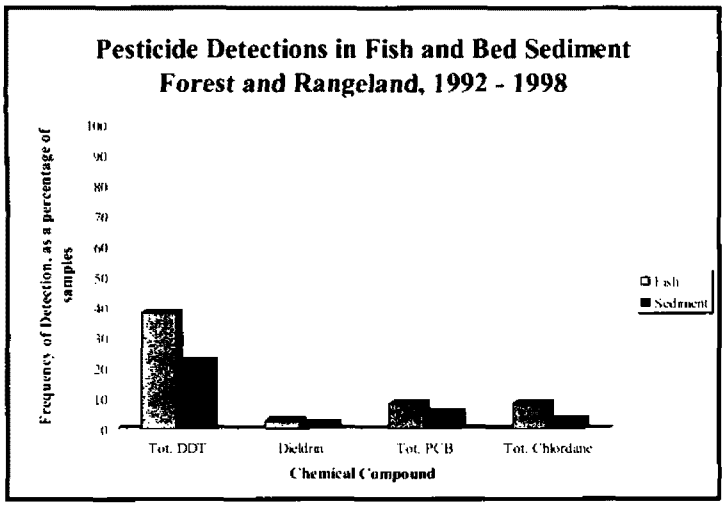
Due to the known harmful effects of these chemical compounds, it is important to monitor their concentrations not only in water, but also in bed sediment and aquatic biota. In hydrologic systems, these compounds may be detected in bed sediment or aquatic biota even when concentrations in the water column are too low to be detected using conventional sampling and analytical methods. Sampling bed sediment and aquatic biota provides a sensitive means of determining whether organochlorine compounds persist in a given hydrologic system. Monitoring pesticide accumulation in fish and bed sediment is also useful data for researchers trying to link pesticide exposure with health effects such as endocrine disruption.

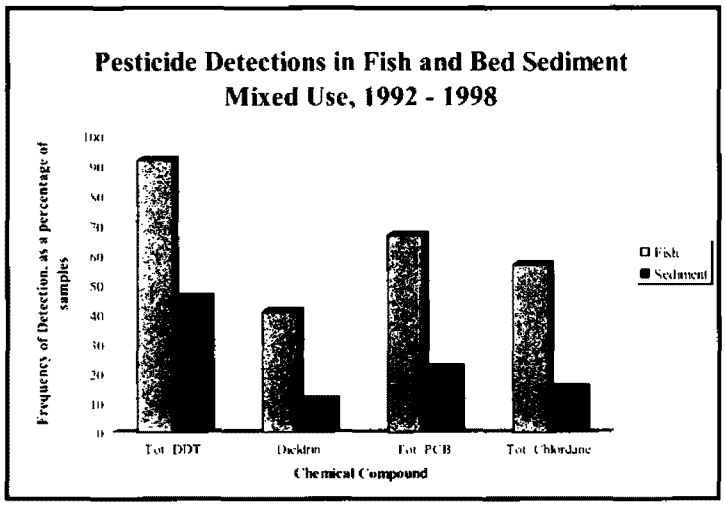
The U.S. Geological Survey began testing samples of the nation's fish and bed sediment for pesticides concentration through its National Water Quality Assessment (NAWQA) Program beginning in 1992. The NAWQA Program focuses on 36 of the nation's major hydrologic basins (NAWQA study units), which represents water resources available to more than 60% of the population. Data collected from 1992 to 1998 constitute part of the first cycle of NAWQA and represent two-thirds of what eventually will be the most extensive national data set that contains both bed sediment and aquatic biota tissue data for the same sites in U.S. rivers and streams. The second cycle of NAWQA data collection will allow for the comparison of trends over time when study units systematically are reassessed and an increasing number of sites will have had 10 years of consistent monitoring.

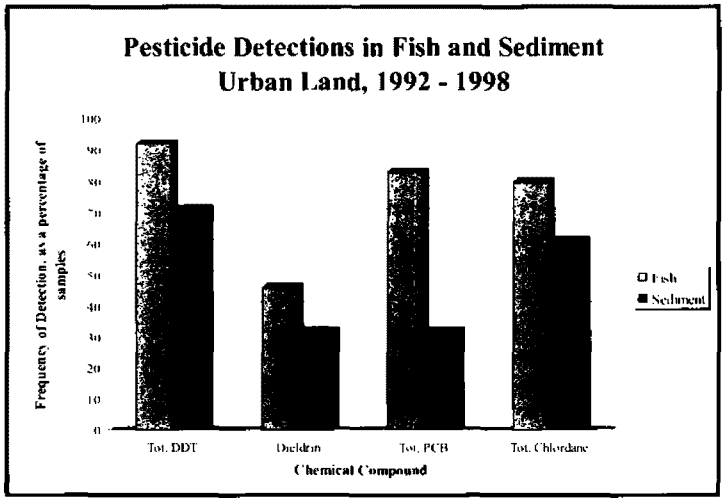
The four charts below show the most frequently detected pesticides in fish and bed sediment within agricultural areas, forest and rangelands, mixed land use areas, and urban areas. Key findings from the NAWQA studies include:

- Detection frequencies were higher in fish rather than in sediment, while total DDT was the most frequently detected compound.
- Urban streams had the highest frequencies of occurrence of DDT, chlordane, dieldrin, and PCBs in both fish and sediment samples.
- Sediment quality guidelines for protection of aquatic life were exceeded at nearly 40 percent of urban sites, and concentrations in whole fish exceeded guidelines for protection of wildlife at 20 percent of urban sites.









Notes: Total DDT = sum of DDT plus its degradation products, Total PCB =

Source: USGS, National Water Quality Assessment, Pesticide National Synthesis Project, 2001.

Scale: National and regional data available for selected hydrologic basins.

Data Characteristics and Limitations: In the NAWQA, the USGS tests for 83 pesticide compounds (76 pesticides and 7 pesticide-breakdown products). These 83 compounds account for 75% of all synthetic pesticides used in the U.S. This list includes 17 of the top 20 herbicides and 15 of the top 20 pesticides. The NAWQA study design comprises an initial 3 to 4 years of intensive study, followed by 6 to 7 years of low-level monitoring, after which intensive study resumes to evaluate any water-quality changes. At each site, fish, sediment and water samples are collected and tested for pesticide concentrations. Although NAWQA represents the broadest range of pesticides ever included in a single monitoring system, there are many pesticide compounds not accounted for. These include inorganic pesticides, biological pesticides and many pesticide breakdown products.

In the second cycle of studies, beginning in 2001, NAWQA will initiate assessment of three main categories of contaminants not included in the national design for the first cycle: (1) selected new pesticides with high usage in agricultural and populated areas across the Nation, and pesticide degradation products; (2) indicators of water-borne diseases in streams and ground water that are sources of drinking water and in streams that are used for water-contact recreation; and (3) total mercury and methylmercury in streams that have the greatest potential for human exposure through the consumption of fish.

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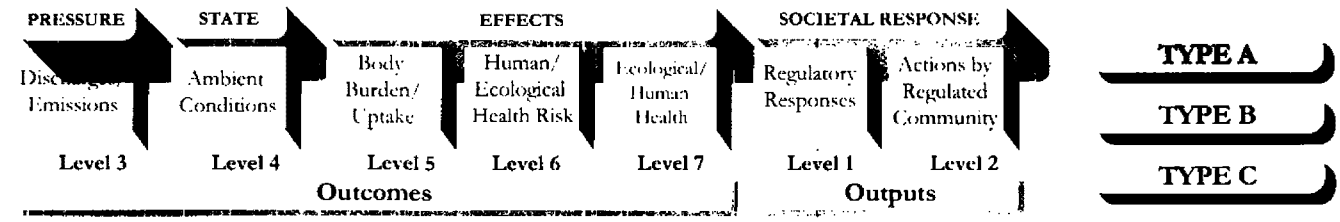
CHEMICAL AND PESTICIDE SAFETY AND USE
ALTERNATIVE FARMING SYSTEMS



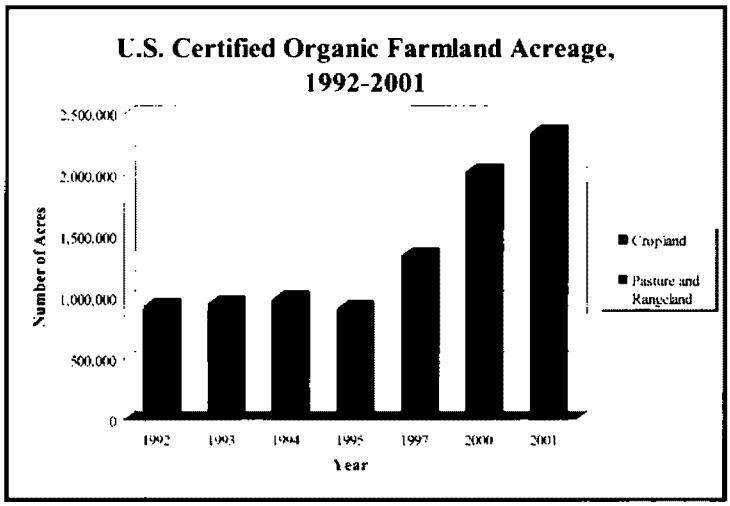
Indicator: Number of Certified Organic Farmland Acres

Organic agriculture is the production of food and fiber that does not use synthetic chemical pesticides or fertilizers. Emphasis is placed on developing biological diversity in the growing environment and maintaining soil fertility through natural processes. Foods produced organically undergo minimal processing without artificial ingredients, synthetic preservatives, or irradiation.

Certified organic products have been produced according to strict standards that are verified by independent public or private certifiers. Currently, each state manages its own certification process and standards. However, with authority from the Organic Food Production Act of 1990, the U.S. Department of Agriculture (USDA) has promulgated guidelines for national standards for organic agricultural production.

This indicator measures the trend in the number of acres in farm production that meet organic certification requirements. Since organic agriculture rejects synthetic toxic pesticides and chemical fertilizers, growth or decline in certified organic farmland acreage represents changes in agriculture practices less reliant on commercial pesticides or chemicals.

- Total certified organic farmland acreage increased by 44% between 1992 and 1997, 76% between 1997 and 2000, and 16% between 2000 and 2001.
- Approximately 2.35 million acres of farmland were organically certified in 2001.
- In spite of a fairly rapid rate of growth during the 1992-2001 period, certified organic cropland acreage still represents only 0.3% of all U.S. cropland acreage.



Source: USDA Agricultural Marketing Service (1992-1994), Agrisystems International (1995), USDA Economic Research Service (1997, 2002).

Data Characteristics and Limitations: The USDA Economic Research Service obtained membership directories, acreage reports and other sources of certified acreage and livestock from 40 State and private organic certifiers to calculate estimates. Uncertified organic production is excluded from these estimates, even though it may represent a large segment of organic production, because of difficulty in determining production criteria used by uncertified growers. Certified organic acreage and livestock estimates were calculated by State and by commodity.

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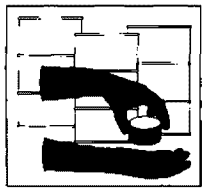
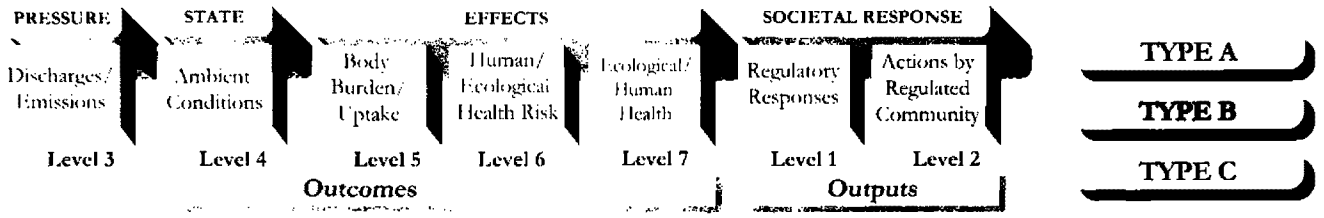


CHEMICAL AND PESTICIDE SAFETY AND USE
ALTERNATIVE FARMING SYSTEMS



Indicator: Number of Acres in Integrated Pest Management

The U.S. Environmental Protection Agency (EPA) defines integrated pest management (IPM) as "the coordinated use of pest and environmental information with available pest control methods to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to people, property, and the environment." (1998). Proponents of IPM believe that it offers the best opportunity to reduce environmental and human health risk resulting from exposure to pesticides, protect and conserve natural resources, make farming more profitable, and provide high-quality and safe foods and agricultural products.

The U. S. Department of Agriculture (USDA) in cooperation with the EPA, has identified four general components of IPM (2001): prevention, avoidance, monitoring, and suppression. The purpose of prevention practices is to prevent the infestation of the pest and includes practices such as, the use of disease resistant varieties, and pest-free seeds/transplants. Avoidance is used where some level of infestation may exist but serious problems can be avoided through appropriate practices such as, crop rotation, using trap crops, and selective planting. Monitoring involves surveying and scouting conditions to determine what needs to be done rather than routinely applying pesticides. Suppression involves utilizing a variety of cultural, physical, biological, and chemical pesticides practices to prevent or eliminate pests.

While data on the use of pest management practices exists (USDA 1997-2000), currently there is no complete, practical and acceptable method to measure overall IPM adoption. IPM data is presented in a disaggregate manner by crop, specific pest management practice, location, and percent of acres or farms using IPM practices. An attempt to create an overall IPM measure was made by scientists through the creation of a weighted index, (PAMS Diversity Index) however, the process to weigh each IPM practice is a complex and time-consuming task (Coble 1998). The creation of this index or a similar measure was not complete as of the date of this publication.

Without a reliable summary measure, conclusions can only be drawn on the extent individual pest management practices have been used for major field crops and selected fruits and vegetables. The completion of a summary IPM index would provide a strong measure of progress of the use of techniques that would minimize the need for and use of chemical pesticides.

Data Characteristics and Limitations: Pest Management Practices Summaries are based largely on data compiled from a nationwide farmer survey conducted annually since 1997. The results refer to responses from sampled producers concerning specific practices. The producers were first asked how many acres of a specific commodity they grew that year, followed by questions regarding the use of specific pest management practices, in yes/no format. Pests were defined as weeds, insects, and diseases. If the respondent used a specific practice on a crop, it was assumed that the practice was used on all acres of that crop. The data are published in two tables for each crop: percent of acres receiving the specific pest management practice and percent of farms using the specific pest management practice.

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ENVIROMENTAL ISSUE 4: FOOD SAFETY

List of Indicators

Percent of Foods Sampled with Detectable Pesticide Residues

Percent of Foods Sampled with Pesticide Residues that Violated or Were Presumed to Violate Tolerances

Percent of Foods Sampled with Detectable Industrial Chemical Residues

U.S. Annual Volume of Pesticide Usage by Type of Active Ingredient

Annual Pesticide Use on Select Field Crops by Type of Active Ingredient

Annual Pesticide Use on Select Vegetables by Type of Active Ingredient

Annual Pesticide Use on Select Fruits by Type of Active Ingredient

Percent of Harvested Acres where Farmer Reported Use of a Genetically Modified Variety

Percent of Imported Foods Sampled with Detectable and Violative Pesticide Residues

ENVIRONMENTAL ISSUE 4:
FOOD SAFETY

The EPA's 2000 Strategic Plan states that "the foods Americans eat will be free from unsafe pesticide residues." For the purposes of this project, it was determined that it was important to measure not only the degree to which foods are affected by the use of pesticides, but also the degree to which other industrial chemicals might affect food safety. Other industrial chemicals include chemical classes such as dioxins, furans, and polychlorinated biphenyls (PCBs). There is a great deal more information regarding pesticides than there is for industrial chemicals in the context of food safety. This relative wealth of pesticide information is presented in the indicators in this section. The common definition of a pesticide is "any agent used to kill or control undesired insect, weeds, rodents, fungi, bacteria, or other organism" (EPA 1999). The U.S. Department of Agriculture estimates that approximately $7.5 billion is spent each year in the United States on agricultural pesticides (USDA, 1996). As an industry that many argue is essential to the sustained production of food not only the U.S., and throughout the world, there is considerable pressure to ensure that the benefits of pesticide use outweigh the costs. While the degree to which benefits must outweigh costs is obviously difficult to quantify, the EPA has worked diligently to ensure that the risks posed to the population by pesticide use are as low as possible. It is also the goal of the EPA to ensure that these risks continue to decline. The set of indicators that compose this issue can be separated into five different dimensions. These are pesticide residues, industrial chemical residues, agricultural pesticide use, biotechnology, and international food safety.

Issue Dimensions

Pesticide Residues

Pesticides are used to enhance the agricultural yield and avoid the use of marginal land for crops by reducing the number of pests that prey on the crops. Scientific evidence suggests that some pesticides used to protect agricultural products may adversely affect human and biological health. While the EPA is responsible for registering pesticides and establishing the specific tolerances (maximum amounts of residues that are permitted in or on food) associated with those pesticides, the Food and Drug Administration bears the principal authority for monitoring the majority of the U.S. food supply. Extensive scientific review has determined reasonable limits of pesticide exposure. These limits are used to guide the monitoring of the U.S. food supply. The indicators identified in this section provide information on the degree to which the U.S. food supply is tainted by harmful pesticide residues.

Industrial Chemical Residues

Though there is limited information regarding the degree to which industrial chemical residues affect the U.S. food supply, this issue is still one of great importance. Industrial chemicals released into the environment can be absorbed into crops during their growth. They can also be absorbed into animals or fish either by direct absorption from the animals' habitats or by consuming other animals that have accumulated toxic chemicals in their tissues. By consuming these chemically tainted foods, humans absorb toxic substances into their bodies. Scientific research has shown that certain types of these chemicals may adversely affect human health. The chemical groups that are currently of greatest concern are dioxins, furans, and polychlorinated biphenyls (PCBs). Dioxins and furans are chemicals that are inadvertently produced by a variety of human activities. Natural processes can also produce these chemicals. PCBs, on the other hand, are man-made. In 1977, the production of these chemicals was ceased, but only after 1.5 billion pounds had already been manufactured in the United States (EPA, 2000). The indicator presented in this section provides guidance on the types of data that are necessary to fully understand this issue.

Agricultural Pesticide Use

The United States, as much of the world, has become reliant on the use of pesticides in the production of food. Pesticide use is believed to enable farmers to produce greater quantities and varieties of food at lower costs. Pesticide products, however, are developed from chemicals that have potentially harmful effects. To ensure that the food produced is safe for consumption, the EPA thoroughly reviews pesticides before allowing them to be sold for use in agricultural production. The objective of this regulation for the producers of pesticides used in the production of foods is to find ways to make their products safer over time.

The pesticides used to enhance agricultural production are commonly separated into four different categories: herbicides, insecticides, fungicides, and other conventional pesticides. Other conventional pesticides include chemicals used as rodenticides, nematicides, and fumigants. Some pesticide use estimates also account for chemicals registered as pesticides but produced mostly for other purposes (e.g. sulfur and petroleum). It is estimated that, of the three major categories of pesticides, insecticides are generally the most toxic followed by herbicides and then fungicides. These estimates are based on both chronic and acute toxicity scores (USDA, 1996). The indicators presented in this section illustrate overall trends in pesticide use as well as per acre application volumes of pesticides for major agricultural sectors.

Biotechnology

The concept of biotechnology, as it applies to the current scientific and political debate, can be defined as "the use of cellular and molecular processes to solve problems" (BIO, 2000). A paper written by Marshall Martin, et al, and published by the Purdue University Cooperative Extension Service, defines biotechnology as "a set of tools that utilize living organisms or parts of organisms to make or modify products, to improve plants or animals for agriculture, or to engineer microorganisms for specific purposes" (Martin, 1996). While the debate has been invigorated in recent years, the techniques of biotechnology have been used for centuries to breed livestock or to produce foods, such as bread, cheese, beer, wine, pickles, and yogurt. Current attempts at genetic modification of pesticides and crops have been regarded with a substantial amount of caution.

Biotechnology is a highly contentious issue. There is without doubt enormous potential to achieve a wide variety of benefits in terms of meeting human needs with more productive agricultural and livestock industries. There are other interests among the public and the scientific community who are deeply concerned that rapid and unregulated development of biotechnological products exposes society to a range of serious and possibly catastrophic outcomes. Due to its emerging character, the development of biotechnology indicators is relatively limited, but will become the subject of work in future years.

Import/Export—International Food Safety

As the world's economies increasingly globalize, the volume of food moving across international borders increases. In 1998, the United States imported nearly $42 billion worth of agricultural products from other countries (FAO 2000). This amount has increased dramatically over the past 40 years. While technological advances around the world have made the production of food more efficient and generally of higher quality, food safety will continue to play an important role in the internationalization of food production. John Lupien, the Director of the Food and Nutrition Division of the Food and Agriculture Organization of the United Nations (FAO), states: "as the volume of food traded increases, the potential increases for exposing consumers in one country to the food quality and safety-related problems of other regions of the world" (CAST, 1998).

Consumers of imported food in the U.S. are protected by several different entities. The U.S. is a member of the Codex Alimentarius Commission. This commission, which is a joint program of the FAO and the World Health Organization, is responsible for the establishment of an international food standard that guides the processes that are used throughout the cycle of food production in the world. In the U.S., the USDA's Animal and Plant Health Inspection Service (APHIS) "enforces animal and plant import and export regulations to help ensure that foreign pests and diseases are not introduced into this country and that U.S. agricultural products meet the standards of importing countries" (1997). Additionally, both the USDA's pesticide monitoring program and the FDA's pesticide residue monitoring program are involved in

testing foods eaten by consumers in the U.S. for residues on foods that have been imported. The indicator that is presented in this section is taken from FDA data and illustrates trends in the proportion of imported foods that contain pesticide residues.

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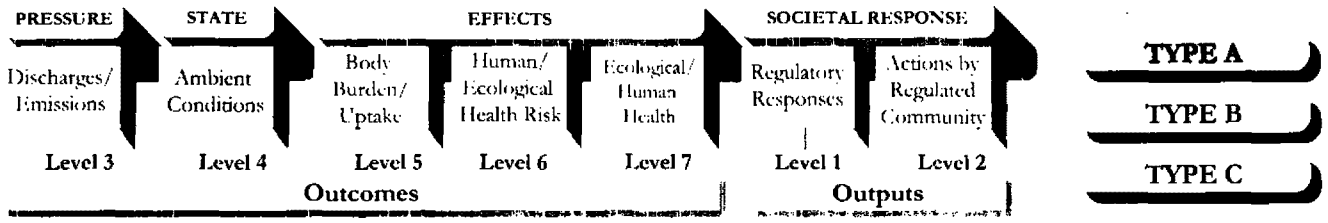
FOOD SAFETY
PESTICIDE RESIDUES



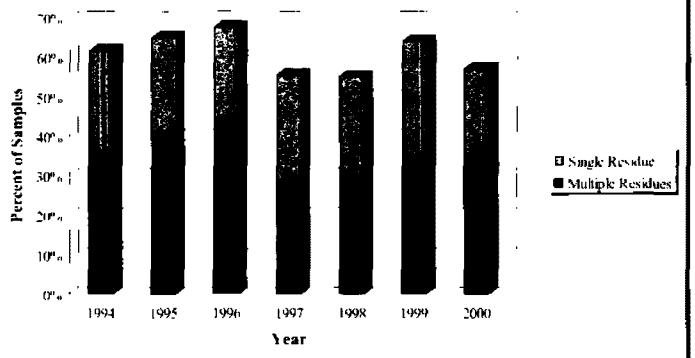
Indicator: Percent of Foods Sampled with Detectable Pesticide Residues

Most of the food produced for human consumption is grown using pesticides. Chemical control of weeds, insects, fungi and rodents has allowed the pesticide-using world to intensify agriculture and increase its productivity. However, these economic benefits are not without their risks to human and environmental health. Because pesticides are so widely used in agriculture, they may remain as residues on fruits, vegetables, grains and other foods. These pesticide residues are a public health concern because, in certain doses, pesticides are known to cause acute and chronic health effects.

To prevent the occurrence of these adverse health effects, the U.S. EPA is charged to establish maximum allowable residue "tolerances" for pesticides and the Food and Drug Administration monitors and regulates the U.S. food supply for compliance with these tolerances. In addition, the U.S. Department of Agriculture's Pesticide Data Program (PDP) collects data on pesticide residues on food. Since 1991, the PDP has tested fruits, vegetables, grains, dairy and processed products for residues of more than 160 different pesticides. The PDP relies on random sampling of food commodities to provide realistic estimates of the population's exposure to pesticide chemicals. The chart displays the foods sampled by the PDP from 1994 to 2000 with detectable pesticide residues.

- Single residue detections on sampled food commodities exhibit a stable through 1999 ranging between 25 to 29% of sampled foods each year. In 2000, single residue detection on sampled food dropped to 22%.
- Multiple residue detections on sampled food commodities declined after an initial rise: from 36% of sampled foods in 1994 to 29% in 1998. However, there was another rise in 1999 and remained steady in 2000 at 35%.
- Overall, detectable residues on sampled foods have risen from 61% in 1994 to 64% in 1999 but decreased to 57% in 2000.

Pesticide Residue Detection on Foods Sampled, by Number of Residues Detected, 1994-2000



Source: U.S. Department of Agriculture's Pesticide Data Program, 1994-2000

Scale: Data is collected from selected states and aggregated to illustrate national trends.

Data Characteristics and Limitations: PDP samples are collected by 10 participating States, which represent all regions of the country and 50% of the national population. Samples are collected close to the point of consumption, at end markets and large chain store distribution centers. The PDP's sampling strategy is statistically reliable and allows for realistic estimation of pesticide residues in the total food supply and of consumer exposure to these pesticide chemicals.

Data are available annually and reported by food product and pesticide for which the food product was tested.

References

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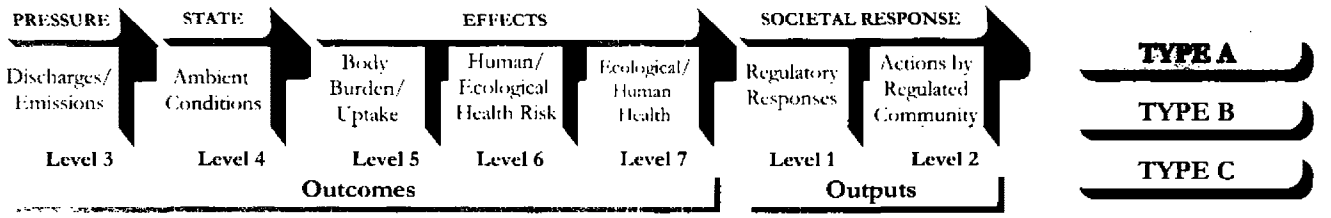
FOOD SAFETY
PESTICIDE RESIDUES



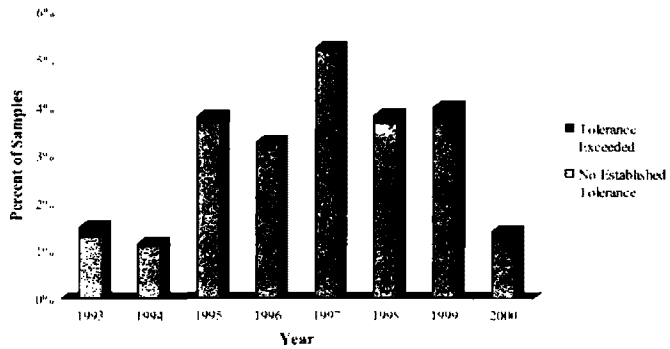
Indicator: Percent of Foods Sampled with Pesticide Residues that Violated or Were Presumed to Violate Tolerances

Most of the food produced for human consumption is grown using pesticides. Chemical control of weeds, insects, fungi and rodents has allowed the pesticide-using world to intensify agriculture and increase its productivity. However, these economic benefits are not without their risks to human and environmental health. Because pesticides are so widely used in agriculture, they may remain as residues on fruits, vegetables, grains and other foods. These pesticide residues are a public health concern because, in certain doses, pesticides are known to cause acute and chronic health effects. To prevent the occurrence of these adverse health effects, the EPA sets a tolerance, which is the amount of pesticide residue allowed to remain on a food commodity. A violation occurs when a residue is detected that exceeds the tolerance or when a residue is found for which there is no tolerance set for that specific crop.

The U.S. Department of Agriculture's Pesticide Data Program (PDP) is charged with monitoring and collecting data on pesticide residues on food. Since 1991, the PDP has tested fruits, vegetables, grains, dairy and processed products for residues of more than 160 different pesticides. The PDP relies on random sampling of food commodities to provide realistic estimates of the population's exposure to pesticide chemicals. The chart displays the foods sampled by the PDP from 1993 to 2000 that had residues that violated or were presumed to violate (i.e., no tolerance level was established for that crop) tolerances.

- From 1991 to 1998, less than 0.2% of all sampled foods had residues that violated established tolerances.
- In 1999, the percent of all sampled foods having residues that violated established tolerances increased to 0.3%.
- However, in 2000 the percent of all sampled foods having residues that violated established standards went back down to 0.2% percent.
- Despite a generally high trend in the percent of foods sampled that violated or were presumed to violate tolerances between 1995 and 1999, in 2000 the percentage decrease substantially.

Percent of Foods Sampled that Violated or Were Presumed to Violate Tolerances 1993-2000



Source: U.S. Department of Agriculture's Pesticide Data Program, 1993-2000

Scale: Data are collected from select states and aggregated to illustrate national trends.

Data Characteristics and Limitations: PDP samples are collected by 10 participating States, which represent all regions of the country and 50% of the national population. Samples are collected close to the point of consumption, at end markets and large chain store distribution centers. The PDP's sampling strategy is statistically reliable and allows for realistic estimation of pesticide residues in the total food supply and of consumer exposure to these pesticide chemicals.

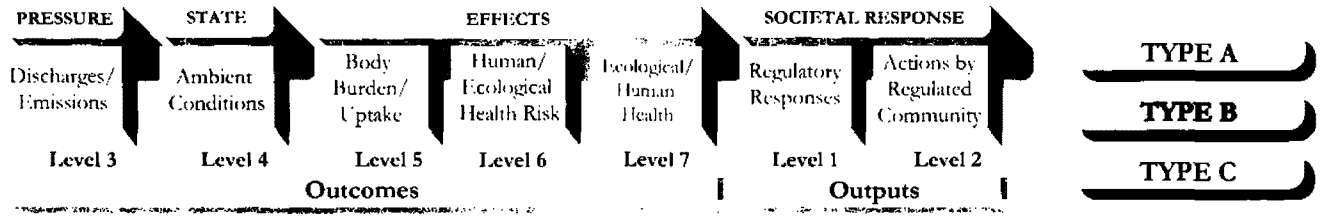
Data are available annually and reported by food product and pesticide for which the food product was tested.

References

U.S. Department of Agriculture, Agricultural Marketing Service. *Pesticide Data Program: Annual Summary* (Calendar years 1993-2000). 11 February 2003. Available online at: http://www.ams.usda.gov/science/pdp/.

U.S. Environmental Protection Agency, Office of Pesticide Programs. *Setting Tolerances for Pesticide Residues in Foods*. 20 November 2002. Available online at: http://www.epa.gov/pesticides/citizens/stprf.htm

FOOD SAFETY
INDUSTRIAL CHEMICAL RESIDUES



Indicator: Percent of Foods Sampled with Detectable Industrial Chemical Residues

An overwhelming amount of the literature available regarding chemical residues found on foods is related to agricultural chemicals and pesticides. Understanding the presence of chemical residues that originate from other sources, however, is also important in assessing the safety of the food supply. The US Food and Drug Administration (FDA) has expressed serious concern about the effect that residues of dioxins, which are industrial by-products, or PCBs, which are restricted use industrial chemicals, may have on human health. The FDA has stated that these groups of compounds "include chemicals that may be carcinogens at low levels of exposure over extended periods of time and may have other toxicological effects." Currently, there are no tolerances established that regulate the levels of dioxins allowed in food. The tolerances for PCBs are outlined in the Code of Federal Regulations, Title 21, Parts 109.30 and 509.30.

It is the responsibility of the FDA to enforce the PCB tolerances mandated in the Federal Code. To satisfy this requirement, the FDA includes industrial chemicals (e.g. PCBs) in the list of chemicals covered by their pesticide monitoring program. While the findings regarding industrial chemicals are presented in the analytical data files that are published, the results are typically excluded from the summary data files. It is for this reason that no data set is included with this indicator. Due to the analytical complexity required to summarize this data in a manner that would lend itself to presentation in an indicator, this indicator is considered to be a Type B.

Scale: Data is collected from select states and aggregated to show national trends.

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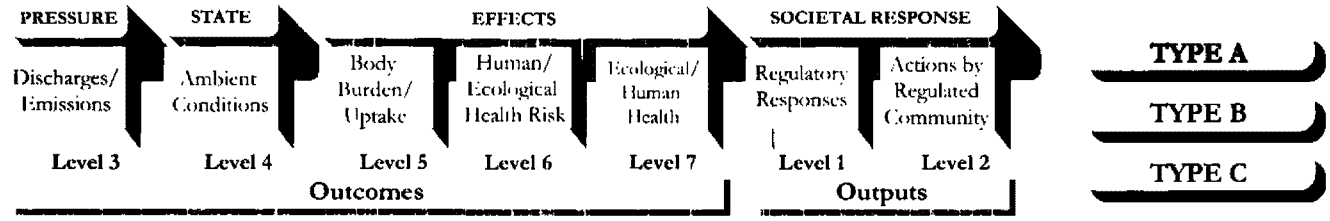
FOOD SAFETY
AGRICULTURAL PESTICIDE USE



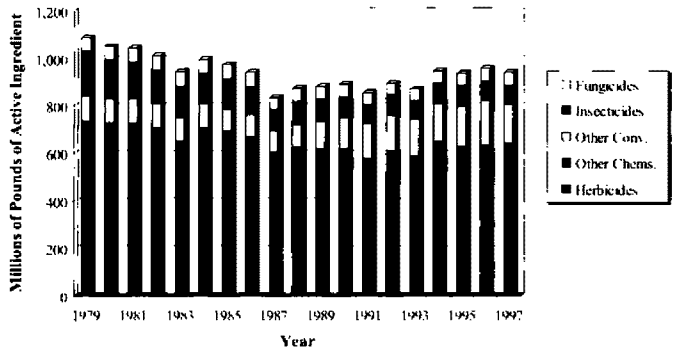
Indicator: U.S. Annual Volume of Pesticide Usage by Type of Active Ingredient

Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems. For these reasons, it is important to monitor the agricultural usage of pesticides.

This indicator measures agricultural pesticide usage by pesticide type. Although this indicator does not explicitly consider the toxicity of the pesticides used, one can cautiously infer relative toxicity according to pesticide type. According to the USDA, insecticides generally are more toxic than herbicides, which are both usually more toxic than fungicides. Again, this indicator measures only usage and not toxicity or risk.

- From 1979 to 1997, the volume of herbicides used decreased by 4.7%.
- From 1979 to 1997, the volume of insecticides used decreased by 56.4%.
- From 1979 to 1997, the volume of fungicides used decreased by 7.0%.
- From 1979 to 1997, the volume of other conventional pesticides used increased by 55.7%.
- From 1979 to 1997, the volume of other chemicals used decreased by 29.3%.
- Overall, the volume of pesticides used decreased by 13.3% from 1979 to 1997.

U.S. Annual Volume of Pesticide Usage by Type of Active Ingredient, 1979-1997



Source: Environmental Protection Agency / Office of Pesticide Programs / Biological and Economic Analysis Division estimates

Scale: Data is comparable on a national level.

Notes: "Other Conv" refers to conventional pesticides other than fungicides, insecticides and herbicides (e.g., nematicides, rodenticides and fumigants). "Other Chems" refers to chemicals registered as pesticides but are produced mostly for other purposes (e.g., sulfur and petroleum).

Data Characteristics and Limitations: For these estimates, the EPA consults public and proprietary data sources. Public data include a 1990 EPA survey of pesticide usage by homeowners and a 1993 EPA survey of commercial applicators. The EPA reports that the proprietary sources consulted are well-known organizations that are utilized by pesticide registrants and other private sector firms. Files on pesticide usage are maintained at the Pesticide Data Center in the Biological and Economic Analysis Division (BEAD) of the EPA Office of Pesticide Programs (OPP).

References

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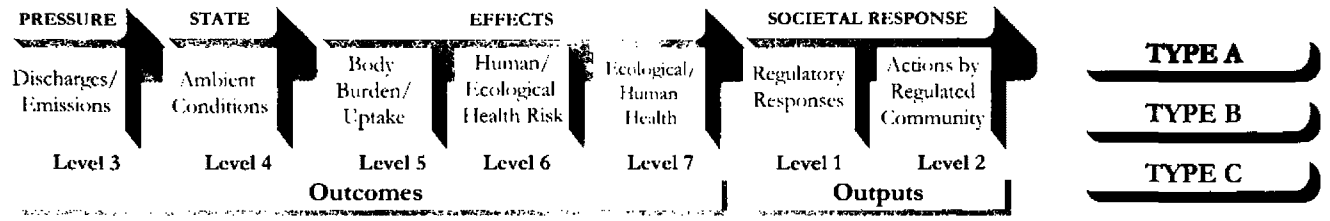
FOOD SAFETY
AGRICULTURAL PESTICIDE USE



Indicator: Annual Pesticide Use on Select Field Crops by Type of Active Ingredient

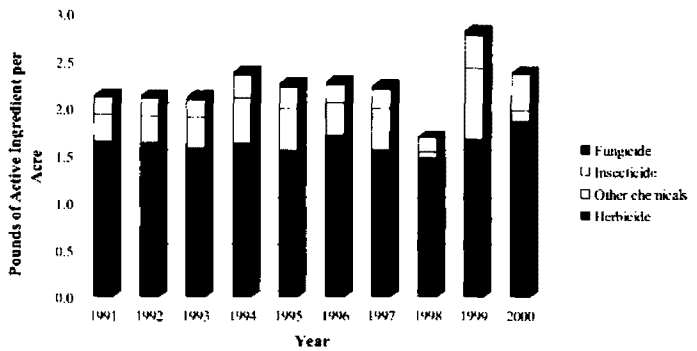
Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems.

For these reasons, it is important to monitor the agricultural usage of pesticides. The U.S. Department of Agriculture (USDA) is charged with monitoring the usage of pesticides on field crops, fruits, vegetables and for livestock and general farm uses. Every year, the USDA National Agricultural Statistics Service (NASS) administers the Agricultural Resources Management Survey (ARMS) to a sample of farmers. Information on pesticide usage on field crops is obtained through this annual survey.

This indicator measures agricultural pesticide usage by pesticide type. Although this indicator does not explicitly consider the toxicity of the pesticides used, one can cautiously infer relative toxicity according to pesticide type. According to the USDA, insecticides generally are more toxic than herbicides, which are both usually more toxic than fungicides. Again, this indicator measures only usage and not toxicity or risk.

- The chart shows that herbicides represent the largest share of pesticide usage on field crops in the U.S. Its share has increased from 77% in 1991 to 78% in 2000 following a decrease to 59% in 1999.
- Until 1999, insecticide usage remained stable at roughly 0.2 pounds of active ingredient per acre. In 1999, this figure jumped to 0.35 pounds per acre and increased to .39 in 2000.
- Overall, total pounds of active ingredient per acre have increased from 2.14 in 1991 to 2.37 in 2000.

Annual Pesticide use on Select Field Crops, by Type of Active Ingredient, 1991-2000



Source: USDA National Agricultural Statistics Service, Field Crop Summaries for 1991-2000.

Notes: Select field crops include corn, upland cotton, fall potatoes, soybeans and winter wheat for 1991-1999. In 2000, fall potatoes were excluded with a subsequent reduced number of acres being included in the sample.

The large apparent decrease in the use of other chemicals in 1998 is due to the fact that only Pennsylvania and Wisconsin were surveyed for pesticide use on potatoes. Desiccants, which are defined as other chemicals in this report, are a key chemical requisite in the production of potatoes. In other years, the percentage of these chemicals applied in other states, such as Idaho, has been far greater.

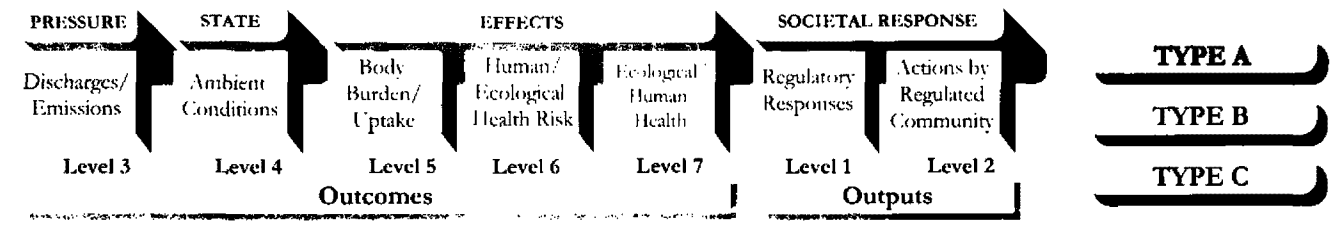
Scale: Data are collected from select states and aggregated to illustrate national trends

Data Characteristics and Limitations: Every year, the USDA NASS administers the ARMS to a sample of farms that produce the crops of interest that particular year. Although the list of the crops of interest varies from year to year, this indicator tracks pesticide usage on the five field crops that have been surveyed every year (corn, upland cotton, fall potatoes, soybeans and winter wheat). This is to ensure comparability of the data over time. The operator of the sampled farm is personally interviewed by NASS staff to obtain information about chemical applications on the selected field. The survey and the sampling scheme are designed so that the usage estimates are statistically representative of chemical use on the targeted crops in the surveyed states. The estimates are reviewed for reliability and consistency.

Reference

National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. *Agricultural Chemical Usage, Field Crop Summary* (1991-2000). 27 November 2002. Available online at: http://www.usda.gov/nass

FOOD SAFETY
AGRICULTURAL PESTICIDE USE



Indicator: Annual Pesticide Use on Select Vegetables by Type of Active Ingredient

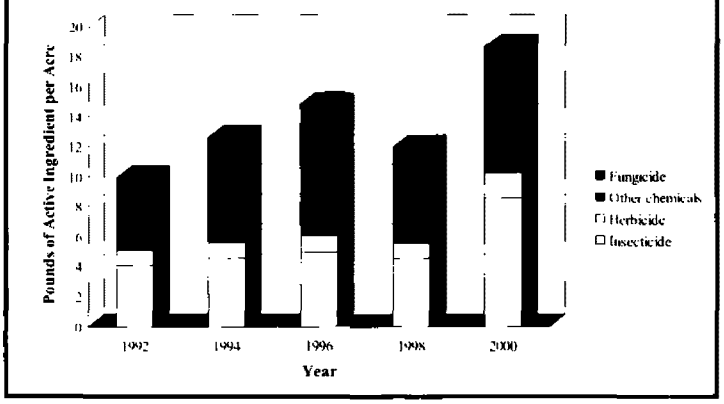
Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems.

For these reasons, it is important to monitor the agricultural usage of pesticides. The U.S. Department of Agriculture (USDA) is charged with monitoring the usage of pesticides on field crops, fruits, vegetables and for livestock and general farm uses. Every year, the USDA National Agricultural Statistics Service (NASS) administers the Agricultural Resources Management Survey (ARMS) to a sample of farmers. Information on pesticide usage on vegetables is obtained through this annual survey.

This indicator measures agricultural pesticide usage by pesticide type. Although this indicator does not explicitly consider the toxicity of the pesticides used, one can cautiously infer relative toxicity according to pesticide type. According to the USDA, insecticides generally are more toxic than herbicides, which are both usually more toxic than fungicides. Again, this indicator measures only usage, and not toxicity or risk.

- The chart illustrates that insecticides and fungicides have represented the bulk of the pesticides applied to vegetables since 1992. The percentage of pesticides applied that has been insecticides has ranged from 41% in 1992 to 46% in 2000, while the percentage that has been fungicides has ranged from 33% in 1992 to 22% in 2000.
- Overall, total pounds of active ingredient per acre have increased from 9.9 in 1992 to 18.6 in 2000.

Annual Pesticide Use on Select Vegetables, by Type of Active Ingredient, 1992-2000



Source: USDA National Agricultural Statistics Service, Vegetable Summaries for 1992-2000.

Notes: Select vegetables include asparagus, fresh lima beans, fresh snap beans, processing snap beans, broccoli, fresh cabbage, processing cabbage, cauliflower, celery, fresh sweet corn, processing sweet corn, fresh cucumbers, processing cucumbers, eggplant, head lettuce, other lettuce, watermelons, processing green peas, bell peppers, fresh spinach, processing spinach, strawberries, fresh tomatoes, and processing tomatoes.

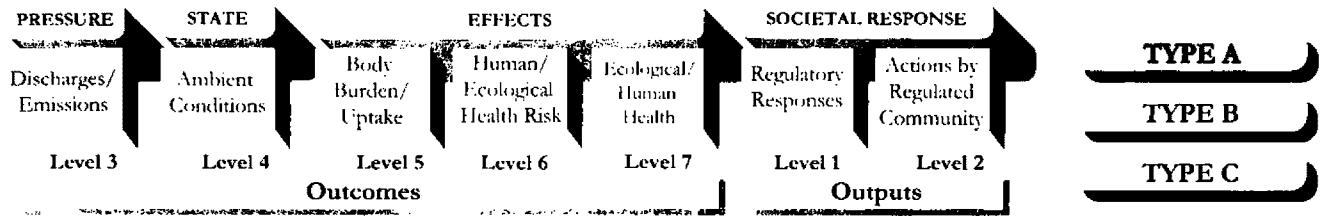
Scale: Data are collected from select states and aggregated to show national trends.

Data Characteristics and Limitations: Every year, the USDA NASS administers the ARMS to a sample of farms that produce the vegetables of interest that particular year. Although the list of the vegetables of interest varies from year to year, this indicator tracks pesticide usage on the twenty-four vegetables that have been surveyed every year. This is to ensure comparability of the data over time. NASS staff, to obtain information about chemical applications on the selected vegetable, personally interview the operator of the sampled farm. The survey and the sampling scheme are designed so that the usage estimates are statistically representative of chemical use on the targeted crops in the surveyed states. The estimates are reviewed for reliability and consistency.

Reference

National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. *Agricultural Chemical Usage, Vegetable Summary* (1992-1998). 20 November 2002. Available online at: http://www.usda.gov/nass

FOOD SAFETY
AGRICULTURAL PESTICIDE USE



Indicator: Annual Pesticide Use on Select Fruits by Type of Active Ingredient

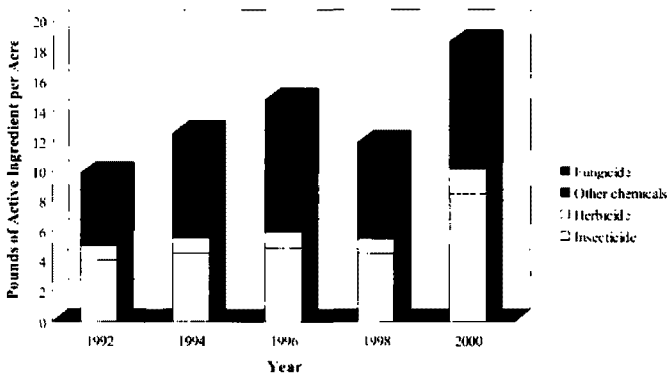
Over the past 50 years, the use of pesticides has increased faster than that of any other agricultural production input. Chemical control of weeds, insects, fungi and rodents has contributed to the maintenance of high agricultural productivity levels in this country. These economic gains are not without their trade-offs. There are many public health and environmental concerns regarding the widespread use of pesticides in U.S. agriculture. There is the issue of human health risks due to pesticide residues on food and in drinking water, and farm worker exposures. There are also many cases where pesticides have adversely affected wildlife and sensitive ecosystems.

For these reasons, it is important to monitor the agricultural usage of pesticides. The U.S. Department of Agriculture (USDA) is charged with monitoring the usage of pesticides on field crops, fruits, vegetables and for livestock and general farm uses. Every year, the USDA National Agricultural Statistics Service (NASS) administers the Agricultural Resources Management Survey (ARMS) to a sample of farmers. Information on pesticide usage on fruits is obtained through this annual survey.

This indicator measures agricultural pesticide usage by pesticide type. Although this indicator does not explicitly consider the toxicity of the pesticides used, one can cautiously infer relative toxicity according to pesticide type. According to the USDA, insecticides generally are more toxic than herbicides, which are both usually more toxic than fungicides. Again, this indicator measures only usage and not toxicity or risk.

- The chart shows that insecticides represent the largest share of pesticide usage on fruits in the U.S. Its share has increased from 64% in 1991 to 76% in 1999.
- During this same period, the share of pesticide usage that has been fungicides has decreased from 28% in 1991 to 17% in 1999.
- Overall, total pounds of active ingredient per acre have remained relatively stabile, decreasing only slightly from 51.32 pounds per acre in 1991 to 51.10 pounds per acre in 1999.

Annual Pesticide Use on Select Vegetables, by Type of Active Ingredient, 1992-2000



Notes: Select fruits include apples, avocados, blackberries, blueberries, sweet cherries, tart cherries, grapefruit, lemons, oranges, peaches, pears, raspberries, tangelos, tangerines, and temples.

Source: USDA NASS, Fruit Summaries for 1991-1999.

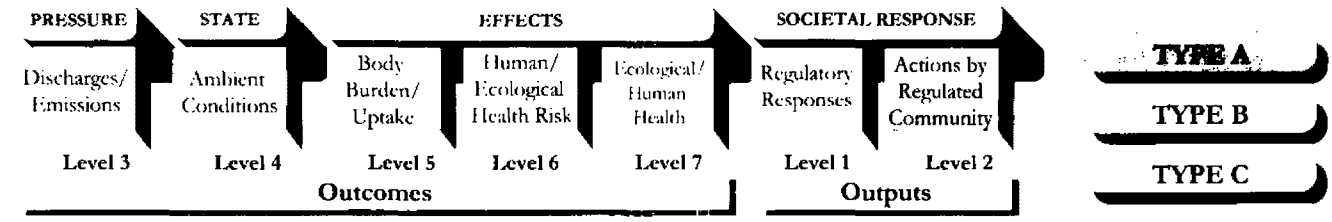
Scale: Data are collected from select states and aggregated to illustrate national trends.

Data Characteristics and Limitations: Every year, the USDA NASS administers the ARMS to a sample of farms that produce the fruits of interest that particular year. Although the list of the fruits of interest varies from year to year, this indicator tracks pesticide usage on the fifteen fruits that have been surveyed every year (apples, avocados, blackberries, blueberries, sweet cherries, tart cherries, grapefruit, lemons, oranges, peaches, pears, raspberries, tangelos, tangerines, and temples). This is to ensure comparability of the data over time. The operator of the sampled farm is personally interviewed by NASS staff to obtain information about chemical applications on the selected field. The survey and the sampling scheme are designed so that the usage estimates are statistically representative of chemical use on the targeted fruits in the surveyed states. The estimates are reviewed for reliability and consistency.

Reference

National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. *Agricultural Chemical Usage, Fruit Summary* (1991-1999). 20 November 2002. Available online at: http://www.usda.gov/nass

FOOD SAFETY
BIOTECHNOLOGY



Indicator: Percent of Harvested Acres where Farmer Reported Use of Genetically Modified Variety

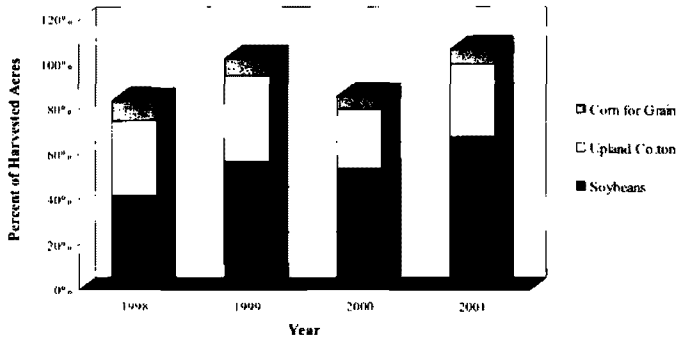
One of the most important emergent trends in agriculture is the use of biotechnology. Biotechnology refers to a set of techniques that make use of cellular and molecular processes to solve problems. With respect to agriculture, biotechnology has been used to manage pests, enhance the nutritional content of food products, and immunize crop varieties against pest and pesticide damage.

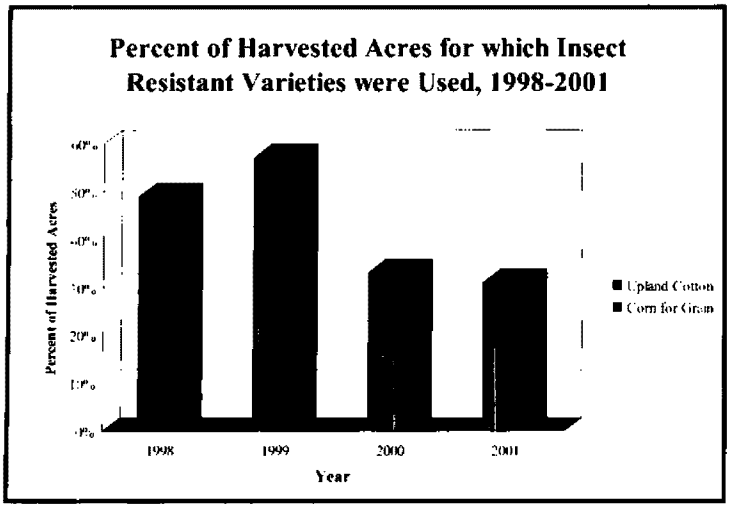
Although biotechnology produces many immediate benefits – such as allowing reduced use of conventional pesticides there is no consensus about its long-term impacts on human health and the environment. While scientists are assessing these long-term impacts, it is important to monitor the diffusion of biotechnology in agricultural practices. This indicator tracks the use of crop varieties that are genetically enhanced to resist herbicides and insects. Crop varieties that are resistant to damage by herbicides or pests allow farmers to decrease their applications of conventional herbicides and insecticides.

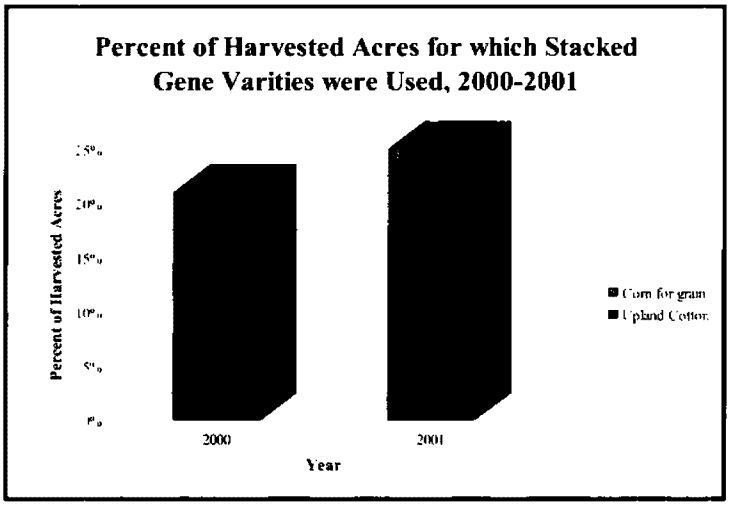
The charts display the trends in use of genetically enhanced crop varieties reported by farmers to an annual survey by the U.S. Department of Agriculture (USDA). Because biotechnology has only recently garnered widespread attention, farmers have been surveyed about their biotechnology practices only since 1998. The category for stacked-gene varieties was added to the survey in 2000.

- From 1998 to 1999, the percentage of harvested acres in which insect-resistant varieties of corn for grain and upland cotton were used increased by four percent (26% to 30% for corn for grain, 23% to 27% for upland cotton).
- A dramatic increase occurred in the use of herbicide-resistant varieties of soybeans from 1998 to 1999 (from 42% to 57% of harvested acres).
- In 2001, the percentage of harvested acres in which herbicide-resistant varieties of soybeans were used increased to 68%.
- There was a 5% increase in the use of herbicide-resistant varieties of upland cotton from 1998 to 1999.
- The percentage of harvested acres in which insect-resistant varieties of corn for grain and upland cotton were used decreased 8% and 10% respectively between 1998 and 2001.
- The use of stacked-gene varieties in upland cotton increased from 20% in 2000 to 24% in 2001.

Percent of Harvested Acres for which Herbicide Resistant Varieties were Used, 1998-2001







Notes: Herbicide-resistant varieties include those developed using both biotechnology and conventional breeding techniques. Insect-resistant varieties include those containing *bacillus thuringiensis (Bt.)* only. Stacked-gene varieties include those containing genetically modified traits for both herbicide and insecticide resistance.

Source: USDA National Agricultural Statistics Service Crop Production Reports, 1999-2001.

Scale: Data are collected from select states and aggregated to illustrate national trends.

Data Characteristics and Limitations: Each year, NASS conducts yield surveys of sampled farms that produce corn, soybeans and upland cotton. The operators of the farms are interviewed personally by NASS staff from August through harvest to obtain specific counts and measurements. Respondents were asked if they planted seed that, through conventional breeding or biotechnology, was resistant to herbicides or insects.

References

National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture. *Crop Production: Acreage Supplement.* (Information published in October Report). 27 November 2002. Available online at: http://usda.mannlib.cornell.edu/reports/nassr/field/pcp-bb/

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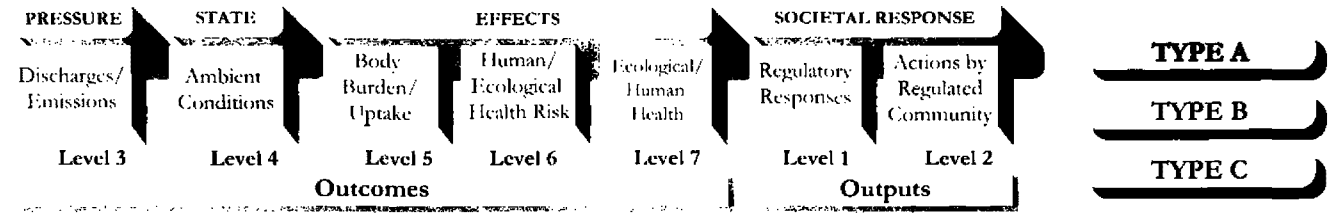
FOOD
IMPORT/EXPORT—INTERNATIONAL FOOD SAFETY



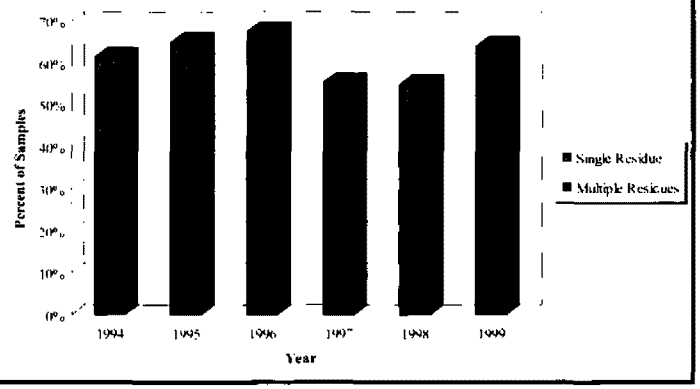
Indicator: Percent of Imported Foods Sampled with Detectable and Violative Pesticides Residues

Most of the food produced for human consumption is grown using pesticides. Chemical control of weeds, insects, fungi and rodents has allowed the pesticide-using world to intensify agriculture and increase its productivity. However, these economic benefits are not without their risks to human and environmental health. Because pesticides are so widely used in agriculture, they may remain as residues on fruits, vegetables, grains and other foods. These pesticide residues are a public health concern because, in certain doses, pesticides are known to cause acute and chronic health effects.

In the United States and other developed countries (Japan and the nations of Western Europe), the majority of pesticide applications represent herbicides, which tend to have lower acute toxicity than insecticides. However, in most developing countries, the situation is reversed. In these countries, insecticides are primarily used, often older compounds in the organophosphate and carbamate families known for their acute and chronic toxicities. Because of the potential risks to human health that the agricultural practices in other countries impose, it is important to monitor pesticide residues on food imports. The U.S. Food and Drug Administration (FDA) is charged with enforcing the EPA's pesticide residue tolerances in imported foods. The chart displays the foods sampled by the FDA from 1993 to 1999 with detectable and violative pesticide residues.

- Total pesticide residue detections exhibit a reasonably stable trend from 1993 to 1999, ranging from 31% to 35.6% of sampled food imports.
- Violative pesticide residue detections also exhibit a reasonably stable trend from 1993 to 1999; however the 1997-1999 period shows a slight increase from 1.6% to 3.1% of sampled food imports.

Pesticide Residue Detection on Foods Sampled, by Number of Residues Detected, 1994-1999



Notes: In these reports, a violative residue is defined as a residue that exceeds a tolerance or a residue at a level of regulatory significance for which no tolerance has been established in the sampled food.

Source: FDA Pesticide Monitoring Program, 1993-1999.

Scale: Data are comparable on a national scale.

Data Characteristics and Limitations: The FDA collects imported food samples at the point of entry into U.S. commerce. The FDA samples raw agricultural commodities and processed food products. The FDA relies on multiresidue methods (MRMs) that can simultaneously detect a number of different pesticide residues. In 1999, the FDA collected 6,012 food samples representing shipments from 92 countries.

Data are reported annually.

References:

Pesticide Monitoring Program, U.S. Food and Drug Administration. *Residue Monitoring* (Calendar years 1993-1999). 20 November 2002. Available online at: http://vm.cfsan.fda.gov/~dms/pesrpts.html.

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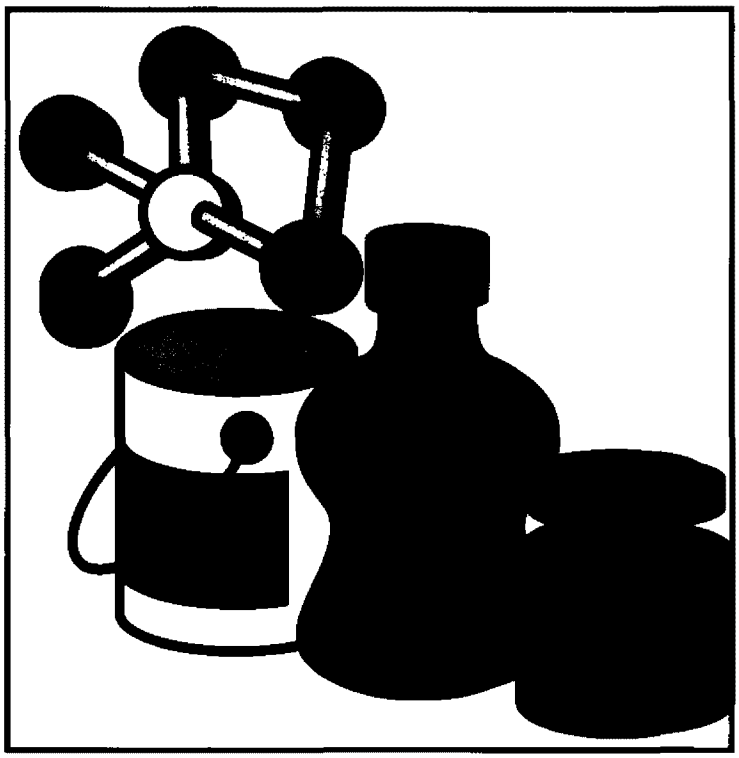
ENVIROMENTAL ISSUE 5: PRODUCT SAFETY



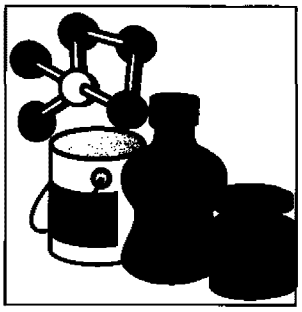
List of Indicators

Number of Human Poison Exposure Cases, By Medical Outcome, due to Chemical Misuse

Number of Human Poison Exposure Cases, By Medical Outcome, due to Pesticide Misuse

Annual Pesticides Usage by Residential Sectors and by Pesticide Type

ENVIRONMENTAL ISSUE 5:
PRODUCT SAFETY



American consumers expect that the products they purchase are safe to use. Indeed, there are a host of federal regulations and agencies that help to ensure the safety of consumer products. The EPA, Consumer Product Safety Commission, and the Food and Drug Administration are the key federal agencies responsible for identifying and controlling chemical hazards posed by consumer products. These agencies conduct this work under the authority of federal laws such as: the Toxic Substances and Control Act; the Federal Insecticide, Fungicide, and Rodenticide Act; the Federal Hazardous Substances Act;and the Consumer Product Safety Act.

Despite this web of federal consumer protection, there are still many chemical hazards posed by consumer products. These hazards occur when safety relies on compliance with voluntary product standards, proper usage of the product, and patchy surveillance of potential product hazards (Dawson 1998). Also contributing to this problem is the fact that consumer protection is more often reactive than proactive; meaning that recalls and bans often happen only after a consumer product has caused injuries or illnesses in the population. Moreover, toxic hazards from chemical constituents are often more difficult to identify and prove than mechanical hazards (from product malfunctions). The issue of products is divided into three sub-issues that reflect the key dimensions of the problem of safety: (1) product toxicity; (2) chemical and pesticide product misuse; and (3) non-agricultural pesticide use.

Issue Dimensions

Product Toxicity

Product toxicity is a broad concept that refers to the amount of toxicity found in a wide range of products to which people may be exposed through contact or use. At the household level it may relate to the myriad of chemicals used for all manner of purposes, (e.g., cleaning solvents, household pesticides, silver polish, and drain cleaner). Products for home repair and maintenance, for gardening, or for hot tub or swimming maintenance are also areas for concern. The toxicity of children's toys is an area of special concern. Hand-to-mouth activity, and frequent and prolonged mouthing and teething on toys and other products put children at risk of toxic chemical exposure. Studies have shown that mouthing, sucking and teething on a product can cause chemicals to leach from the product into the child's system (CPSC, 1998). Since children's bodies are still developing, and also metabolize and excrete toxins at slower rates than do adults, they are highly sensitive to toxic effects.

Although the shipping of toxics in industrial product is not directly related to the level of such harmful chemicals in consumer products, industry data can be used to develop an estimate of trends in the level of toxics in products in general.

Chemical and Pesticide Product Misuse

Registered chemical and pesticide products are deemed safe only in the context of proper product usage. In the processes of product manufacturing and product regulation, some risk is transferred to the consumer. It is expected that consumers use a product only for its intended application and in accordance with all warnings and directions accompanying the product. Studies have shown, however, that consumers are often risk-taking and ignore product safety information (Diamond 1988). Indeed, the fact that safety is not the primary consideration of product choice for many consumers (price being the primary consideration) creates a disincentive for firms to make their product as safe as possible (Curlo 1999). There are economic costs attached to making products safe, which must be reflected in the final price of the product. Thus, the overall safety of a particular chemical or pesticide product is the outcome of tradeoffs between the costs and consumer demand for safety and the ability of the firm to produce a reduced-risk product. Therefore, because

the production of zero-risk products is economically and sometimes technologically unfeasible, the misuse of chemical and pesticide products poses risks to human health and the environment. The indicators in this section track the human health effects (poisonings) of chemical and pesticide product misuse. The American Association of Poison Control Centers, the source of the indicator data, distinguishes between unintentional misuse (unplanned or unforeseen by the user) and intentional misuse (planned by the user in order to obtain better or faster results with the product) in its categorization of chemical and pesticide poisonings. These categories reflect the consumer behaviors that increase the risk of registered chemical and pesticide products.

Non-Agricultural Pesticide Use

Non-agricultural pesticide use represents only about one-third of total pesticide use in the United States (Aspelin and Grube 1999). Non-agricultural pesticide use (also called urban pesticide use) is not as well documented or as studied as is agricultural pesticide use. Urban pesticide use includes individual consumer and professional applicators in home and commercial settings for lawn and landscape care, and turf management of golf courses, parks, cemeteries, roadways, railroads, and pipelines (Hodge 1993). While professional applicators typically undergo training and licensing, home users are unregulated and untrained in correct pesticide use.

Patterns of pesticide use differ in non-agricultural sectors from agricultural sectors. In agriculture, pesticides are often applied in one large application, typically within a 2 to 3 week period around planting. Home and garden pesticide use typically comprises 3 to 5 small applications throughout the spring and summer months (Gold and Groffman 1993). Although the volume and pattern of urban pesticide use may seem inconsequential, it still poses serious risks to the environment. In its National Water Quality Assessment (NAWQA) Program, the U.S. Geological Survey (USGS) found that urban pesticide use has created water quality problems in and around urban areas. The USGS observed a widespread water presence of insecticides commonly used in homes, gardens, and commercial areas. These insecticide detections occurred at higher frequencies, and typically at higher concentrations, in urban streams than in agricultural streams (USGS 1999). Insecticides, which are generally more toxic than herbicides, were commonly found in urban streams at concentrations that exceeded EPA safe guidelines for aquatic life.

It is important to note that, unlike agricultural sectors, data are not collected on the volume of specific active ingredients applied in non-agricultural sectors. This prevents the estimation of the average toxicity or health risk posed by non-agricultural pesticide use. The indicator in this section tracks only the use of pesticides in non-agricultural sectors.

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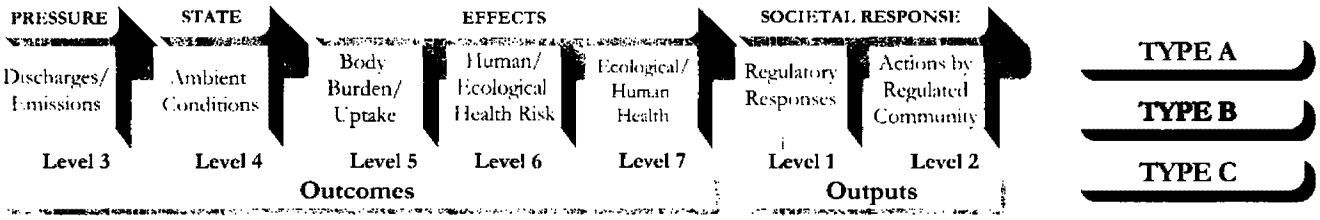
PRODUCT SAFETY
CHEMICAL AND PESTICIDE PRODUCT MISUSE



Indicator: Number of Human Poison Exposure Cases, by Medical Outcome, due to Chemical Misuse

The American Association of Poison Control Centers (AAPCC) administers the Toxic Exposure Surveillance System (TESS), the only comprehensive poisoning surveillance database in the United States. TESS is a cumulative database, with data dating back to its inception in 1983, of poison exposure cases. These cases are poison exposures reported by telephone to one of the AAPCC's regional poison control centers.

For each reported exposure, the gender, age and location of each caller is recorded. The locational site of exposure, substance(s) involved, reason for and route of exposure are also recorded for each case. To complete the profile of the poison exposure case, the medical outcome and intervention (type of decontamination and/or therapy) are also documented.

This indicator draws upon a subset of annual TESS data, the parameters of which are: substance involved (chemical), reason for exposure (misuse), and medical outcome of exposure (ranging from no effect to death). This indicator will allow for the tracking of reported incidents of chemical product misuse and the health effects associated with such product misuse. A trend of rising chemical misuse and/or increasingly serious outcomes associated with such misuse could serve as a signal to initate a regulatory response, such as mandating the reformulation or repackaging of chemical products, to reduce the risk of toxic effects or prevent product misuse.

The number of non-fatal human exposure cases due to chemical misuse in the TESS database is not publicly available. In the AAPCC Annual Report, the annual number of fatal poison exposures due to chemical misuse is provided. Since 1983, the annual number of fatalities is very small - no more than 5 reported deaths each year are associated with chemical misuse.

Data Characteristics and Limitations: The cumulative AAPCC database contains 27 million human poison exposure cases for the reporting years 1983-1999. Each year, the AAPCC publishes an annual report of select releases of TESS data in the September issue of the American Journal of Emergency Medicine. Since 1983, TESS has grown dramatically, with increases in the number of participating poison centers and population served by those centers (refer to chart below).

Annual changes in the number of human poison exposure cases may reflect changes in participation and reporting of cases may not be accurate due to self-reporting. Chemicals may not be the cause of all poisonings because the sources of exposures were not verified.

To control for the increase in annual reporting, the reported indicator is the number of non-fatal poisoning cases due to chemical exposure per million people in the serviced population.

The following TESS categories of products are reflected in the number of chemical exposures in the indicator data series: chemicals and heavy metals.

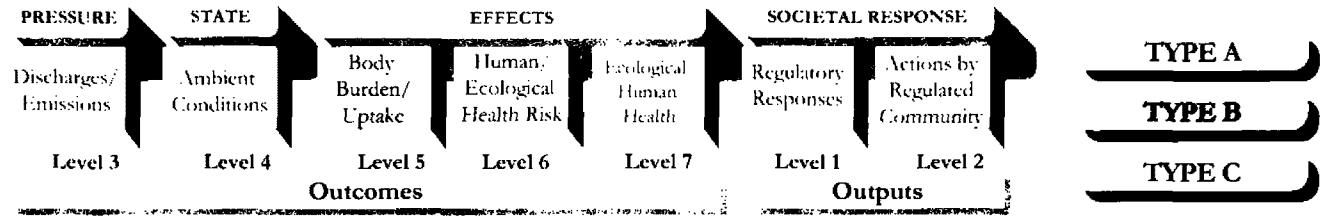
A noteworthy limitation of the TESS data is that diagnoses are not established, except in cases of known ingestion. The health effects associated with the poison exposure are reported and not proven through thorough investigation (Wagner).

References

Annual Report of the AAPCC TESS published in the *American Journal of Emergency Medicine*, 1984-1998.

Telephone conversation with Dr. Sheldon Wagner, Clinical Toxicologist, Department of Environmental and Molecular Toxicology, Oregon State University

PRODUCT SAFETY
CHEMICAL AND PESTICIDE PRODUCT MISUSE



Indicator: Number of Human Poison Exposure Cases, by Medical Outcome, due to Pesticide Misuse

The American Association of Poison Control Centers (AAPCC) administers the Toxic Exposure Surveillance System (TESS), the only comprehensive poisoning surveillance database in the United States. TESS is a cumulative database, with data dating back to its inception in 1983, of poison exposure cases. These cases are poison exposures reported by telephone to one of the AAPCC's regional poison control centers.

For each reported exposure, the gender, age and location of each caller is recorded. The locational site of exposure, substance(s) involved, reason for and route of exposure are also recorded for each case. To complete the profile of the poison exposure case, the medical outcome and intervention (type of decontamination and/or therapy) are also documented.

This indicator draws upon a subset of annual TESS data, the parameters of which are: substance involved (pesticides), reason for exposure (misuse), and medical outcome of exposure (ranging from no effect to death). This indicator will allow for the tracking of reported incidents of pesticide product misuse and the health effects associated with such product misuse. A trend of rising pesticide misuse and/or increasingly serious outcomes associated with such misuse could serve as a signal to initate a regulatory response, such as mandating the reformulation or repackaging of pesticide products, to reduce the risk of toxic effects or prevent product misuse.

The number of non-fatal human exposure cases due to pesticide misuse in the TESS database is not publicly available. In the AAPCC Annual Report, the annual number of fatal poison exposures due to pesticide misuse is provided. Since 1983, the annual number of fatalities is very small – no more than 3 reported deaths each year are associated with pesticide misuse.

Data Characteristics and Limitations: The cumulative AAPCC database contains 27 million human poison exposure cases for the reporting years 1983-1999. Each year, the AAPCC publishes an annual report of select releases of TESS data in the September issue of the American Journal of Emergency Medicine. Since 1983, TESS has grown dramatically, with increases in the number of participating poison centers and population served by those centers (refer to chart below).

Annual changes in the number of human poison exposure cases may reflect changes in participation and reporting of cases may not be accurate due to self-reporting. Chemicals may not be the cause of all poisonings because the sources of exposures were not verified.

To control for the increase in annual reporting, the reported indicator is the number of non-fatal poisoning cases due to chemical exposure per million people in the serviced population.

The following TESS categories of products are reflected in the number of chemical exposures in the indicator data series: chemicals and heavy metals.

A noteworthy limitation of the TESS data is that diagnoses are not established, except in cases of known ingestion. The health effects associated with the poison exposure are reported and not proven through thorough investigation (Wagner).

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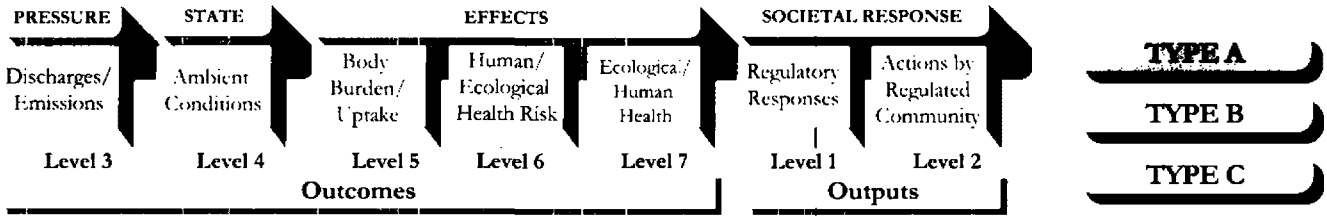
Telephone conversation with Dr. Sheldon Wagner, Clinical Toxicologist, Department of Environmental and Molecular Toxicology, Oregon State University

PRODUCT SAFETY
NON-AGRICUTURAL PESTICIDE USE



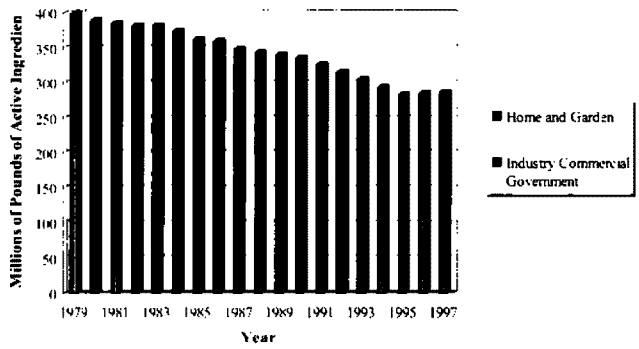
Indicator: Annual Pesticides Usage by Residential Sectors and by Pesticide Type

Non-agricultural pesticides use represents a significant portion of the demand for and use of pesticides nationwide. Pesticides are used for aesthetic purposes (e.g., lawn and garden maintenance), home pest control, and public health benefits. There are potential health and environmental risks associated with non-agricultural pesticides use because such applications occur where people live and work. Risk also arises from the potential applicator error due to infrequent and/or uninformed use in non-agricultural settings.

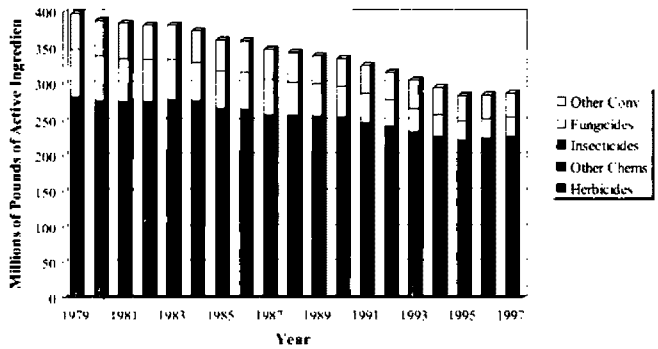
Because of these potential risks, it is important to track non-agricultural pesticide usage. This indicator measures the annual volume of non-agricultural pesticide use by different sectors and by pesticide type. Although this indicator does not explicitly consider the toxicity of the pesticides used, one can cautiously infer relative toxicity according to pesticide type. According to the USDA, insecticides generally are more toxic than herbicides, which are both usually more toxic than fungicides. Again, this indicator measures only usage and not toxicity or risk.

- In the non-agricultural sectors, total pesticides usage has declined from 398 million pounds to 287 million pounds from 1979 to 1997.
- This decline in non-agricultural pesticide usage is primarily due to the decrease in use by the industry, commercial and government sectors (from 243 million pounds in 1979 to 151 million pounds in 1997).
- In the non-agricultural sectors, herbicide usage represents the largest share of pesticide applications. In 1997, herbicide usage represented 34% of total pesticide use.
- In the non-agricultural sectors, insecticide usage exhibits a trend of decline, from 67 to 47 million pounds of active ingredient from 1979 to 1997.

Annual Pesticides Usage by Non-Agricultural Sectors, 1979-1997



Non-agricultural Pesticides Usage by Pesticide Type, 1979-1997



Source: 1990 EPA survey of pesticide usage by homeowners and a 1993 EPA survey of commercial applicators

Notes: "Other Conv" refers to conventional pesticides other than fungicides, insecticides and herbicides (e.g., nematicides, rodenticides and fumigants). "Other Chems" refers to chemicals registered as pesticides but are produced mostly for other purposes (e.g., sulfur and petroleum).

Data Characteristics and Limitations: For these estimates, the EPA consults public and proprietary data sources. Public data include a 1990 EPA survey of pesticide usage by homeowners and a 1993 EPA survey of commercial applicators. The EPA reports that the proprietary sources consulted are well-known organizations that are utilized by pesticide registrants and other private sector firms. Files on pesticide usage are maintained at the Pesticide Data Center in the Biological and Economic Analysis Division (BEAD) of the EPA Office of Pesticide Programs (OPP).

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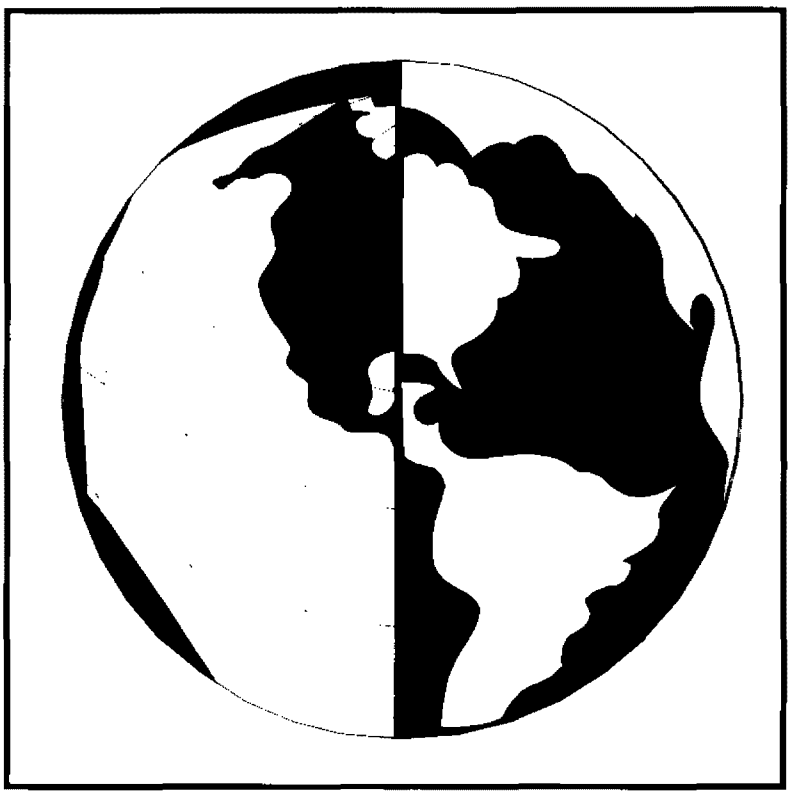
ENVIROMENTAL ISSUE 6:

TRANSBOUNDARY MOVEMENT OF CHEMICALS AND PESTICIDES



List of Indicators

Volume of Exports of Hazardous Waste from the U.S. by Treatment Method and Receiving Country

Mercury Deposition in the Florida Everglades

Atmospheric Deposition of Toxic Chemicals and Pesticides into the Great Lakes

Hazardous Pesticides Exports from the U.S.

U.S. Imports and Exports of Persistent Organic Pollutants

ENVIRONMENTAL ISSUE 6:

TRANSBOUNDARY MOVEMENT OF CHEMICAL AND PESTICIDES

A complexity of environmental protection is that environmental effects do not respect international borders. Actions taken in other countries can create adverse environmental conditions for the U.S. and vice versa. Environmental effects are globalized through human activity, such as international trade, and natural processes such as atmospheric circulation. Such globalization processes serve to magnify the impact of local pollution and create risk for non-local ecosystems and populations. At the core of this issue is the question of equity: who pays for the globalization of environmental effects, who benefits from it, and who suffers from it? Analysis of the sub-issues suggests that the costs are borne by many while the benefits of the globalization of environmental effects are reaped by a few. The indicator system developed for this issue will help to identify the distribution of these costs and benefits, and represents a necessary step in ensuring transboundary environmental justice. The major issue of the globalization of environmental effects is divided into three sub-issues that reflect the key dimensions of the problem: (1) the transboundary management of toxics, (2) the environmental transport of chemicals and pesticides, and (3) the international trade of toxic chemicals and pesticides.

Issue Dimensions

Transboundary Management of Toxics

Approximately 350 million metric tons of toxic waste are generated annually, with over 90% of this generated in industrialized countries (World Resources Institute, 1998). Almost all industrialized countries have adopted hazardous waste management policies in order to minimize the ecological and human health risks posed by the generation and management of this waste. These stringent policies have resulted in rising costs for the treatment and disposal of toxic waste. From the early 1970's to the late 1980's, the price for land filling hazardous waste in the U.S. increased by 1600% (Hilz, 1992). Currently in the U.S., the cost to incinerate one metric ton of polychlorinated biphenyls (PCB) waste ranges from $200 to $2,300 (EPA ,1997). Also contributing to these rising costs is the limited number of disposal and treatment facilities. Many existing facilities are nearing capacity and few new facilities are built due to strong public objections against their presence.

An unintended consequence of stringent policies, rising disposal costs, and public objections to local disposal has been the shift toward transboundary management of toxic wastes. Approximately 2 million metric tons of toxic waste are traded among developed countries in the Organization for Economic Cooperation and Development (OECD) (World Resources Institute, 1998). According to official reports, fewer than 1,000 metric tons of toxic waste are exported to developing countries. However, many more exports of toxic waste to developing countries are conducted illegally and go unreported. Although there are no reliable data on the illegal waste trade, the EPA has estimated illegal shipments outnumber legal ones by 8 to 1(World Resources Institute, 1998).

Hazardous wastes are illegally exported to developing countries because of the lax to non-existent environmental regulations there and the significantly lower costs of treatment and disposal. For these developing countries, most of which are burdened by tremendous debt, the importing of these toxic wastes represents an important source of income and a rare opportunity to obtain hard currency (e.g., U.S. dollars). The major problem of this practice is that most of these countries do not have the technical expertise or facilities for safe management and disposal. In these countries, unanticipated situations of environmental damage (e.g. soil contamination, air and ground water pollution), adverse human health effects (e.g., acute reactions and birth defects) and high economic costs (e.g. site cleanup and compensation for poisoned victims) have been documented.

The concern over the toxic waste trade and its documented dangers from cases around the world led to the drafting of the Basel Convention on the Control of the Transboundary Movements of Hazardous Waste and Their Disposal in 1989. Over 100 countries have ratified the Convention, which requires that toxic waste exporters notify and receive permission from importers prior to shipment; that all waste shipments are accurately labeled; and that countries prohibit waste shipments to nations that have banned them. The notable country among the non-ratifiers is the United States, which is the largest generator of toxic waste. The indicators in this section track the movement of toxic wastes across U.S. borders.

Environmental Transport of Chemicals and Pesticides

Pollutants in one ecosystem can often be traced to source pollution hundreds or thousands of miles away. Persistent organic pollutants (POPs) have been observed to undergo extensive movement and redistribution on a global scale. Scientists have studied the movement of POPs and have discovered a pattern of global distillation whereby POPs migrate from warm regions of release to colder regions of condensation. Called the "grasshopper effect," multiple cycles of evaporation, air transport, and condensation allow POPs to travel large distances in relatively short periods of time (Newman, 1998). In cold climates, low evaporation rates trap transported POPs locally where they often enter the food chain. These POPs are known to bioaccumulate in the food chain, as significant concentrations have been detected in humans. In some Inuit women in northern Canada, blood levels of PCBs have been found to exceed Health Canada standards. Additionally, breast milk samples from Inuit women showed certain POP levels to be up to nine times higher than that of women who live in southern Canada (Environment Canada, 2002).

Pesticides are commonly transported from the site of application into non-local water sources and sediments; trace concentrations of pesticides have even been detected in the Arctic regions (Bidleman & Falconer, 1999). In a sampling of tree bark sites around the world, the banned pesticide Hexachlorobenzene was found to be globally distributed over large distances from the points of emission (Bidleman & Falconer, 1999). The U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program monitors the ambient concentrations of the most commonly used pesticides in urban, agricultural, and mixed land use areas. The NAWQA Program shows that pesticides pose contamination risks in water bodies both near and far from the site of pesticide application. The indicators in this section track the transport of toxic chemicals and pesticides to important U.S. ecosystems (the Florida Everglades and the Great Lakes).

International Trade of Toxic Chemicals and Pesticides

International trade is one process by which chemicals and pesticides pose a transboundary environmental risk. Much of the international pesticides trade involves developing countries, in which pesticides are used for a number of agricultural and public health purposes. Because of the limited financial resources of many developing countries, many of the pesticides exported to them are less expensive, highly toxic, obsolete, or even banned. The Foundation for Advancements in Science and Education (FASE) found that large quantities of hazardous (banned, severely restricted, never registered, or restricted use) pesticides are annually shipped from the U.S. to developing countries. Many of these shipments are illegal, but bypass detection due to inadequate federal controls (FASE, 1998).

The environmental and human health risks of these hazardous pesticides are further magnified by the poor state of pesticides management, weak to nonexistent regulatory capacity, and working conditions found in the developing world. A 1996 survey by the United Nations Food and Agricultural Organization (FAO) revealed that safe storage of pesticides is a serious problem in 48% of developing countries. Also, in 75% of developing countries, pesticide distributors are not adequately trained to inform buyers about the safe and efficient use of pesticides.

The inappropriate packaging or labeling of chemical and pesticide products, lack of facilities for proper storage, and lack of user education, increase the potential for product misuse, environmental contamination, and adverse human health effects. At heightened risk in these countries are children, whose metabolic and immune systems offer less protection against toxic substances than those of an adult. According to the International Labour Organization (ILO), more than 90% of rural working children in developing countries are involved in agriculture. According to the ILO, children mix or apply pesticides and fertilizers and also pick crops still wet with pesticide applications (1996).

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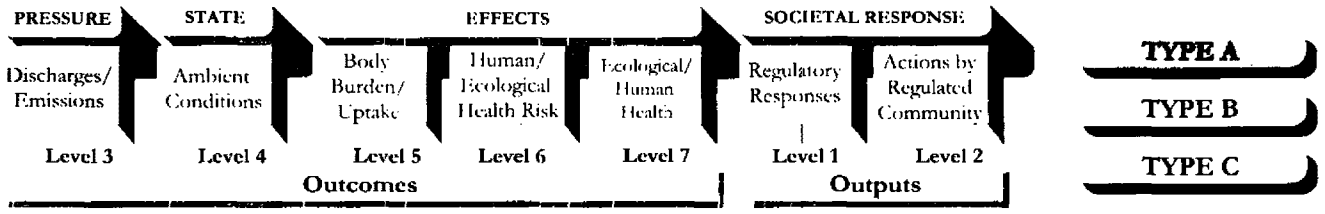
TRANSBOUNDARY MOVEMENT OF CHEMICALS AND PESTICIDES

TRANSBOUNDARY MANAGEMENT OF TOXICS



Indicator: Volume of Exports of Hazardous Waste from the U.S., by Treatment Method and Receiving Country

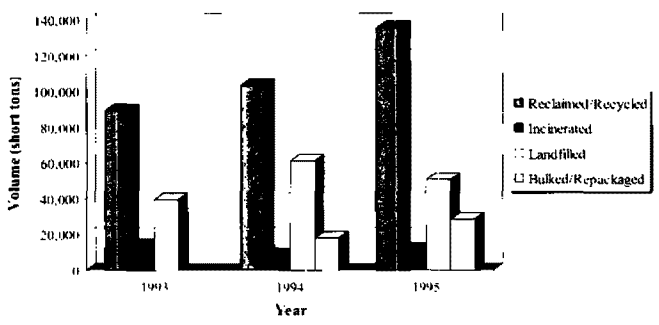
Exports of hazardous waste from the U.S. are subject to the Resource Conservation and Recovery Act of 1976 (RCRA). RCRA provides for the tracking and management of hazardous waste from generator to transporter then to its final phase in treatment, storage, or disposal. Under RCRA requirements, hazardous waste exporters must: notify EPA of an intended export before the scheduled shipment; provide EPA with written consent of the receiving country to accept the hazardous waste; comply with manifest requirements; and, file an annual report with EPA summarizing all hazardous waste exports for the previous calendar year.

The EPA Office of Enforcement and Compliance Assurance (OECA) reviews export notifications, manifests annual reports, and tracks hazardous wase exports in a database called the Hazardous Waste Export Systems (HWES). In addition, OECA issues Acknowledgements of Consent for hazardous waste exports.

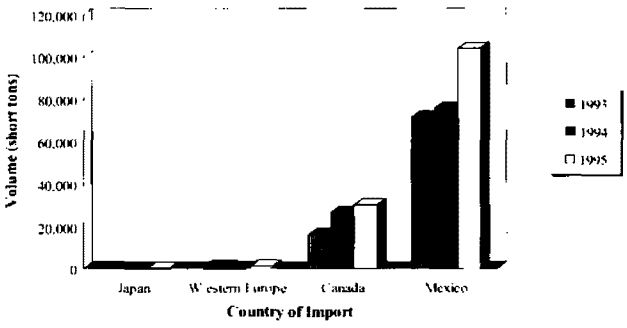
Hazardous wastes are exported from the U.S. for the following treatments in recipient countries: reclamation and recycling, bulking and repackaging, landfilling, and incineration. This indicator allows for the tracking of hazardous waste exports for each intended treatment method by recipient country. Exports to lesser developed countries (LDCs) have caused problems in the past because these countries often do not have the necessary facitilities or expertise for hazardous waste management. This indicator will allow for the trend tracking of exports to LDCs; a trend of increased exporting could serve as a signal to inspect facilities and ensure proper management in the importing LDCs.

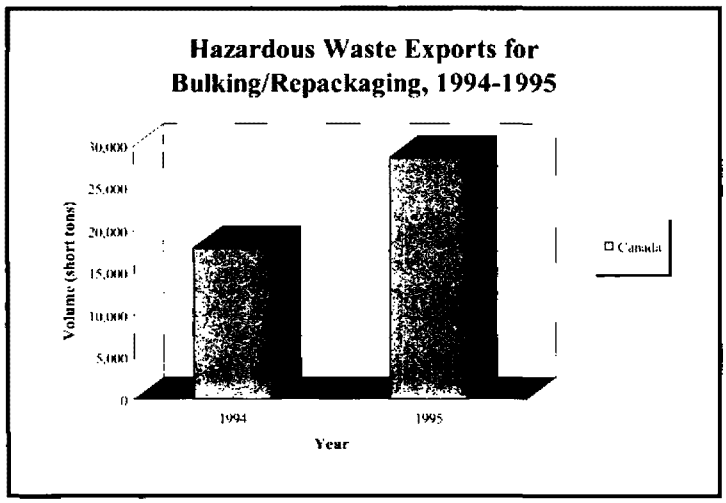
- Total hazardous waste exports increased by 59% from 1993 to 1995 (from 146,708 tons to 226,393 tons).
- Canada and Mexico are the largest importers of U.S. hazardous waste, accepting over 99% of total exports each year.
- Most (approximately 60% annually) exported hazardous wastes are reclaimed/recycled in the recipient countries.

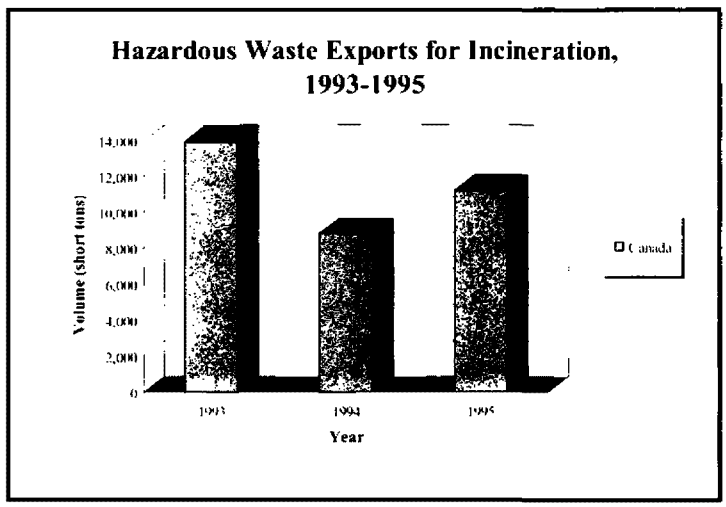
Total Hazardous Waste Exports by Treatment Method, 1993-1995

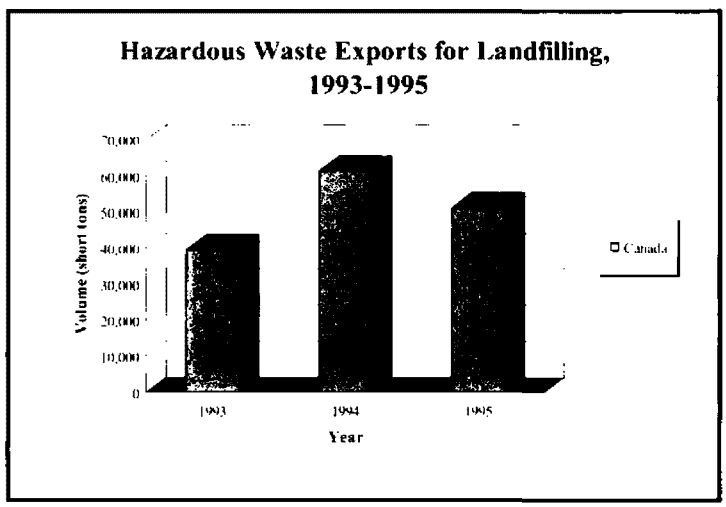


Hazardous Waste Exports for Reclamation/Recycling, 1993-1995









Notes: Japan imported less than 14 tons of hazardous waste from the U.S. each year. Exports to Western Europe total to less than 1,000 tons per year.**Source**: *Charts derived from HWES export volume data, as compiled by Paul Borst, EPA Office of Solid Waste*

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: HWES tracks hazardous waste data for each calendar year, but it is not available publicly. Waste export data for 1996 and 1997 are still being analyzed and compiled by the EPA Office of Solid Waste. A noteworthy limitation to this data is that it does not include export data for spent lead-acid battery wastes. Exports of spent lead-acid battery wastes are exempt from annual reporting requirements. However, spent lead-acid batteries are known to be exported from the U.S. and are the principal hazardous waste legally exported to lesser developed countries.

References:

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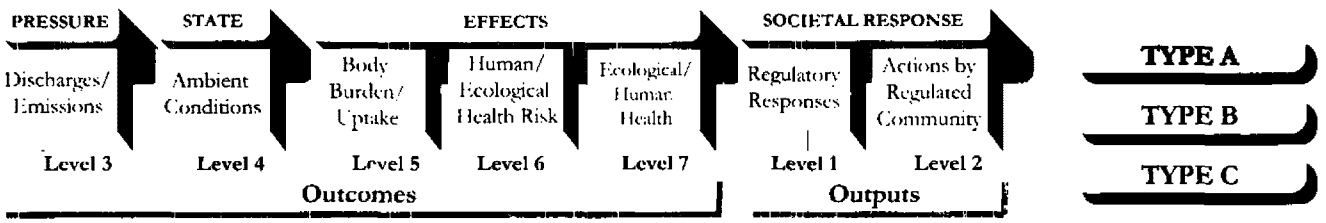
TRANSBOUNDARY MOVEMENT OF CHEMICALS AND PESTICIDES

ENVIRONMENTAL TRANSPORT OF CHEMICALS AND PESTICIDES



Indicator: Mercury Deposition in the Florida Everglades

The environmental transport of mercury has caused a significant problem in the Florida Everglades. The Everglades are inhabited by fish with mercury concentrations that consistently exceed the guideline of 1.5 parts per million established by the Florida Department of Environmental Protection. The first detection of these unsafe mercury levels in Everglades fish was made in 1988. Shortly thereafter, biologists discovered toxic concentrations and effects of mercury throughout the Everglades food chain – in raccoons, otters, alligators, egrets and endangered Florida panthers. Because mercury is a known neurotoxicant in humans, the consumption of fish and other game from the Florida Everglades has been severely restricted.

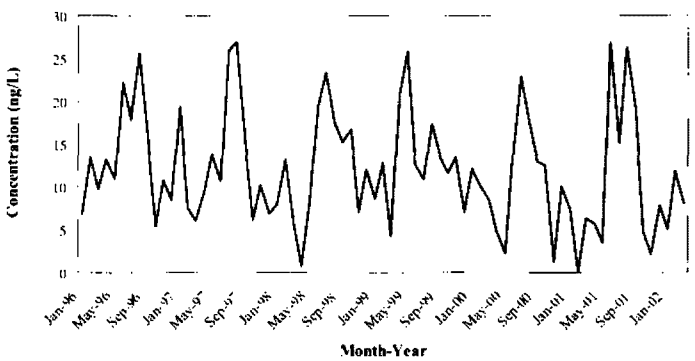
Scientists from the EPA, Florida Department of Environmental Protection, U.S. Geological Survey and Florida State University have studied, and continue to study. the mercury problem in the Everglades. These scientists found that over 95% of the annual mercury deposition in the Everglades occurs through rainfall. Moreover, much of the mercury in this rainfall deposition originates from overseas sources. Scientists estimate that between 30% and 70% of mercury deposition in the Everglades comes from the environmental transport of mercury emissions from other countries.

The deposition of mercury in the Everglades is monitored through the National Atmospheric Deposition Program's Mercury Deposition Network (MDN). The MDN is a national database of weekly concentrations of mercury in precipitation and the seasonal change of total mercury in wet deposition. Of the 38 sites monitored in the MDN, mercury deposition has been highest in the Everglades.

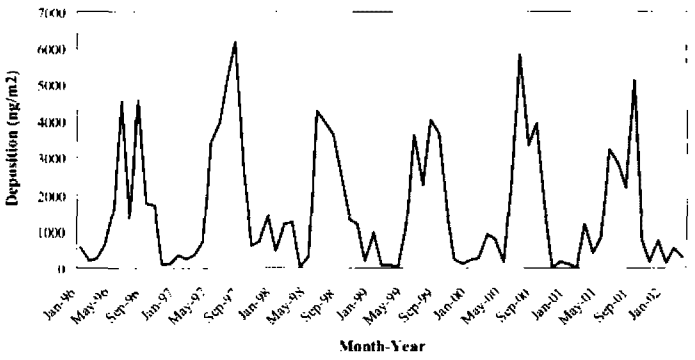
The charts depict the monthly trends in mercury concentration in rainfall and mercury deposition in the Everglades from January 1996 to April 2002.

- Mercury concentration and deposition are seasonal: they are highest during the summer months and lowest during the winter months.
- The seasonal cycles of concentration and deposition show a relatively stable trend over the 5 year period.

Average Monthly Concentration of Mercury in Rainfall, Everglades National Park, 1996-2002



Monthly Deposition of Mercury in Everglades National Park, 1996-2002



Source: Mercury Deposition Network

Scale: Data is comparable on a regional level.

Data Characteristics and Limitations: Weekly precipitation samples are collected at each MDN site and sent to Frontier Geosciences, Inc., in Seattle, Washington for total and methylmercury concentration. The MDN data is subject to quality assurance/quality control programs in the field and in the laboratory. Weekly concentration and deposition data are available for all MDN sites, which are located throughout the country.

The MDN is anticipated to operate for at least five years and is managed by the National Atmospheric Deposition Program Coordination Office.

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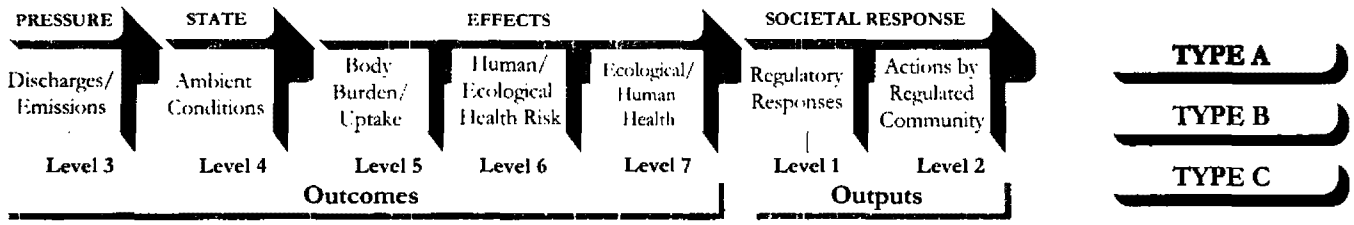
TRANSBOUNDARY MOVEMENT OF CHEMICALS AND PESTICIDES

ENVIRONMENTAL TRANSPORT OF CHEMICALS AND PESTICIDES



Indicator: Atmospheric Deposition of Toxic Chemicals and Pesticides into the Great Lakes

In the mid-1980s, it was observed that contaminant levels in fish and other biota in the Great Lakes continued to persist at high levels, despite the implementation of pollution control programs in the United States and Canada. Surveillance of lake water and river tributaries could not account for all sources of the continuing contamination. In light of this finding, American and Canadian scientists began to investigate the possible role of the atmosphere in maintaining high concentrations of pollutants in the Lakes.

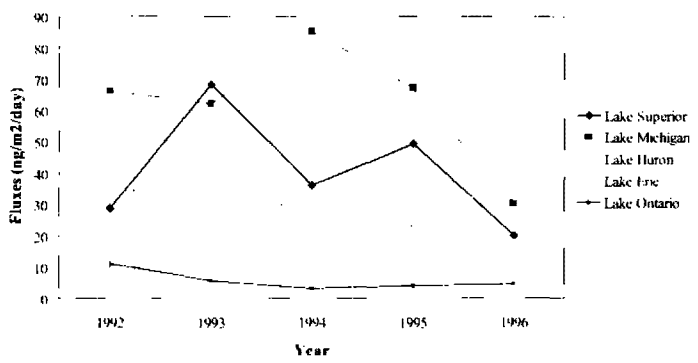
The Integrated Atmospheric Deposition Network (IADN) was created under the U.S.-Canada Great Lakes Water Quality Agreement for this purpose. Its objectives include: the identification of airborne toxic substances, the identification of their sources, and the estimation of their deposition to the Great Lakes. The IADN measures the loadings of atmospheric contaminants into the Lakes through wet deposition, dry deposition, and gas exchange. The IADN maintains a system of master stations and satellite stations around the Great Lakes and their watershed areas. At these stations, measurements are collected for: banned and restricted pesticides, current-use pesticides, combustion products, trace metals and industrial chemicals (polychlorinated biphenyls or PCBs).

IADN data have shown that substances that have been banned in the U.S. and Canada for years continue to be deposited into the Great Lakes. These findings have demonstrated the significance of long-range atmospheric transport of toxic substances into the Great Lakes Basin. These substances not only affect the water quality, but also adversely affect fish and other wildlife in the Great Lakes ecosystem. This indicator tracks the atmospheric deposition of the pesticides dieldrin and DDT and also of PCBs and arsenic into the Great Lakes.

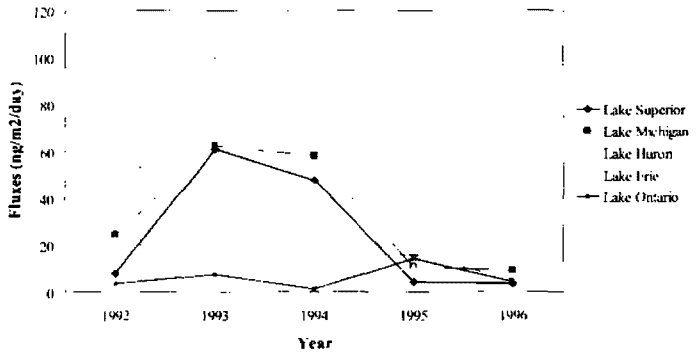
The charts show the trends in deposition for these substances from 1992 to 1996.

- With some annual variation, the atmospheric deposition of dieldrin, DDT and PCBs have slightly declined from 1992 to 1996.

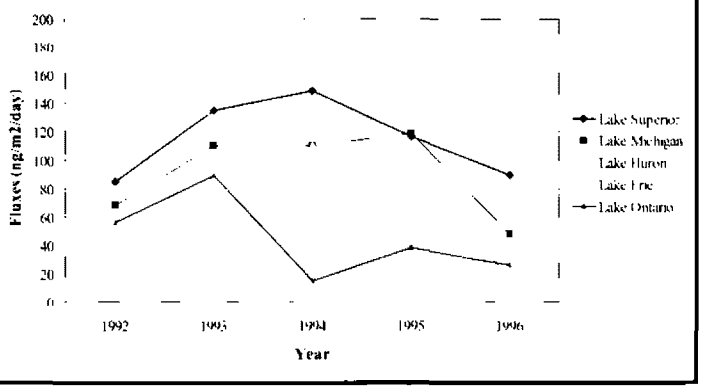
Atmospheric Deposition of Dieldrin into the Great Lakes, 1992-1996



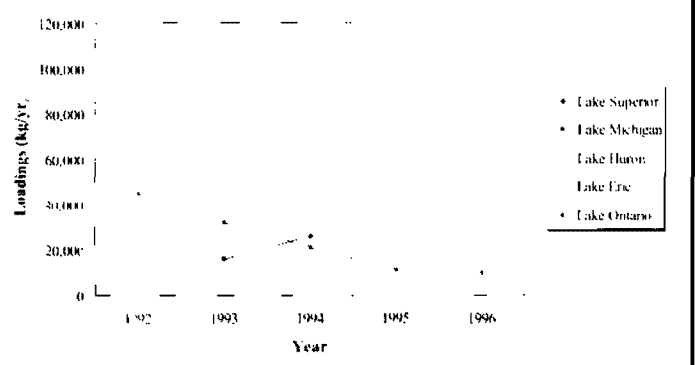
Atmospheric Deposition of DDT into the Great Lakes, 1992-1996



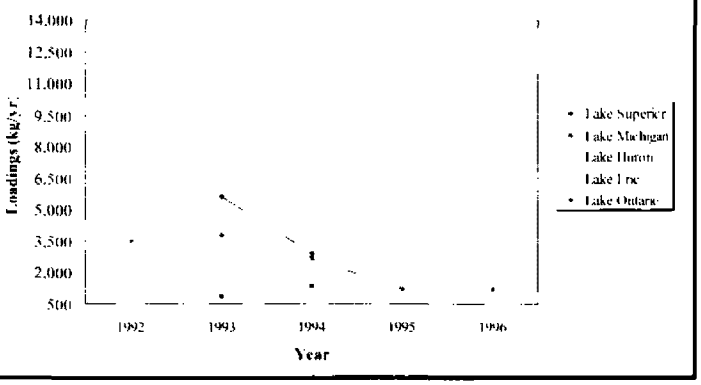
Atmospheric Deposition of PCBs into the Great Lakes, 1992-1996



Atmospheric Loadings of Lead into the Great Lakes, 1992-1996



Atmospheric Loadings of Arsenic into the Great Lakes, 1992-1996



Notes: Deposition reflects the sum of wet and dry deposition into the Lakes. Deposition is presented in terms of fluxes (mass/unit area/unit time, that is, nanogram/square meter/day) in order to account for differences between lakes due to their areas.

Notes: Loadings reflect the sum of wet and dry deposition into the lakes. A missing value means that a loading could not be calculated, not that no loading occurred. This measure does not take into account the size differences among the Great Lakes.

Source: Environment Canada and the EPA. *Atmospheric Deposition of Toxic Substances to the Great Lakes: IADN Results to 1996.*

Scale: Data are comparable on a regional level.

Data Characteristics and Limitations: The IADN monitoring system comprises five master stations (one at each Great Lake) and fourteen satellite stations. Several instruments are grouped at each site to collect air and rain samples. In IADN, three deposition processes are considered: wet deposition by precipitation, dry particle deposition by sedimentation, and net diffusive gas exchange that accounts for the effects of air to water absorption and water to air volatilization. In addition to the toxic substances cited previously, the IADN is considering adding following to its regular roster of chemicals: atrazine and other triazine herbicides, toxaphene, mercury, dioxins and furans, and an expanded polycyclic aromatic hydrocarbon (PAH) list. The data reported in this indicator reflect work from the first phase of IADN, which was conducted from 1990 to 1996. The second phase of IADN, preliminary data from which are not yet available, is scheduled to run until 2004. No major changes to IADN are anticipated.

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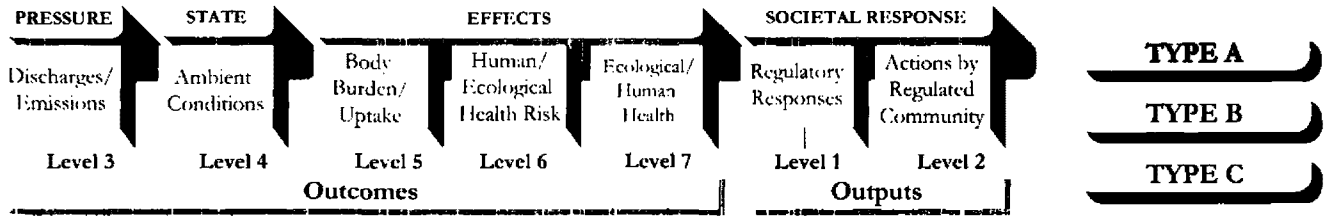
1889 Pennsylvania Avenue

TRANSBOUNDARY MOVEMENT OF CHEMICALS AND PESTICIDES

INTERNATIONAL TRADE IN TOXIC CHEMICALS AND PESTICIDES



Indicator: Hazardous Pesticide Exports from the U.S.

Many hazardous pesticides are exported to developing countries, where they adversely affect human health and the environment. Exports of these pesticides are problematic not only because of their toxicity, but also because of the poor state ofpesticides management in the developing world. In 1996, the United Nations Food and Agricultural Organization (FAO) published the results of its international survey regarding pesticide distribution and management. The survey revealed that:

- 87% of developing countries have modest, little or no resources available for pesticides management.
- In 78% of developing countries, inadequate educational and training materials are distributed to pesticide users.

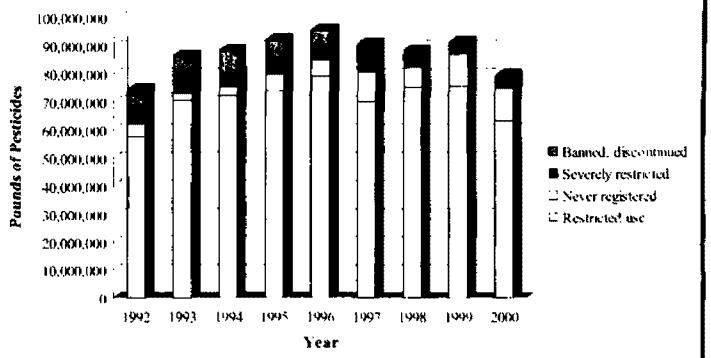
Since 1992, the Foundation for Advancements in Science and Education (FASE) has tracked the reported exports of hazardous pesticides from the U.S. FASE defines hazardous pesticides to include: restricted use and severely restricted use compounds, banned or discontinued compounds, and compounds that have never been registered with the EPA.

The FASE relies on a time-consuming process of sorting, decoding and analyzing the shipping records of the U.S. Customs Service. The chart depicts the export trends of hazardous pesticides from the U.S., as reported to the U.S. Customs Service.

- Reported annual exports of hazardous pesticides rose steadily until the mid-1990s. Since 1997, the anuual exports of hazardous persticides habe begun to decrease.
- Reported anuual exports of never registered pesticides more than doubled from 1992 to 20000 (4.% million pounds to 11.2 million pounds).
- By the year 2000, no instance of export of banned products was reported.

As the chart shows, the export of hazardous pesticides from the U.S. is a problem that has worsened since tracking began.

Reported Hazardous Pesticide Exports from the U.S., 1992-2000



Source: *FASE Research Reports*

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: The FASE reports that much of the data in Customs shipping records is cryptic or vague. For about 75% of all pesticides exported, the specific chemical names were omitted from the shipping records. For this reason, the FASE caution that these estimates are extremely conservative and that hazardous pesticide exports are likely much higher. Also, many of the companies who export unidentified pesticides obtain permission from the Treasury Department to withhold their names from shipping records.

In addition to general classes of pesticides, the FASE reports pesticide exports by active ingredient (chlordane, heptachlor, DDT, etc.).

References

Foundation for Advancements in Science and Education. 1996. "Exporting Risk: Pesticide Exports from U.S. Ports, 1992-1994." *FASE Research Report*. 13 November 2002. Available online at: http://www.fasenet.org/pesticide_report92-94.pdf

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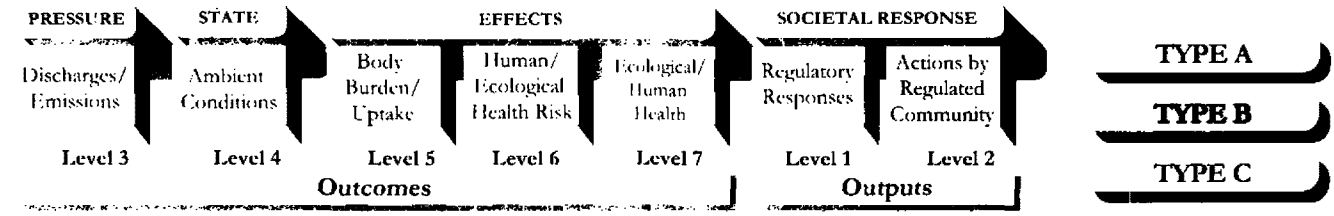
TRANSBOUNDARY MOVEMENT OF CHEMICALS AND PESTICIDES

INTERNATIONAL TRADE IN TOXIC CHEMICALS AND PESTICIDES



Indicator: U.S. Imports and Exports of Persistent Organic Pollutants

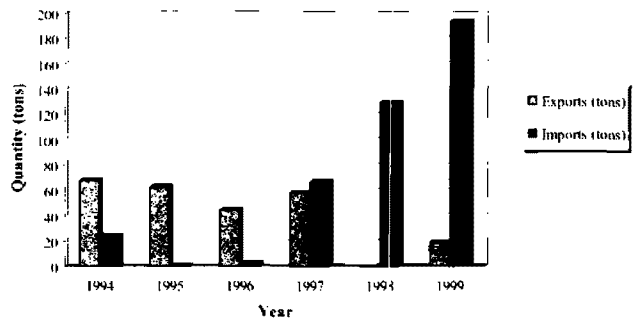
Many hazardous chemicals are exported from and imported into the United States. Some of the traded chemicals are known as persistent organic pollutants (POPs). Persistent organic pollutants bioaccumulate in living organisms, do not readily break down in the environment, and have exhibited long-term toxic effects. For these reasons, POPs have been the target of many national and international strategies. Currently, the United States and many other countries are negotiating a global agreement on POPs under the mandate of the United Nations Environmental Programme (UNEP). The mandate for these negotiations is to reduce and/or eliminate emissions and discharges of twelve specified POPs:

- Eight cancelled pesticides (DDT, Aldrin, Dieldrin, Endrin, Chlordane, Heptachlor, Mirex, Toxaphene)
- Two industrial chemicals (PCBs and hexachlorobenzene)
- Two combustion by-products (dioxins and furans)

This indicator tracks the U.S. exports and imports of the eight cancelled pesticides and two industrial chemicals targeted by the international POPs negotiations. However, public data on the exports and imports of chemical compounds is not disaggregated enough to track specific POPs. Currently, the only specific POPs whose imports and exports can be tracked are DDT and hexachlorobenzene. The chart shows the export and import trends of these two compounds since 1994. It shows that the United States still engages in international trade of these chemicals, even though both are banned from use domestically and in many other countries.

- Although the export trend of these two chemicals is irregular, overall it exhibits a decline: from approximately 68 tons in 1994 to 19 tons in 1999.
- The chart shows a dramatic increase in the imports of DDT and hexachlorobenzene: from 24 tons in 1994 to over 193 tons in 1999.

U.S. Imports and Exports of Hexachlorobenzene and DDT, 1994-1999



Source: U.S. International Trade Commission

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: The U.S. International Trade Commission maintains an interactive tariff and trade database on their website (http://www.dataweb.usitc.gov). Using this database, export and import information (quantities and monetary values) can be obtained for a specific commodity. This requires use of the 10-digit identification code of the commodity from the Harmonized Tariff Schedule (HTS) of the United States. Chapter 29 of the HTS lists the 10-digit codes for all organic chemicals. The organic chemicals are organized by broad category (except DDT and HCB). The categories that include the POPs of interest also include chemicals that do not rate as POPs; therefore, tracking the exports and imports of these categories of organic chemicals is not appropriate for this indicator. The acquisition of import and export data for specific POPs will require further research with the appropriate staff in the U.S. Customs Service and the U.S. International Trade Commission. Data are reported annually and compiled by the U.S. Department of Commerce, the U.S. Treasury and the U.S. International Trade Commission.

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Section VI, Chapter 29 of the Harmonized Tariff Schedule of the U.S. (2000). 14 November 2002. Available online at:http://dataweb.usitc.gov/SCRIPTS/tariff/toc.html

United Nations Environmental Programme POPs Home Page. 14 November 2002. Available online at: http://www.chem.unep.ch/pops

SPECIAL POPULATIONS

Special Populations Issues List

Children

Environmental Justice

Tribes

Special Populations Issue 1: Children

List of Indicators

Pathologies in Children Caused by Chemical or Pesticide Exposure

Incidence of Asthma in Children

Incidence and Mortality of Childhood Cancers

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Number of Fatal and Non-Fatal Child Poisonings due to Pesticide Exposure

Number of Fatal and Non-Fatal Child Poisonings due to Chemical Exposure

Children's Chronic Health Risk Index from Toxic Releases

Children's Acute Health Risk Index from Toxic Releases

Pesticide Residue Levels of Carcinogenic and Cholinesterase Inhibiting Neurotoxic Pesticides on Foods Commonly Eaten by Children

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Blood Mercury Levels in Children

SPECIAL POPULATIONS ISSUE 1:

CHILDREN

There has been increasing concern over the past several years for the current and future health of children, since children are more vulnerable to the detrimental effects of environmental pollution. Exposed to a pervasive and increasingly large number of chemicals and pollutants, children are exhibiting a wide variety of health effects at seemingly higher levels of occurrence than had previously been noted. As a result, research is increasingly focusing on the associations between environmental pollution and chemicals in the environment and the effect on children's health. Asthma, respiratory infections, bronchitis, and pneumonia have all been linked to poor indoor and outdoor air quality. The incidence of childhood cancer increased significantly and is now the fourth largest cause of death for children under the age of 15. Toxic substances and some pesticides are believed to be associated with this increased incidence of cancer. Neurotoxic substances, such as lead and other heavy metals, solvents, pesticides, and polychlorinated biphenyls (PCBs), are associated with a variety of developmental effects. Diminished intelligence, behavioral problems, sexual dysfunction, and physical deformity are some of the health effects believed to result from exposure to such chemicals. Children's environmental health is rapidly rising as an issue of important public policy. The indicators in this section measure the acute health effects and chronic health risk from chemical and pesticide exposure among children. The issues of acute health risks and chronic health effects will also be discussed in the context of potential future indicators.

Issue Dimensions

Pathologies and Direct Health Impacts

Evidence suggests relationships between exposure to toxic chemicals and cardiovascular disorders, developmental disorders, endocrine system dysfunction, gastrointestinal or liver dysfunction, weakening of the immune system, kidney failure, musculoskeletal disease, neurological and behavioral dysfunction, interference with sexual function or the ability to reproduce, respiratory system dysfunction, and skin or sense organ dysfunction.

The most powerful indicators of children's environmental health would be those that measured direct relationships between chemical exposure and physical health effects. Unfortunately, the science and the data needed to support these relationships are not currently available. Many health effects have multiple causes that prevent measurement of the contribution of specific chemical exposures to specific health effects. For many chemicals, it is unknown what long-term effects they will have on children's health. For those chemicals about which some effects are known, there still exists the ignorance of some long-term risks. The National Children's Study is initiating new data collection processes that may produce the evidence necessary to establish such relationships. If such relationships are established, then long-term tracking through indicators can occur.

Health Risk

A potential intermediate measurement of the impact of chemicals on children's health is the estimation of the change in risk associated with increases or decreases in chemical exposure. While the concept of risk is thoroughly integrated into the culture of environmental protection agencies, and risk-based analysis is increasingly employed to make environmental decisions, risk-based data sets suitable for indicator development have not existed until recently. The Risk Screening Environmental Indicators project at the EPA permits the estimation of children's health risk resulting from modeled exposure to Toxics Release Inventory chemicals. The indicators in this section use health risk as a proxy for health outcomes.

Chemical and Pesticide Safety

This issue focuses chemical and pesticide safety for children. One of the ways to measure children's chemical and pesticide safety is to monitor the number of fatal and non-fatal child poisonings caused by exposure to chemicals and pesticides. Tracking child poisonings due to pesticide and chemical exposure is important to monitor because children are especially vulnerable to toxic substances. Their bodies are in developmental stages and their metabolic and immune systems may offer less protection against toxic effects than those of an adult. Children also have a greater risk of exposure due to playing in areas where pesticides are applied and accidental ingestion of chemical and pesticide products can occur.

Body Burden

A more direct assessment of children's exposure to environmental chemicals is to measure child body burden. This assessment is possible through an advanced technology known as biomonitoring. Through the use of biomonitoring, scientists are able to measure chemicals directly in blood and urine samples rather than to estimate population exposures by measuring air, water, or soil samples. The National Children's Study and the National Report on Human Exposure to Environmental Chemicals, as developed by the Centers for Disease Control and Prevention, will provide annual, high-quality data for a range of important chemical constituents found in human tissue. The first year data for the National Report on Human Exposure to Environmental Chemicals was released in 2000 and provided a baseline for subsequent studies. Currently data are available for 116 chemical constituents, including a number of pesticides. As data are collected over the years, researchers will be better able to determine possible health effects and design appropriate public health strategies.

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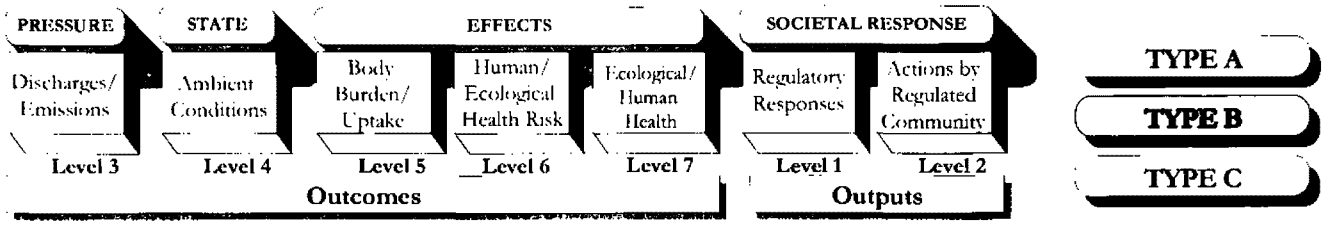
CHILDREN
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Pathologies in Children Caused by Chemical or Pesticide Exposure

With respect to exposure to toxic chemicals and pesticides, children represent a population of special concern. Their pattern of growth and developments, their small size, their unique pathways of exposure, and their diet make children vulnerable to toxic exposure and its effects. Hand-to-mouth activity, and frequent and prolonged mouthing and teething on objects put children at heightened risk of toxic exposure. Children also require greater amounts of food, in proportion to their body weight, than do adults. While a diet rich in fruit and vegetable products provides children with necessary nutrients, it also increases the potential for exposure to pesticide residues. Children can exhibit adverse physical effects at much lower levels of toxic exposure than do adults. During the developmental stage from the peri-natal period to two years of age, children are especially sensitive to toxic exposures; exposures during this phase in life can interfere with development and may result in permanent physical or mental damage.

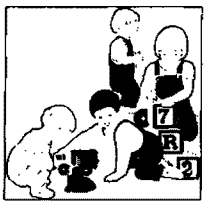
The ideal measurement of the children's health impact of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The development of such indicators may soon be possible. In conjunction with the U.S. Department of Health and Human Services and the U.S. Environmental Protection Agency, the development of a National Children's Study (NCS) is presently underway. The NCS will examine medical outcomes and body burden data collected from a cohort of over 100,000 children. The cohort will be followed from early gestation to the age of 21. Analysis of the data will permit the identification of causal relationships between chemical exposure and specific medical outcomes. The confirmation of such relationships, however, will take many years due to the lengthy scientific process of data analysis, results validation or replication, and peer review. Pilot studies will begin in fiscal year 2002-03 and the full study will begin in fiscal year 2004-05. The study is projected to conclude in fiscal year 2027-28.

The NCS, however, by concluding the monitoring when the cohort reaches age 21 may be missing an opportunity to considerably expand knowledge of chemical exposure and health effects well into adulthood. By continuing the cohort study indefinitely or until death, information could be collected that could be used to conclusively establish the relationship between chemical exposure and the character and timing of medical outcomes across the entire life span.

Reference

National Children's Study. 29 January 2003. Available online at: http://nationalchildrensstudy.gov/.



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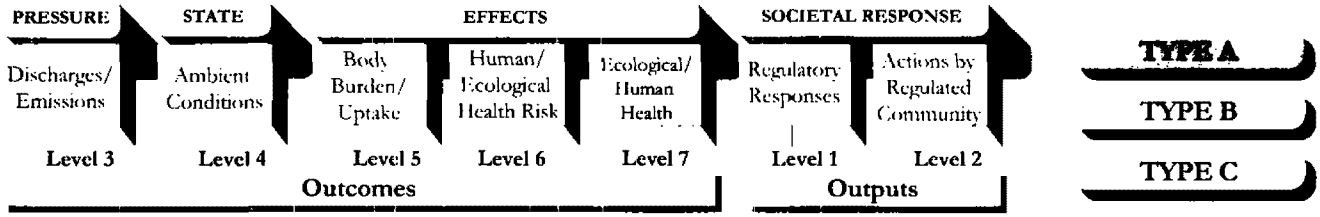


Indicator: Incidence of Asthma in Children

Asthma is a chronic lung disease characterized by airway inflammation and obstruction in which symptoms include wheezing, coughing, and shortness of breath (Mannino, Homa, Pertowski, Ashizawa, Nixon, Johnson, Ball, Jack, & Kang, 1998). Asthma may be caused or triggered by "familial, infectious, allergenic, socioeconomic, psychosocial, and environmental factors" (Mannino et al., 1998, p. 1). Although there is not cure for asthma, it can be treated with anti-inflammatory agents (inhaled steroids) and bronchodilators. Another way to control asthma is to avoid environmental triggers such as allergens, viruses, tobacco smoke, certain chemicals, and other indoor and outdoor air pollutants (Centers for Disease Control and Prevention, 2002). With good management, people with asthma may gain control over the disease. An estimated 25% of children with asthma show no symptoms when they become adults (American Lung Association, 2002). However, damage to the lungs due to asthma may become irreversible if the condition persists for a long period of time and is insufficiently treated (Mannino et al., 1998).

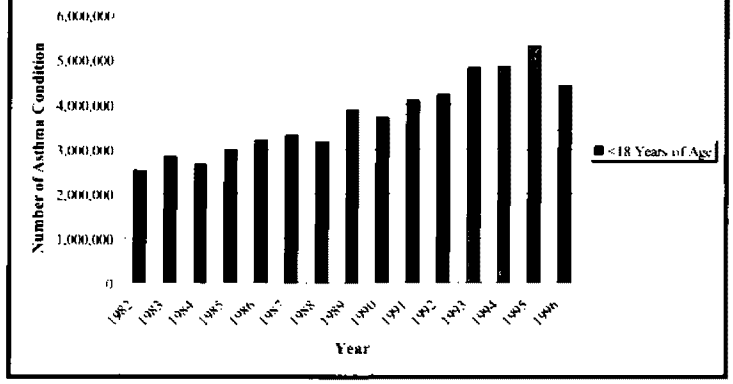
Asthma affects nearly 15 million Americans, more than 5 percent of the U.S. population. The scope of the health care problem caused by asthma lies not only in the large number of Americans with the disease, but also in the limitations that asthma imposes on daily activities, such as school, work, sports, and recreation. Asthma is the leading cause of school absenteeism for children and a common cause of work absenteeism for adults.

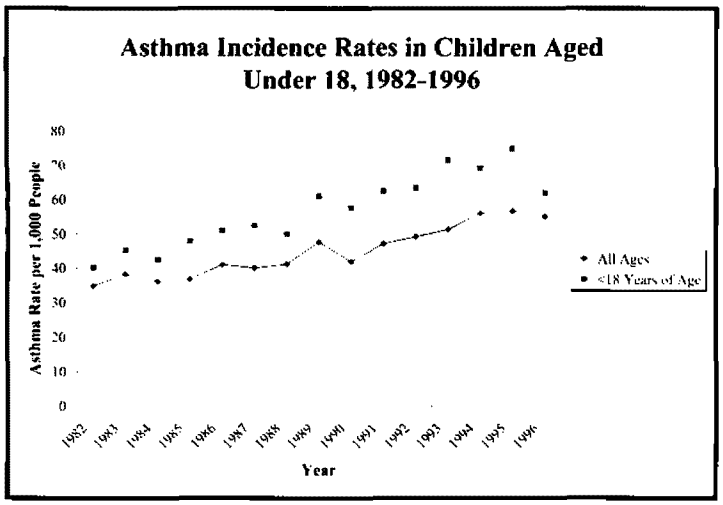
Asthma is also the most common chronic disease in childhood. Children may be more at risk for getting asthma than adults because they breathe almost twice the air inhaled by adults when body weight is taken into account and therefore, they often have more exposure to environmental contaminants. They are also particularly at risk because their airways are still developing.

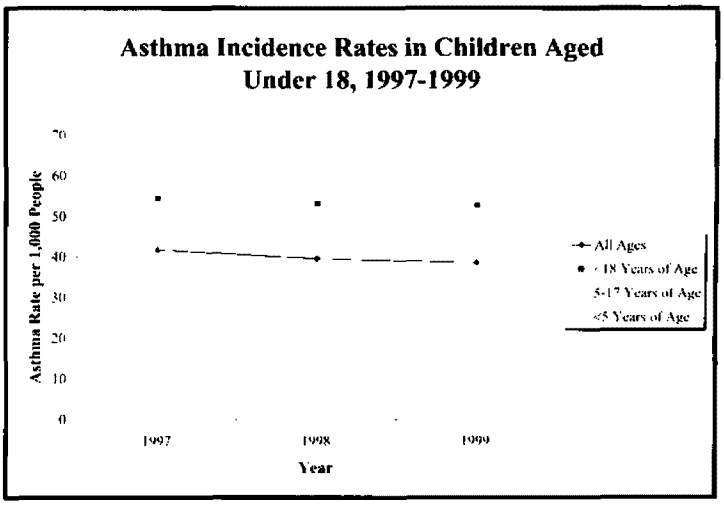
The following charts show trends in asthma incidence for children less than 18 years of age in the U.S., as measured in the National Health Interview Survey between 1982 and 1999. Due to the use of a new design in the Survey in 1997, asthma incidence rates prior to 1997 cannot be compared with later rates.

- From 1982 to 1996, the number of asthma conditions for children under 18 has increased from 2,513,000 to 4,429,000.
- Asthma incidence rates per 1,000 people were higher and increased faster for children under 18 than for people of all ages.
- Asthma incidence rates increased from 34.8 to 55.2 for people of all ages.
- Asthma incidence rates increased from 40.1 to 62.0 for children under 18.

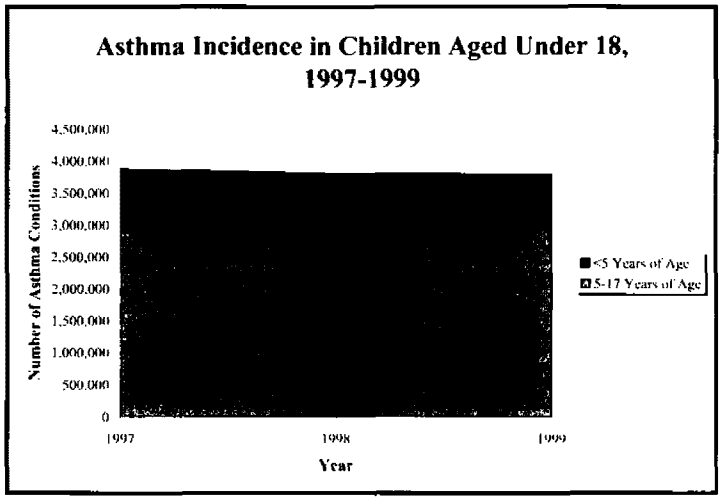
Asthma Incidence in Children Aged Under 18, 1982-1996







- From 1997-1999, there was a small decline in asthma incidence rates for children 5-17 and a small incline in rates for children under 5. However, more data points are needed to establish an overall trend.
- Children under 18 consistently had higher asthma incidence rates than those seen in the overall population.
- Children aged 5-17 consistently had higher asthma incidence rates than any other age group.



Note: An asthma condition was defined as answering yes to "Have you EVER been told by a doctor or other health professional that you had asthma?" and "During the past 12 MONTHS, have you had an episode of asthma or asthma attack?"

Source: National Center for Health Statistics, National Health Interview Survey, 1982-1996, 1997-1999 as reported in the Trends in Asthma Morbidity and Mortality, February 2002 by the American Lung Association.

Scale: Asthma incidence data is at the national level and is not available at the state or local level.

Data Characteristics and Limitations: These estimates are based on a sample. Therefore, they may differ from the figures that would be obtained from a census of the population. Each data point is an estimate of the true population value and is subject to sampling variability. Due to the use of a new design in the National Health Interview Survey in 1997, asthma incidence rates prior to 1997 cannot be compared with later rates.

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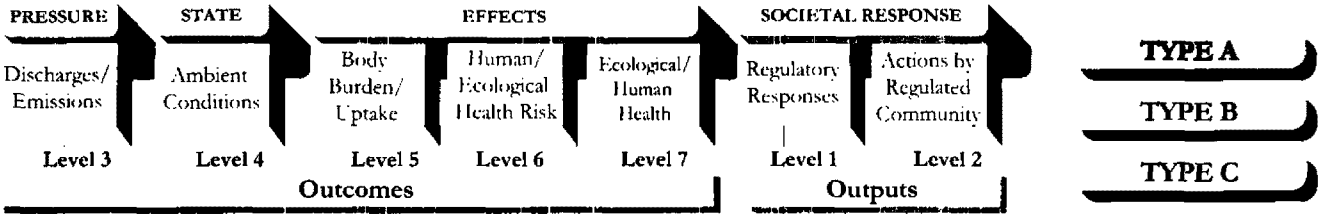


Indicator: Incidence and Mortality of Childhood Cancers

Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA).

Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a).

Compared to adults, cancer in children is rare and children develop different types of cancers than adults (American Cancer Society, 2001). The most common types of childhood cancers include brain cancer, leukemia, lymphoma, neuroblastoma, Wilms' tumor, and bone cancer. While the causes of childhood cancers are unknown, it is expected that different factors cause different types of cancer (U.S. EPA, 2000). Causes of childhood cancers are difficult to study because of the low numbers of children with each type of cancer. Risk factors for childhood cancer include "family history, genetic defects, radiation, and certain pharmaceutical agents used in chemotherapy" (U.S. EPA, 2000). Environmental factors such as chemicals and pesticides may increase the incidence of some childhood cancers (U.S. EPA, 2000).

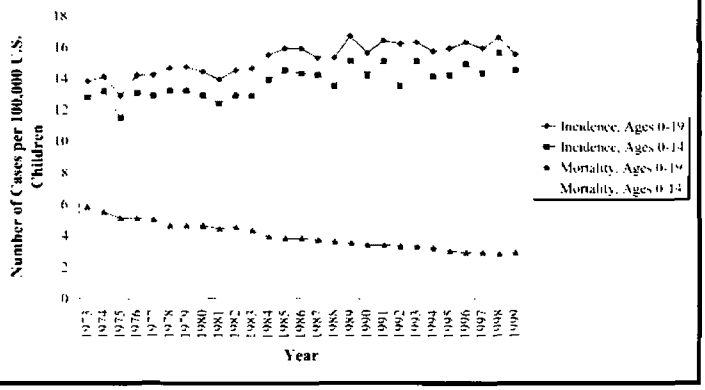
With respect to exposure to chemicals and pesticides, children represent a population of special concern. Their pattern of growth and development, their small size, their unique pathways of exposure, and their diet make children vulnerable to toxic exposure and its effects. Hand-to-mouth activity, and frequent and prolonged mouthing and teething on objects put children at heightened risk of toxic exposure. Children also require greater amounts of food, in proportion to their body weight, than do adults. A diet rich in fruit and vegetable products increases the potential for children's exposure to pesticide residues.

Children exhibit adverse physical effects at much lower levels of toxic exposure than do adults. During the developmental stage, from the peri-natal period to two years of age, children are especially sensitive to toxic exposures. Parental exposure to carcinogenic chemicals and pesticides may contribute to childhood cancer incidence by causing mutations in the parents' germ cells or by passing the exposure to the fetus (U.S. EPA, 2000). Children's direct exposure to carcinogenic chemicals and pesticides may also contribute to childhood cancer incidence (U.S. EPA, 2000). According to Zahm and Ward (1998), leukemia, non-Hodgkin's lymphoma, brain cancer, and Ewing's Sarcoma have been linked to pesticide exposure in case reports on childhood cancer.

While only about 130 out of 1 million children are found to have cancer each year, childhood cancer is the leading cause of death from disease for children aged 1-19 (U.S. EPA, 2001). However, mostly due to improvements in treatment, childhood mortality due to cancer has decreased in recent years (U.S. EPA, 2000). The following charts show cancer incidence and mortality rates for U.S. children.

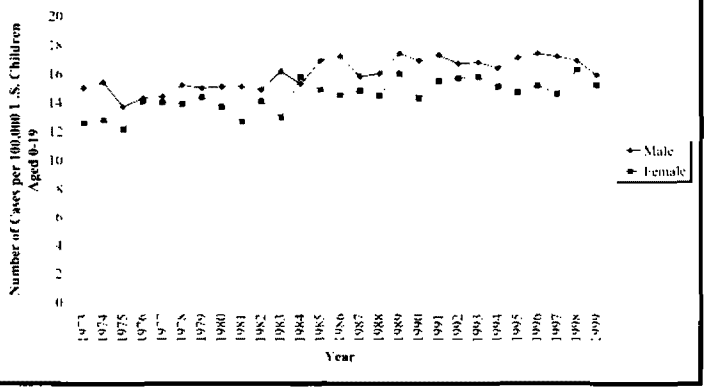
- From 1973 to 1999, cancer incidence rates per 100,000 children increased from 12.8 to 14.5 for children aged 0-14. Rates for children aged 0-19 increased from 13.8 to 15.5.
- Cancer mortality rates for children aged 0-14 decreased from 5.5 to 2.6. Rates for children aged 0-19 decreased from 5.8 to 2.9.
- Of the total incidence rates for children aged 0-19, between 83% and 94% of those rates are accounted for in children aged 0-14.

Childhood Cancer Incidence and Mortality Rates, 1973-1999



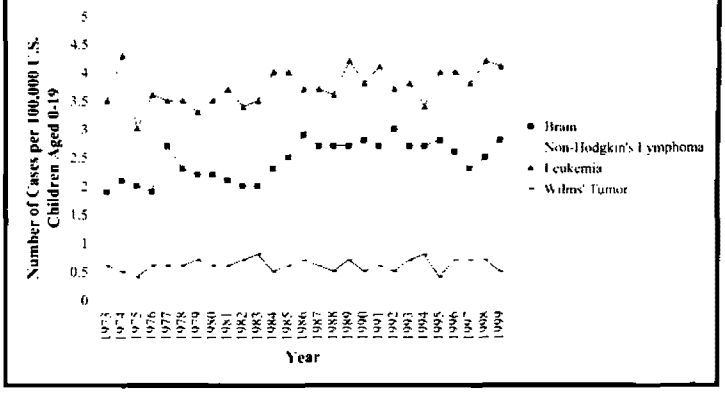
- From 1973 to 1999 (with the exception of 1984) cancer incidence rates per 100,000 children aged 0-19 were highest in males.

Incidence Rates of Childhood Cancer by Sex, 1973-1999



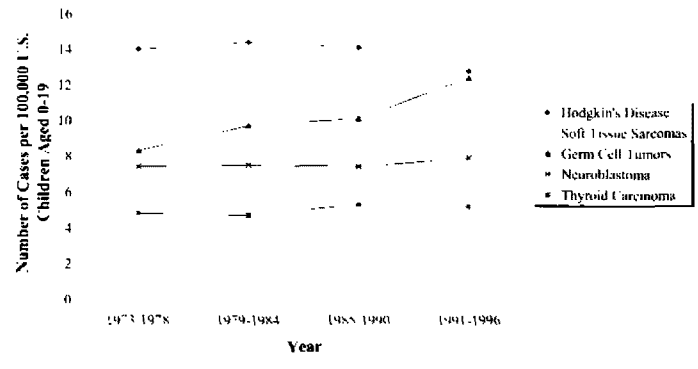
- The following chart shows incidence rates for childhood cancers suspected of being associated with pesticide exposure (Ewing's sarcoma not shown) (Zahm and Ward, 1998).
- From 1973 to 1999, incidence rates of leukemia per 100,000 children aged 0-19 increased from 3.5 to 4.1.
- Rates of brain cancer incidence increased from 1.9 to 2.8.
- Rates of non-Hodgkin's lymphoma remained at about 1.0.
- Rates of Wilms' tumor remained at about 0.6.

Incidence Rates of Childhood Cancer by Type, 1973-1999

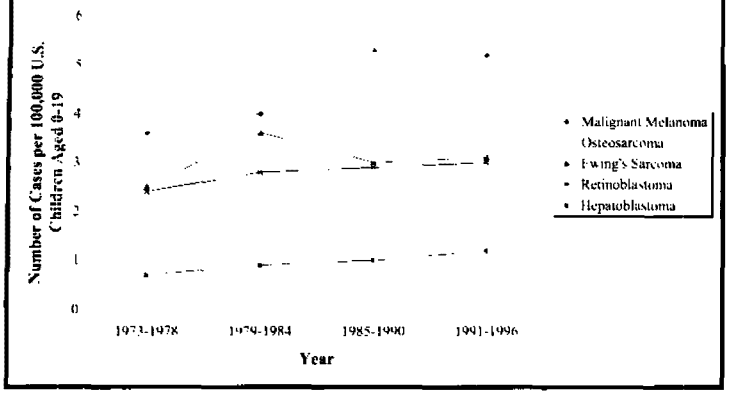


- The following two charts show incidence rates for other childhood cancers (U.S. EPA, 2000).
- From 1973 to 1996, incidence rates of Hodgkin's disease per 100,000 children aged 0-19 decreased from 14 to 12.8.
- Rates of soft tissue sarcomas increased from 10 to 11.
- Rates of germ cell tumors increased from 8.3 to 12.4.
- Rates of neuroblastoma increased from 7.4 to 7.9.
- Rates of thyroid carcinoma increased from 4.8 to 5.2.
- Rates of malignant melanoma increased from 3.6 to 5.2.
- Rates of osteosarcoma increased from 3.9 to 4.9.
- Rates of Ewing's Sarcoma increased from 2.5 to 3.1.
- Rates of retinoblastoma increased from 2.4 to 3.
- Rates of hepatoblastoma increased from 0.7 to 1.2.

Incidence Rates of Childhood Cancer by Type, 1973-1996



Incidence Rates of Childhood Cancer by Type, 1973-1996



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Sources: National Cancer Institute, Surveillance Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002, http://seer.cancer.gov/canques/ (30 January 2003). Hodgkin's disease, soft tissue sarcomas, germ cell tumors, neuroblastoma, thyroid carcinoma, malignant melanoma, osteosarcoma, Ewing's Sarcoma, retinoblastoma, and hepatoblastoma data are from SEER 1973-1996 as reported in "America's Children and the Environment: A First View of Available Measures" (U.S. EPA, 2000).

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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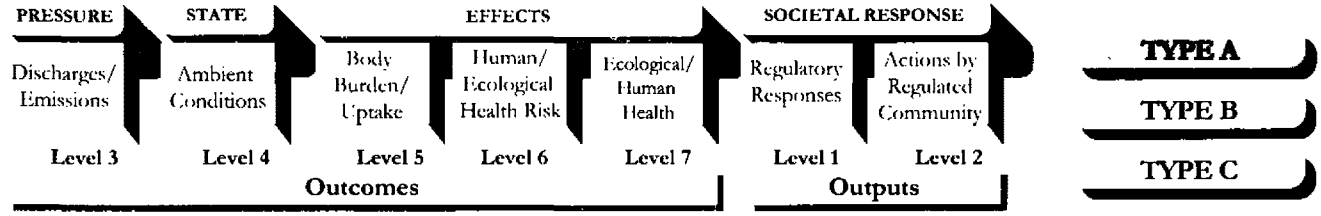
CHILDREN
PATHOLOGIES AND DIRECT HEALTH IMPACTS



Indicator: Incidence of Birth Defects

A birth defect (sometimes called a congenital malformation) is a structural, functional, or chemical abnormality that a child has at birth (March of Dimes, 2002). A birth defect causes physical or mental disability or death. Birth defects are the leading cause of infant deaths in the U.S. Thousands of birth defects have been discovered such as Down syndrome and fetal alcohol syndrome. Approximately 150,000 children (about 1 in 28) are born each year with one or more birth defect (March of Dimes, 2002).

The causes of about 70% of the different types of birth defects are unknown. However, genetic disorders and environmental factors may cause birth defects. The three types of genetic disorders are single gene, chromosomal, and multifactorial (environmental and genetic factors). Single gene disorders are known to cause neurofibromatosis, cystic fibrosis, and hemophilia and chromosomal disorders are known to cause Down syndrome (Florida Birth Defects Registry, 2002). As maternal age increases, the risk of a child having certain chromosomal defects also increases (March of Dimes, 2002).

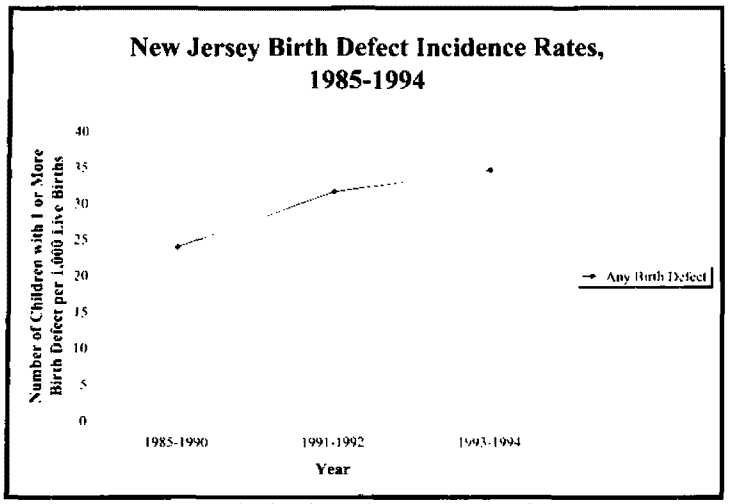
Multifactorial disorders occur when genes interact with environmental factors such as drugs, chemicals, pesticides, prenatal infections, and maternal diseases. It is suspected that many birth defects, such as heart defects, cleft lip and palate, and clubfoot are caused by multifactorial disorders (March of Dimes, 2002).

It is difficult to determine which factor is actually causing the birth defect. Drugs (including alcohol) and chemicals are also associated with birth defects in the absence of genetic disorders. Doses of drugs and chemicals that can be accepted by an adult can cause serious damage to a developing fetus. Prenatal exposure to thalidomide, a drug prescribed to pregnant women as a tranquilizer and to prevent nausea until the 1960s, is known to cause brain, heart, and muskuloskeletal defects. Prenatal exposure to diethylstilbestrol (DES), a synthetic form of estrogen that was used to prevent complications during pregnancy from the 1940s to 1971, is known to cause female reproductive tract and uterus deformities in female babies and associated with underdeveloped or undescended testicles and stunted penises in male babies.

Prenatal exposure to dioxin is associated with brain dysfunction and immune system abnormalities and prenatal exposure to PCBs, DDE (a breakdown product of the pesticide, DDT), and the herbicide 2,4-D are associated with genitourinary and musculoskeletal defects. Environmental factors such as carbon monoxide, ozone as air pollution, some pesticides, and drinking water contaminated with trichloroethylene, trichloroethane, and dichlorethylene are associated with congenital heart defects and diseases. Also, lead, methylmercury, some pesticides, some hazardous wastes, and other environmental factors are associated with structural defects.

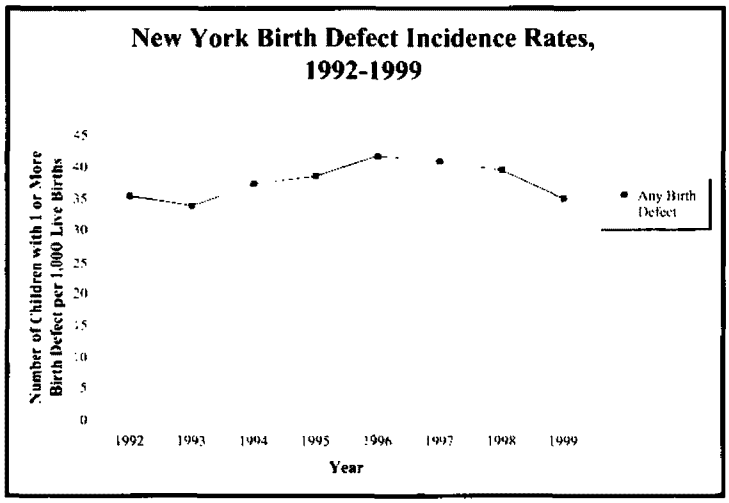
The Centers for Disease Control and Prevention is attempting to meet the need for further birth defects research with the Centers for Birth Defects Research and Prevention (CBDRP) which includes the following seven individual state centers: Arkansas, California, Iowa, Massachusetts, New Jersey, New York, and Texas. The following charts show birth defect incidence data from New York, New Jersey, California, and Iowa. While other states collect birth defect incidence data, these states are represented in this indicator because they have the most historical and accessible data. Efforts to standardize state center collection methods are being made in order to estimate national birth defect incidence data.

- New Jersey birth defect incidence rates per 1,000 live births increased from 23.88 in 1985-1990 to 34.53 in 1993-1994.

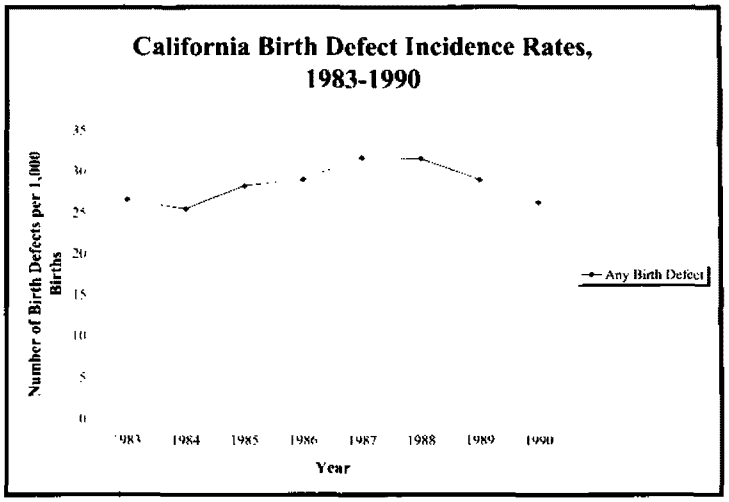


Note: The discontinuity in the above time periods may imply a more rapid increase in incidence rates than the actual increase.

- From 1992 to 1999, New York birth defect incidence rates per 1,000 live births decreased from 35.33 to 34.94.

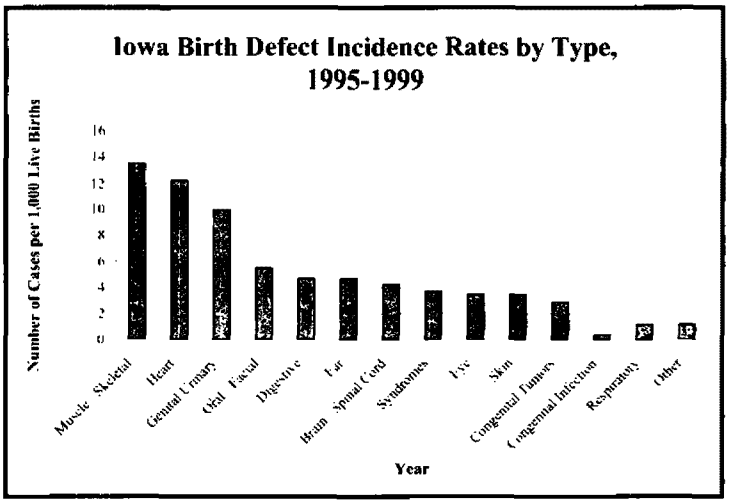


- From 1983 to 1990, California birth defect incidence rates per 1,000 births reached a high of 31.6 in 1987 and a low of 25.4 in 1984. The average rate from 1983 to 1990 is 28.4.

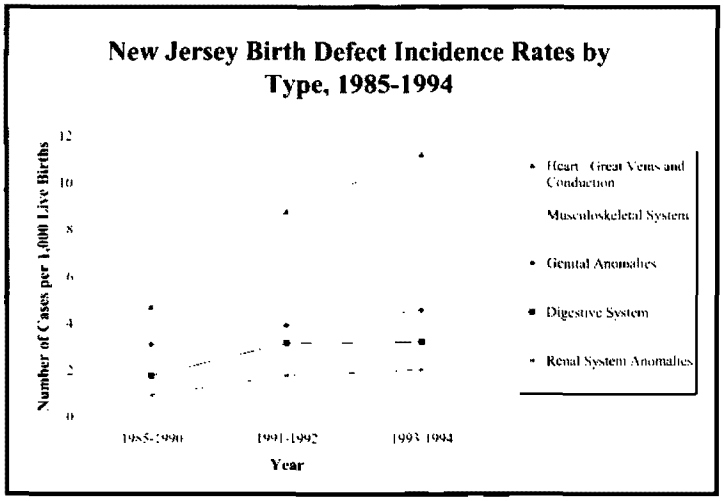


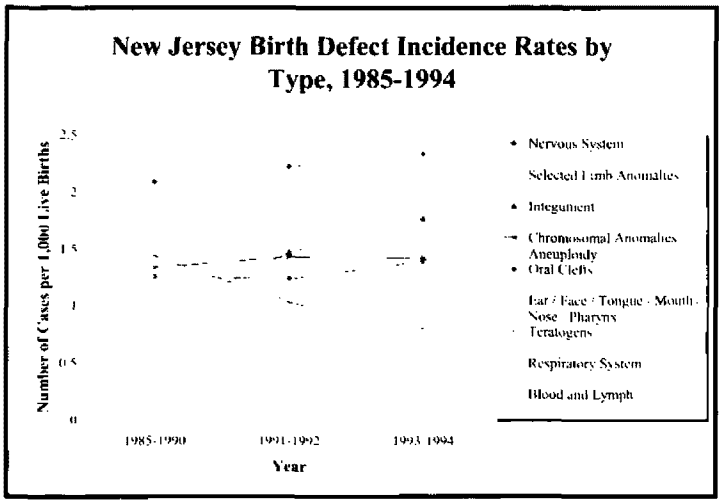
- The following charts show state birth defect incidence data by organ system, by type, by sex, or for the most common or serious defects. The types associated with chemical or pesticide exposure, including heart, musculoskeletal, and genitourinary defects, also have some of the highest incidence rates.

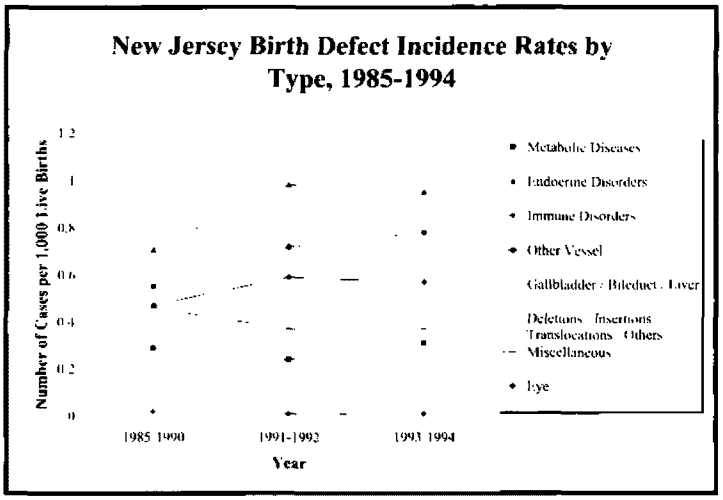
- From 1995 to 1999, Iowa birth defect incidence rates per 1,000 live births were highest for muscle / skeletal, heart, and genital / urinary defects.



- New Jersey data for 23 types of birth defects are grouped on the following three charts by scale. From 1985 to 1994, New Jersey birth defect incidence rates per 1,000 live births were highest for heart / great veins and conduction defects, genital anomalies, and musculoskeletal system defects.



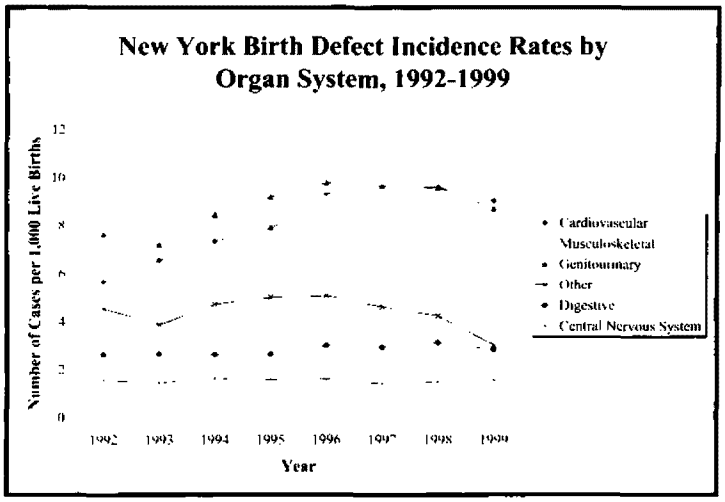


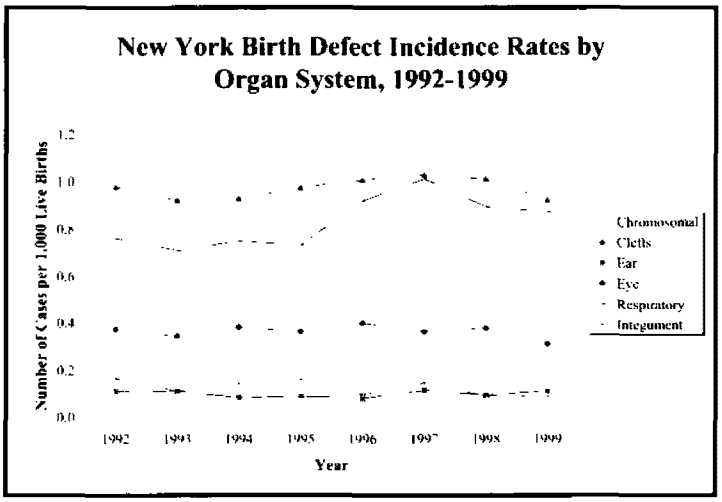


Note: The discontinuity in the above time periods may imply a more rapid increase or decrease in incidence rates than the actual increase or decrease.

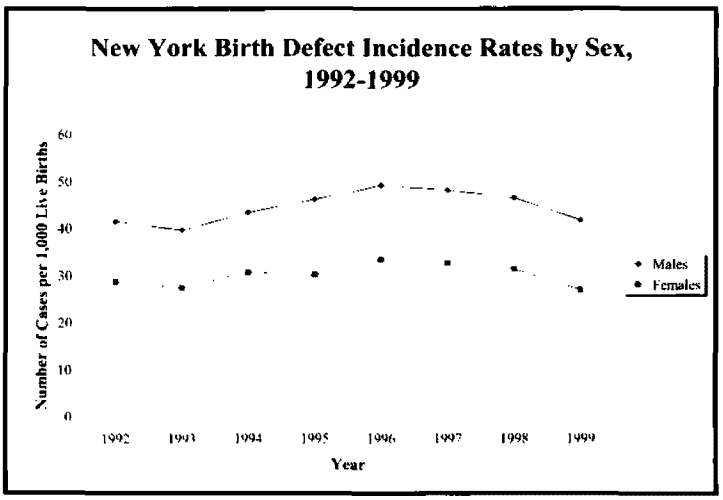
- In New Jersey, the ratio of male to female babies born with a defect is 1.27, while the ratio for the birth population is 1.02. External / internal genital anomalies are the primary source of the gender difference (New Jersey Special Child Health Services Registry, 2002).

- From 1992 to 1999, New York birth defect incidence rates per 1,000 live births were highest for cardiovascular, musculoskeletal, and genitourinary defects.

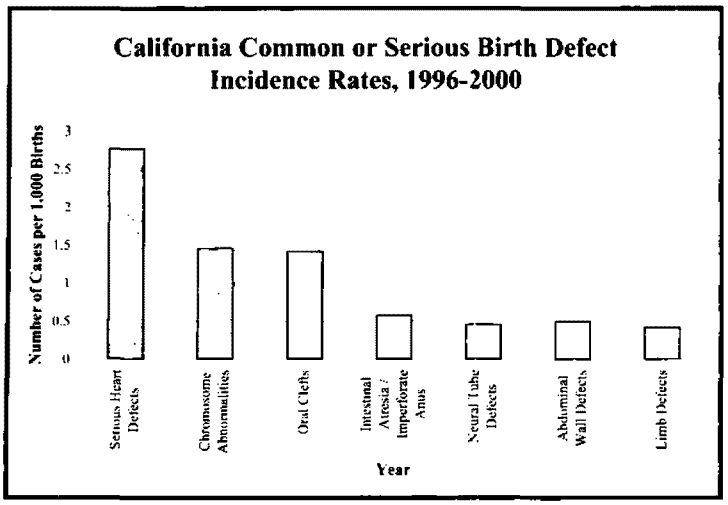




- From 1992-1999, New York birth defect incidence rates per 1,000 live births were highest for males.



- From 1996 to 2000, California birth defect incidence rates per 1,000 births were highest for serious heart defects, chromosome abnormalities, and oral clefts.



- In California, from 1990 to 1992, 26.4 males and 19.0 females per 1,000 live births had one or more malformation.

Sources: Individual state Centers for Birth Defects Research and Prevention (CBDRP) in New Jersey, New York, California, and Iowa. See descriptions in the data characteristics and limitations sections below.

Scale: The presented data is at the state level.

California Birth Defects Monitoring Program Data Characteristics and Limitations: Structural defects occur when a body part is missing or malformed. Metabolic defects often occur when the chemistry of the body is unregulated due to cells producing incorrect protein levels (Iowa Birth Defects Registry, 2002). The California Birth Defects Monitoring Program data includes children born with any of more than two hundred types of structural birth defects that require medical treatment or cause disability (2002). From 1983 to 1990 and from 1996 to 2000, the program included live births and fetal deaths. From 1990 to 1992 it included live births only. In 1990, the registry began publishing data for fewer conditions, primarily those most common and serious and from fewer counties, those most representative of California in terms of demographics and birth defect incidence rates. Data is available online at http://www.cbdmp.org/ (14 January 2003).

Iowa Birth Defects Registry Data Characteristics and Limitations: Iowa has an active surveillance system for collecting birth defects data in which trained personnel review hospital, clinic, and other facility records. Data is available online at http://www.public-health.uiowa.edu/birthdefects (14 January 2003).

New Jersey Special Child Health Services Registry Data Characteristics and Limitations: All health care providers such as hospitals, physicians, and dentists are required to report each live born child with one or more birth defect diagnosed by age one to the registry. However, 10% are registered at age one or older. Imprecise classification of some defects, improved medical technology, and increasing ability to prenatally diagnose birth defects may affect overall and specific birth defect incidence rates. Annual data was aggregated for confidentiality reasons. Data is available online at http://www.state.nj.us/health/fhs/t07.htm (14 January 2003).

New York State Department of Health Congenital Malformations Registry Data Characteristics and Limitations: Hospitals and physicians are required to report cases of birth defects diagnosed in children under two years of age to the registry. The presented data comes from a response to a data request (2002). The registry began collecting data in 1983, however, in 1992, it began matching cases with birth certificates to eliminate duplicate cases reported under different names. Therefore, data prior to 1992 is not comparable to more recent data and is not included in the above charts. Fluctuations in specific birth defect incidence rates may be the result of the small numbers of cases of each birth defect, diagnosing difficulty, and varying hospital and physician ability and interest.

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New Jersey Special Child Health Services Registry. (2002). *Birth years 1985-1994.* 14 January 2003. Available online at: http://www.state.nj.us/health/fhs/t07.htm.

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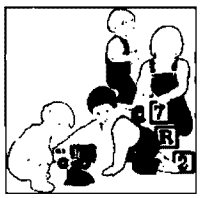
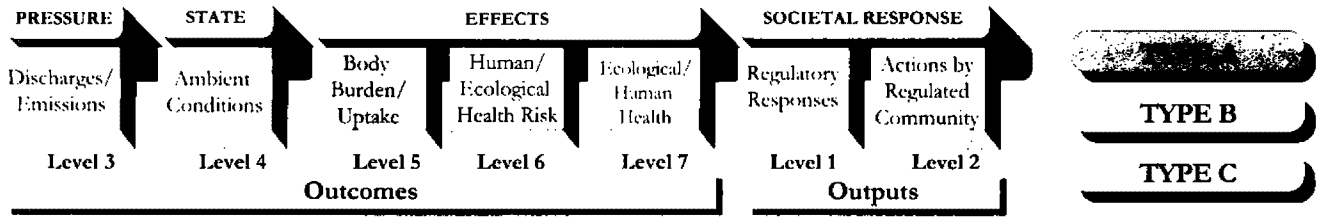


CHILDREN
PATHOLOGIES AND DIRECT HEALTH IMPACTS



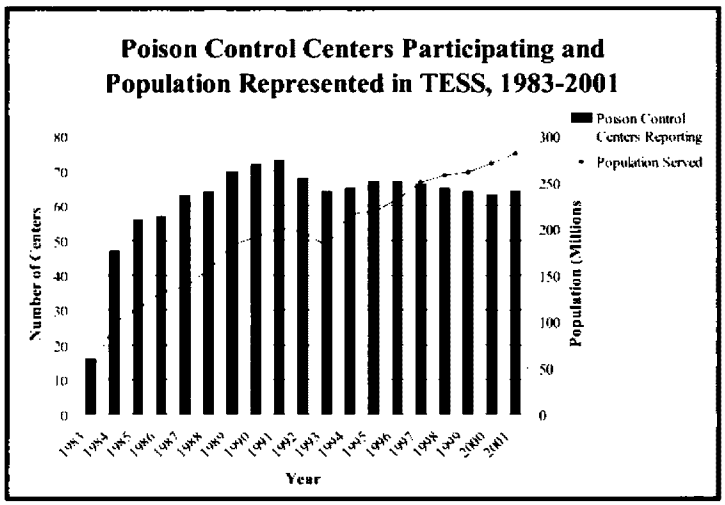
Indicator: Number of Fatal and Non-Fatal Child Poisonings due to Pesticide Exposure

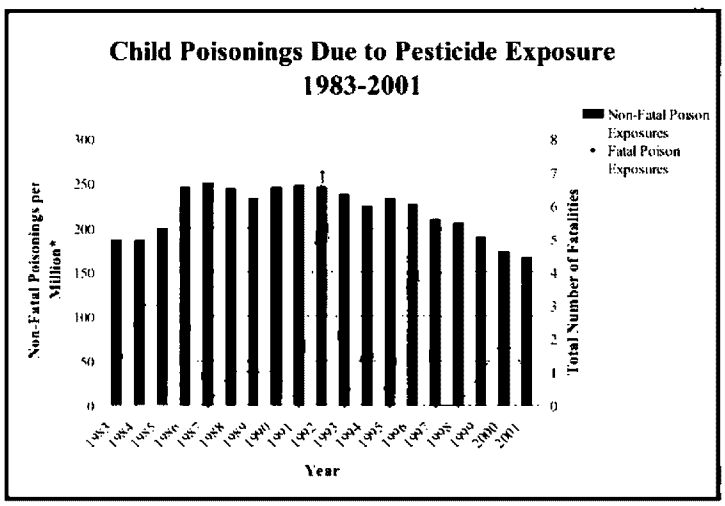
The American Association of Poison Control Centers (AAPCC) administers the Toxic Exposure Surveillance System (TESS), the only comprehensive poisoning surveillance database in the United States. TESS is a cumulative database, with data dating back to its inception in 1983, of poison exposure cases. These cases are poison exposures reported by telephone to one of the AAPCC's regional poison control centers.

For each reported exposure, the gender, age and location of each caller is recorded. The locational site of exposure, substance(s) involved, reason for and route of exposure are also recorded for each case. To complete the profile of the poison exposure case, the medical outcome and intervention (type of decontamination and/or therapy) are also documented.

The chart displays non-fatal child poisonings due to pesticide exposure per million population and total fatalities for the years 1983-2001.

- The number of non-fatal child poisonings due to pesticide exposure exhibits annual fluctuations, but has increased overall since 1983.
- The total number of child fatalities due to pesticide exposure has remained below 8 deaths per year since 1983.





*Per million people in the population serviced by participating poison control centers

Source: Annual Report of the AAPCC TESS published in the American Journal of Emergency Medicine, 1984-2002.

Scale: Data are available on a national level. States are not comparable due to variations in Poison Control Center participation.

Data Characteristics and Limitations: The cumulative AAPCC database contains 27 million human poison exposure cases for the reporting years 1983-2001. Each year, the AAPCC publishes an annual report of select releases of TESS data in the September issue of the American Journal of Emergency Medicine. Since 1983, TESS has grown dramatically, with increases in the number of participating poison centers and population served by those centers (refer to chart below).

Annual changes in the number of human poison exposure cases may reflect changes in participation and reporting of cases may not be accurate due to self-reporting. Chemicals may not be the cause of all poisonings because the sources of exposures were not verified.

To control for the increase in annual reporting, the reported indicator is the number of child poisoning cases due to pesticide exposure per million people in the serviced population.

The following TESS categories of products are reflected in the number of pesticide exposures in the indicator data series: fungicides, herbicides, insecticides/pesticides, moth repellents, and rodenticides.

A noteworthy limitation of the TESS data is that diagnoses are not established, except in cases of known ingestion. The health effects associated with the poison exposure are reported and not proven through thorough investigation (Wagner).

References

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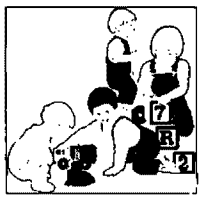
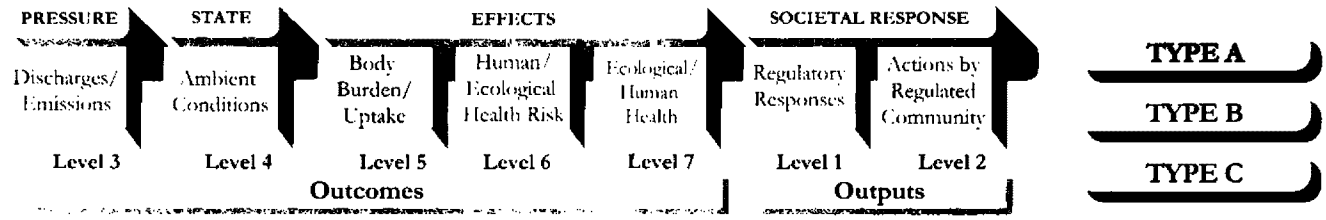
Telephone conversation with Dr. Sheldon Wagner, Clinical Toxicologist, Department of Environmental and Molecular Toxicology, Oregon State University

U.S. Environmental Protection Agency, Office of Pesticide Programs., *Protecting Children from Pesticides*. 27 January 2003. Available online at: http://www.epa.gov/pesticides/citizens/kidpesticide.htm



CHILDREN
PATHOLOGIES AND DIRECT HEALTH IMPACTS



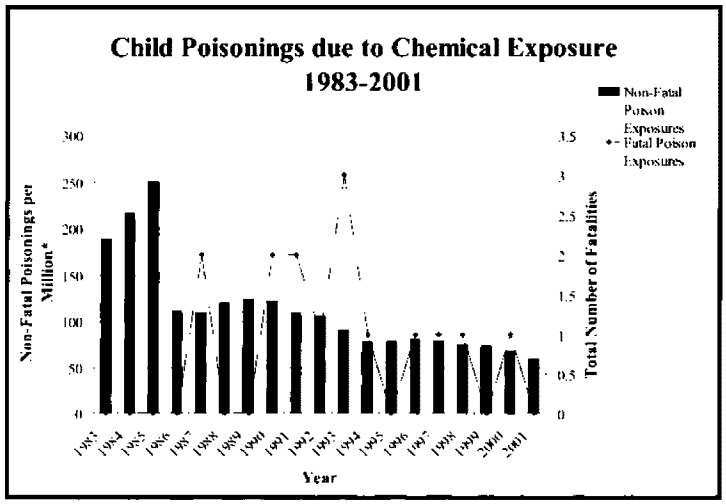
Indicator: Number of Fatal and Non-Fatal Child Poisonings due to Chemical Exposure

The American Association of Poison Control Centers (AAPCC) administers the Toxic Exposure Surveillance System (TESS), the only comprehensive poisoning surveillance database in the United States. TESS is a cumulative database, with data dating back to its inception in 1983, of poison exposure cases. These cases are poison exposures reported by telephone to one of the AAPCC's regional poison control centers.

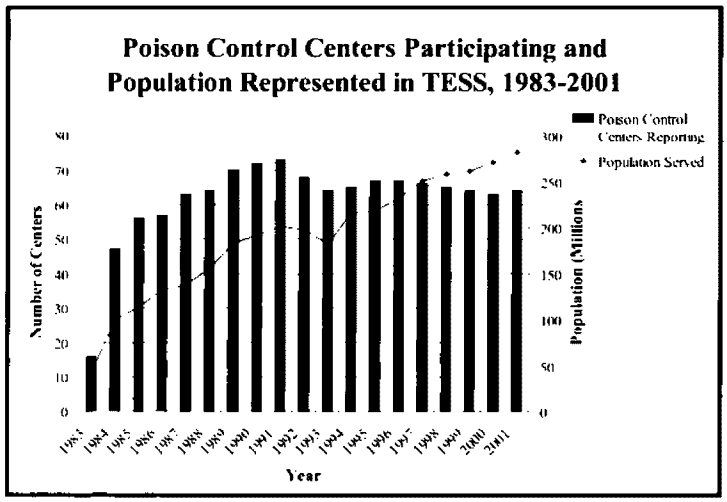
For each reported exposure, the gender, age and location of each caller is recorded. The locational site of exposure, substance(s) involved, reason for and route of exposure are also recorded for each case. To complete the profile of the poison exposure case, the medical outcome and intervention (type of decontamination and/or therapy) are also documented.

The chart displays non-fatal child poisonings due to chemcial exposure per million population and total fatalities for the years 1983-2001.

- The number of non-fatal child poisonings due to chemical exposure has decreased considerably, from 188 to 59 poisonings per million population from 1983 to 2001.
- The total number of child fatalities due to chemical exposure has remained below 4 deaths per year since 1983.



* Per million people in the population serviced by participating poison control centers.



Source: Annual Report of the AAPCC TESS published in the American Journal of Emergency Medicine, 1984-2002

Scale: Data are available on the national level. States are not comparable due to variations in Poison Control Center participation.

Data Characteristics and Limitations: The cumulative AAPCC database contains 27 million human poison exposure cases for the reporting years 1983-2001. Each year, the AAPCC publishes an annual report of select releases of TESS data in the September issue of the American Journal of Emergency Medicine. Since 1983, TESS has grown dramatically, with increases in the number of participating poison centers and population served by those centers (refer to chart below).

Annual changes in the number of human poison exposure cases may reflect changes in participation and reporting of cases may not be accurate due to self-reporting. Chemicals may not be the cause of all poisonings because the sources of exposures were not verified.

To control for the increase in annual reporting, the reported indicator is the number of child poisoning cases due to chemical exposure per million people in the serviced population.

The following TESS categories of products are reflected in the number of pesticide exposures in the indicator data series: chemicals and heavy metals.

A noteworthy limitation of the TESS data is that diagnoses are not established, except in cases of known ingestion. The health effects associated with the poison exposure are reported and not proven through thorough investigation (Wagner).

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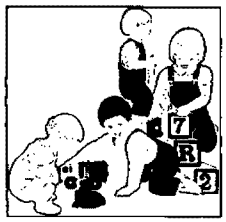
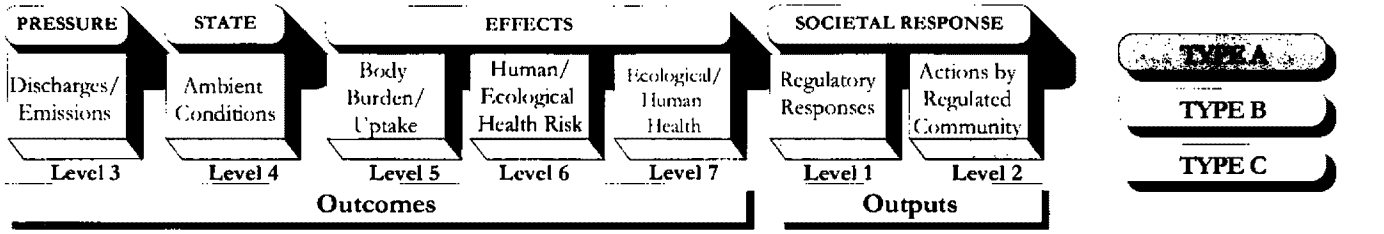
Telephone conversation with Dr. Sheldon Wagner, Clinical Toxicologist, Department of Environmental and Molecular Toxicology, Oregon State University



CHILDREN
HEALTH RISK



Indicator: Children's Chronic Health Risk Index From Toxic Releases

With respect to exposure to toxic chemicals and pesticides, children represent a population of special concern. Their pattern of growth and development, their small size, their unique pathways of exposure, and their diet make children vulnerable to toxic exposure and its effects. Hand-to-mouth activity, and frequent and prolonged mouthing and teething on objects put children at heightened risk of toxic exposure. Children also require greater amounts of food, in proportion to their body weight, than do adults. While a diet rich in fruit and vegetable products provides children with necessary nutrients, it also increases the potential for exposure to pesticide residues. Children can exhibit adverse physical effects at much lower levels of toxic exposure than do adults. During the developmental stage, from the peri-natal period to two years of age, children are especially sensitive to toxic exposures; exposures during this phase in life can interfere with development and may result in permanent physical or mental damage.

The ideal measurement of children's health impacts of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by the volume of releases of a specific chemical or set of chemicals or by the volume of managed waste. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators (RSEI). RSEI expand the application of the TRI by incorporating data that, for each chemical: reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the chronic human health risk posed by a toxic chemical release or waste stream can be estimated.

The analysis available through RSEI produces an unanchored or unit-less measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the chronic health risk measures were adjusted to create a chronic health risk index. It is conventional to present unit-less data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the chronic health risk estimate for the baseline year was adjusted to equal a value of 100; subsequent estimates less than or greater than 100 indicate a decrease or increase in the chronic health risk posed by toxic chemical releases and wastes, respectively. In a broad sense, this indicator reflects whether human populations in the U. S. are at a higher or lower risk of adverse health effects from environmental toxics than they were in previous years.

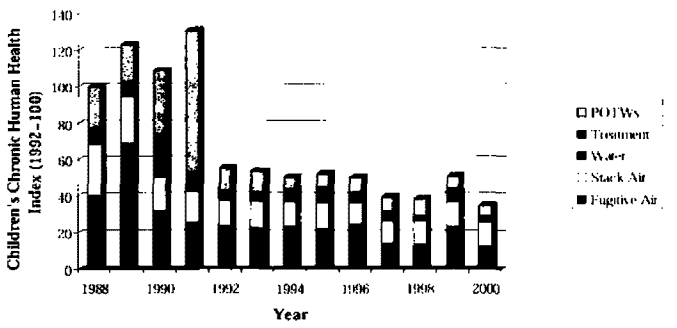
Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total health risk of the entire population. It can be inferred, however, as a measure of the relative gains the U.S. is making in reducing the chronic health risk posed by toxic chemicals. There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much

more complete and accurate reflection of the scope and impact of toxic releases into the environment and managed wastes.

Two different subsets of TRI data are reflected in the following charts. The first chart reflects data for a core list of chemicals that were reported every year from 1988 to 1999. The second chart reflects data for an enhanced list of chemicals that have been reported every year from 1995 to 1999.

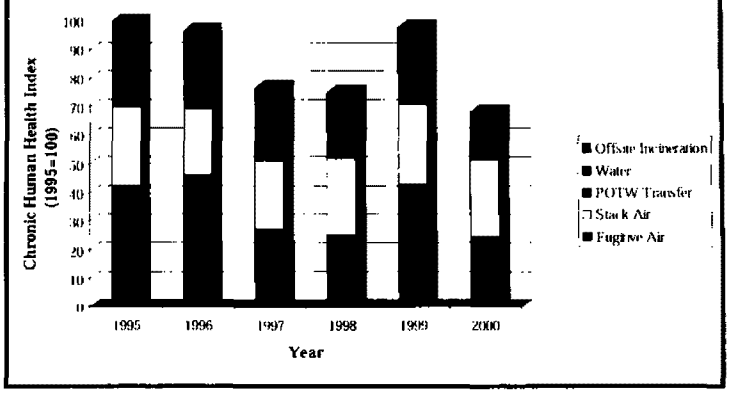
- The first chart shows that the chronic children's (ages 17 and under) health risk index for the core chemicals list decreased from 100 to 49 points from 1988 to 1999.
- The second chart shows that the chronic children's health risk index for the enhanced chemicals list decreased from 100 to 88 points from 1995 to 1999.
- Releases to air, transfers to wastewater treatment facilities (publicly owned treatment works (POTWs)), and releases to water account for most of the chronic children's health risk index (for both the core and enhanced chemicals lists).
- The chronic children's health risk posed by off-site incineration composes a small portion of the index (for both the core and enhanced chemicals lists).

Children's Chronic Human Health Index for Releases and Managed Waste (Core Chemicals List), 1988-2000



Note: The large risk in 1991 is likely due to a release of 144,000 pounds of Nickel to a wastewater treatment facility in Los Angeles, which resulted in drinking water exposure to 3.9 million people.

Children's Chronic Human Health Index (Enhanced Chemicals List), 1995-2000



Source: Risk Screening Environmental Indicators, Custom computer queries of national, January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expand the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection.

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: off-site incineration, off site landfill, POTW (publicly owned treatment works) transfers, direct water releases, stack air releases and fugitive air releases. Releases to land, underground injection, disposal, recycling, energy recovery and treatment operations are estimated to pose very small risks (i.e., an index score less than 1), such that they would not be visible in graphic representation. Therefore, they are not included in this indicator.

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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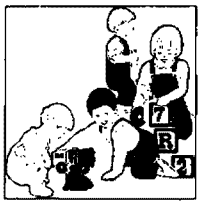
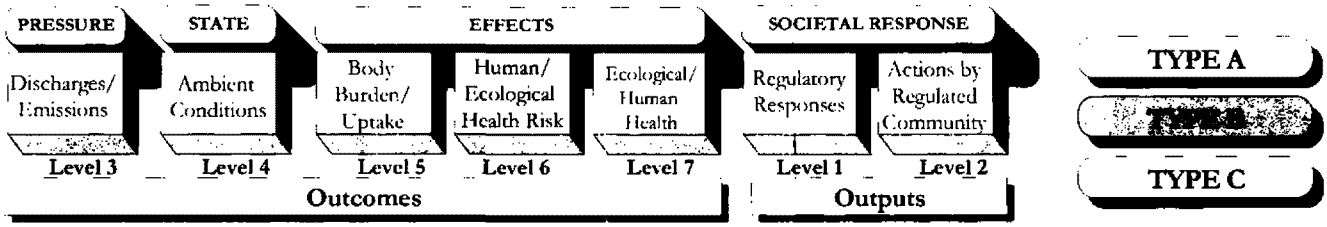
(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators may be viewed or downloaded at http://www.epa.gov/opptintr/env_ind/. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov).



CHILDREN
HEALTH RISK



Indicator: Children's Acute Health Risk Index from Toxic Releases

With respect to exposure to toxic chemicals and pesticides, children represent a population of special concern. Their pattern of growth and developments, their small size, their unique pathways of exposure, and their diet make children vulnerable to toxic exposure and its effects. Hand-to-mouth activity, and frequent and prolonged mouthing and teething on objects put children at heightened risk of toxic exposure. Children also require greater amounts of food, in proportion to their body weight, than do adults. While a diet rich in fruit and vegetable products provides children with necessary nutrients, it also increases the potential for exposure to pesticide residues. Children can exhibit adverse physical effects at much lower levels of toxic exposure than do adults. During the developmental stage from the peri-natal period to two years of age, children are especially sensitive to toxic exposures; exposures during this phase in life can interfere with development and may result in permanent physical or mental damage.

The ideal measurement of the children's health impact of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The Toxics Release Inventory (TRI) is a database of reported toxic chemical releases into the environment. TRI data are commonly used as a measure of toxic exposure. TRI data are normally reported by volume of release of a specific chemical. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of health risk posed by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators.

The Risk Screening Environmental Indicators represent an analytical expansion of TRI by incorporating data that, for each chemical: reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the human health risk posed by a toxic chemical release can be estimated.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unitless measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the health risk measures would be adjusted to create a health risk index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the children's acute health risk estimate for the baseline year would be adjusted to equal a value of 100; subsequent estimates less than or greater than 100 would indicate a decrease or increase in the children's health risk posed by toxic chemical releases, respectively. In a broad sense, this indicator would reflect whether children in the U.S. are at a higher or lower risk of adverse health effects from environmental toxics than they were in previous years.

Currently, the Risk Screening Environmental Indicators can produce estimates for only chronic (long-term) health risk. Next on the research schedule is the development of a methodology for estimating acute (short-term) health risk. Current expectations are that an acute health risk model will be available within two years. When an acute health risk model is functional, children's acute environmental health risk can be estimated by running the model for the population under 18 years of age.

Since TRI includes only a subset of chemicals to which people are exposed, this indicator would not be a complete measure of the total acute health risk of the population under 18 years of age. It may be inferred, however, as a measure of the relative gains the U.S. is making in reducing the acute health risk to children posed by toxic chemicals.

There are, however, efforts to move the TRI toward comprehensive coverage. This past year, the TRI was expanded to include the reporting of releases from seven new economic sectors – electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. By the time this prospective indicator is available, the expanded reporting will provide a more complete and accurate reflection of the scope and impact of chemical releases to the environment.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and cannot reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) represent an attempt to capitalize on the extensive chemical inventory that constitutes TRI and to introduce flexibility and manipulability of the inventory by introducing new data elements. These new data elements allow estimations of toxicity, fate, and size and distribution of the receptor population for a toxic chemical release. The RSEI model integrates estimated toxicity scores for individual chemicals and chemical categories with a measure of exposure potential based upon reported multi-media release and transfer data and the size of the potentially exposed general population. The result is a screening level, risk-related perspective for relative comparisons of chemical releases. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk related targeting, and community-based environmental protection

The data elements that will be used to construct this indicator are:

- Air Releases
  - Fugitive Air Releases
  - Stack Air
- Water Releases
  - Direct water
  - POTW Transfers
- Land Releases
  - Onsite Landfill
  - Land Treatment/Application/Farming
  - Surface Impoundment
  - Other Land Disposal
  - Other Landfills

Underground injection treatment was not included among the releases to land due to the very small health risk posed by injection.

Scale: Data are available at the national, state, and facility levels. Data are comparable across states.

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

References

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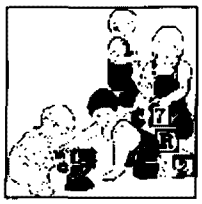
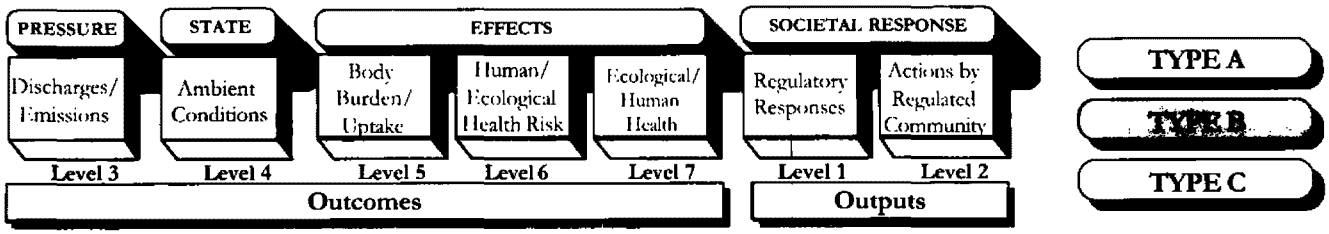


CHILDREN HEALTH RISK



Indicator: Pesticide Residue Levels of Carcinogenic and Cholinesterase Inhibiting Neurotoxic Pesticides on Foods Commonly Eaten by Children

With respect to exposure to toxic chemicals and pesticides, children represent a population of special concern. Their pattern of growth and developments, their small size, their unique pathways of exposure, and their diet make children vulnerable to toxic exposure and its effects. Hand-to-mouth activity, and frequent and prolonged mouthing and teething on objects put children at heightened risk of toxic exposure. Children also require greater amounts of food, in proportion to their body weight, than do adults. While a diet rich in fruit and vegetable products provides children with necessary nutrients, it also increases the potential for exposure to pesticide residues. Children can exhibit adverse physical effects at much lower levels of toxic exposure than do adults. During the developmental stage from the peri-natal period to two years of age, children are especially sensitive to toxic exposures; exposures during this phase in life can interfere with development and may result in permanent physical or mental damage.

Among these factors diet has a particular significance. The Office of Prevention, Pesticides, and Toxic Substances (OPPTS) has begun work on an indicator to pesticide tolerance levels for two types chemicals that have high relevance for children – carcinogens and cholinesterase inhibitors.

Carcinogens. For carcinogens (chemicals potentially capable of causing cancers), OPPTS is using the Pesticide Data Program (PDP) to establish a baseline for an indicator measuring the incidence of residue tolerances of 14 suspected pesticides being exceeded. Those pesticides include:

Captan
Chlordane cis
Chlordane trans
Chlorothalonil
DDD (TDE)
DDE
DDT
Dieldrin
Diuron
Ethoprop
Hexachlorobenzene
Iprodione
Lindane
Propargite

OPPTS is using data from 19 foods to form the baseline. They are: apples, apple juice, bananas, broccoli, carrots, celery, grapes, green beans (fresh, canned, and frozen), lettuce, milk, oranges, peaches, potatoes, spinach, sweet corn (canned and frozen), sweet potatoes, tomatoes, and wheat. The years of 1994, 1995, and 1996 are being used to set the baseline.

Preliminary analysis shows that out of 19,762 samples that were analyzed for one or more of the potential carcinogens, 5,019, or 25.4%), had detectable residues of one or more chemicals.

OPPTS also utilized the Food and Drug Administration (FDA) Total Diet Study. Using a similar and slightly expanded set of potential carcinogenic pesticides residue data from 1995 relating to 261 food types. Out of 783 total samples analyzed, 252, or 32%, had detectable levels.

Cholinesterase Inhibitors. Cholinesterase is an enzyme required for the proper nervous system functioning of people, other vertebrates, and insects. There are certain types of chemicals, generally known, as cholinesterase inhibitors, that interfere with action of cholinesterase. Among those chemicals are classes of pesticides known as organophosphates (OPs) and carbamates (CMs). Ingestion, inhalation, eye, or dermal contact can lead to a variety of symptoms. In severe cases symptoms could include: abdominal cramps, urinating, diarrhea, muscular tremors, staggering gait, pinpoint pupils, hypotension, show heartbeat, breathing difficulty, and death.

OPPTS is using the same two data sets to analyze cholinesterase inhibiting chemical residues.

Using the USDA Pesticide Data Program data, analysis was conducted of the same 19 foods as before using organophosphate and carbamate pesticides. Of the 20,742 food samples analyzed:

- 6,943 samples (33.5%) had detectable levels of at least one cholinesterase inhibiting chemical,
- 5,178 samples (25%) had a least one detectable organophosphorus residue, and
- 2511 samples (12%) had at least one detectable carbamate residue.

Using the FDA Total Diet Study:

- 45% of the items had at least one detectable organophosphorus or carbamate residue,
- 39% of the items had a least one detectable organophosphorus residue, and
- 10% of the items had a least one detectable carbamate residue.

OPPTS is presently working to collect future data points for both data sets for both carcinogens and cholinesterase inhibitors.

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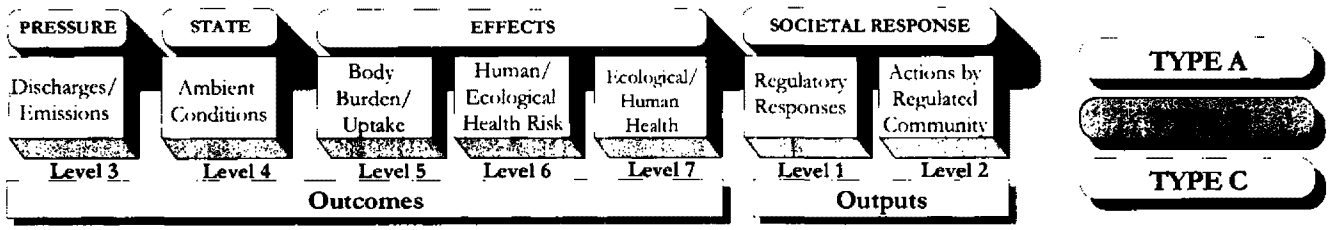
CHILDREN
BODY BURDEN



Indicator: Body Burden of Toxic Substances in Children

With respect to exposure to toxic chemicals and pesticides, children represent a population of special concern. Their pattern of growth and developments, their small size, their unique pathways of exposure, and their diet make children vulnerable to toxic exposure and its effects. Hand-to-mouth activity, and frequent and prolonged mouthing and teething on objects put children at heightened risk of toxic exposure. Children also require greater amounts of food, in proportion to their body weight, than do adults. While a diet rich in fruit and vegetable products provides children with necessary nutrients, it also increases the potential for exposure to pesticide residues. Children can exhibit adverse physical effects at much lower levels of toxic exposure than do adults. During the developmental stage from the peri-natal period to two years of age, children are especially sensitive to toxic exposures; exposures during this phase in life can interfere with development and may result in permanent physical or mental damage.

The ideal measurement of the children's health impact of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment

The Second National Report on Human Exposure to Environmental Chemicals (2003) will provide an ongoing assessment of the U.S. population's exposure to environmental chemicals using biomonitoring. The Report provides exposure information for people participating in the Centers for Disease Control and Prevention's (CDC's), National Health and Nutrition Examination Survey (NHANES) for 1999-2000. This data will establish the baseline for these chemical levels in future years and future data will also be released in two-year groups. The Report presents levels of 116 environmental chemicals measured in the U.S. population.

The Report provides reference range values for physicians and health researchers but separate research from the report is required to determine which blood or urine levels are safe and which levels cause disease. This information is available for chemicals such as lead where studies have provided a good understanding of the health risks resulting from different blood levels.

The 116 chemicals included in the Report belong to one of the following chemical groups:

- metals
- polycyclic aromatic hydrocarbons
- tobacco smoke
- phthalates
- polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls
- polychlorinated biphenyls
- phytoestrogens
- organophosphate pesticides
- organochlorine pesticides
- carbamate pesticides
- herbicides
- pest repellents and disinfectants

In the future, the Report will provide more detailed assessments of exposure levels among different population groups defined by age, gender, race/ethnicity, income, urban/rural residence and other characteristics.

Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

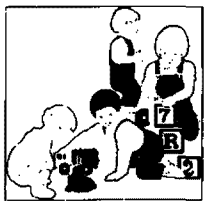
Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.

It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

Reference

Centers for Disease Control and Prevention. (2003). *Second National Report on Human Exposure to Environmental Chemicals*. 4 March 2003. Available online at: http://www.cdc.gov/exposurereport/



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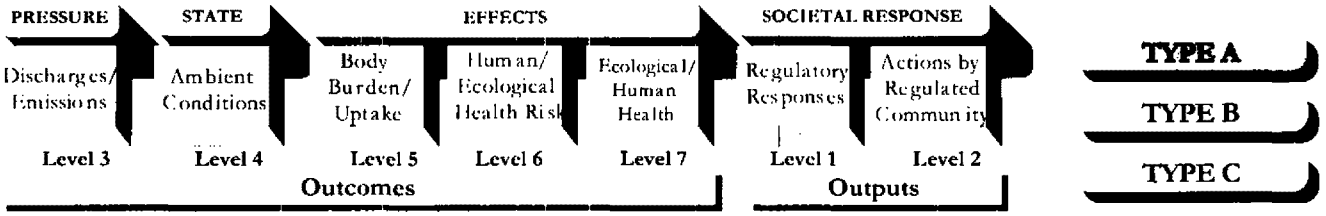
BODY BURDEN



Indicator: Blood Lead Levels in Children

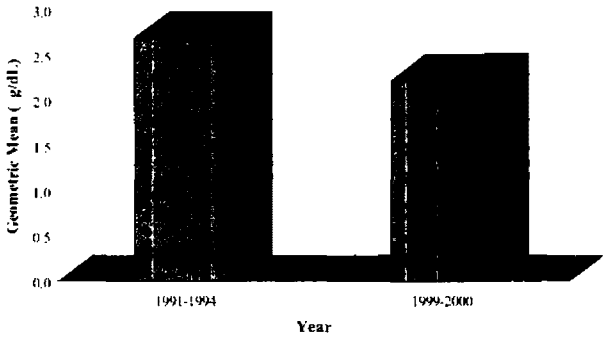
Lead exposure can cause a variety of adverse effects to a child's nervous system including: mental retardation, reading disabilities, and speech or hearing impairment (CDC 1997). Children under six years of age are especially sensitive to the toxic effects of lead, since children absorb and retain more lead in proportion to their body weight than do adults. Moreover, children's nervous systems are still developing and are more vulnerable to the effects of neurotoxic substances. Children are exposed to lead primarily through lead-based paint and contaminated soil and water.

The Centers for Disease Control (CDC) has defined an elevated blood lead level for children 1-5 years as 10 micrograms per deciliter (g/dL). However, studies suggest harmful effects of lead can occur at even lower levels (Schwartz 1994). The CDC regularly measures blood lead levels (BLLs) in children through the National Health and Nutrition Examination Survey (NHANES). The NHANES is administered to a statistical sample of children in the U.S.; its results are taken to be reliable estimates of the BLLs of all children in the U.S.

The following chart shows that average BLLs in children aged 1-5 years decreased from 2.7 g/dL for 1991-1994 to 2.2 g/dL for 1999-2000. Other important findings from NHANES studies not seen in the chart include:

- Between the late 1970's and early 1990's, average BLLs in children decreased approximately 80%. This dramatic decline was primarily from the phase-out of leaded gasoline, and resulting decline in lead emissions (CDC 1997).
- Elevated BLLs remain common among low-income children, urban children, and those living in older housing (Pirkle 1994).
- According to NHANES III data, 16.4% of poor children living in older housing had BLLs 10 g/dL or higher.

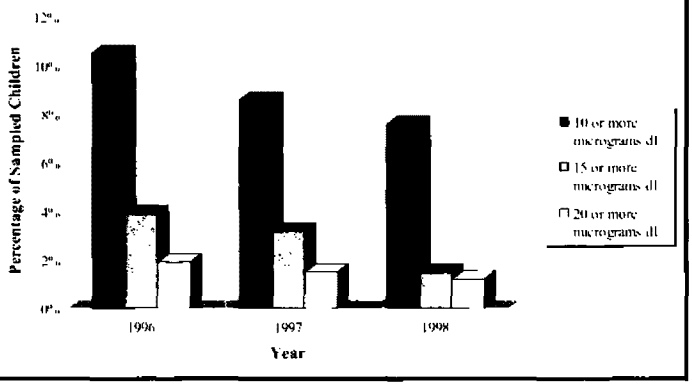
Blood Lead Levels of Children Aged 1-5 Years, 1991-1999



To provide more information about elevated BLL risks in specific subgroups and geographic areas, the CDC also measures progress at the state and local level. This is accomplished through a program known as, the Childhood Blood Lead Surveillance (CBLS), which summarizing data from state surveillance programs. The following chart provides a summary of data collected from 1996 to 1998.

- The number of children with BLLs 10 g/dL, decreased by 28%.
- The number of children with BLLs 15 and 20 g/dL also decreased by 62% and 37%, respectively.

Blood Lead Levels in Children Aged 1-5 Years, 1996-1998 for Selected States



Notes: g/dL micrograms per deciliter of blood

Sources for 1996-1998 Data: NHANES III, Phase 2; NHANES 1999, CBLS 1996-1998 as reported in the CDC MMWR (2000).

Source for 1999-2000 Data: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http: www.cdc.gov/exposurereport/ (4 March 2003).

Source for 1991-1994 Data: The NHANES as reported by Pirkle, J.L., Kaufmann, R.B., Brody, D.J., Hickman, T., Gunter, E.W., & Paschal, D.C. (1998, November). Exposure of the U.S. population to lead, 1991-1994. Environmental Health Perspectives, 106(11), 745-750.

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

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It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

References

Centers for Disease Control and Prevention. 2003. *Second National Report on Human Exposure to Environmental Chemicals*. 4 March 2003. Available online at: http://www.cdc.gov/exposurereport/

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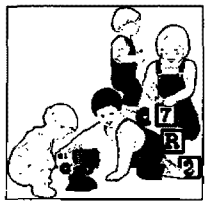
Pirkle, J.L., D.J. Brody, E.W. Gunter et al. 1994. "The Decline in Blood Lead Levels in the United States: The National Health and Nutrition Examination Surveys (NHANES). Journal of the American Medical Association. July 27, 1994; 272(4): 284-291.

Schwartz, J. 1994. "Low-level lead exposure and children's IQ: a meta-analysis and search for a threshold". Environment, Volume 65, p. 42-55.



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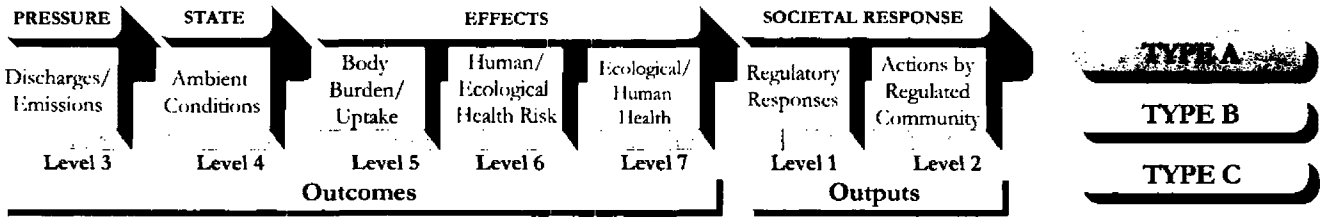

Indicator: Blood Mercury Levels in Children

Mercury exposures to very young children are of great concern because they are more sensitive to mercury than adults. Children poisoned by mercury may develop problems of their nervous and digestive systems and kidney damage. Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Children may also be exposed to mercury as nursing infants through their mother's breast milk.

Due to the adverse human health affects associated with mercury it is important to monitor mercury levels. This indicator was developed to track blood mercury levels for children selected to represent the general U.S. population ages 1 through 5 years using the Second National Report on Human Exposure to Environmental Chemicals conducted by the Centers for Disease Control and Prevention (CDC) (2003). The Report will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals. This data will establish the baseline for blood mercury levels in children in future years and future data will also be released in two-year groups. Data from the 2003 Report showed that:

- the geometric mean for total blood mercury concentration in children was 0.34 µg/L and
- mercury levels in young children are generally below those considered hazardous.

Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

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References

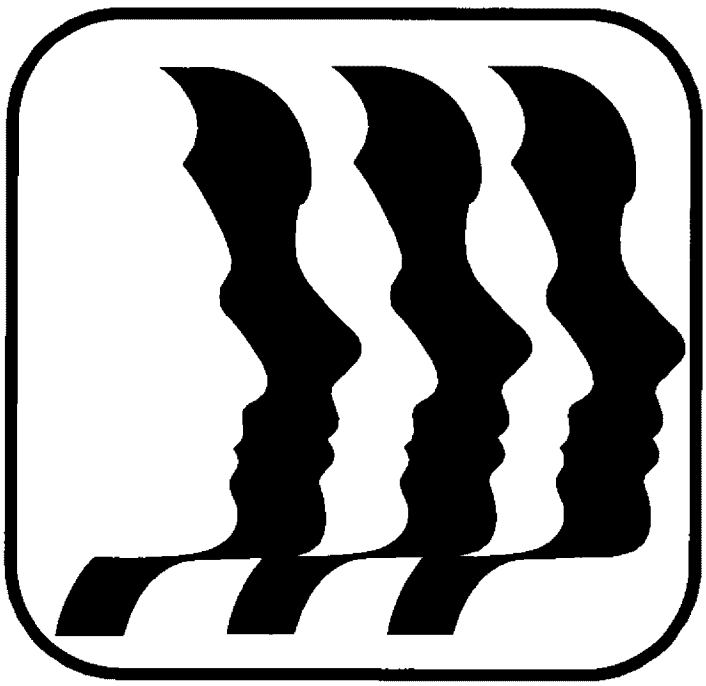
Centers for Disease Control and Prevention. (2003). *Second National Report on Human Exposure to Environmental Chemicals*. 4 March 2003. Available online at: http://www.cdc.gov/exposurereport/

Centers for Disease Control and Prevention. 2001. "Blood and Hair Mercury Levels in Young Children and Women of Childbearing Age – U.S., 1999" *Morbidity and Mortality Weekly Report*. 8 January 2003. Available online at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5008a2.htm

U.S. Department of Health and Human Services (HHS), Agency for Toxic Substances and Disease Registry. 1999. *ToxFAQs: Mercury*. 8 January 2003. Available online at: http://www.atsdr.cdc.gov/tfacts46.html

Special Population Issue 2:

Enviromental Justice



List of Indicators

Incidence of Asthma By Race

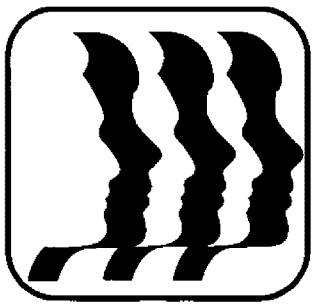
Comparative Chronic Health Risk Index for Toxic Releases by Race and Income

Body Burden of Toxic Substances by Race and Income

Blood Lead Levels in People Ages 1 and Older by Race

SPECIAL POPULATIONS ISSUE 2:

ENVIRONMENTAL JUSTICE



Overview

An issue of increasing international and national importance is environmental justice. One of the key components of the concept of sustainability is that all people are treated fairly with regard to the distribution of the benefits and costs of society. There is a growing concern that the distribution of negative environmental impacts are not proportionately borne across the U.S society and the world, such that certain ethnic, age, gender, and income groups disproportionately bear those impacts. Despite its importance, however, the development of indicators and indicator systems to measure impacts has not occurred to any significant degree. The lack of appropriate environmental data that can be effectively overlaid with social, ethnic, economic, and cultural data, is a major limiting factor. Further, the issue can be politically volatile, with cultural and methodological sensitivities that must be taken into account.

At the conclusion of CAPRM I, a review was conducted concerning areas of growth for the project. One of the suggested areas was environmental justice. The importance of the issue, and the relative scarcity of indicator work, identified it as an issue area ripe for investigation. The development of environmental justice indicators, however, is a difficult undertaking, requiring careful methodological work and attention to political sensitivities. CAPRM II staff decided not to attempt to develop a full system of indicators, but instead, to identify data sets relating to chemicals and pesticides that can be used to prepare sample indicators. The indicators in CAPRM may serve as a starting point for a larger effort to develop a full system of environmental justice indicators; and as models for local programs to develop their own indicators.

Project Purpose

The purpose of the Environmental Justice issue of CAPRM is to advance environmental indicator development for an issue of major policy and program importance. The indicators were not developed for use as a recommended set, but as a demonstration of how data can be used to construct environmental justice indicators. The mission of this part of CAPRM II is to:

1. Review current research associated with environmental justice in the context of chemicals and pesticides;

2. Survey existing environmental indicator activities associated with environmental justice;

3. Identify the types of environmental justice issues relating to chemicals and pesticides that need to be addressed;

4. Identify data sets that can be used at the national level to develop environmental indicators for these issues; and

5. Develop national level sample indicators to show how the data sets can be used.

Full achievement of these objectives was not possible. Unfortunately, several data sources that had been expected to be available were not accessible at publication and, consequently, several important series of indicators dealing with health risk and body burden could not be produced. These indicators represented the focal point of the project's expectations for environmental justice, and their loss was critical.

However, project staff were able to conduct a survey of environmental justice work in the area of chemicals and pesticides, take at least a preliminary look some other data sets capable of supporting environmental justice indicators, and develop several example indicators.

Several conclusions can be drawn from these efforts:

1. Environmental justice is an issue of considerable interest and has a rapidly growing body of research associated with it;

2. While some of the work may use indicators type information (trend data) to support the research, there is virtually no evidence of explicit indicator system development, at least at the national level;

3. Data systems capable of supporting environmental justice indicators related to chemicals and pesticides, at the national level, are relatively few, but have some promise. When data can be available from the Risk Screening Environmental Indicator (RSEI) project, the National Report on Human Exposure to Environmental Chemicals, and the National Child Study, a sizable set of national health-based environmental justice indicators associated with chemicals and pesticides are possible.

4. Considerably more research will be required before an acceptable set of indicators for national use can be developed.

Environmental Justice at the Environmental Protection Agency

Definition

Environmental justice has been defined by various organizations. The National Institute of National Health Sciences (NIH) defines environmental justice as "the fair treatment of people of all races, cultures, and income with respect to the development, implementation, and enforcement of environmental laws, regulations, programs, and policies" (NIH, 2002). Robert Bullard states, "the environmental justice movement is about trying to address all of the inequities that result from human settlement, industrial facility siting, and industrial development. It's more of a concept of trying to address power imbalances, lack of political enfranchisement, and to redirect resources so that we can create some healthy, livable, and sustainable types of models" (Errol Schweizer, 1999).

Perhaps the best and most complete definition, however, is provided by the U.S. EPA, which defines environmental justice as "the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations, or the execution of federal, state, local, and tribal programs and policies" (U.S. EPA, 2002).

The U.S. Environmental Protection Agency Activities

A major cross-cutting policy issue of the Environmental Protection Agency has been their concern that the burden of human environmental impacts has been inequitably shared across society, and that the heaviest burden has been borne by segments of society that are the least capable of protecting themselves. All programs at the EPA have been charged with the responsibility of identifying and correcting such disproportionate and inequitable impacts. For the Office of Prevention, Pesticides and Toxic Substances (OPPTS) such environmental justice concerns center around the differential impacts of exposure to toxic chemicals and the application of pesticides for populations defined by social, ethnic, cultural, and economic divisions.

The EPA's mission is to protect human health and to safeguard the natural environment, air, water, and land upon which life depends. The EPA states that this holds true for the American public, regardless of race, color, national origin, culture, education, or income, and where individuals live, learn, and work.

In her memorandum, dated August 9, 2001, EPA Administrator Christine Todd Whitman stated that the EPA was committed to the issue of environmental justice and its integration into all programs, policies, and activities. In that memorandum, Administrator Whitman also stated "environmental justice is achieved when everyone, regardless of race, culture, or income enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making to have a healthy environment in which to live, learn, and work" (Administrator Whitman, 2001).

On February 11, 1994, Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," was signed. The aim of the agenda was to focus the attention of federal agencies on the environmental and human health conditions of minority and low-income communities. The Executive Order states that each federal agency has to make achieving environmental justice a part of its mission. To achieve this federal agencies must develop environmental justice strategies that identify and address disproportionately high exposure and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (U.S. EPA, 2003).

Office of Prevention, Pesticides, and Toxic Substances (OPPTS) Activities
The Office of Prevention, Pesticides and Toxic Substances (OPPTS) major role is protecting public health and the environment from the potential risk of toxic chemicals for present and future generations. OPPTS promotes pollution prevention and the public's right to know about chemical risks. The program evaluates pesticides and chemicals to safeguard all Americans, including children and other vulnerable members of the population, from environmental harm. The program deals with the emerging issues of endocrine disruption and lead poisoning prevention as top priorities (U.S. EPA, 2003).

The 1992 EPA report, Environmental Equity: Reducing Risk for All Communities revealed that minority and low-income communities are exposed to higher levels of pollution in their neighborhoods than the general population. The EPA has invested in a number of initiatives to help communities mitigate pollution damage in their neighborhoods. These initiatives originally focused on acute and immediate problems faced by environmental justice committees. The EPA recognizes that preventing pollution at the source can help break cycles of repeated degradation and injustice. The EPA created Environmental Justice through Pollution Prevention (EJP2) grant program to support pollution prevention approaches in environmental justice communities as a strategy to help break the cycle (U.S. EPA, 1998).

In the first five years of the program, the EJP2 provided more than $15 million for a total of 198 innovative projects identified by communities to prevent pollution. The EPA believes pollution prevention is the best method to address environmental problems because it refocuses efforts from pollution control (cleaning up damaged environments) to preventing degradation from happening in the first place. Through EJP2, the EPA funded a wide array of organizations and communities interested in environmental justice, including urban areas, rural communities, tribes, different ethnic groups, and the poor. The EPA designed the program as a fund for innovation. Through EJP2, a wide range of community groups, tribes, and local governments identified environmental problems and potential approaches for their communities within the general context of pollution prevention solutions. Industry, small businesses, farmers, teachers, students, and residents across diverse ethnic and cultural backgrounds have learned firsthand the value of pollution prevention in reducing environmental risks within their communities (U.S. EPA, 2002).

Key Literature

Environmental Justice Overview Sources

There is a substantial and growing literature concerning environmental justice that extends well beyond the scope of the project to present in detail. In this review, a few key sources will be identified.

General Sources

A useful overview of environmental justice is the Szasz and Meuser (1997) article titled "Environmental Inequalities: Literature Review and Proposals for New Directions in Research and Theory," It provides a good summary of research that has been conducted on environmental justice and presents proposals for new directions in approaching environmental justice research.

Foreman (1998), in his book titled The Promise and Peril of Environmental Justice, provides a comprehensive analysis of environmental justice. Foreman shows why the environmental justice movement requires serious attention and recommends specific institutional reform necessary for the movement to be more successful.

Studies Related to Chemicals and Pesticides

A number of studies have examined the disproportionate distribution of exposures to chemicals and pesticides; the health risk associated with those exposures, body burden, and health effects as a function of race and income.

Szasz and Meuser (1997) give alternative explanations for the location of hazardous facilities. Their article "Environmental Inequalities: Literature Review and Proposals for New Directions in Research and Theory," states that hazardous facilities might be sited for several reasons other than demographics such as closeness to the source of raw materials or consumers of the product; abundant affordable acreage with access to infrastructure, such as highways, rail lines, rivers, or ports; the area is zoned as industrial; or the geological conditions of the site are suitable. Because land prices near hazardous facilities are inexpensive, poor minorities can afford to live in and around the facilities. Additionally, those who can afford to leave, flee the area around the facility for some other area. Another explanation given assumes that the area chosen was already different demographically, not chosen based on the demographic aspect but on the criteria, necessary for the location of the hazardous facility. The researchers also propose explanations for sites chosen based on demographics, such as neighborhood acceptance for the facility in hope that it will create jobs, taxes, and perhaps long range renewal and stabilization. The site could also be chosen because the residents are seen as less likely to resist the siting, a position consistent with Bullard's observations. Szasz and Meuser (1997) further state that a neighborhood may be chosen out of racial prejudice and discrimination. The researchers suggest that further research should examine the local histories of a neighborhood to determine which of these processes are at work.

Been (1994) believed that determining whether toxic waste landfills came to the low-income minority neighborhoods or whether the poor and minorities came to the sites was important for public policy. He believed that determining siting processes, market dynamics, or some combination of the two, resulted in a situation necessary in determining on what solutions to focus. Been believed this was lacking from the previous studies conducted; and that the history of the neighborhoods could be used to accurately determine which process was at work.

Several studies by EPA have indicated that minority and low-income communities often bear a disproportionate level of the environmental and health effects of pollution (EPA, 2002). The Conference on Race and the Incidence of Environmental Hazards held at the University of Michigan in 1990 cemented these developments. At this conference, researchers and activists came together to share their latest findings and then met with state and federal officials to discuss the necessary strategies for change. At the conference, Mohai and Bryant presented 15 studies that provided objective and systematic information about the social distribution of environmental hazards. They found that in nearly every case, the distribution of pollution was inequitable by income and in all cases with only one exception; distribution of pollution was inequitable by race (Mohai & Bryant, 1993).

Szasz et al. (1993) used the Toxic Release Inventory (TRI) to make comparisons between tracts of low and high-income levels. The study found that facilities were most likely to be located in tracts with a $20,000-50,000 income range. Within this range there was a clear race gradient. The study found that as the African-American and Latino percentage increased, the likelihood that the tract had toxics emitting industry located within it increased.

Some epidemiological studies have examined the link between facility operation and exposure to toxics and negative health effects. Greshwind, Stolwijk, Bracken, Fitzgerald, Carolyn and Melius (1992) conducted an example of such a study; the result indicated that maternal proximity to hazardous waste sites might carry a small additional risk of bearing children with congenital malformations. However, this study is less useful for national application because the study had limited geographic scope and various factors were difficult to control.

Philips and Birchard (1991) and Philips (1992), examined human toxic exposure nationwide; however the studies were not linked to specific facilities and used large geographic areas. The data from the study linked increases in background toxic levels to increased accumulation of those toxics in human tissue. This could be used to provide evidence of a link if

hazardous waste sites could be shown to have higher background levels of toxins within their vicinity. Stockwell, Sorensen, Eckert and Carreras (1993), used Geographic Information Systems (GIS) technology to examine the geographic distribution of EPA Toxic Chemical Release Inventory (TRI) data. The EPA toxicity matrix provided analysis of TRI chemicals according to possible human health and environmental effects they can produce. When applied to the EPA Region IV (Southeast), the GIS map showed gradation on a county scale of TRI emissions, and those emissions based on type of potential toxic effects.

Bullard (1990) identified evidence of environmental racism in several communities. A West Dallas, Texas neighborhood, which is 85% black, is the home of the 63-acre Murph metals lead smelter. Also, Alsen, a community in Louisiana which is 99% black, is located at the beginning of the 85-mile industrial corridor where a quarter of America's petrochemicals are made. Located adjacent to the Alsen community is the fourth largest commercial hazardous waste site in the nation, Rollins Services facility. Bullard also examined the Emelle community, located in Alabama, which is 90% black. This community is located near the nation's largest hazardous waste treatment, storage, and disposal facility.

Explicit Environmental Justice Indicators

In 1994 the Strategic Assessment of Florida's Environment (SAFE) Report, developed indicators that were concerned with the distribution of households in proximity to TRI facilities. Additionally, other indicators were developed to examine average pollutant releases grouped by racial composition. Using information from the 1990 Census and Toxic Release Inventory (TRI) data reports, it was shown that race and ethnicity are critical in explaining proximity to TRI facilities. The percentage of each racial/ethnic group living within a mile or less from the nearest facility was just over five percent of all households earning $14,999 or less. For low-income Native Americans the percentage living within a mile or less of the facility was 5.97% and Hispanics, 6.4%. The low-income African American percentage was substantially higher at 8.27% living within a half mile of a TRI facility. The average pollutant releases indicator showed that increases in the concentration of African Americans and Native Americans is generally associated with increased average air releases. Therefore, there is a concentration of minorities in areas of increased air releases, within a mile or less of TRI facilities. (Bergquist et al., 1994). These are the only indicators found during the project that were part of a formal environmental indicator system.

Environmental Justice Issue Dimensions

Pathologies and Direct Health Impacts

The most powerful indicators of human environmental health would be those that can measure direct relationships between chemical exposure and physical health effects. Unfortunately, the science and the data needed to support these relationships are not currently available. Many health effects have multiple causes that prevent measurement of the contribution of specific chemical exposures to specific health effects. The genetic factors associated with race and ethnicity, and the diversity of associated lifestyles add yet additional variables for scientists to research. For many chemicals, it is unknown precisely what long-term effects they will have on human health. For those chemicals about which some effects are known, there still exists the ignorance of some long-term risks.

The National Children's Study is initiating new data collection processes that may produce the evidence necessary to establish such relationships. This project will examine the effects of environmental influences, including chemical bioassay data, on the health and development of more than 100,000 children, following them from before birth until age 21. This project will have the explicit benefit of allowing bioassay information to be related to health and pathology outcomes. It is not clear as yet if this data will allow useful racial, ethnic, and income distinctions.

Health Risk

A potential intermediate measurement of the impact of chemicals on human health is the estimation of the change in risk associated with increases or decreases in chemical exposure. Environmental justice indicators are concerned with whether or not certain populations are at greater health risk than others. While the concept of risk is thoroughly integrated into the culture of environmental protection agencies, and risk-based analysis is increasingly employed to make environmental decisions, risk-based data sets suitable for indicator development have not existed until recently. The Risk Screening

Environmental Indicators (RSEI) project at the EPA permits the estimation of human health risk resulting from modeled exposure to Toxics Release Inventory chemicals.

Unfortunately, the potential of RSEI could not be tapped for this project and a number of planned indicators could not be executed. Census definitions relating to racial or ethnic identifications could not be resolved in time for inclusion in the model. Further, Census data associated with income distribution was not available for the latest release of RSEI. When these elements are in place, however, the potential for development of a series of indicators relating to the distribution of health effects from chemical releases based on race, ethnicity, and income will be high.

Body Burden

A more direct assessment of various populations' exposure to environmental chemicals is to measure human body burden by race, ethnicity, or income. Through the use of biomonitoring, scientists are able to measure chemicals directly in blood and urine samples rather than to estimate population exposures by measuring air, water, or soil samples. Of particular concern are toxic chemicals that persist in the environment, bioaccumulate in human and animal tissues, and result in negative health effects. Such chemicals - known as persistent bioaccumulative toxics (PBTs) - are worthy of special consideration because of the serious health risk they pose. The measurement of bioaccumulation of these substances does not measure direct health effects, but it is a good surrogate measure.

The Second National Report on Human Exposure to Environmental Chemicals developed by the Centers for Disease Control and Prevention (CDC) has just released the first set of two-year aggregations of high-quality biomonitoring data for 116 important chemical constituents associated with health issues. The first year data was released in 2001 and provides a baseline for subsequent studies. The first report provided data for lead, mercury, cadmium, and other metals; dialkylphosphate metabolites of organophosphate pesticides; cotinine; and phthalates. The second report presents exposure data from NHANES 1999-2000 for 116 chemicals, including expanded information on 27 chemicals listed in the first report and an additional 89 chemicals. This report also presents data for the U.S. population by age, sex, and race/ethnicity, (CDC, 2003). As data are collected over the years, researchers will be better able to determine possible health effects and design appropriate public health strategies. This data, released too late to be fully used in this report, should be an increasingly productive source of indicator data for environmental justice. Also a second major future source of biomonitoring information is the National Children's Study which is currently being developed. If the sampling resolutions for race and ethnicity for these programs is high enough, some very interesting environmental justice indicators can be developed.

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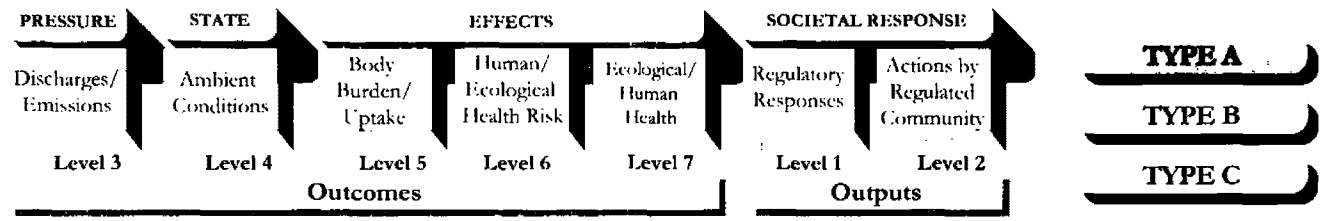
ENVIRONMENTAL JUSTICE
PATHOLOGIES



Indicator: Incidence of Asthma by Race

Asthma is a chronic lung disease characterized by airway inflamation and obstruction in which symptoms include wheezing, coughing, and shortness of breath (Mannino, Homa, Pertowski, Ashizawa, Nixon, Johnson, Ball, Jack, & Kang, 1998). Asthma may be caused or triggered by "familial, infectious, allergenic, socioeconomic, psychosocial, and environmental factors" (Mannino et al., 1998, p. 1). Although there is no cure for asthma, it can be treated with anti-inflammatory agents (inhaled steroids) and bronchodilators. Another way to control asthma is to avoid environmental triggers such as allergens, viruses, tobacco smoke, certain chemicals, and other indoor and outdoor air pollutants (Centers for Disease Control and Prevention, 2002). With good management, people with asthma may gain control over the disease. An estimated 25% of children with asthma show no symptoms when they become adults (American Lung Association, 2002). However, damage to the lungs due to asthma may become irreversible if the condition persits for a long period of time and is insufficiently treated (Mannino et al., 1998).

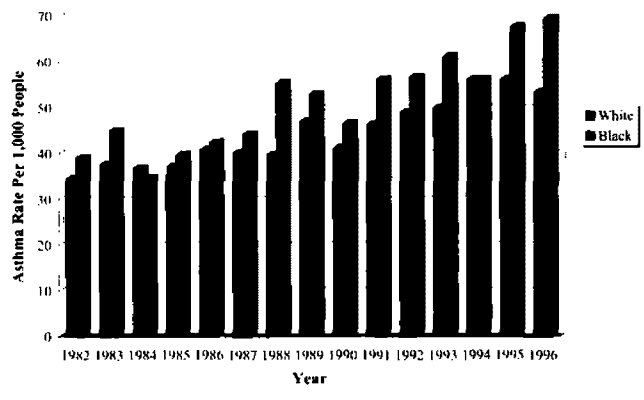
Asthma affects nearly 15 million Americans, more than 5 percent of the U.S. population. The scope of the health care problem caused by asthma lies not only in the large number of Americans with the disease, but also in the limitations that asthma imposes on daily activities, such as school, work, sports, and recreation. Asthma is the leading cause of school absenteeism for children and a common cause of work absenteeism for adults.

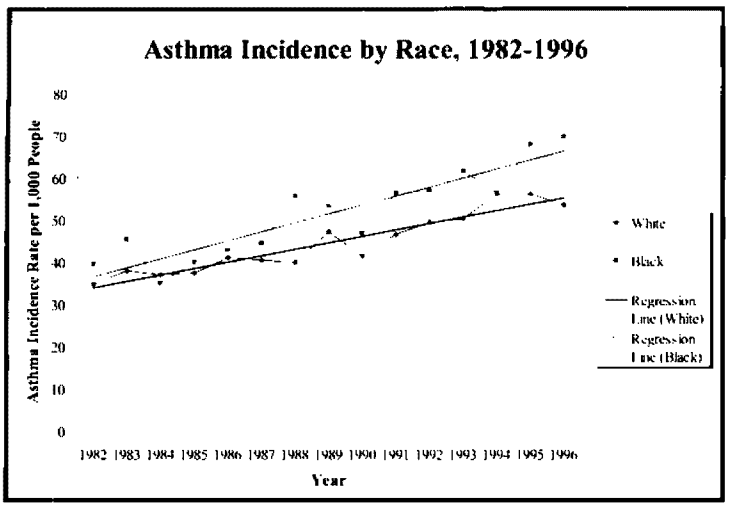
Although asthma affects Americans of all races, minorities and low-income populations have significantly "higher rates of fatalities, hospital admissions, and emergency room visits due to asthma" than the overall population (Dept. of Health and Human Services, 2000). According to the Centers for Disease Control and Prevention (CDC) (2002), blacks are significantly more likely than whites to experience childhood asthma.

The following charts show trends in asthma incidence by race in the U.S., as measured in the National Health Interview Survey between 1982 and 1999. Due to the use of a new design in the Survey in 1997, asthma incidence rates prior to 1997 cannot be compared with later rates.

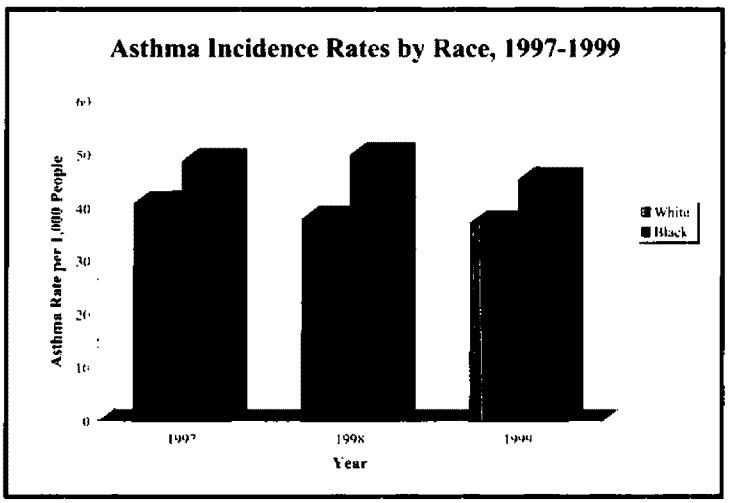
- From 1982 to 1996, asthma incidence rates increased for both whites and blacks.
- Except for 1984, each year, blacks had a higher rate of asthma incidence than whites.
- In 1982, 35 out of 1,000 whites had asthma while 39 out of 1,000 blacks had asthma.
- In 1996, 54 out of 1,000 whites had asthma while 70 out of 1,000 blacks had asthma.
- Asthma incidence rates for blacks have increased at a significantly faster rate than for whites.

Asthma Incidence Rates By Race, 1982-1996





- From 1997-1999, there was a small decline in asthma incidence rates for both whites and blacks. However, more data points are needed to establish an overall trend.
- In 1997, 41 out of 1,000 whites had asthma while 49 out of 1,000 blacks had asthma.
- In 1999, 37 out of 1,000 whites had asthma while 46 out of 1,000 blacks had asthma.



Note: An incidence of asthma was defined as answering yes to "Have you EVER been told by a doctor or other health professional that you had asthma?" and "During the past 12 MONTHS, have you had an episode of asthma or asthma attack?"

Source: National Center for Health Statistics, National Health Interview Survey, 1982-1996, 1997-1999 as reported in the Trends in Asthma Morbidity and Mortality, February 2002 by the American Lung Association.

Scale: Asthma incidence data is at the national level and is not available at the state or local level.

Data Characteristics and Limitations: These estimates are based on a sample. Therefore, they may differ from the figures that would be obtained from a census of the population. Each data point is an estimate of the true population value and is subject to sampling variability. Due to the use of a new design in the National Health Interview Survey in 1997, asthma incidence rates prior to 1997 cannot be compared with later rates.

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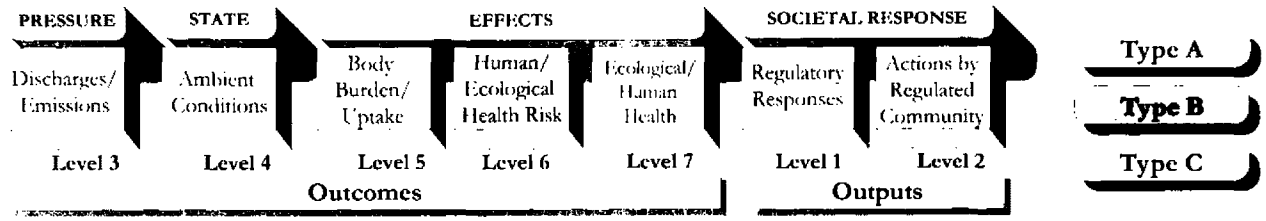
ENVIRONMENTAL JUSTICE
HEALTH RISK



Indicator: Comparative Chronic Health Risk Index For Toxic Releases by Race and Income

The ideal measurement of the human health impacts of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

The Toxics Release Inventory (TRI) is a database of reported toxic chemical releases into the environment. TRI data are commonly used as a measure of toxic exposure. TRI data are normally reported by the volume of releases of a specific chemical or set of chemicals or by the volume of managed waste. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of health risk posed by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics (OPPT) developed the Risk Screening Environmental Indicators (RSEI). The RSEI represent an analytical expansion of TRI by incorporating data that, for each chemical: reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the human health risk posed by a toxic chemical release can be estimated.

The analysis available through the RSEI produces an unanchored or unit-less measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the health risk measures would be adjusted to create a health risk index. It is conventional to present unit-less data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the health risk estimate for the baseline year would be adjusted to equal a value of 100; subsequent estimates less than or greater than 100 would indicate a decrease or increase in the health risk posed by toxic chemical releases, respectively. In a broad sense, this indicator would reflect whether or not certain segments of the U.S. population (i.e. racial and income level groups) have a greater risk of adverse health effects from environmental toxics than others. It would also show trends in health risk for those segments over time.

Measuring the chronic (long-term) health risk for toxic releases by race and income is important for determining which groups in society are most affected by toxic chemical releases. According to Whitman (2001), "environmental justice is achieved when everyone, regardless of race, culture, or income, enjoys the same degree of protection from environmental and health hazards." Therefore, the health risk posed to different racial and income level groups by toxic chemical releases must be measured. Once any disparate health risks are determined, the next step for achieving environmental justice is to find out why they exist. For example, if low-income neighborhoods have a higher health risk than high-income neighborhoods, it might be because they lack the financial and organizational resources to successfully oppose the location of facilities and industries that release toxic chemicals in or near their neighborhoods. Once the causes of disparate health risks can be explained, action can be taken to correct them.

Currently, the Risk Screening Environmental Indicators can produce estimates of disparate chronic health risks only by age group. The OPPT is modifying the RSEI model to estimate disparate health risks by other socioeconomic characteristics, including income and race. Income information has not yet been incorporated into the model and the Census must resolve the inconsistencies in ethnic identifications before the model will be able to estimate health risks by race. RSEI will aggregate the impacts associated with toxic releases that affect a certain geographic area. Then, the model will use demographic information on the affected population in that area to study the distribution of environmental impacts for different racial and income level groups.

Since TRI includes only a subset of chemicals to which people are exposed, this indicator would not be a complete measure of

the total chronic health risk of the entire population. It may be inferred, however, as a measure of the relative gains the U.S. is making in reducing the chronic health risk posed by toxic chemicals.

There are, however, efforts to move the TRI toward comprehensive coverage. This past year, the TRI was expanded to include the reporting of releases from seven new economic sectors electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. Currently, only a single year of data is available. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and cannot reflect human or ecological health impacts. The Risk Screening Environmental Indicators represent an attempt to capitalize on the extensive chemical inventory that constitutes TRI and to introduce flexibility and manipulability of the inventory by introducing new data elements. These new data elements allow estimations of toxicity, fate, and size and distribution of the receptor population for a toxic chemical release. The RSEI model integrates estimated toxicity scores for individual chemicals and chemical categories with a measure of exposure potential based upon reported multi-media release and transfer data and the size of the potentially exposed general population. The result is a screening level, risk-related perspective for relative comparisons of chemical releases. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection.

The data elements that will be used to construct this indicator are:

- Air Releases
  - Fugitive Air Releases
  - Stack Air
- Water Releases
  - Direct water
  - POTW Transfers
- Land Releases
  - Onsite Landfill
  - Land Treatment/Application/Farming
  - Surface Impoundment
  - Other Land Disposal
  - Other Landfills

Underground injection treatment was not included among the releases to land due to the very small health risk posed by injection.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well. Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

Also included in the TRI are a variety of transfers of toxic chemicals. Transfers include amounts transferred off site for recycling, energy recovery, treatment, and disposal.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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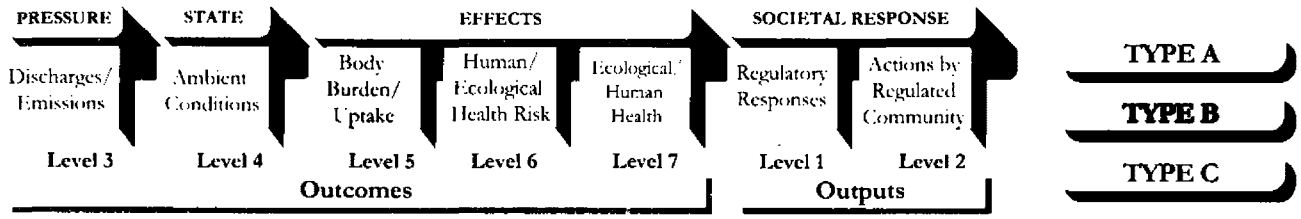
(These and other technical documents relating to Risk Screening Indicators, as well as other information relating to Risk Screening Indicators may be viewed or downloaded at http://www.epa.gov/opptintr/env_ind/. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov).

ENVIRONMENTAL JUSTICE
BODY BURDEN



Indicator: Body Burden of Toxic Substances by Race and Income

The ideal measurement of the human health impact of toxic releases would involve indicators capable of causally linking toxic exposure to specific pathologies in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected toxic chemicals, measures of ambient concentrations of toxic chemicals, and measures of the releases of toxic chemicals into the environment.

Some population groups are disproportionately at higher risk for elevated levels of toxic substances. These are usually people with low income, non-Hispanic black, and persons living in large metropolitan areas, or in older housing (Pirkle, Brody, Gunter, Kramer, Paschal, Flegal, Matte, 1994).

The Second National Report on Human Exposure to Environmental Chemicals (2003) will provide an ongoing assessment of the U.S. population's exposure to environmental chemicals using biomonitoring. The Report provides exposure information for people participating in the Centers for Disease Control and Prevention's (CDC's), National Health and Nutrition Examination Survey (NHANES) for 1999-2000. This data will establish the baseline for these chemical levels in future years and future data will also be released in two-year groups. The Report presents levels of 116 environmental chemicals measured in the U.S. population.

The 116 chemicals included in the Report belong to one of the following chemical groups:

- metals
- polycyclic aromatic hydrocarbons
- tobacco smoke
- phthalates
- polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls
- polychlorinated biphenyls
- phytoestrogens
- organophosphate pesticides
- organochlorine pesticides
- carbamate pesticides
- herbicides
- pest repellents and disinfectants

An indicator for blood lead levels by race has been developed and a detailed description is provided in this updated Chemical and Pesticides Results Measures document.

In the future the Report will provide more detailed assessments of each environmental chemical by race and income.

Source: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Scale: The Second National Report on Human Exposure to Environmental Chemicals and NHANES data provide national estimates and cannot be disaggregated to the state or EPA regional levels.

Data Characteristics and Limitations: The Report provides exposure information by drawing data annually from CDC's National Health and Nutrition Examination Survey (NHANES). It displays levels of exposure for these chemicals disaggregated, where possible, by gender, race/ethnicity, age, income, region, urban/rural residence and other variables. The second release of the Report is restricted to general U.S. population data for the years 1999 to 2000 from the NHANES. It currently provides information about levels of 116 environmental chemicals in the U.S. population.

The NHANES is conducted by the CDC National Center for Health Statistics. The NHANES is administered to a sample of people in the civilian non-institutionalized population. A household interview and physical examination are conducted for each survey participant. During the physical examination, blood and urine specimens are collected. Environmental chemicals are then measured in the specimens.

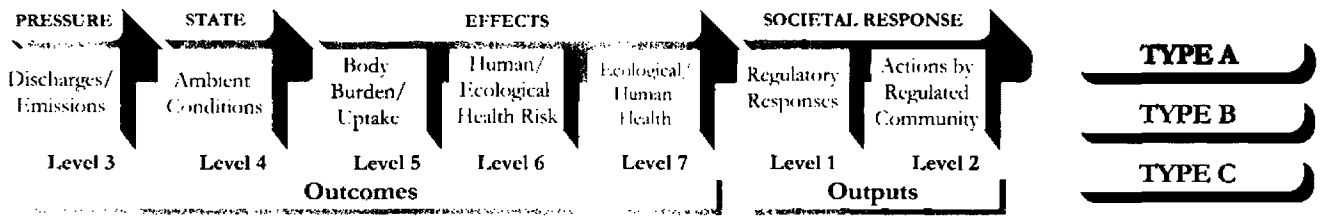
It is important to note that just because people have an environmental chemical in their blood or urine does not mean that the chemical will cause disease. Research studies separate from the Report are required to determine which levels of specified chemicals will cause disease.

Reference

Centers for Disease Control and Prevention. (2003). *Second National Report on Human Exposure to Environmental Chemicals.*4 M arch2 003. Available online at: http://www.cdc.gov/exposurereport/

Pirkle, J.L., Brody, D.J., Gunter, E.W., Kramer, R.A., Paschal, D.C., Flegal, K.M. Matte, T.D. (1994). The decline in blood lead levels in the United States: The National Health and Nutrition Examination Surveys (NHANES). *Journal of the American Medical Association, 272(4),* 284-291.

ENVIRONMENTAL JUSTICE
BODY BURDEN



Indicator: Blood Lead Levels in People Ages 1 and Older by Race

The hazardous effects of lead on human health have been well researched and established. Lead can affect almost every organ and system in the body and cause both acute and chronic health problems. The most sensitive system to lead in the body is the central nervous system. In adults, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead also damages kidneys and the immune system. Lead may cause anemia, abortion, or damage to the male reproductive system. Several chemical compounds of lead such as, lead acetate and lead phosphate are suspected carcinogens based on studies in animals; however there is inadequate evidence to clearly determine lead's carcinogenicity in humans (U.S. Dept. of Health and Human Services, 1993).

Humans are exposed to lead through a number of sources. The most common sources of lead exposure include:

- Breathing workplace air (lead smelting, refining, and manufacturing industries);
- Drinking water that comes from lead pipes or lead soldered fittings;
- Breathing or ingesting contaminated soil, dust, air, or water near waste sites;
- Breathing tobacco smoke;
- Eating contaminated food grown on soil containing lead or food covered with lead-contaminated dust;
- Breathing fumes or ingesting lead from hobbies that use lead (leaded-glass, ceramics).

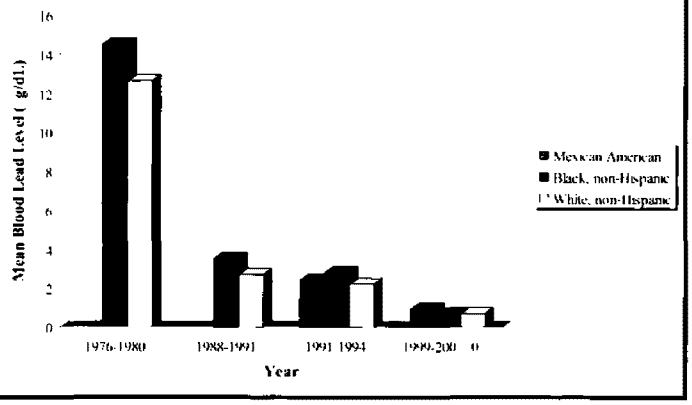
Because of the multiple pathways for lead exposure and the potential adverse health effects associated with exposure, it is important to monitor lead body burden. This indicator tracks blood lead levels using the Second National Report on Human Exposure to Environmental Chemicals (2003) and the National Health and Nutrition Examination Survey conducted by the Centers for Disease Control and Prevention (CDC). The Report will provide an ongoing assessment of the exposure of the U.S. population to environmental chemicals.

There has been a substantial decline of blood lead levels of the entire U.S. population since the late 1970s. The major cause of this decline was the removal of 99.8% of lead from gasoline and the removal of lead from soldered cans. Even with this decline in blood lead levels, some population groups are disproportionately at higher risk for elevated lead exposure. These are usually persons with low income, non-Hispanic blacks, and persons living in large metropolitan areas or in older housing (Pirkle, Brody, Gunter, Kramer, Paschal, Flegal, Matte, 1994).

The following chart shows trends in blood lead levels of people age 1 year and older from 1976 to 2000. Due to the unavailability of Mexican American data prior to 1991, blood lead levels prior to 1991 cannot be compared with later years.

- From 1991 to 2000 blood lead levels for each race declined, however, more data points are needed to establish an overall trend.
- For 1999-2000, the mean blood lead level for Mexican Americans was 0.94 g/dL; for blacks it was 0.72 g/dL; and for whites it was 0.69 g/dL.

Blood Lead Levels in People Aged 1 Year and Older by Race, 1976-2000



Notes: g/dL micrograms per deciliter of blood

Source for 1999-2000 Data: The National Health and Nutrition Examination Survey (NHANES), 1999-2000, as reported by the CDC's Second National Report on Human Exposure to Environmental Chemicals (2003). Available online at: http://www.cdc.gov/exposurereport/ (4 March 2003).

Source for 1991-1994 Data: National Health & Nutrition Examination Survey (NHANES) as reported by Pirkle, J.L., Kaufmann, R.B., Brody, D.J., Hickman, T., Gunter, E.W., & Paschal, D.C. (1998, November). Exposure of the U.S. population to lead, 1991-1994. Environmental Health Perspectives, 106(11), 745-750.

Source for 1976-1980 & 1988-1991 Data: National Health & Nutrition Examination Survey (NHANES) as reported by Pirkle, J.L., Brody, D.J., Gunter, E.W., Kramer, R.A., Paschal, D.C., Flegal, K.M. Matte, T.D. (1994). The decline in blood lead levels in the United States: The National Health and Nutrition Examination Surveys (NHANES). Journal of the American Medical Association, 272(4), 284-291.

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SPECIAL POPULATIONS ISSUE 3: TRIBES

1990 Pennsylvania Avenue

List of Indicators

Arctic Monitoring and Assessment Program (AMAP)

Toxicity Index for Releases and Managed Waste on Tribal Lands

Cancer Incidence by Race

Human Health Risk for Releases and Managed Waste on and off Tribal Reservations

Gila River Indian Community Pesticide Indicators

Minnesota Chippewa Tribe Environmental Quality Indicators

Number of Active and Closed Underground Storage Tanks on Tribal Lands

Number of Confirmed Releases from Underground Storage Tanks on Tribal Lands

Number of Emergency Responses from Underground Storage Tanks on Tribal Lands

Number of Underground Storage Tank Cleanups Initiated and Completed on Tribal Lands

Open Dump Sites on Tribal Lands

SPECIAL POPULATIONS ISSUE 3:

TRIBES

Project Overview and Background

During 1997 and 1998, The Florida Center for Public Management (FCPM) of the Institute of Science and Public Affairs (ISPA) at The Florida State University conducted, in cooperation with the Office of Air and Radiation (OAR) of the U.S. Environmental Protection Agency (USEPA), a project known as the State and Tribal Air and Radiation Planning Project (STARPP). The purpose of this project was to meet with state air agencies and tribes in the 10 EPA regional offices and discuss a range of new planning and management tools and opportunities available to states and tribes in their relationship with EPA. During these meetings, over 70 representatives from 60 different tribes attended 9 workshops in regions where tribal participation was relevant. At eight of these workshops, tribes and states met together for a full day and participated in joint discussions regarding the issues central to STARPP. Additionally, a half-day or full-day meeting was held at each location specifically for tribes. In Region 8 (Denver), a full two-day meeting was held and the agenda broadened to include an expanded range of planning and management topics.

The discussions at the tribal portions of each of the nine workshops spilled over the set agenda and a wide range of issues related to tribal environmental planning and the tribal management of EPA programs were engaged. One of the clear themes to emerge from these workshops was tribal difficulties in acquiring and using environmental data that could be used to support tribal measurement systems. STARPP concluded, "It is not surprising that tribal participants identified the lack of environmental data as a serious impediment to planning and managing their air programs. Without good environmental data, important planning activities, such as goal setting, progress measurement, and program evaluation, cannot meaningfully take place. Tribes strongly urged the development of programs to expand traditional data collection useful to tribes or the development of alternative mechanisms to collect useful tribal environmental data." (Bergquist).

Since these workshops, the role of measurement in national environmental planning has expanded. National planning initiatives such as the Government Performance and Results Act (GPRA) and the National Environmental Performance Partnership System (NEPPS) have laid the foundation for improving planning and management of environmental programs by focusing attention on environmental results, elevating the importance of planning, and highlighting the need for meaningful stakeholder participation and positive intergovernmental relationships. For both programs, accountability through measurable goals and objectives, and program metrics is absolutely central. A strong planning system is fundamental in keeping attention focused on important goals and concerns. Higher demands for closer intergovernmental cooperation, greater legislative scrutiny, demands for more public accountability, and tighter, more competitive budgets have compelled states and tribes to improve their management systems, particularly planning. Fundamental to the functioning of effective planning programs is the ability to measure mission-based results. Without such measurement, strategic goals cannot be set, accomplishments cannot be documented, and programs cannot be adaptively managed. EPA has now taken the step of developing a State of the Environment Report and is identifying a set of indicators that will be used for that document. Further, EPA is now in the preliminary process of designing a Tribal State of the Environment Report to be made available sometime next year.

CAPRM and WISE

The Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and the Office of Solid Waste and Emergency Response (OSWER), both of USEPA, have separately engaged the Institute of Science and Public Affairs of The Florida State University in cooperative agreements to assist stakeholders in developing indicator systems. These two projects,

Chemical and Pesticide Results Measures (CAPRM) for OPPTS and Waste Indicator System for the Environment (WISE) for OSWER, both begin with strong direction to include tribal indicators as a major component of the broader indicator development process. An early decision was made to effectively combine the tribal portion of both projects. This was done for several reasons. First, the tribal membership on each of the larger TAWs would have represented a relatively small number, and the total amount of tribal representation would have been slight. By combining the two groups and having them work cooperatively on both projects, the number of tribal participants could be concentrated and the level of participation expanded. Second, a workgroup composed completely of tribes could devote more time to tribal issues. If tribal TAW members had remained as part of the larger project's TAWs, the amount of time and energy that could have focused on tribes would have been small. Third, the two project TAWs would have little expertise or interest in tribal concerns. Combining the two projects for tribal purposes has magnified the ability to focus resources and expertise on tribal indicators. Tribal environmental indicator development is presently in an exploratory mode, searching for known tribal indicator systems and for data sets capable of supporting tribally relevant environmental indicators for chemical, pesticide, and waste issues. The name for this joint project is the Tribal Environmental Indicators System (TREIS). Current work elements include bibliographic research, research to locate existing tribal indicator systems, research on the appropriateness of existing environmental data sets for use in tribal settings, discussions with tribal environmental experts, focused meetings with tribalrepresentatives, and the development and publication of a small set of preliminary tribal indicators.

Over the past year CAPRM has held three major meetings with tribes to discuss tribal indicators relating to chemicals, pesticides, and waste, to identify key environmental issues for tribes, and to gather information regarding data that can be used to support indicators. Based on that input, CAPRM staff has conducted a preliminary search for potential indicators useful to tribes. The results of that work is summarized in the document.

The work accomplished in STARPP, CAPRM, and WISE presents a preliminary picture regarding tribal environmental indicators. Several conclusions can be made:

1. **Indicator Quality Data Available to Tribes is Limited Compared to Nontribal Governmental Organizations.** The nonurban character of tribes, their general remoteness, and relatively small, scattered populations served to keep them out of the path of monitoring systems and other data collection systems. Further, since much national environmental data is collected by states, tribes may not be included. Additionally, since tribal populations are often relatively small, sampled data-bases cannot include tribal results because the tribal resolution is too small. Sometimes tribes are just not considered, and

2. **Formal Work on Developing Tribal Environmental Indicator Systems is Virtually Nonexistent.** Individual studies or reports may provide graphs of certain data sets, but the development of a comprehensive set of environmental indicators is, with scant exception, not in evidence. As a result, there are few examples for tribes to use to build their own systems.

CAPRM I Project Purpose

The broad purpose of CAPRM II is to identify key environmental issues and sub-issues relating to chemicals and pesticides and to identify and develop indicators that best measure those issues and sub-issues. The target audience for these indicators is relatively diffuse. States, tribes, nonprofits, the private sector, and the public at large all should have an interest in the indicators in CAPRM and their specific uses could vary widely. The tribal portion of this project has a somewhat different focus and is, obviously, considerably more focused. Several distinct purposes for the tribal portion of CAPRM can be identified:

1. **Support Tribal Capacity to Develop their Own Indicator Systems for their Own Uses.** The broader CAPRM indicators can be used by stakeholders to support any number of purposes. The tribal portion of CAPRM is directed toward identifying data sets that tribes can use to develop their own indicator systems relating to chemicals, pesticides, and waste. While uses at the regional and national levels are possible and useful, tribal level information supporting tribal uses is the focal point.

2. **Perform an Exploratory Examination as a Foundation for Future Work.** While some environmental indicators for tribes have been developed and used, work on an explicit system of tribal indicators is virtually nonexistent. A major purpose of this project is to build a system of indicators capable of measuring all of the key dimensions of chemical and pesticide issues as they relate to tribes. However, given the lack of preceding work on tribal environmental indicators and the limited resources available, CAPRM has treated the investigation of tribal indicators as preliminary and exploratory. Effort has been focused on foundational concerns, such as beginning to identify the key issues and sub-issues to relating to chemicals and pesticides in the tribal context, identifying data sets capable of supporting appropriate indicators at the national and the tribal level, and preparing sample indicators to serve as illustrations or models. The expansion of the system to its full capacity needs to be left to the future.

3. **Focus on National Data Sets.** With over 600 tribes spread across most of the states, a full examination of all of the opportunities for data that could support tribal indicators at some level is a daunting task requiring resources well beyond the current project's limited capacity. Consequently, choices had to be made. The decision was made to focus initial research on the potential of common national level data sets capable, at minimum, of describing tribal environmental conditions at the national level, and, in the best case, allowing the measurement of environmental trends at the individual tribal level.

Tribal Concerns with CAPRM

CAPRM staff conducted three meetings with tribal representatives. One 4-hour focus group meeting was held in Denver, Colorado on February 24, 2002 with a group of approximately 20 tribal representatives, a 11/2 meeting was held in Tahlequah, Okalahoma on August 15, 2002, with the CAPRM Technical Advisory Group (TAW), and a 11/2 day meeting was held in Albuquerque, New Mexico on November 21, 2002, with tribal TAW members and members of the National Tribal Environmental Council (NTEC). During those meetings, a number of concerns were expressed. They are:

1. **Limited Scope of the Project.** The TAW was near unanimous in its dislike of the limitation of the project to only chemical, pesticide, and waste issues. They strongly expressed the notion that all environmental concerns are inextricably linked and that issues relating to human and ecological health, air quality, water quality, and natural resources as well as chemical, pesticide, and waste issues, could not be disassociated. Only with great reluctance did they accept the structural and funding limitations of the project.

2. **Merging CAPRM and WISE.** While taking on the full range of environmental issues was not possible within the current version of TREIS, the tribal TAW was insistent the pesticides and chemicals not be treated separately from waste issues. For that reason, the TAWs for each project were combined into a single TREIS TAW, and the deliberations jointly focused on the issues associated with both projects.

3. **Insuring that TREIS Reflects the Tribal World-View and Environmental Priorities.** Tribal members of the TAW wanted TREIS to reflect the way tribes conceive of environmental issues. Further, they asserted that tribal priorities for the environment might be considerably different than nontribal priorities and that prospective indicators should reflect that difference. The tribal issue structure should project tribal environmental concerns as tribes perceive them, and the selection and content of the indicators should conform to that perception.

4. **Inclusion of Tribally-Specific Indicators.** While generally accepting the focus on examining national data sets for tribal applicability, the tribal TAW wanted to provide a few examples of tribally-specific indicators as models for replication.

5. **Inclusion of Cultural Indicators.** TAW members strongly supported the eventual inclusion of cultural indicators - indicators that support a unique tribal cultural value related to the environment or that measure a standard environmental issue that is expressed in cultural terms. While this is a broad and very

underdeveloped area, the TAW wanted the value of these indicators to be recognized and included in the discussion for the future of tribal indicators.

6. **Inclusion of Program Capacity Indicators.** While the focus of TREIS is to develop indicators that reflect environmental conditions, the TAW members argued for the inclusion of some management related indicators. They wanted a series of program indicators capable of measuring the current capacity of tribes to deal with their programs to meet tribal environmental needs.

7. **Process Concerns.** The TAW also identified are series of concerns they believed seriously reduced their capacity to produce indicators. They are the:
   a. the lack of appropriate and adequate risk assessment information;
   b. the inadequacy of current ecosystem research, particularly on tribal lands; and
   c. the need for improved interagency coordination.

Data Opportunities for Tribal Indicators.

While the current focus in TREIS is the examination of national level data sets, it is likely that the full development of tribal indicator systems cannot rely upon national level sources of environmental data. Tribes may need to become creative in developing other sources of environmental data to support indicator development that meets their specific needs. The range of tribal environmental indicators opportunities might include:

1. **Standard Data Sets.** While many data sets commonly used across the nation are totally inapplicable in reservation settings, there are some data sets that can have direct or approximate application to tribal settings. The Toxic Release Inventory and the closely associated Risk Screening Environmental Indicators Project, are plainly such data sources. RCRA, Superfund, Enviro Mapper, and the American Indian Lands Environmental Support Program (AILESP) should be of service. The Baseline Assessment being conducted by the American Indian Environmental Office (AIEO) is a potentially rich source of indicator data. Other data sets should be examined for application to reservation or tribal settings.

2. **State and Local Data Sets.** While some states may not commonly work closely with some tribes or conduct environmental monitoring on reservations, they may conduct such activities near enough to reservations to provide useful information. The review of state-owned data may provide environmental information capable of supporting tribal data needs.

3. **Ecological Monitoring and Assessment Programs.** EPA's Office of Research and Development is developing and supporting regional ecological assessment projects in a variety of locations (Chesapeake Bay, Great Lakes, the mid-Atlantic states, the 12 most western states, the San Francisco Bay and Joachin River River Delta) that will yield solid ecological indicators. While some of these sites will have no significance to reservations, others might. Such projects have or will have a wealth of location-specific data that should be assessed for their ability to provide high quality ecological indicator data on or near tribal areas. For projects in development, the possibility of placing some of the monitoring on or near reservations should be considered.

4. **Permit Data.** The federal government and states requires the holders of permits to provide monitoring data in support of the maintenance of their permits. At the national or state scale, such information is too inconsistent and too voluminous to use in environmental monitoring. Such monitoring information is generally useless for indicator purposes. At the tribal scale, however, monitoring information from some kinds of permitted facilities could be quite useful and, perhaps, not too difficult or expensive to collect.

5. **Specialized Tribal Data Sources.** There may be some sorts of information available through Indian support organizations that can assist individual tribes with environmental information. The Indian Health Service, for example, may have data of use in portraying environmental health issues on reservations. Similarly, there may be tribally collected data systems unique to individual reservations that can yield good results.

6. **Tribal Scale Modeling.** Many indicators are produced, not from direct data collection or monitoring, but from modeling activities. Modeling schemes might be developed on tribal scales that could allow individual tribes to produce their own environmental estimates.

7. **Regional Impact.** For some issues like deposition, regional information might be fully appropriate. Air deposition information might be a good example of this type of data. Such issues should be identified, along with appropriate measures for use by tribes.

8. **Tribewatch.** In Florida, there is an effective program for monitoring lake water quality that is dependent on volunteers. With over 7,800 lakes, the Florida Department of Environmental Protection can monitor water quality in only a few of them. However, using a network of lake residents who periodically collect a sample of water from their lake and send it to a common analysis point, a much greater number of lakes can be assessed and monitored. A similar approach could be used with tribes. A cooperative program with EPA regional offices or with state or regional governments could provide improvements in the data capabilities of both the tribe and their cooperator.

9. **Tribal Environmental Data Self-Collection.** The collection of much environmental data is scientifically exacting and expensive, requiring expensive equipment or access to laboratory resources. For most tribes, the development and maintenance of such data collection capabilities is not practical, and if data from agencies outside the reservation are not available, tribes have little access to data. Opportunities to develop simplified, less scientifically exacting, and cheaper measurement methods for tribes that will produce acceptable, if somewhat less sensitive, environmental measurements. For example, dipstick tests for many water constituents have been developed. The development of such a dipstick to roughly measure water quality or the general availability of certain chemical constituents or substances, could provide useful information where no other reasonable alternative exists.

10. **Community Collected Data.** Some types of data collection activities could be conducted as part of tribal community activities. On specific reservations, groups within the tribe could "adopt an indicator" and collect information. Biodiversity, plant and animal population surveys, exotics surveys, water quality, and flows and levels data are a few examples of data that, with minimal training, could be collected. An example of this type of activity is the Frog Listening Network staffed by volunteers in the Hillsborough River basin in Florida. In this program, community volunteers received training in distinguishing between the sounds made by different species of frogs. They then go to listening posts on a periodic basis and count the number of different frog calls they hear and their frequency, within a specified period of time. The information is compiled into a database and used to support an indicator of environmental quality — the number and diversity of frogs in the Hillsborough River basin.

11. **Environmental Education.** Many tribes have extensive training programs to teach and maintain cultural information regarding tribes and the natural environment. Such activities could be expanded and adapted to make data collection concerning important tribal natural resources a part of the program.

12. **Culturally Specific Indicators.** Tribes could also include measurements of tribally important environmental concerns in their indicator systems that would not reflect broader, standard environmental concerns. There may be important plant, animal, or mineral resources of special tribal significance that individual tribes would want to include in their indicator systems. It is also possible that tribes may wish to express their environmental concerns in a non-standard manner that would require different types of indicators than are commonly employed. The indicator systems being developed by the Ministry of the Environment in New Zealand to provide culturally specific parallel indicators for the Maori, might serve as a good example of the types of indicators that might be developed by tribes.

Tribal Environmental Issues Related to Chemical, Pesticides, and Waste

Considerable energy at the three tribal meetings held as part of CAPRM and WISE focused upon identifying, from a tribal perspective, what the key chemical, pesticide, and waste issues are. These issues serve as the primary structure directing the selection of indicators to be developed. That issue structure is not yet finalized, and probably will not be until it can be incorporated into a fully integrated tribal environmental indicator issue structure. Below is found the consolidated presentation of the issue identification work completed by the TAW at the Tahlequah and Albuquerque meetings:

Joint Issues of Both CAPRM and WISE:

1. Legacy Pollution Issues
2. Homeland Security
3. Ecosystem Impacts
4. International Transport of Chemicals and Pesticide

CAPRM Environmental Issues:

1. Pesticides
   a. Agricultural Pesticide Runoff
   b. Spray Drift of Pesticides onto Non-Target Areas
   c. Impacts of Indoor Exposures
   d. Impacts of Pesticides on Ecosystem Values (Habitat, Species Diversification)
   e. Storage of Pesticides on Tribal Lands
   f. Impacts on Traditional Foods
   g. Transport of Pesticides Through Tribal Lands
   h. Pesticide Impacts on Ground Water
   i. Future Impacts on the Environment

2. Chemicals
   a. Lead and Other Metals
   b. Toxics
   c. Inadequacy of Information About the Health Effects of Untested Chemicals
   d. Indoor Chemical Pollution
   e. Future Impacts on the Environment
   f. Ground Water Impacts
   g. Impacts of Traditional Food (Bioaccumulation in Fish and Wildlife)

WISE Environmental Issues:

1. Waste Generation
2. Waste Management
   a. Waste Minimization
   b. Waste Reduction
   c. Disposal of Waste
   d. Disposal of Common Household Hazardous Wastes
3. Sludge Management
4. Release/Discharges/ Emissions from Waste Management Facilities
5. Leaking Underground Storage Tanks
6. Water Well Contamination
7. Polluted Sites
   a. Superfund
   b. RCRA Sites
   c. Brownfields
   d. Abandoned Industrial Complexes and Sites

8. Mining Impacts
9. Emergency Preparedness

Management Issues:

1. Problems Running EPA Programs on Tribal Lands
2. Development of Tribal Regulatory Programs
3. Differences Between EPA and Tribes in Overall Management Philosophies
4. Maintaining Compliance with Tribal Law

Responding fully to this list of issues is well beyond the scope and capacity of the current project. This list is important, however, in setting the framework, and it may become useful when work is begun on the prospective Tribal State of the Environment Report.

Sample Tribal Indicators

On the following pages are a group of sample tribal indicators reflecting chemical, pesticides, and waste issues. This is not a definitive set of indicators. They are examples of the kinds of indicators that can be produced for inclusion in a full indicator system. Included are some examples of national level indicators, as well as some tribal level indicators.

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Bergquist, Gilbert, et. al., Air and Radiation Planning in an Era of Change: A State and Tribal Perspective, Final Report, State and Tribal Air and Radiation Project, Florida Center for Public Management, The Florida State University, December, 1998, pg. 5-7.

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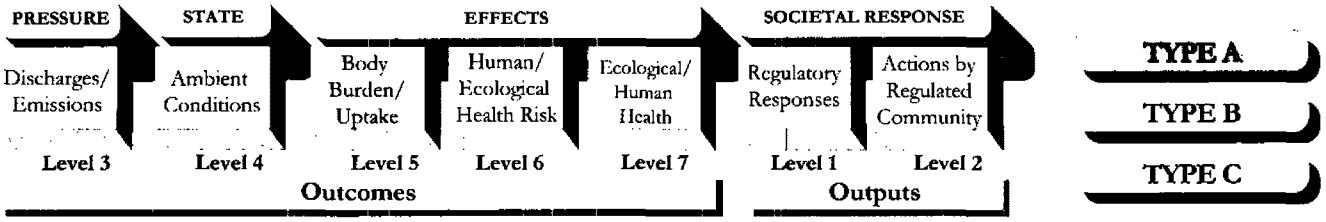

Indicator: Arctic Monitoring and Assessment Program (AMAP)

The Arctic region is the unique home to numerous exotic wildlife and untouched landforms. Unfortunately, the impacts of human progress have begun to affect the pristine Arctic environment. The Arctic Monitoring and Assessment Program (AMAP) was formed in 1991 "to provide reliable and sufficient information on the status of, and threats to, the Arctic environment, and to provide scientific advice on actions to be taken in order to support Arctic governments in their efforts to take remedial and preventive actions relating to contaminants" (AMAP website, 2002). To achieve this goal, AMAP has been challenged to "measure the levels, and assess the effects of anthropogenic pollutants in all compartments of the Arctic environment, including humans; document trends of pollution; document sources and pathways of pollutants; examine the impact of pollution on Arctic flora and fauna, especially those used by indigenous people; report on the state of the Arctic environment; and give advice to Ministers on priority actions needed to improve the Arctic condition" (AMAP website, 2002).

To begin the research efforts, AMAP had to establish one agreeable definition of the Arctic. Various peoples, nations, and governments inhabit the lands collectively known as the Arctic region, and each holds their own distinct definition of the Arctic. Thus, AMAP combined several definitional interpretations of the Arctic to established one agreeable definition for study purposes. The research area is to include the terrestrial and marine areas north of the Arctic Circle (66°32'N), and north of 62°N in Asia and 60°N in North America, modified to include the marine areas north of the Aleutian chain, Hudson Bay, and parts of the North Atlantic Ocean including the Labrador Sea (AMAP website, 2002).

At this time, AMAP has already started/completed numerous research studies that have documented environmental conditions in the Arctic over time. The content of several of these studies is directly related to body burden/intake of chemicals and pesticides to indigenous people in the Arctic. On the AMAP website, the following indicators are listed to

- Geometric mean levels of HCB, DDE, and PCBs in cord blood of newborns in different Canadian population groups
- Distribution (in percentiles) of whole blood mercury concentrations in four regions in Greenland and in Greenlanders living in Denmark
- Distribution (in percentile) of whole blood lead concentrations in four regions in Greenland and in Greenlanders living in Denmark
- Distribution (in percentile) of whole blood cadmium concentrations in four regions in Greenland and in Greenlanders living in Denmark
- Distribution (in percentile) of whole blood selenium concentrations in four regions in Greenland and in Greenlanders living in Denmark
- Nickel levels in urine from pregnant and delivering women in different areas of Russia and Norway
- Nickel levels in urine from newborn children in different areas of Russia and Norway
- Organochlorine intake from traditional food consumed by indigenous women in Canadian Arctic
- Time trends of mean methylmercury concentrations
- Mean maternal plasma lipid concentrations of DDE and DDT; figures below the graph show the DDE/DDT ratios
- PCB congener profiles in cord blood of Canadian and Greenlandic population groups, and in cord and maternal blood from Greenland

However, because of extenuating circumstances, the raw data contained in these reports was not available to this research team at the time of publishing and therefore accurate result graphs cannot be provided.

Sources: *Arctic Monitoring and Assessment Program,* www.amap.no. For further information please contact Simon Wilson at s.wilson@inter.nl.net

Data Characteristics and Limitations cannot be determined at this time because direct access to the data was not provided by AMAP.

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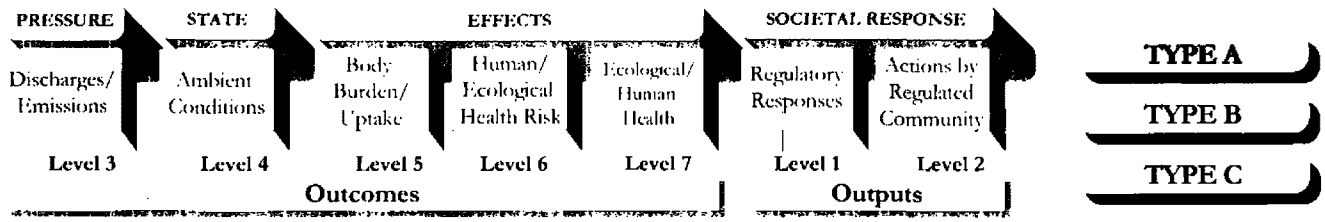


Indicator: Toxicity Index for Releases and Managed Waste on Tribal Lands

Information on a federal chemical monitoring program can be used as an indicator of the state of public monitoring efforts in general.

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating a toxicity score for each chemical. The toxicity score is multiplied by the pounds of chemical released or managed in waste; the toxicity of each chemical release and waste stream can be aggregated to provide an estimate of the total toxicity of releases and managed waste for a given year.

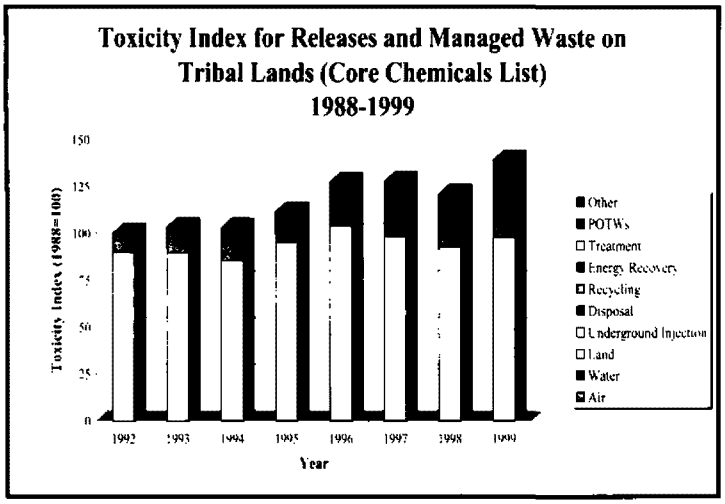
TRI data pertaining to releases and managed waste on tribal lands is of particular interest in light of the EPA report, Environmental Equity: Reducing Risk for all Communities. This 1992 document found low-income communities and people of color to be at a level of risk of exposure to toxic pollutants disproportionate to that experienced by the general public. In order to alleviate such environmental inequities, on tribal lands, it is important to ascertain existing trends in pollution and waste management in these areas. TRI data can be used as an indicator of trends in these areas.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unit-less measure of toxicity. These measures can only be interpreted relatively: to display trends and to make comparisons of toxicity over time. For this indicator, the toxicity of releases and managed waste was adjusted to create an index. It is conventional to present unit-less data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the estimate of toxicity of releases and managed waste for the baseline year was adjusted to equal a value of 100; subsequent estimates reflect changes from that baseline of 100. If industries are maintaining or improving pollution efficiencies or succeeding at pollution prevention, then the index should display constant or declining trends.

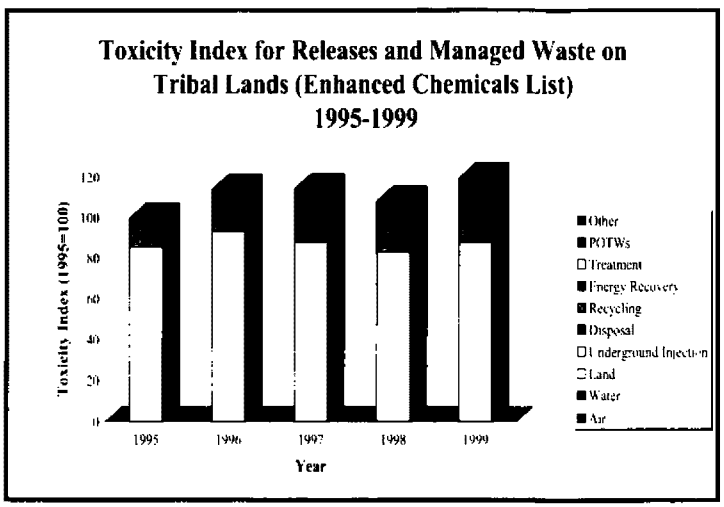
Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total toxicity of releases into the environment and managed chemical waste. It can be inferred, however, as a measure of the relative gains the U.S. is making in pollution prevention and improving pollution efficiencies.

There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. Currently, only a single year of data is available. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Two different subsets of TRI data are reflected in the presented charts. The first chart reflects data for a core list of chemicals that have been reported every year since the inception of TRI in 1988; however, the chart reflects data beginning in 1992, which is when recycling, energy recovery and treatment operations were incorporated into TRI. The second chart reflects data for an enhanced list of chemicals that have been reported every year from 1995 to 1999.



- The TRI for tribal lands generally increased from 1988 to 1999.
- Land release accounted for the majority (>60%) of the toxicity index for the core chemicals list on tribal lands between 1988 and 1999.
- An increasingly large percentage (from ~10% in 1988 to ~40% in 1999) of the core chemical component of the toxicity index was managed through recycling.



- The toxicity of releases and managed waste on tribal lands increased from 1995 to 1998.
- Land release accounts for the majority of the toxicity index for the enhanced chemicals list; however, its share of the toxicity index decreased from 83% in 1995 to 57% in 1999 as a larger percentage of the toxicity was recycled.
- Toxicity of both the core list and enhanced list of chemicals on tribal lands has been increasing but this increased toxicity is generally being absorbed by recycling rather than released to land.

Source: Risk Screening Environmental Indicators, Custom computer queries of national summary data prepared in August, 2002.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection. Using models with varying assumptions, three risk indicators in addition to the chronic human health risk index will eventually be available: 1) an acute human health risk index; 2) a chronic ecological health risk index; and 3) an acute ecological health risk index.

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening

Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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1998 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, August 2000. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. This document may also be viewed and downloaded at http://www.epa.gov/tri/tri98/.

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User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators may be viewed or downloaded at http://www.epa.gov/opptintr/env_ind/. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline(a epa.gov).

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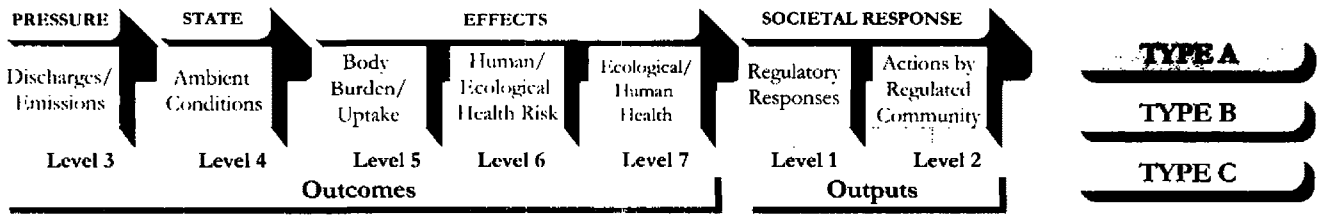


Indicator: Cancer Incidence by Race

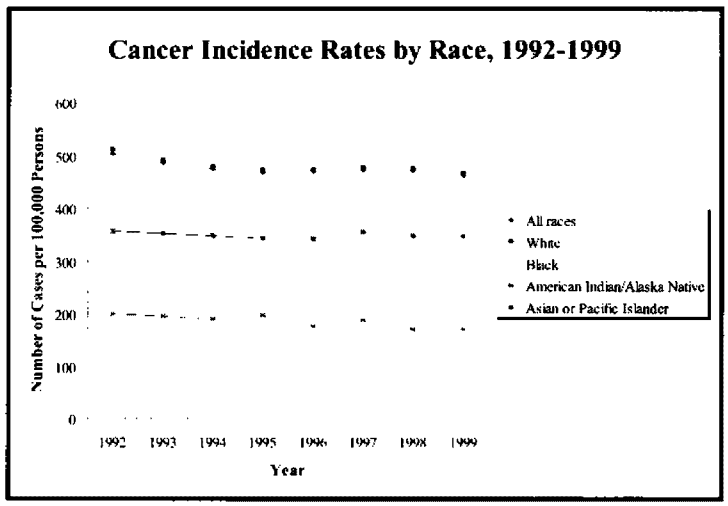
Cancer is a disease of increasing national concern. While the development of cancer is likely multi-causal and interactive, research linking some types of cancer with chemical exposures has elicited a broad and significant regulatory response from the Environmental Protection Agency (EPA).

Cancer refers to a group of diseases in which cells continually divide to produce new cells when they are not needed. Groups of extra cells are called tumors, which can be either benign (not cancer) or malignant (cancer). Cancer cells can spread to and damage other parts of the body through the bloodstream or the lymphatic system in a process called metastasis (National Cancer Institute, 2002a).

Although the causes of cancer are not known, people with certain conditions, such as a personal or family history of cancer, have an increased risk of developing the disease. People who use tobacco, drink alcohol, are overweight, have low physical activity, or have a high fat diet are more likely to develop cancer. Other risk factors for cancer include chemicals and other substances, radiation, and hormone replacement therapy (NCI, 2002a).

The following chart shows trends in cancer incidence in the U.S. by race, as reported by the Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics (NCI, 2002b).

- From 1992 to 1999, cancer incidence rates per 100,000 people were highest for blacks and lowest for American Indians and Alaska Natives.



Note: The year refers to the year of diagnosis for cancer incidence and the year of death for cancer mortality.

Source: National Cancer Institute (NCI), Surveillance, Epidemiology, and End Results (SEER) Incidence and U.S. Mortality Statistics, 2002, http://seer.cancer.gov/canques/ (30 January 2003).

Scale: The presented data is at the national level. SEER Incidence and U.S. Mortality Statistics data may also be viewed at the state level.

Data Characteristics and Limitations: Data is collected from 11 population-based cancer registries and three supplemental registries, which cover approximately 26 percent of the U.S. population. The registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, San Jose-Monterey, Alaska, Arizona, and certain rural counties in Georgia. The population used in the SEER study may not be a complete representation of the general U.S. population due to the fact that it tends to be somewhat more urban and has a larger proportion of foreign-born persons than the general population.

Most types of cancer are more frequently seen in older people and the U.S. population has aged over the past 30 years, which means the country's age distribution changes each year. Therefore, cancer incidence and mortality rates are age-adjusted to the 2000 U.S. standard million population by 5-year age groups to eliminate the confounding effect of age when comparing rates from year to year. An age-adjusted rate is a weighted average of the age-specific rates, where the weights are the proportions of persons in the corresponding age groups of a standard million population.

Reporting delay and reporting error can temporarily produce downwardly biased cancer incidence trends until corrections of annual data are made. Reporting delay time refers to the time elapsed before a diagnosed cancer case is reported to the National Cancer Institute (NCI). Reporting error occurs when a reported case must be deleted due to incorrect reporting (Clegg, Feuer, Midthune, Fay & Hankey, 2002).

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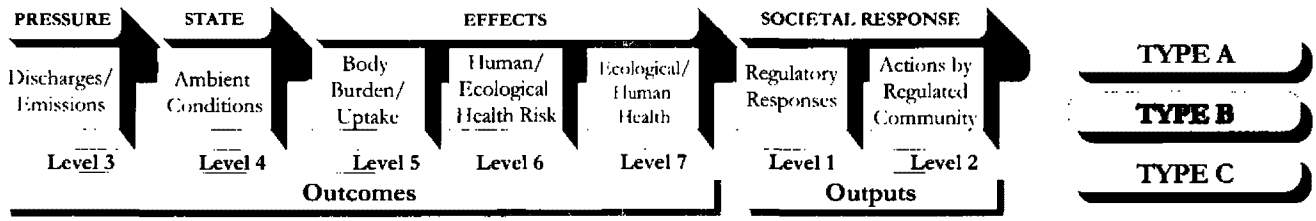

Indicator: Human Health Risk for Releases and Managed Waste on and off Tribal Reservations

The Risk Screening Environmental Indicators (RSEI) process allows the highly flexible manipulation of TRI data to go beyond just reporting pounds of releases to estimating the toxicities associated with those releases and estimating the associated health risks. RSEI can be used as the first step in evaluating potential risk-related impacts industrial releases and management of toxic chemicals.

This screening level tool can be used to produce a variety of indicators of use to tribes. Tribes can use RSEI's GIS mapping capabilities to manually select facilities on and around tribal lands to examine estimated health risk for releases and managed waste in a given geographical area. Tribes can develop measures to assess their own efforts in managing industrial facilities located on tribal land. Furthermore, tribes can also assess how much of their potential health risk solely comes from industrial facilities off of tribal lands. Additionally, several other refinements are possible that allow tribes to assess toxic release related issues of specific concern to a tribe.

The ideal measurement of the human health impacts of chemical releases would involve indicators capable of causally linking toxic exposure to specific health impacts in a valid and reliable manner. However, science is not yet ready or able to confirm such relationships. In the absence of such indicators, fallback measures are employed, which include: bioassay or body burden analysis for known or suspected harmful chemicals, measures of ambient concentrations of harmful chemicals, and measures of the releases of chemicals into the environment.

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals.

These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating data that, for each chemical, reflects the toxicity, models the fate, and estimates the size and distribution of the receptor population. By incorporating these data with the TRI, the chronic human health risk posed by a carcinogenic chemical release or waste stream can be estimated.

The analysis available through the Risk Screening Environmental Indicators program produces an unanchored or unitless measure of health risk. These measures can only be interpreted relatively: to display trends and to make comparisons of health risk over time. For this indicator, the chronic health risk measures were adjusted to create a chronic health risk index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the chronic health risk estimate for the baseline year was adjusted to equal a value of 100; subsequent estimates less than or greater than 100 indicate a decrease or increase in the chronic health risk posed by carcinogenic chemical releases and wastes, respectively. In a broad sense, this indicator reflects whether human populations in the U.S. are at a higher or lower risk of adverse health effects from carcinogenic chemicals than they were in previous years.

Since TRI includes only a subset of chemicals to which tribal members are exposed, this indicator is not a complete measure of the total health risk of the entire tribal population. It can be inferred, however, as a measure of the relative gains the U.S. is making in reducing the chronic health risk posed by toxic chemicals.

There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Source: Risk Screening Environmental Indicators, Custom computer queries of national summary data prepared by the Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, August, 2000.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection. Using models with varying assumptions, three risk indicators in addition to the chronic human health risk index will eventually be available: 1) an acute human health risk index; 2) a chronic ecological health risk index; and 3) an acute ecological health risk index.

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

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There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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1998 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 2000. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. 31 January 2003. Available online at: http://www.epa.gov/triinter/tridata/tri98/pdr/index.htm.

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Toxics Release Inventory Relative Risk-Based Environmental Indicators Methodology, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, June 1997.

User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Indicators, as well as other information relating to Risk Screening Indicators may be viewed or downloaded at http://www.epa.gov/opptintr/rsei/. 31 January 2003. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov.)

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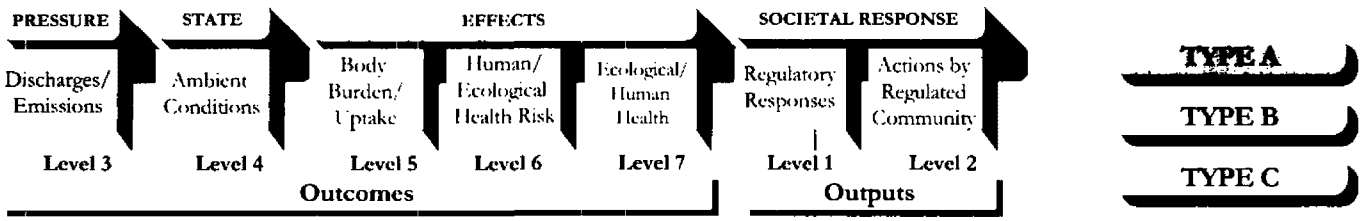


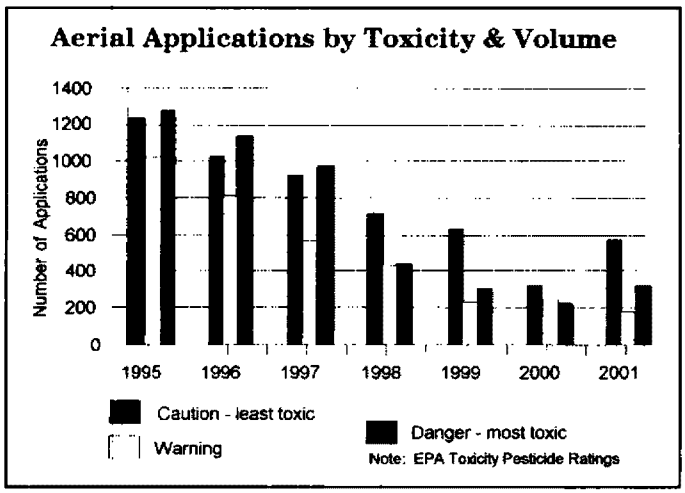
Indicator: Gila River Indian Community Pesticide Indicators

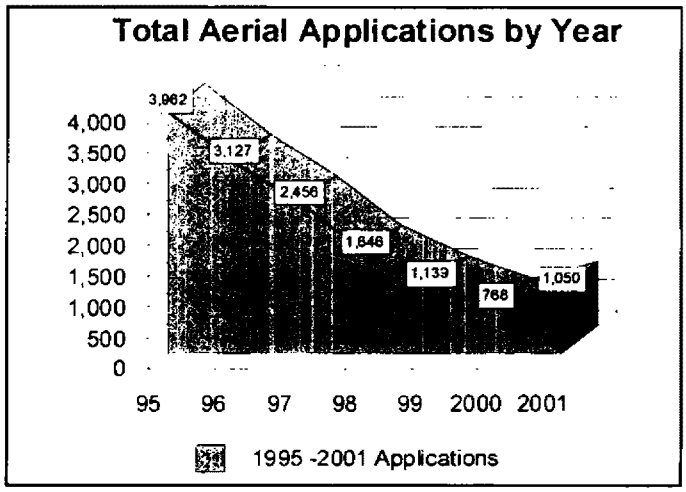
This indicator is provided courtesy of the Gila River Indian Community and is an excellent example of an individual tribe collecting and displaying important environmental information not otherwise available from other sources.

The aerial application of pesticides is an important issue in areas of large scale farming. The possibility for pesticides to drift into adjacent areas puts at risk other crops, water quality, wildlife health, and human health. Risk is reduced by application of less volume as well as less toxic material."

These indicators measure the total number of applications per year, as well as the toxicity of those applications. Toxicity is approximated by using three signal word classifications used in pesticide labeling. A signal word is included on the product label for all farm chemicals. The three signal words are CAUTION (slightly toxic or relatively non-toxic), WARNING (moderately toxic), and DANGER (highly toxic). Since the formulations of active ingredients can vary among products, there are instances in which an active ingredient may have more than one signal word. This indicator measures agricultural pesticide usage by pesticide product signal word. This indicator does not explicitly consider the risk to human or environmental health posed by each of the pesticides used. However, because these signal words are derived from the acute toxicity classifications of each active ingredient, they can be inferred to be proxy measures of the toxicity of pesticides applied.

- Both charts show rapid progress in reducing the overall toxicity of the pesticide mix, and reducing the total number of pesticides applications.
- While all three signal word types declined at a similar proportionality, the Danger category declined from approximately 1280 applications in 1995 to slightly over 200 applications in 2000, about an 85% decline.
- Increases in applications rose in 2001 due to substantial increases in farming acreages. Decline in toxicity is due to the use of plant growth regulators and insect growth regulators as opposed to using traditional broad spectrum insecticides which tend to be more toxic.





Source: Environmental Accomplishments, Gila River Indian Community Department of Environmental Quality, August 30, 2002.

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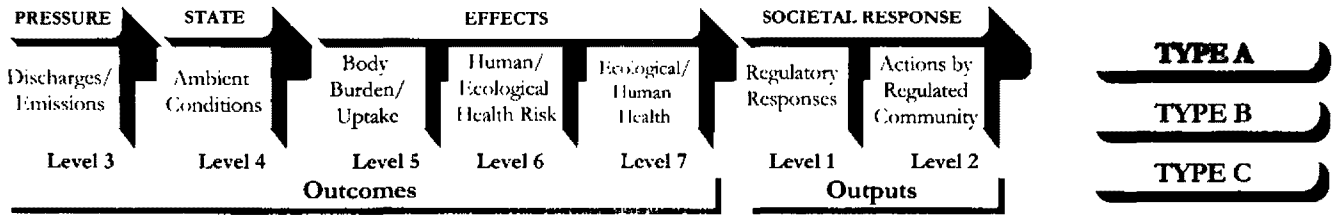

Indicator: Minnesota Chippewa Tribe Environmental Quality Indicators

This indicator is provided courtesy of the Minnesota Chippewa Tribe. It is an excellent example of a tribe collecting scientific information to support indicators that relate to a specific health issue and additionally reflects an important historical and cultural concern for the tribe. The following text is provided by the tribe.

Background

The Minnesota Chippewa Tribe is a Federally Recognized Tribal Confederation with approximately 40,000 enrolled members. The Tribe is comprised of six autonomous Reservations (Bands): Bois Forte, Fond du Lac, Grand Portage, Leech Lake, Mille Lacs and White Earth. These six Reservations occupy approximately 1.8 million acres, of which approximately 700,000 acres is lakes and 250,000 acres is wetlands. The 667 lakes and 702 stream miles are located between 46° and 48° north latitude, and 89.5° and 96° west longitude in the northern portion of the State of Minnesota. All of these waters are at, or very near, the apex of three major North American watersheds, the Great Lakes, the Hudson Bay, and the Mississippi River. The hydrodynamics of this area is quite active in both a surface and groundwater context. The geology ranges from exposed Canadian Shield bedrock, to several hundred feet of glacial till (sand, gravel, boulders, clay lenses) over the bedrock, with terminal and lateral moraines readily apparent on the landscape. The upland vegetation is dominated by coniferous and mixed conifer/hardwood forests. The wetlands contain typical wetland vegetation including trees, sedges, and wild rice. Many thousands of Reservation acres are wilderness or semi-wilderness. Forestry dominates anthropogenic land uses, with some hay, grain and livestock agriculture. The vast majority of agricultural lands are located on the western half of White Earth Reservation, in an area of glacial lake deposits known as the Red River valley.

An additional 15 million acres of lakes, streams and forests of northern Minnesota are Ceded Territories of the Chippewa. Resource use rights, hunting, fishing and gathering, on these lands and waters were reserved by the Tribe in several Treaties with the United States Government.

Indicators

The primary environmental indicator used by the Minnesota Chippewa Tribe at this time is quantity of fish from Tribal waters that may be safely consumed by the most at risk Tribal members, women of childbearing age, lactating mothers, and children. The major, widespread contaminants in Tribal waters have been found to be mercury, and the congeners and toxic breakdown products of DDT, PCBs, and Dioxin/Furans. Tissues of the several most utilized fish species are screened, lake by lake, as prioritized by fishing pressure. Screening for mercury is done by analyzing muscle tissue from the top predator species *Stizostedion vitreum* (walleye), or the northern pike, *Esox lucius*. The screening species for organic contaminants is done by analyzing liver tissue from the burbot *(Lota lota)*, lake trout *(Salvelinus namaycush)* muscle tissue, whitefish *(Coregonus clupeaformis)* muscle tissue, or tulibee *(Coregonus artedii)* muscle tissue. Other fish species are assessed in each water body as indicated by the screening, with the intent of identifying fish that are safe to eat. An EP A approved quality assurance plan is followed for all fish collection and analytical work. The analyses are done using method detection levels that are relevant to risk assessment at a Tribally designated, traditional fish consumption level of 180 pounds per year (224 grams per day).

The analytical information collected is assessed for cumulative cancer and non-cancer risks of the measured contaminants using EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 2, Risk Assessment and Fish Consumption Limits (EP A 823B-OO-OO8). Lake specific, multiple species fish consumption guides are prepared and made available to Tribal fish consumers in an effort to promote informed decision making for healthy food choices.

Rationale

The decision to use the most at risk individuals as environmental indicators permits an environmental quality management model that ultimately protects the entire population and offers the best opportunity to minimize acute and chronic health impacts, and costs associated with anthropogenically introduced contaminants. Based on our current fish contaminant information, the quantity of preferred species fish that may be

safely consumed by our most at risk citizens is limited to 5% or less of the Tribally designated, Treaty protected quantity o f224 grams per day.

The Tribe is fully aware that efforts to minimize the impacts of environmental contaminants goes well beyond the borders of any jurisdiction. The persistent bio-accumulative toxic contaminants (PBTs) impacting the Minnesota Chippewa Tribe have a regional, continental, and global depositional scale. The United States' output reduction of these PBTs needs to continue. Of equal importance, best available technologies must be exported to, and utilized, by industrialized and developing nations in order to reduce the global deposition of PBTs. This is the only way, we believe, that our Treaty protected fish consumption rights may ever again be fully exercised by our most at risk, and arguably most important citizens, women and children.

Source:

Percell, John, "Minnesota Chippewa Tribe Environmental Quality Indicators, Unpublished paper, 2002.

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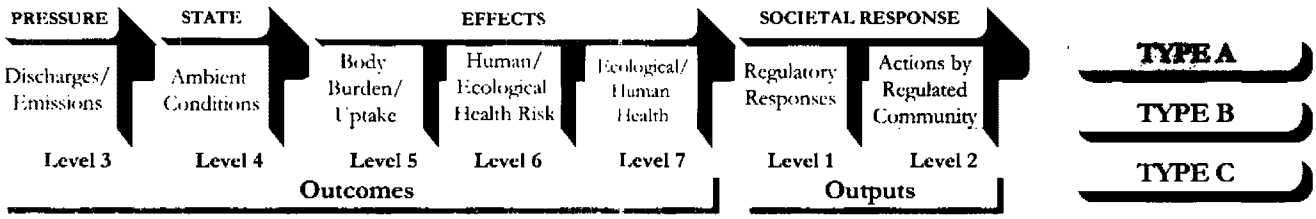


Indicator: Number of Active and Closed Underground Storage Tanks on Tribal Lands

An underground storage tank system (UST) is a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground (USEPA). The federal UST regulations pertain solely to underground tanks and piping that contain either petroleum or certain hazardous substances. Under UST regulations, owners and operators of USTs located on tribal lands must register with the EPA.

USTs can be of special concern to the environment and health of Native Americans because petroleum or other hazardous substances can leak into the soil and contaminate groundwater, an important source for drinking water. Among other enviromental and health risks associated with USTs is the potential for fire and explosion. Through the mid-1980's, the majority of USTs were constructed from bare steel, which eventually corrodes and causes the contents of USTs to seep out. Substandard installation or poor operating and maintenance measures can also lead USTs to discharge their contents into the environment.

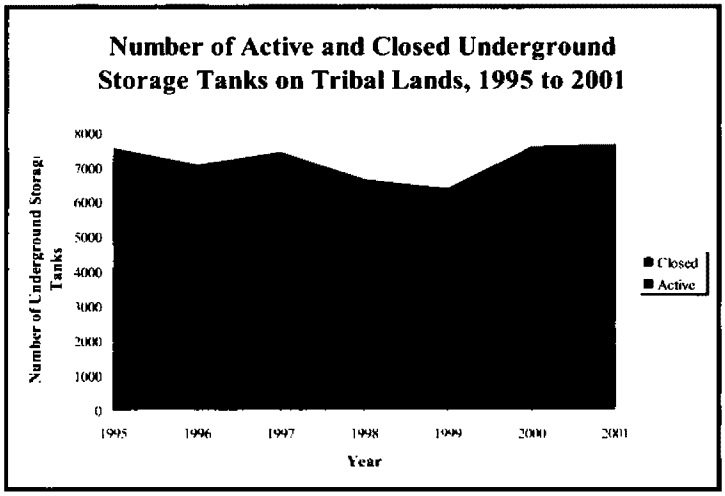
Although federal regulations call for technical requirements to install and operate new tanks, and to maintain and upgrade existing tanks, releases of UST contents still present a problem. Additional requirements for the correct operation of USTs consist of release detection, corrosion protection for metal USTs and piping, recordkeeping, release reporting, corrective action, and financial responsibility. Principally, the goals of UST regulations endeavor to prevent, identify, and clean up leaks and spills.

A substantial number of tribes own and/or operate service stations with underground storage tanks. There are also independently owned tanks located on tribal lands and within the exterior boundaries of Reservations.

The number of active and closed USTs on Indian lands can provide a way to measure the extent of their prevalence and their trend overtime. Closed USTs are older tanks which have minimized their threat to human health and the environment, particularly groundwater. Closing of an UST involves removing it from the ground or leaving it in the ground. Either way, the tank must be drained and cleaned by removing all liquids, dangerous vapor levels, and accumulated sludge. This is a very dangerous process which must be carried out by a trained professional. If an UST is left on the ground, it must be filled with a safe, chemically inactive solid, such as sand.

The following chart reveals the cumulative number of active and closed underground storage tanks on Native American lands.

- From 1995 to 2001 the number of active USTs has significantly declined, while the number of closed USTs has continued to substantially increase.



Source: Chart derived from Corrective Action Measures data as archived by the EPA Office of Underground Storage Tanks.

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: The data on active underground storage tanks does not include all petroleum tanks, it only includes the cumulative number of active petroleum UST systems registered with the State and regulated under Subtitle I of the Resource Conservation and Recovery Act. It does not include exempt or deferred UST systems. The number of closed underground storage tanks refers to the cumulative number of Subtitle I federally regulated petroleum UST systems that have been reported to the State as being closed permanently, which are either left in the ground or removed from the ground. This measure does not include exempt or deferred UST systems, nor does it include temporary closures (Corrective Action Measures). This data is based primarily on registration forms from owners and operators who have to register their tanks by law. Each EPA regional office is responsible for the data for their respective region. Although the data are collected cumulatively, the EPA allows tribal regions to make ongoing corrections to their data to account for errors such as overcounting. This will have a substantial effect on any given one year analysis. For this reason, it is best to focus on the overall trend, over time.

References

E-mail communication with Mr. William Lienesch, U.S. Environmental Protection Agency, Office of Underground Storage Tanks.

U.S. Environmental Protection Agency, Office of Underground Storage Tanks. *Corrective Action Measures*. Available online at: http://www.epa.gov/swerust1/overview.htm

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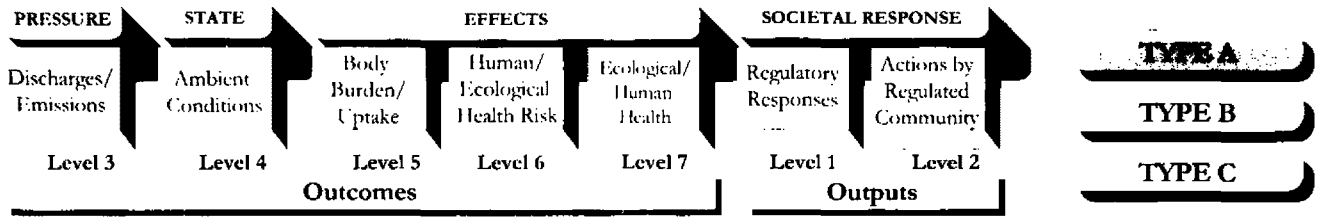


Indicator: Number of Confirmed Releases from Underground Storage Tanks on Tribal Lands

An underground storage tank system (UST) is a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground (USEPA). The federal UST regulations pertain solely to underground tanks and piping that contain either petroleum or certain hazardous substances. Under UST regulations, owners and operators of USTs located on tribal lands must register with the EPA.

USTs can be of special concern to the environment and health of Native Americans because petroleum or other hazardous substances can leak into the soil and contaminate groundwater, an important source for drinking water. Through the mid-1980's, the majority of USTs were constructed from bare steel, which eventually corrodes and causes the contents of USTs to seep out. Substandard installation or poor operating and maintenance measures can also lead USTs to discharge their contents into the environment.

Although federal regulations call for technical requirements to install and operate new tanks, and to maintain and upgrade existing tanks, releases of UST contents still present a problem. Additional requirements for the correct operation of USTs consist of release detection, corrosion protection for metal USTs and piping, recordkeeping, release reporting, corrective action, and financial responsibility. Principally, the goals of UST regulations endeavor to prevent, identify, and clean up leaks and spills.

A substantial number of tribes own and/or operate service stations with underground storage tanks. There are also independently owned tanks located on tribal lands and within the exterior boundaries of Reservations.

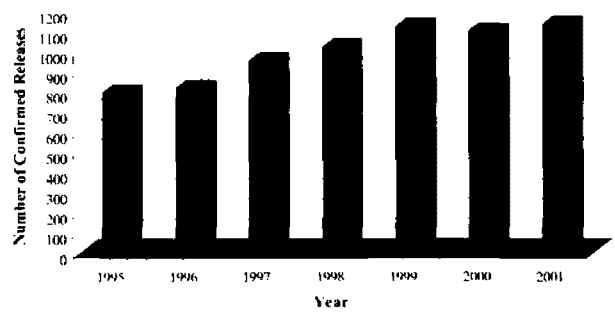
The cumulative number of confirmed releases on tribal lands from UST systems indicates the amount of incidents where an UST owner or operator has identified a release from a Subtitle I (of the Resource Conservation and Recovery Act) regulated petroleum UST system. All regulated tanks and piping must have release detection so that leaks are discovered quickly before contamination spreads from the UST site.

EPA's federal underground storage tank (UST) regulations require that contaminated UST sites must be cleaned up to restore and protect groundwater resources and create a safe environment for those who live or work around these sites. Petroleum releases can contain contaminants like MTBE and other pollutants of concern that can make water unsafe or unpleasant to drink. Releases can also result in fire and explosion hazards, as well as produce long-term health effects.

The following chart reveals the cumulative number of confirmed releases from underground storage tanks on tribal lands.

- The cumulative number of confirmed releases has steadily increased from 1995 to 2001.
- The greatest increase in confirmed releases occurred between 1996 and 1997, which was 134 more confirmed releases than the year before, while in year 2000, 1136 confirmed releases were reported.

Number of Confirmed Releases from Underground Storage Tanks on Tribal Lands, 1995 to 2001



Notes: In 2000, a slight drop on the number of confirmed releases from USTs occurred due to corrections made by the tribal regions. See Data Characteristics and Limitations.

Source: Chart derived from Corrective Action Measures data as archived by the EPA Office of Underground Storage Tanks.

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: The number of confirmed releases is a cumulative category, even as cleanup is initiated and completed, it is still counted as a confirmed release. A release which requires no further action as determined by the implementing agency would still be counted as a confirmed release. Further, the number of confirmed releases refers to the cumulative number of incidents and not UST systems, where the owner or operator of a Subtitle I regulated petroleum UST reported the release to a regulating authority, who has verified the release as dictated by state procedures, such as site visit, phone call, follow-up letter, or by other means that confirmed the release. Although the data are collected cumulatively, the EPA allows tribal regions to make ongoing corrections to their data to account for errors such as overcounting. This will have a substantial effect on any given one year analysis. For this reason, it is best to focus on the overall trend, overtime.

References

E-mail communication with Mr. William Lienesch, U. S. Environmental Protection Agency, Office of Underground Storage Tanks.

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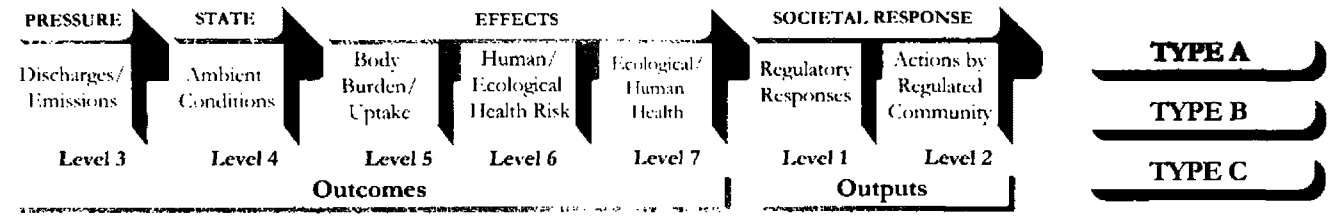


Indicator: Number of Emergency Responses from Underground Storage Tanks on Tribal Lands

An underground storage tank system (UST) is a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground (USEPA). The federal UST regulations pertain solely to underground tanks and piping that contain either petroleum or certain hazardous substances. Under UST regulations, owners and operators of USTs located on tribal lands must register with the EPA.

USTs can be of special concern to the environment and health of Native Americans because petroleum or other hazardous substances can leak into the soil and contaminate groundwater, an important source for drinking water. Among other enviromental and health risks associated with USTs is the potential for fire and explosion. Through the mid-1980's, the majority of USTs were constructed from bare steel, which eventually corrodes and causes the contents of USTs to seep out. Substandard installation or poor operating and maintenance measures can also lead USTs to discharge their contents into the environment.

The number of emergency responses as applied to this indicator, refers to the cumulative number of sites where an immediate action was taken by the implementing agency in order to mitigate imminent threats to human health and the environment caused by an UST system release. Emergency response actions can range from venting of explosive vapors to providing bottled water. If petroleum contamination is discovered during an emergency response, the site is considered to be both a confirmed release and an emergency response. Once a confirmed release is established, cleanup is initiated.

Although federal regulations call for technical requirements to install and operate new tanks, and to maintain and upgrade existing tanks, releases of UST contents still present a problem. Additional requirements for the correct operation of USTs consist of release detection, corrosion protection for metal USTs and piping, recordkeeping, release reporting, corrective action, and financial responsibility. Principally, the goals of UST regulations endeavor to prevent, identify, and clean up leaks and spills.

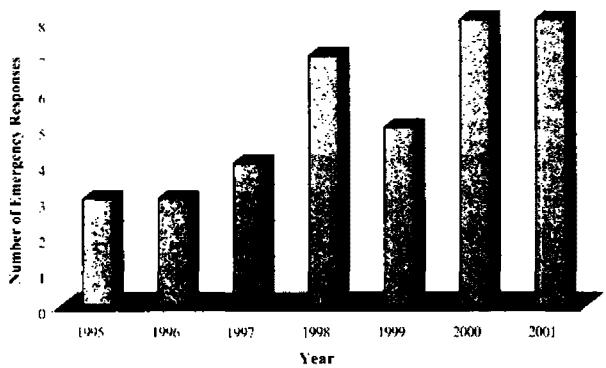
A substantial number of tribes own and/or operate service stations with underground storage tanks. There are also independently owned tanks located on tribal lands and within the exterior boundaries of Reservations.

The number of emergency responses on tribal lands can provide a way to measure the extent of their prevalence and the trend overtime of actions taken to decrease the threats that are posed by UST systems.

The following chart illustrates the cumulative number of emergency responses from underground storage tanks on tribal lands, from 1995 to 2001:

- The cumulative number of emergency responses has steadily increased from 1995 to 2001.

Number of Emergency Responses on Tribal Lands, 1995 to 2001



Notes: In 1999, the number of emergency responses on tribal lands decreased due to corrections made to the data by the tribal regions. See Data Characteristics and Limitations.

Source: Chart derived from Corrective Action Measures data as archived by the EPA Office of Underground Storage Tanks.

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: Data on the number of emergency responses is a cumulative category. Emergency responses are not included as cleanups initiated or cleanups completed unless unless activities listed under those categories have occurred (Corrective Action Measures). The number of emergency responses only account for those UST systems that are regulated by the EPA and that reported an emergency response. Although the data are collected cumulatively, the EPA allows tribal regions to make ongoing corrections to their data to account for errors such as overcounting. This will have a substantial effect on any given one year analysis. For this reason, it is best to focus on the overall trend, overtime.

References

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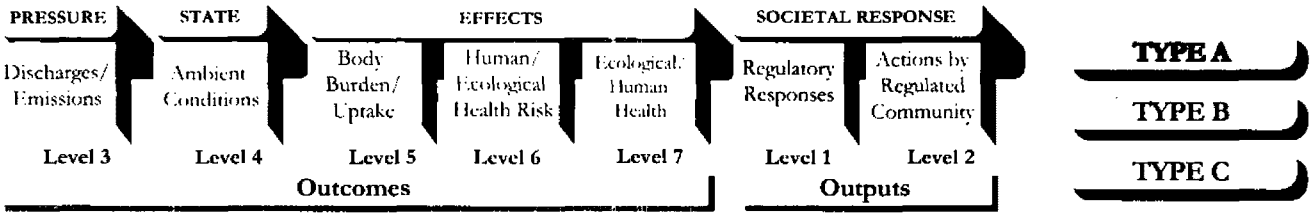


Indicator: Number of Underground Storage Tank Cleanups Initiated and Completed on Tribal Lands

An underground storage tank system (UST) is a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground (USEPA). The federal UST regulations pertain solely to underground tanks and piping that contain either petroleum or certain hazardous substances. Under UST regulations, owners and operators of USTs located on tribal lands must register with the EPA.

USTs can be of special concern to the environment and the health of Native Americans because petroleum or other hazardous substances can leak into the soil and contaminate groundwater, an important source for drinking water. Among other enviromental and health risks associated with USTs is the potential for fire and explosion. Through the mid-1980's, the majority of USTs were constructed from bare steel, which eventually corrodes and causes the contents of USTs to seep out. Substandard installation or poor operating and maintenance measures can also lead USTs to discharge their contents into the environment.

Although federal regulations call for technical requirements to install and operate new tanks, and to maintain and upgrade existing tanks, releases of UST contents still present a problem. Additional requirements for the correct operation of USTs consist of release detection, corrosion protection for metal USTs and piping, recordkeeping, release reporting, corrective action, and financial responsibility. Principally, the goals of UST regulations endeavor to prevent, identify, and clean up leaks and spills.

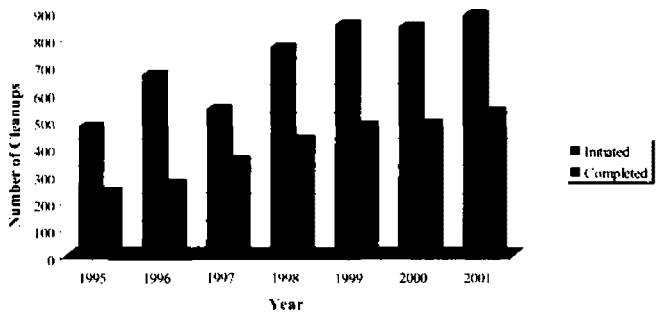
A substantial number of tribes own and/or operate service stations with underground storage tanks. There are also independently owned tanks located on tribal lands and within the exterior boundaries of Reservations.

Contaminated UST sites differ significantly. Some extremely contaminated sites where groundwater resources have been greatly harmed, may require years of cleanup activities that can cost over $ million. Other sites may contain little or no groundwater contamination, allowing cleanup contractors to restore the site more rapidly and at less cost. The number of UST cleanups initiated and completed can provide a way to measure the level at which such corrective actions have been necessary for federally regulated USTs on tribal lands.

The following chart reveals the cumulative number of underground storage tank cleanups initiated and completed on tribal lands.

- From 1995 to 2001 the number of cleanups initiated and completed have both increased.

Number of Underground Storage Tank Cleanups Initiated and Completed on Tribal Lands, 1995 to 2001



Notes: In 1997, the number of cleanups initiated on tribal lands decreased due to corrections made to the data by the tribal regions. See Data Characteristics and Limitations.

Source: Chart derived from Corrective Action Measures data as archived by the EPA Office of Underground Storage Tanks.

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: The data on UST cleanups initiated and completed does not include all petroleum tanks, it only includes the cumulative number of petroleum UST systems registered with the State and regulated under Subtit e I of the Resource Conservation and Recovery Act; where the state or state designated authority has initiated management of petroleum contaminated soil, removal of free product from the the surface or subsurface environment, management or treatment of dissolved petroleum contamination, or monitoring of the groundwater or soil being remediated by natural attenuation. Site investigations and emergency responses do not qualify unless one of the activities noted above has occurred (Corrective Action Measures Data). It does not include exempt or deferred UST systems. Each EPA regional office is responsible for the data from their respective region. Although the data are collected cumulatively, the EPA allows tribal regions to make ongoing corrections to their data to account for errors such as overcounting. This will have a substantial effect on any given one year analysis. For this reason, it is best to focus on the overall trend, overtime.

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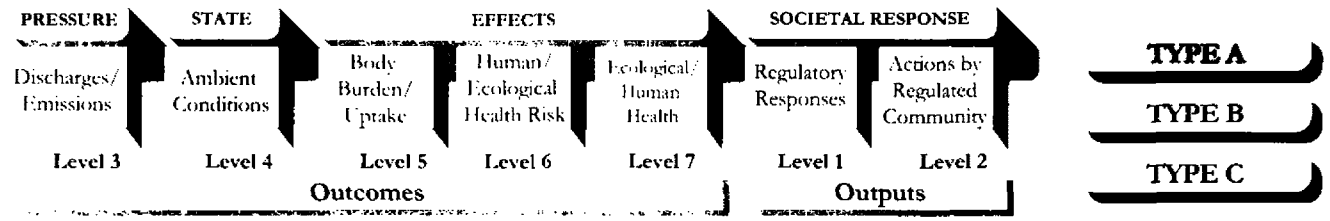


Indicator: Open Dump Sites on Tribal Lands

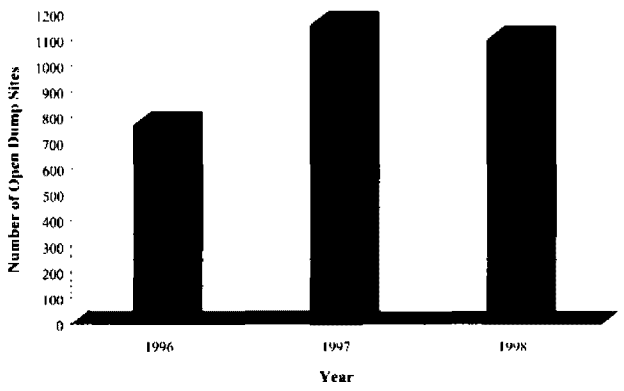
In 1994, Congress enacted The Indian Lands Open Dump Cleanup Act. According to the Act, an open dump is any facility or site where solid waste is disposed of which is not a sanitary landfill and which is not a facility for the disposal of hazardous waste (TASWER, 2002). This Act was the result of numerous studies that demonstrated the negative effects that open dump sites located on American Indian or Alaskan Native lands have on the health and safety of residents of those lands and contiguous areas. These negative effects include risk of fire, injury to children playing on or around the dump site, disease carried by mosquitos and rodents, soil and water contamination, and a decrease in surrounding land values (Illinois EPA, 2002). The purpose of the Act is to identify the location of open dumps on tribal lands, assess the relative health and environmental hazards posed by those sites, and provide financial and technical assistance to tribal governments to close the dumps (Indian Health Service, 1998).

Under the provisions of the Act, the Director of the Indian Health Service (IHS) is assigned responsibility for the development of an inventory of all open dump sites on Indian lands. The results of this ongoing process are the annual Reports on the Status of Open Dumps on Indian Lands.

This indicator measures the number of open dump sites identified on tribal lands in 1997 and 1998. The year to year changes in this indicator reflect a decrease in the total number of sites coupled with increases resulting from the inclusion of newly identified sites.

- The number of open dumps on Indian lands decreased 5% between 1997 and 1998.
- The considerable increase of open dump sites after 1996 is attributed to an emphasis on including sites smaller than ½ acres in size, as well as efforts by Tribes to identify open dump sites not previously accounted for.

Open Dump Sites on Tribal Lands, 1996 to 1998



Source: Indian Health Services. Data found in the 1998 Status of Open Dumps on Indian Lands report.

Scale: Data are comparable on a national level.

Data Characteristics and Limitations: Open dump site identification is an ongoing process, and it is expected that the number of sites will continue to increase. Completion of the open dump inventory is accomplished using limited existing resources, in an attempt to gather as much information as possible without reducing other health services. The comprehensiveness of the inventory is also affected by the fact that some tribes declined permission to include dump sites within their lands. The results of this survey should be viewed as a preliminary identification of open dump sites on Indian lands, which require additional evaluation and analysis when necessary resources are made available (Indian Health Service, 1998).

References

Illinois Environmental Protection Agency, Bureau of Land. 2002. *Open Dumps*. Available online at: http://www.epa.state.il.us/land/open-dumps/

Indian Health Services. 1998. *Status of Open Dumps on Indian Lands*. Available online at: www.epa.gov/tribalmsw/pdftxt/98report.pdf

Tribal Association on Solid Waste and Emergency Response (TASWER). 2002. *Open Dump Definitions and Examples*. Available online at: *http://www.taswer.org/odump1.html*

CROSS-PROGRAM INITIATIVES

List of Initiatives

Product Stewardship

Pollution Prevention

CROSS-PROGRAM INITIATIVE ISSUE 1: PRODUCT STEWARDSHIP

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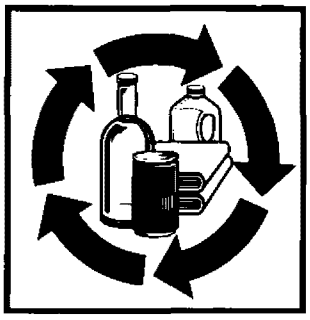
Industry Disposal of Pesticide Containers

The United States Environmental Protection Agency's Design for the Environment Program

Volume of Pesticides and Toxic Chemicals Recovered by Clean Sweep Programs

CROSS-PROGRAM INITIATIVE ISSUE 1:

PRODUCT STEWARDSHIP



An important concept that supports the goal of source reduction is product stewardship, which takes a product-oriented view of protecting the environment. Stewardship calls upon all parties within the lifecycle to participate in reducing environmental effects. At the heart of this model is the producer, since this represents the greatest opportunity for reducing these effects. Through waste minimization and reduction of the toxicity of manufacturing processes, as well as recycling programs, businesses can effectively become stewards of the environment. Additionally, retailers, consumers, and governments are increasingly contributing to the model through purchasing choices and stakeholder participation with waste managers.

Industry is increasingly taking responsibility for the environmental quality and impacts of its products. This may include taking steps to ensure that products are safe to use, or may take a more long-term perspective by integrating concepts such as health, safety, and environmental protection into the life-cycle of products. This life-cycle analysis includes the manufacture, marketing, distribution, use, recycling, and disposal of particular products.

Product stewardship, however, goes beyond the manufacturer. Retailers have an important role to play. By choosing products with high stewardship value to sell, they can direct consumers to products with relatively high environmental value and emphasize those products in the marketplace. Consumers also have a key role. By choosing products with high stewardship value, they can direct the market to support such products.

EPA is actively working with a variety of industries to improve and support stewardship activities. Such industries include producers of tires, carpet, packaging materials, building materials, electronics, vehicles, batteries, and products containing mercury.

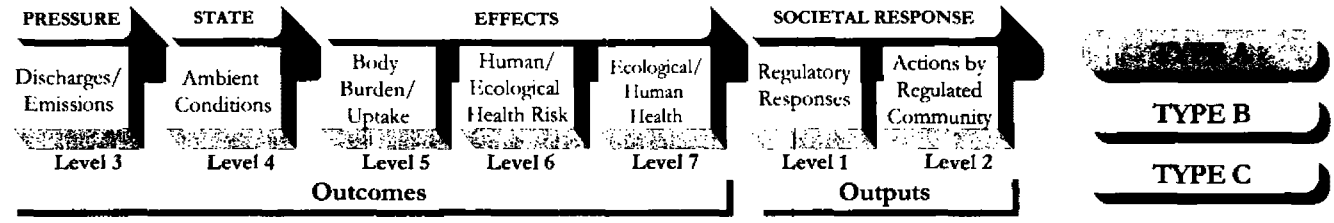
The measurement of life-cycle stewardship for indicator purposes is not well-developed and is presently tied to specific efforts by individual companies to better manage their products. The voluntary, nonregulatory nature of product stewardship as well as the lack of a central program to manage activities and collect data currently limits indicator development. As momentum develops for stewardship and cooperative governmental and private programs expand, the potential for effective indicator development may increase.

References

U.S., EPA, Perspectives from the Pharmaceutical Industry and Examples of Corporate Stewardship Programs, http://www.epa.gov/nerlesd1/chemistry/ppcp/relevant.htm#Perspective

U.S. EPA, Product Stewardship, http://www.epa.gov/epaoswer/non-hw/reduce/epr/about/index.html

PRODUCT STEWARDSHIP



Indicator: Industry Disposal of Pesticide Containers

Industry is increasingly taking responsibility for the environmental quality and impacts of its products. These efforts often referred to as product stewardship or extended product responsibility (EPR), call on those involved in the product life cycle -- manufactures, retailers, users, and disposers to share responsibility for reducing the environmental impacts of products. Common activities of these industries include reducing the use of toxic substances, designing for reuse and recyclability, and takeback programs (U.S. EPA 2001).

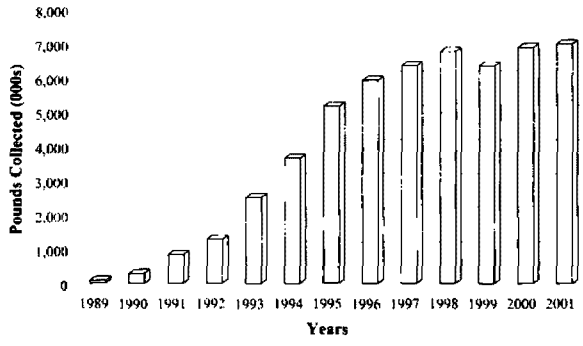
An example of a program that provides an opportunity for companies to become better product stewards is the Agricultural Container Research Council's (ACRC), pesticide container recycling program. The ACRC is a non-profit organization that promotes and supports collection and recycling of high-density polyethylene (HDPE) plastic crop protection and other pesticide product containers. The fundamental purpose of ACRC is the collection of used pesticide plastic containers and their removal as a potential source of environmental contamination. Pesticide containers are obtained from agricultural and professional end-users only.

This program represents an important opportunity to measure industry based product stewardship activities. The removal of pesticide containers from agricultural operations prevents the possibility of their inadvertent release to the environment. This reduces the risks these chemicals pose to human and ecological health. In addition to the recycling of pesticide containers the ACRC also sponsors research programs to develop end uses for cleaned, recycled pesticide containers to further implement product stewardship efforts.

The following chart shows the amount of pesticide containers recycled between 1989 and 2001. An increasing trend in the number of pounds of pesticide containers recycled indicates an increase in industry based product stewardship.

- 7,008,000 million pounds of HDPE were recycled in 2001.

Industry Disposal of Pesticide Containers, 1989-2001



Source: Agricultural Container Research Council, 2001

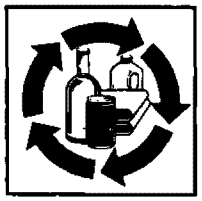
Scale: National

Data Characteristics and Limitations: Data are analyzed and reported annually. Currently the ACRC is supported by twenty-seven full member companies and six affiliate members. Participation in the ACRC is voluntary. The ACRC contracts with two firms for collection and chipping/granulation of containers returned to state sites. Other pesticide product containers collected by the ACRC include EPA registered products including agricultural, turf, forestry, vegetative management, specialty pest control (excluding consumer packages), as well as adjuvants, crop oils, and surfactants.

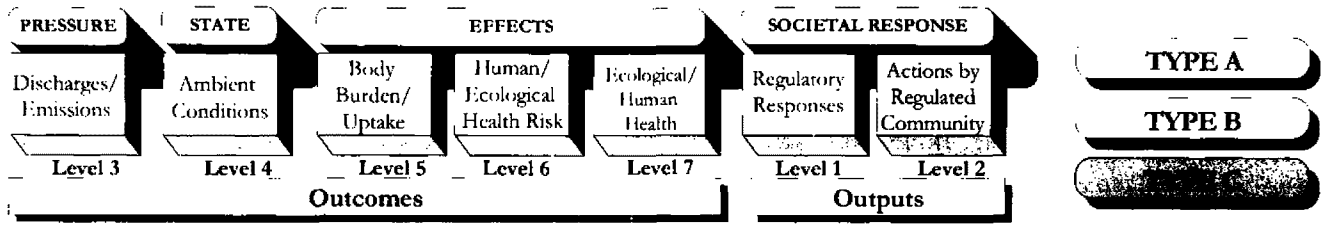
References

Agricultural Container Research Council. 2001. "Annual Container Collections 1989-2001". January 6,2003. Available online at: http://www.acrecycle.org/collections.html

U.S. Environmental Protection Agency, Office of Solid Waste. 2001. "What is Product Stewardship?" January 6,2003. Available online at: http://www.epa.gov/epr/about/index.html



PRODUCT STEWARDSHIP-
PRODUCT LIFE CYCLE



Indicator: The United States Environmental Protection Agency's Design for the Environment Program

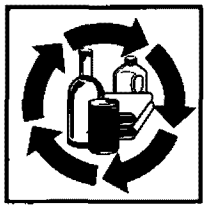
Information on programs that reduce the amount of toxic chemicals used by industry, and influence the manner in which toxics are used, can be developed into an indicator of pollution source reduction efforts in general

The Design for the Environment (DfE) program is intended to work with individual industry sectors to compare and improve the performance and human health and environmental risks and costs of existing and alternative products, processes, and practices. DfE works through developing partnership projects to promote integrating cleaner, cheaper, and smarter solutions into everyday business practices. The program has been active in a number of industries and has suggested improvements to reduce the environmentally harmful effects of an array of processes. Currently DfE maintains partnership programs with the following industries: Automotive Refinishing, Adhesives, Computer Display, Garment & Textile Care, Flexographic Printing, Formulator, Gravure Printing, Industrial & Institutional Laundry, Integrated Environmental Management Systems, Lead-Free Solder, Lithographic Printing, Printed Wiring Board, and Screen Printing. The partnerships work to address a wide range of environmentally related issues in these fields

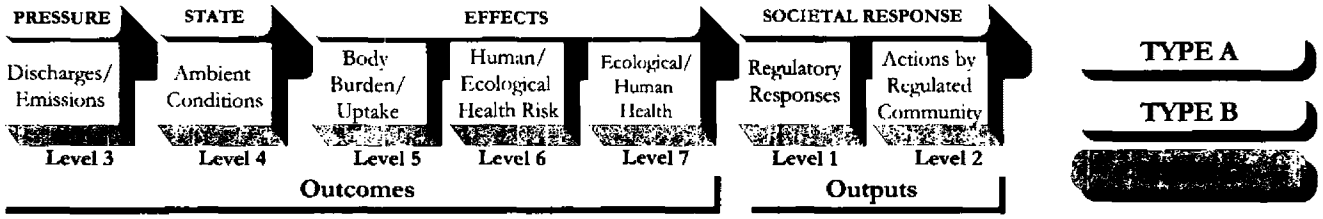
EPA also supports using "benign by design" principles in the design, manufacture, and use of chemicals and chemical processes—a concept known as "green chemistry." EPA's Green Chemistry Program promotes the research, development, and implementation of innovative chemical technologies that prevent pollution in both a scientifically sound and cost-effective manner. In addition, EPA's emerging Green Engineering Program strives to help academia introduce a "green" philosophy into undergraduate chemical engineering curricula. The DfE Program works with these and other related programs such as the Green Engineering Program and the Environmentally Preferable Purchasing Program.

Source: The United States Environmental Protection Agency's Design for the Environment Program Website: http://www.epa.gov/opptintr/dfe/, December 6, 2002

Data Characteristics and Limitations: EPA DfE Programs are designs for improving the environmental performance of specific industries and this industry specific nature makes evaluation of the effectiveness of the program as a whole difficult.



PRODUCT STEWARDSHIP



Indicator: Volume of Pesticides and Toxic Chemicals Recovered by Clean Sweeps Programs

Clean Sweep programs are a loosely coordinated group of state-managed programs that collect unused, unwanted or obsolete agricultural pesticides, household pesticides and toxic chemicals. Some programs recover only household wastes such as unused automotive products, solvents, paints, household cleaners, pesticides and other household chemicals. Other programs accept pesticides and hazardous wastes from agricultural producers and from small businesses. Once collected by the Clean Sweep program, these hazardous materials are characterized and disposed of properly.

These programs represent an important opportunity to measure governmental and community stewardship activity. The removal of large amounts of unused or obsolete hazardous chemical substances from homes, farms and firms prevents the possibility of their inadvertent release to the environment. This reduces the risks these chemicals pose to human and ecological health.

Participation in the Clean Sweep program is patchy within and across states. In total, forty states have some level of participation. Twenty-one states have continuous programs with permanent funding while another eight states have continuous programs with non-permanent funding. Another twelve states have intermittent programs, five states have held a single collection event, and four states have never administered a Clean Sweep program.

As mentioned earlier, the types of activities conducted by each program are inconsistent. Programs collect different kinds of materials and have varying schemes for counting and characterizing what they collect. Currently, data on Clean Sweep programs are not collected or reported on an annual basis.

As a result of these limitations, an indicator cannot be presently developed that tracks the performance of Clean Sweep programs. The EPA, however, is attempting to identify and develop some Clean Sweep data parameters that may eventually allow the development of such an indicator.

The table on the following page summarizes the preliminary Clean Sweep data that have been collected to date.

National Clean Sweep Program Profile

State	Category	Initial Year	Universal Waste?	Pounds Collected in the 1980s	Total Pounds Collected
Alabama	Intermittent	1994	Yes	0	189,393
Alaska	Never	NA	Unknown	0	0
Arizona	Never	NA	Yes	0	0
Arkansas	Once [1]	1992	Yes	5,000	5,000
California	Continuous	1989	No	87,820	1,186,828
Colorado	Intermittent	1995	Yes	0	68,665
Connecticut	Intermittent	1990	No	0	46,100
Delaware	Once	1992	Yes	0	30,423
Florida	Intermittent [1]	1995	Yes (for 2001)	0	89,400
Georgia	Continuous	1995	Yes	0	778,032
Hawaii	Intermittent	1987	Yes	17,471	17,471
Idaho	Permanent	1993	Yes	0	310.689
Illinois	Intermittent [2]	1990	Yes	0	252,316
Indiana	Continuous	1990	Yes	0	60,069
Iowa [6]	Permanent	1986; Permanent in 1991	Yes	No data available	909,154
Kansas	Permanent	1995; Permanent in 1999	Adopted	0	237,455
Kentucky	Permanent	1991; Permanent in 1995	Yes	0	256,084
Louisiana [3]	Intermittent	1992	Yes	0	408,200
Maine	Continuous	1982; Continuous in 1996	Yes	86,000	116,987
Maryland	Continuous	1995	No	0	86,990
Massachusetts	Continuous	1990; Continuous in 1998	Yes	0	147,115
Michigan [3]	Permanent	1990	Yes	0	710,000
Minnesota	Permanent	1989	Unknown	32,396	1,902,686
Mississippi	Permanent (sunset 5 yrs)	1994	Yes	0	839,727
Missouri [3]	Intermittent	1990	Yes	0	8,900
Montana	Permanent	1994	Yes	0	179,186
Nebraska	Intermittent	1995	Yes	0	1,336,033
Nevada	Permanent	1995	Yes	0	47,564
New Hampshire	Once	1990	No	0	20,000
New Jersey [4]	Continuous	1989	Unknown	10,535	371,450
New Mexico	Never	NA	No	0	0
New York [3]	Intermittent	1993	Adopted, not yet authorized	0	217,906
North Carolina [5]	Permanent	1980	Yes	200,000	1,094,517
North Dakota	Permanent	1992	Yes	0	1,029,230
Ohio	Permanent	1993	Adopted, not yet authorized	0	1,088,713
Oklahoma	Never	NA	Yes	0	0

Oregon	Continuous	1991; Continuous in 1997	Yes	0	178,367
Pennsylvania [6]	Permanent	1993	Yes	0	920,189
Rhode Island	Once	1990	No	0	Unknown
South Carolina	Intermittent [1]	1988	Adopted, not yet authorized	6,743	7,100
South Dakota	Permanent	1993	Yes	0	231,403
Tennessee	Permanent	1998	Yes	0	300,000
Texas	Permanent	1992	Yes	0	3,149,820
Utah	Permanent	1993	Unknown	0	118,616
Vermont	Permanent	1991; Permanent in 1996	Yes	0	65,953
Virginia	Permanent	1990; Permanent in 1992	Yes	0	737,448
Washington	Permanent	1988	No for pesticides	84,555	1,008,289
West Virginia	Intermittent	1994	Yes	0	239,430
Wisconsin	Permanent	1990	Yes	0	1,269,995
Wyoming	Once	1992	Adopted, not yet authorized	0	16,000
TOTAL				530,520	22,284,893

Notes:

1 Arkansas and Florida are working to establish programs in 2001. South Carolina is also actively trying to start a program.

2 Illinois hopes to hold at least 1 to 3 collections on an annual basis.

3 These profiles (Louisiana, Michigan, Missouri and New York) have not yet been reviewed by a state contact.

4 The New Jersey information is from household waste collections and includes agricultural and household pesticides. There are some data that still need to be added to this total.

5 For North Carolina, the 1980s amount is an estimate, based on the information EPA holds: 318,711 pounds were collected "pre-1992."

6 Iowa and Pennsylvania's totals are through 1999; there is a good possibility that the current totals are over 1 million pounds.

Source:

Summary Sheet, Provided by Nancy Fitz, Office of Prevention, Pesticides and Toxic Substances, U. S. Environmental Protection Agency, 703-305-7385.

CROSS PROGRAM INITIATIVE ISSUE 2: POLLUTION PREVENTION

List of Indicators

RCRA Hazardous Waste Generated, by Volume and Type

RCRA Hazardous Waste Managed, by Volume and Method of Management

TRI Pollution Prevention Measures

Northeast Waste Management Officials' Association (NEWMOA) Pollution Prevention Metrics Menu

Quantity of Toxic Chemicals Generated as Non-Product Output in New Jersey

Trends in Use of Toxic Chemicals in Massachusetts After Institution of the Toxics Use Reduction Act

Persistent, Bioaccumulative Toxin Use in Massachusetts

Responsible Care Measures

Dow Chemical Company's Efforts as an Example of Pollution Prevention

Dupont Chemical Company's Efforts as an Example of Pollution Prevention

Dry Cleaning Industry Perchloroethylene Decline

Toxicity of Releases and Managed Waste per Dollar of Economic Output Index

Toxicity Per Pound Index for Releases and Managed Waste

Volume of RCRA Hazardous Waste Generated per Dollar of U.S. Gross Domestic Product (GDP)

CROSS-PROGRAM INITIATIVE ISSUE 2:

POLLUTION PREVENTION

Pollution prevention was established as national policy in the Pollution Prevention Act of 1990. Pollution prevention describes a philosophy that is thoroughly integrated into the organizational culture of environmental agencies, an important agency policy to which all programs must be responsive, and an explicit set of programs designed to meet identifiable pollution prevention objectives. At its core is the idea that the prevention of pollution from occurring at all is the most effective pollution related strategy. The most fundamental form of pollution prevention is source reduction, which is the reduction of generated pollution. The objective of pollution prevention programs is to reduce or eliminate the need to control, treat, dispose and cleanup pollutants, and to alleviate the negative health and quality of life consequences of pollution. Effective pollution prevention strategies and programs will reduce the short- and long-term stresses on the environment. P2 is a fundamental building block of a sustainable society. Three core issues were identified.

Issue Dimensions

Waste

Waste is an unavoidable by-product of daily life. While it is impossible to eliminate the generation of waste entirely, it is important that attention be paid to the type of waste that is generated, as some types of waste pose more environmental risks than others. By definition, hazardous waste poses the most environmental risks. According to the EPA, for waste to be considered hazardous it must first be defined as solid waste (1997). Solid waste includes such discarded material as garbage, refuse, and sludge (solids, semisolids, liquids, or contained gaseous materials). These types of waste are considered hazardous only if they exhibit characteristics of ignitability, corrosivity, reactivity, or toxicity. Other types of wastes may be considered hazardous if they are specifically listed as such by the EPA. In 1997, the EPA estimated that more than 2% of the 13 billion tons of industrial, agricultural, commercial, and household wastes were defined as hazardous by the Resource Conservation and Recovery Act (RCRA).

The Resource Conservation and Recovery Act was passed in 1976. The primary goals of this act are to protect human health and the environment from the potential hazards of waste disposal; conserve energy and natural resources; reduce the amount of waste generated; and ensure that wastes are managed in an environmentally sound manner (1997). Part of the RCRA mandate is to establish the regulatory framework for "cradle-to-grave" management of hazardous wastes.

Source Reduction

According to the National Pollution Prevention Roundtable, pollution prevention is the reduction or elimination of pollution at the source. Pollution prevention occurs when raw materials and other substances are subtracted from the production process. Source reduction allows for the greatest and quickest improvements in environmental protection by avoiding the generation of waste and reducing its toxicity. This includes purchasing durable, long-lasting goods and seeking products and packaging that are as free of toxics as possible. It ranges from creating less waste in production processes to more efficient design of products to extend their use.

Recycling and Reuse

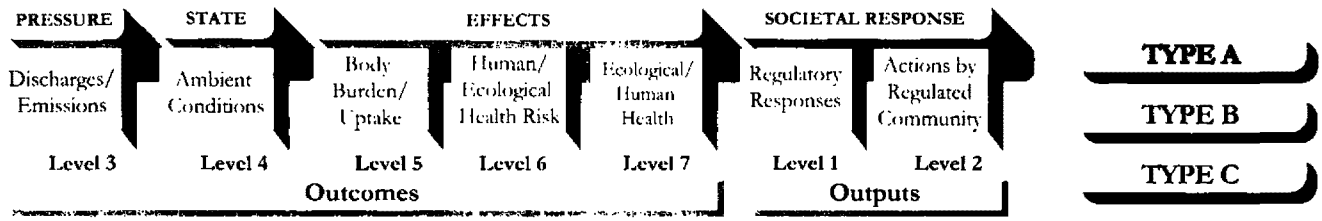
Recycling processes materials that are destined to be waste into valuable resources that can be used in new products. This strategy, including composting, has been a very successful tool for conserving materials, diverting 64 million tons of material away from landfills and incinerators in 1999, up from 34 million tons in 1990. Included in this subissue are

not only consumer products such as packaging, glass, newspaper, and other nondurables, but also industrial by-products, used oil, and yard waste (composting). As greener technologies emerge and marketing of products made with recycled materials increases, options for recycling will continue to expand. Reuse involves using a product multiple times for its original intended use. The reuse of packaging materials or of toner cartridges for printers and copy machines would reflect reuse.

Eco-Efficiency

To some degree, the performance of the economy affects the demand for chemicals and can generate fluctuations in energy and water use, the amount of materials used and the amount waste and pollution produced. Such fluctuations may mask actual increases in environmental efficiencies by industry. Eco-efficiency measures standardize environmental outcomes by establishing a ratio between energy use, water use, materials waste, and pollution, and some measure of economic output. For example, these measures might permit industry, in periods when levels of waste and pollution are rising only because of accelerated economic growth, to show that they are maintaining or improving their waste or pollution-related efficiencies. Situations could also arise in which lower levels of waste and pollution reflect economic stagnation or recession and mask pollution inefficiencies. By standardizing progress, eco-efficiency measures facilitate a more accurate assessment.

POLLUTION PREVENTION
WASTE



Indicator: RCRA Hazardous Waste Generated, by Volume and Type

Hazardous waste is any waste that is ignitable, corrosive, reactive or contains certain amounts of toxic chemicals. Because the improper management of hazardous waste creates significant risks for the environment and human health, it is regulated "cradle-to-grave" by the Resource Conservation and Recovery Act (RCRA). The RCRA is a set of laws and standards for the production, storage, treatment and disposal of hazardous wastes.

Even with proper storage and treatment, there is always the potential for accidents that could result in: groundwater contamination, releases of toxic chemicals, or environmental transport of toxic vapors or liquid wastes. To minimize the risk of these hazards, the EPA has set a goal to reduce the quantity of hazardous waste generated in the U.S.

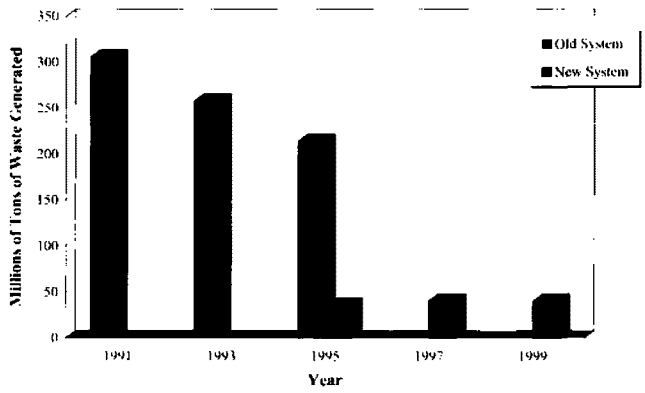
This indicator tracks the progress toward that goal. It monitors the volume of RCRA hazardous waste generated, as reported through the Biennial Reporting System (BRS). Due to a change in the BRS (see notes below chart), future data will be comparable only from 1997 onward.

- The volume of hazardous waste generated decreased considerably from 1991 to 1995: from 306 million tons to 214 million tons.
- From 1995 to 1999, there was a slight increase in the volume of hazardous waste generated, from 36 million tons to 40 million tons.

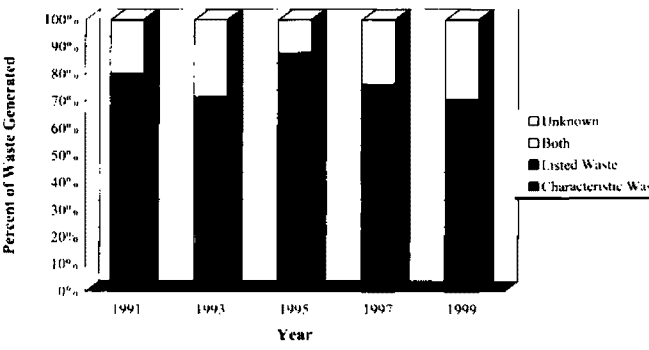
The EPA is also committed to reducing the toxicity of waste generated. The second chart shows the categorization of hazardous waste generated from 1991 to 1999. For the purpose of comparing relative toxicity, a waste that is both characteristic and listed (see notes for definition) is inferred to be more toxic than waste that is only characteristic or listed.

- From 1991 to 1999, the percentage of characteristic waste generated decreased (72% to 52%).
- From 1991 to 1999, the generation of listed waste increased significantly (8% to 18%).
- From 1991 to 1999, the generation of waste that is both characteristic and listed has also increased substantially (19% to 29%).

Tons of RCRA Hazardous Waste Generated 1991-1999



Percentage of RCRA Hazardous Waste Generated by Category, 1991-1999



Notes: In 1997, the scope of information collected for reporting by the Biennial Report changed. The new reports exclude data on all aqueous wastes managed in treatment systems regulated by the Clean Water Act. This information had been included in the 1991-1995 reports. The only type of wastewaters for which the new system collects and reports data are those managed by deepwell/underground injection.

Characteristic wastes refer to any solid waste that exhibits one or more of the following characteristics: ignitability, corrosivity, or reactivity or contains toxic constituents in excess of Federal standards. Listed wastes refer to any waste that the EPA has identified as hazardous as a result of investigations into particular industries or because the EPA has specifically recognized a commercial chemical waste's toxicity.

Source: US EPA, Office of Solid Waste and Emergency Response, National Hazardous Waste Reports for 1991-1999

Scale: Data is collected and reported at the national and state levels.

Data Characteristics and Limitations: The BRS is a national system that collects data on the generation, management and reduction of hazardous waste. Large quantity generators of hazardous waste are required to submit detailed reports about the quantity and characteristics of hazardous waste generated. The BRS also collects data on waste management practices from treatment, storage and disposal facilities.

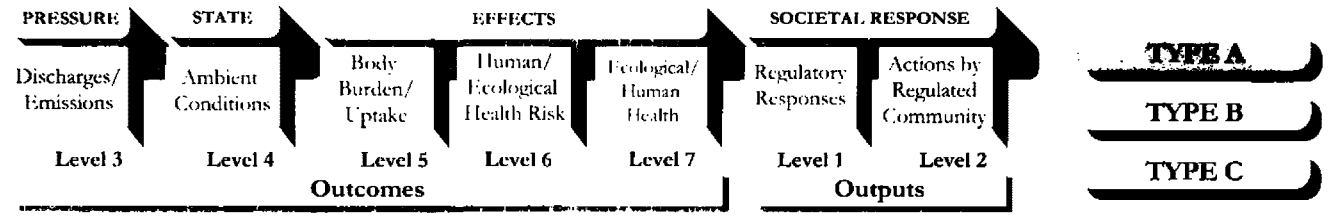
Data is reported in even years about hazardous wastes generated, managed and disposed of the previous year. Data is reported at the state and national level.

References

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER), *National Biennial RCRA Hazardous Waste Report* (1991-1999). 9 January 2003. Available online at http://www.epa.gov/epaoswer/hazwaste/data/

U.S. Environmental Protection Agency Strategic Plan. September 1997.

POLLUTION PREVENTION
WASTE



Indicator: RCRA Hazardous Waste Managed, by Volume and Method of Management

Hazardous waste is any waste that is ignitable, corrosive, reactive, or contains certain amounts of toxic chemicals. Hazardous wastes are regulated "cradle-to-grave" by the Resource Conservation and Recovery Act (RCRA). The RCRA is a set of laws and standards for the production, storage, treatment and disposal of hazardous wastes.

Management methods for hazardous wastes include: aqueous treatment, land disposal, recycling/recovery, incineration and miscellaneous methods (e.g., sludge treatment). Different types of waste require different methods of treatment and disposal. However, certain management methods pose greater risks to the environment and human health than others. Improper land disposal often results in groundwater contamination. The incineration of hazardous wastes at combustion facilities can result in the emission of dioxins and furans, which are persistent organic pollutants (POPs).

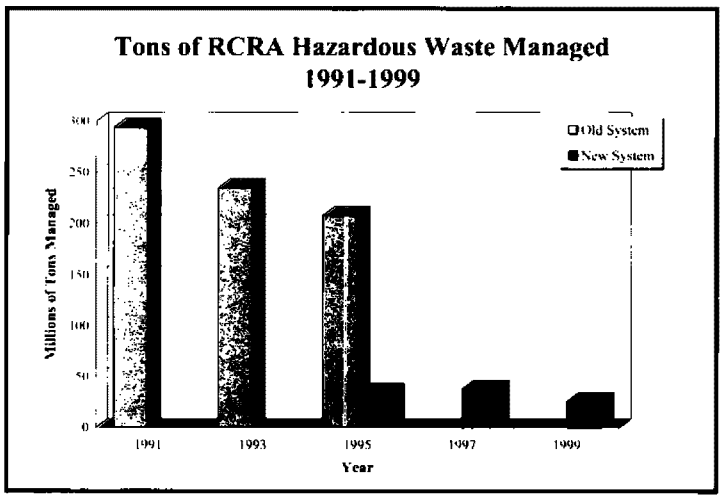
To minimize the risk of these hazards, the EPA has set goals to reduce the quantity of hazardous waste landfilled and incinerated in the U.S. This indicator tracks the progress toward those goals. The EPA is also committed to increasing the recovery/recycling of hazardous wastes, which is also tracked here. This indicator monitors the overall volume and the percentage of RCRA hazardous waste managed by each method, as reported by the Biennial Reporting System (BRS). Due to a change in the BRS (see notes below chart), future data will be comparable only from 1997 onward.

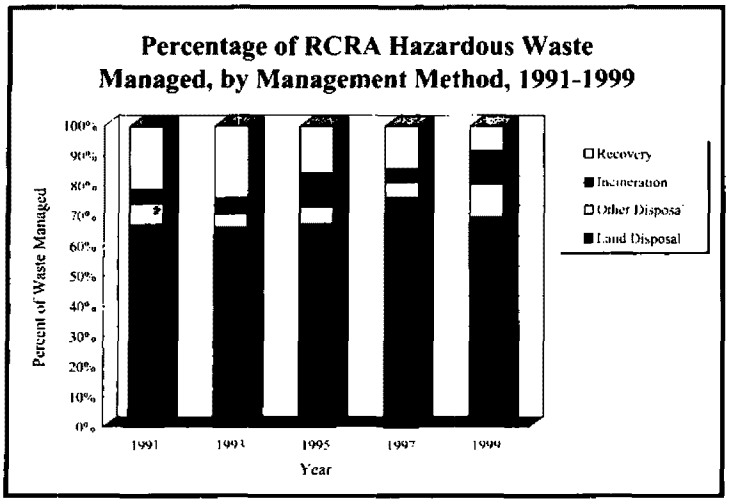
The first chart reports the total amount of RCRA waste managed from 1991-1999 in millions of tons.

- From 1991 to 1995, the volume of RCRA hazardous waste managed decreased by 86 million tons.
- Under the new reporting system, the volume of RCRA hazardous waste managed increased by 3 million tons from 1995 to 1997, and decreased by 12 million tons from 1997 to 1999.

The second chart shows the percent of hazardous waste managed by each method for the same time period (1991-1999).

- From 1991 to 1995, there was an increase in the shares of hazardous wastes managed by land disposal (from 8.6% to 12.3%) and incineration (from 0.6% to 2.1%).
- From 1997 to 1999, there was a decrease in the share of hazardous wastes managed by land disposal (from 76.2% to 69%), and an increase in incineration (from 4.4% to 11%) and other treatment (5.4% to 11%). Other hazardous waste management treatment and disposal practices include stabilization, and sludge treatment.





Notes: In 1997, the scope of information collected for reporting by the Biennial Report changed. The new reports exclude data on all aqueous wastes managed in treatment systems regulated by the Clean Water Act. This information had been included in the 1991-1995 reports. The only type of wastewaters for which the new system collects and reports data are those managed by deepwell/underground injection. To facilitate the comparison of management methods over time, aqueous treatments were excluded from the calculation of the percentage of total waste managed.

Source: US EPA, Office of Solid Waste and Emergency Response, National Hazardous Waste Reports for 1991-1999

Scale: Data is collected and reported at the national and state levels.

Data Characteristics and Limitations: The BRS is a national system that collects data on the generation, management and reduction of hazardous waste. Large quantity generators of hazardous waste are required to submit detailed reports about the quantity and characteristics of hazardous waste generated. The BRS also collects data on waste management practices from treatment, storage and disposal facilities.

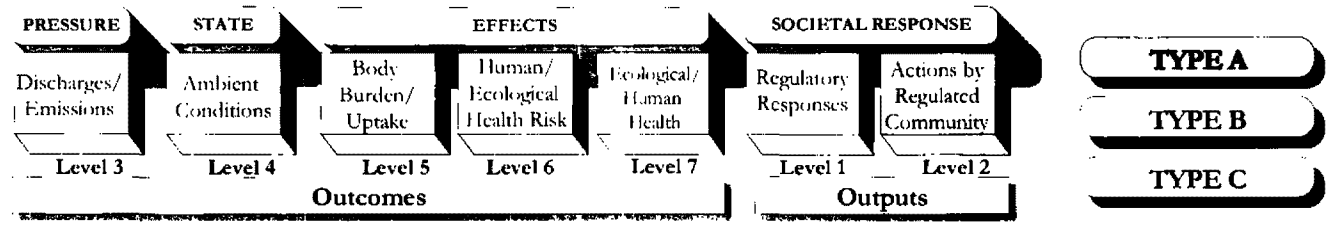
Data is reported in even years about hazardous wastes generated, managed and disposed of the previous year. Data is reported at the state and national level.

References

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response (OSWER), *National Biennial RCRA Hazardous Waste Report* (1991-1999). 9 January 2003. Available online at http://www.epa.gov/epaoswer/hazwaste/data/

U.S. Environmental Protection Agency Strategic Plan. September 1997.

POLLUTION PREVENTION
SOURCE REDUCTION



Indicator: TRI Pollution Prevention Measures

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating a toxicity score for each chemical. The toxicity score is multiplied by the pounds of chemical released or managed in waste; the toxicity of each chemical release and waste stream can be aggregated to provide an estimate of the total toxicity of releases and managed waste for a given year.

The toxicity-refined TRI data can be used to evaluate the success of governmental pollution prevention (P2) programs and of private sector efforts to improve pollution related efficiencies. There are two levels of pollution prevention at which TRI data can be analyzed. The first level is to compare how much pollution toxicity is released with how much is managed in waste. In the Pollution Prevention Act of 1990, release into the environment is identified as the least preferred option for pollution management. Therefore, a favorable P2 trend for this indicator would be an increasingly greater proportion of pollution toxicity managed in waste.

The second level of pollution prevention analysis can be conducted in the managed waste component of the TRI. The extent of pollution prevention in TRI waste management can be discerned by comparing the amount of pollution toxicity managed by each method. The Pollution Prevention Act of 1990 established as national policy a hierarchy of waste management options for situations where source reduction is not feasible. The hierarchy, from most to least preferred method, is: recycling, energy recovery, treatment and disposal. Therefore, a favorable P2 trend for this indicator would reflect waste management occurring at the highest levels of the hierarchy.

Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total toxicity of releases into the environment and managed chemical waste. It can be inferred, however, as a measure of the relative gains the U.S. is making in pollution prevention and improving pollution efficiencies.

There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of pollution prevention in the U.S.

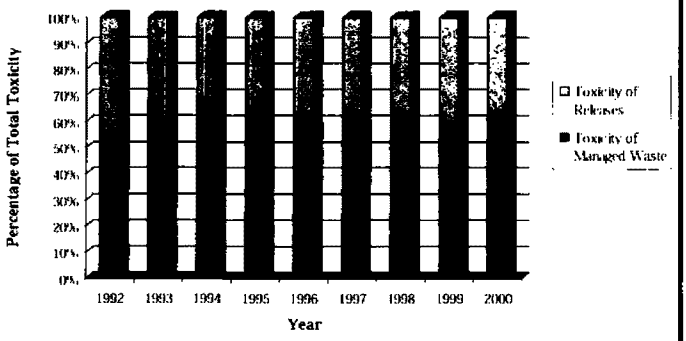
Two different subsets of TRI data are reflected in the presented charts. The first and third charts reflect data for a core list of chemicals that have been reported every year since the inception of TRI in 1988; however, the chart reflects data beginning in 1992, which is when recycling, energy recovery and treatment operations were incorporated into TRI. The second and fourth charts reflect data for an enhanced list of chemicals that have been reported every year from 1995 to 1999.

- The first and second charts show that, from 1992 to 2000, on average over 50% of the pollution toxicity generated was managed in waste.

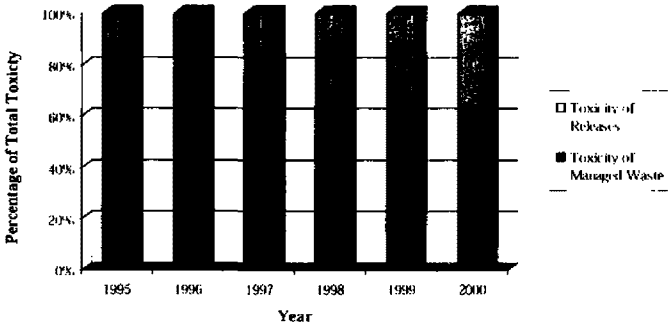
The third and fourth charts show that, from 1992 to 2000, between 85-95% of toxicity in TRI waste was managed by recycling. Treatment and energy recovery were the next waste management methods most frequently used.

Overall, the charts show a high level of pollution prevention activity in the management of TRI chemicals.

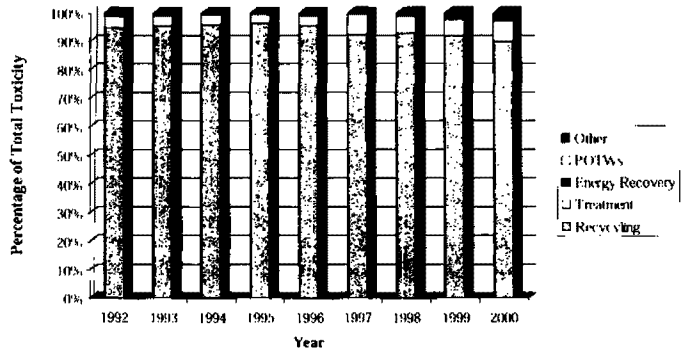
Proportion of Pollution Toxicity Released and Managed in Waste (Core Chemicals List), 1992-2000



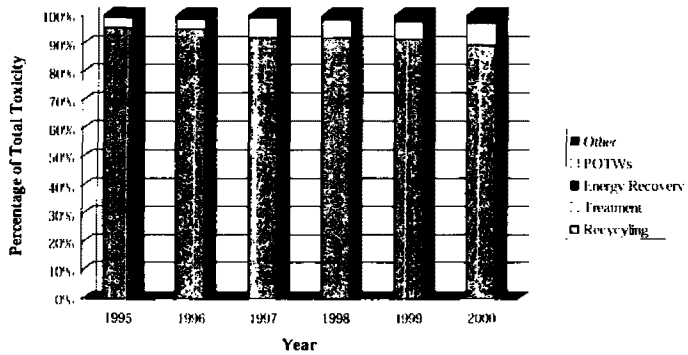
Proportion of Pollution Toxicity Released and Managed in Waste (Enhanced Chemicals List), 1995-2000



Proportion of Pollution Toxicity Managed by Method (Core Chemicals List), 1992-2000



Proportion of Pollution Toxicity Managed by Method (Enhanced Chemicals List), 1995-2000



Source: **Risk Screening Environmental Indicators**, Computer queries of national summary data prepared January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

References

2000 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, August 2000. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. 31 January 2003. Available online at: http://www.epa.gov/tri/tridata/tri00/index.htm.

"Risk Screening Environmental Indicators." Fact Sheet. Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, October 1, 1999.

Toxics Release Inventory Relative Risk-Based Environmental Indicators Methodology, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, June 1997.

User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators are available on at: http://www.epa.gov/opptintr/rsei/. 31 January 2003. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov).

POLLUTION PREVENTION
SOURCE REDUCTION

Indicator: Northeast Waste Management Officials' Association (NEWMOA) Pollution Prevention Metrics Menu

While there are a number of state agencies, businesses, and non-profit organizations that currently have indicators in place to measure pollution prevention (P2) progress, such indicators are not consistently measured. The lack of standardization in data collection presents obstacles when comparatively evaluating P2 programs, especially at the national level.

The Northeast Waste Management Officials' Association (NEWMOA) Pollution Prevention Metrics Menu represents a joint effort between the Northeastern states P2 programs to begin to overcome these obstacles. These states have joined together to create a common multi-state indicator system to measure pollution prevention efforts. The purpose of their efforts is to provide a list of indicators that state programs agree to use in order to facilitate interstate studies on pollution prevention activities. A common indicator framework also will provide a better understanding of actual outcomes of P2 efforts on a regional level.

The NEWMOA P2 Metrics Menu is categorized into three main groups:

- **Assistance Activities** – ex. On-site assistance, workshops/conferences, grants to program clients, partnership programs
- **Regulatory and Enforcement Activities** – Ex. Training, inspections, and enforcement actions
- **Environmental and Economic Outcomes**

No data are currently available as NEWMOA is in the process of developing the software necessary to implement the indicator system. The following is a list of indicators from the NEWMOA P2 Metrics Menu that relate specifically to chemicals and pesticides:

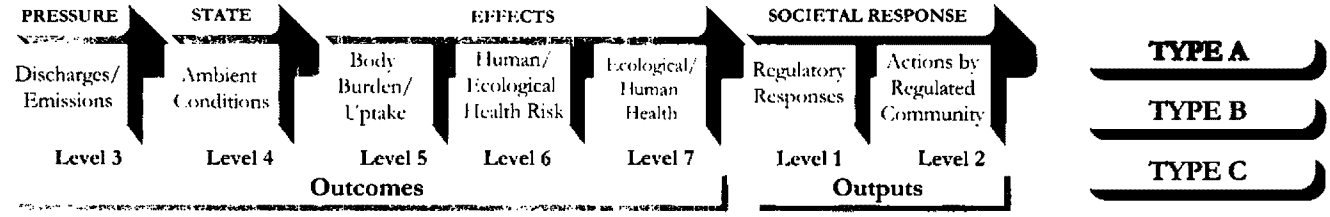
- **Metric #25**: Number of business, institutional or community clients that maintained purchasing and use records for their chemical input inventories.
- **Metric #32**: Total amount of hazardous waste reduced through pollution prevention by program clients.
- **Metric #33**: Number of hazardous waste generators (LQGs) and small quantity generators (SQG).
- **Metric #35**: Total amount of air pollutants reduced through pollution prevention by program clients.
- **Metric #36**: Total amount of water pollution reduced through pollution prevention by program clients.
- **Metric #37**: Total amount of toxic/hazardous chemical use reduced through pollution prevention.

Notes: The Northeastern states include: Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

References

Northeast Waste Management Officials' Association. 1999. "Pollution Prevention Metrics Menu". Draft prepared by the Northeast Pollution Prevention Roundtable. Available online: http://www.newmoa.org/Newmoa/htdocs/prevention/metrics

POLLUTION PREVENTION
SOURCE REDUCTION



Indicator: Quantity of Toxic Chemicals Generated as Non-Product Output in New Jersey

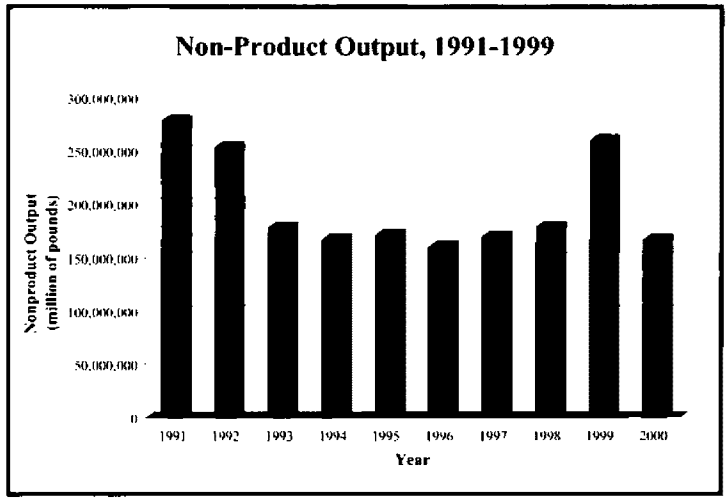
Information on a state chemical monitoring program can be used as an indicator of the state of public monitoring efforts in general.

The Community Right to Know (CRTK) Program in New Jersey's Bureau of Chemical Release Information and Prevention collects, processes, and disseminates the chemical inventory, environmental release and materials accounting data required to be reported under the state Worker and Community Right to Know Act. Information collected by the program can be used to asses the threats chemicals pose, to track trends in chemical use, to examine problems related to the presence of toxic chemicals in products and to evaluate progress toward goals of more efficient and reduced chemical use.

CRTK collects information from two sources Chemical Inventory Data Surveys and Release and Pollution Prevention Reports. Surveys, listing the environmental hazardous substances present at facilities, are collected from a set of more than 33,000 employers whose businesses are assigned one of the Standard Industrial Classification (SIC) codes listed in the Right to Know Act. Businesses with more than 500 pounds of environmental hazardous substances or smaller quantities of substances listed on the federal Emergency Planning and Community Right to Know Act (EPCRA) 302 list of extremely hazardous substances are required to complete surveys. Release and Pollution Prevention Reports are filed by manufacturing and select non-manufacturing companies that have the equivalent of ten or more full-time employees and all firms using toxic chemicals listed on the EPCRA 313 list in quantities exceeding specified thresholds. Approximately 600 companies in New Jersey are required to complete federal Toxic Chemical Release Inventory (TRI) forms and these companies are also required to complete state Release and Pollution Prevention Reports.

One element monitored by CRTK, as part of its assessment of chemical use in New Jersey, is the amount of chemicals in waste generated before recycling, treatment, or disposal, an element known as nonproduct output (NPO).

- Total weight of chemicals in NPO generally decreased, between 1991 and 2000, at a rate of 5.8 million pounds per year.



Source: New Jersey Department of Environmental Protection Community Right to Know Program Website, December 17, 2002.

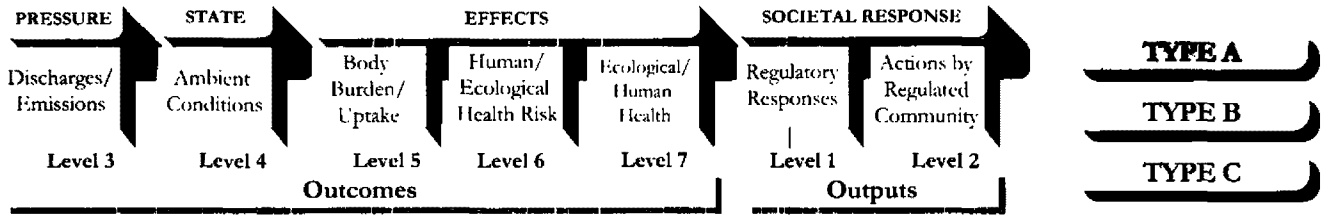
Data Characteristics and Limitations: There are several limitations of CRTK data as an indicator of pollution source reduction efforts in general. First, there is no indication that the trends in the level of toxics in industrial products in New Jersey are representative of the trends in the level of toxics in industrial products in the U.S. Second, due to change in the list of reportable chemicals, depictions of trends can only include chemicals for which data was first collected. This results in the exclusion of data on the levels of chemicals that are of particular concern for health and environmental reasons.

References

New Jersey Department of Environmental Protection Community Right to Know Program Website. 17 December 2002.

Tracking Toxic Chemicals: The Value of Materials Accounting Data. Inform, 1997.

POLLUTION PREVENTION
SOURCE REDUCTION



Indicator: Trends in Use of Toxic Chemicals in Massachusetts After Institution of the Toxics Use Reduction Act

Information on programs that reduce the amount of toxic chemicals used by industry, and influence the manner in which toxics are used, can be developed into an indicator of pollution source reduction efforts in general.

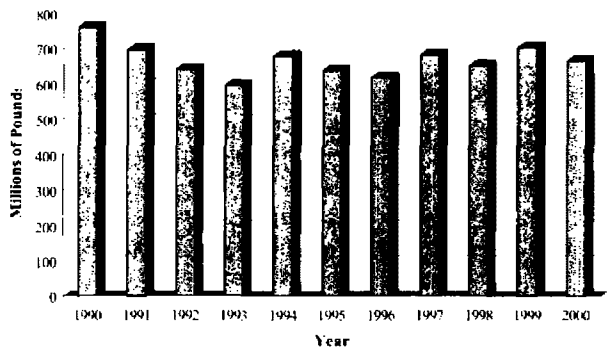
In the state of Massachusetts the Toxic Use Reduction Act (TURA) Program collects data on the use of toxics in all phases of production from firms statewide. The program, which first collected data in 1990, was initiated to encourage safer and cleaner production by industries in the state.

The TURA program uses information reported by industry to analyze trends in the use of toxics. Information used in this indicator is reported by a group of 340 businesses (the Core Group) that have been subject to reporting since 1990. During this time period a number of chemicals have been added to and deleted from the list of slightly less than 200 reposted substances composed by the Administrative Council on Toxics Use Reduction. However, the data on the use of toxics by the core group is stabilized by reporting on only a select group of chemicals for which data has been collected since 1990. Facilities reporting use of these chemicals for the first time are reported as members of the core group but data on newly reported chemicals by any company is excluded from the core group report.

Also reported by TURA are on-site releases and off-site transfers of toxics as defined by the federal Toxic Release Inventory (TRI). TRI is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release.

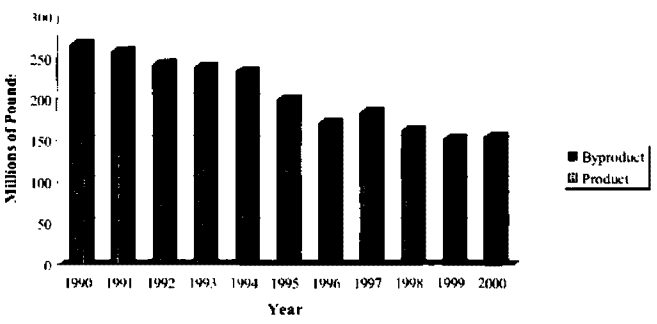
The graphs below illustrate the reductions in the total use of toxic chemicals, the amount of toxics generated as byproduct, the amount of toxics shipped as industrial product and the on-site releases and transfers off-site as defined by the federal Toxic Release Inventory (TRI), by the industries composing the Core Group. All amounts of toxic chemicals are reported by weight in millions of pounds.

Total Toxics Used by Core Group, 1990 to 2000



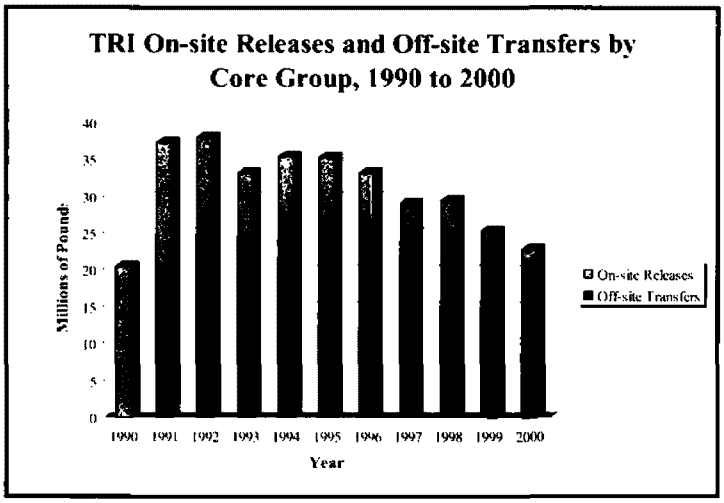
- Between 1990 and 2000 use of toxic chemicals by the Core Group declined 13%.

Toxics Shipped as Industrial Product and Generated as Byproduct by Core Group, 1990 to 2000



- A 40% decrease in the weight of toxins produced as byproduct was recorded.

- Total weight of toxics shipped in product decreased approximately 23% between 1990 and 2000.



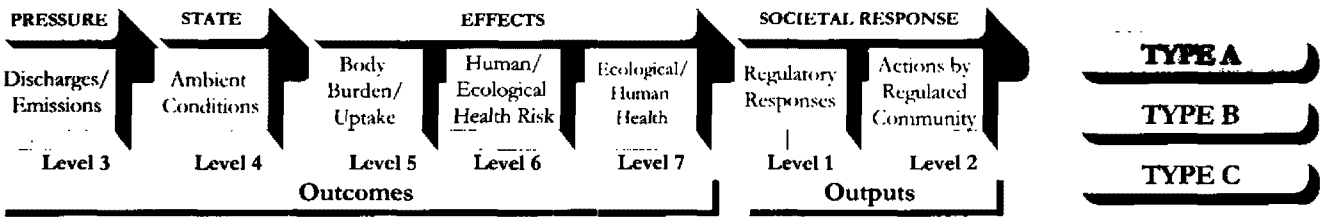
- On-site releases of toxic chemicals, as reported by the TRI, declined 85% between 1990 and 2000.

- TRI reported transfers of chemicals off-site decreased 4% between 1990 and 2000.

Source: 2000 Toxics Use Reduction Information Release. Commonwealth of Massachusetts Department of Environmental Protection, June 2002.

Data Characteristics and Limitations: There are a number of limitations of TURA data as an indicator of pollution source reduction efforts in general. First, there is no indication that the trends in the level of toxics in industrial products in Massachusetts are representative of the trends in the level of toxics in industrial products in the U.S. Second, data for the core group is constrained by reporting on only a select group of chemicals rather than all listed toxics. This results in the exclusion of data on the levels of PBTs that are of particular concern for health and environmental reasons. Third, industries and commercial operations which use small amounts of chemicals on the list, including smaller manufacturing facilities and most commercial operations (such as dry cleaners) will not be included in the report. Fourth, industries and commercial operations that claim quantity information as trade secret information are not required to report. Fifth, companies that employ fewer than 10 employees are not required to report toxic use data at all.

POLLUTION PREVENTION
SOURCE REDUCTION



Indicator: Persistent, Bioaccumulative Toxin Use in Massachusetts

Information on a state chemical monitoring program can be used as an indicator of the state of public monitoring efforts in general.

In the state of Massachusetts the Toxic Use Reduction Act (TURA) Program collects data on the use of toxics in all phases of production from firms statewide. The program, which first began analyzing industry reported data in 1990, was initiated to encourage safer and cleaner production by industries in the state.

Beginning in 2000, in response to lower federal level reporting thresholds, TURA began reporting lower quantity uses of the group of chemicals classified by the U.S. Environmental Protection Agency as "persistent bioaccumulative toxins" (PBTs). This data is expected to become a permanent part of the yearly data set and has potential to be used as an indicator of trends in the use of PBTs in Massachusetts. The first year of information on PBTs, using the new reporting standard, is included here. PBTs are broken down into seven categories.

The table below illustrates the reporting threshold for each of the PBT chemicals, the number of facilities that reported use of each of the PBTs, the total use of PBTs, the amount of PBTs generated as byproduct, the amount of PBTs shipped as product and the on-site releases and transfers off-site as defined by the federal Toxic Release Inventory (TRI). All amounts of toxic chemicals are reported by weight in millions of pounds. It is important to note that the PBT categories vary widely in toxicity so relative harm posed by use and releases cannot be compared using weight data alone.

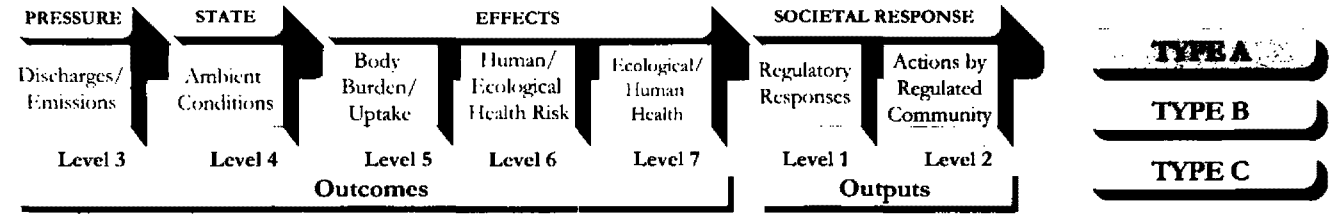
- PBT use was dominated by polycyclic aromatic hydrocarbons of which 109,492,315 pounds were used. PAC use was primarily reported by companies burning fuel oil.
- Shipping of PBTs in product, in 2000, ranged from zero pounds of dioxin to 42,802 pounds of mercury.
- The largest component of on-site releases was mercury compounds, of which 294 pounds were released. Mercury use and release was reported mainly by a single company that recycles fluorescent light fixtures.
- The majority of off-site transfers were of mercury compounds and PCBs. The same single company that reported the majority of mercury releases released 99% of PCBs.

Source: 2000 Toxics Use Reduction Information Release, Commonwealth of Massachusetts Department of Environmental Protection, June 2002.

Data Characteristics and Limitations: First, there is no indication that the trends in the level of toxics in industrial products in Massachusetts are representative of the trends in the level of toxics in industrial products in the U.S. Second, industries and commercial operations which use small amounts of chemicals on the list, including smaller manufacturing facilities and most commercial operations (such as dry cleaners) will not be included in the report. Third, industries and commercial operations that claim quantity information as trade secret information are not required to report. Fourth, companies that employ fewer than 10 employees are not required to report toxic use data at all.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Polycyclic Aromatic Compounds (PACs)	100	140	109,492,315	7,000	31,036	59	66,676
Benzo (g,h,i-) perylene	10	105	9,618,907	70	1,227	5	268
Mercury	10	10	4,927	737	4,189	3	2,527
Mercury Compounds	10	6	90.009	46,901	42,802	294	97,702
Polychlorinated Biphenyls (PCBs)	10	2	118,160	118,116	44	0	118,116
Tetrabromobisphenol A	10	1	332	315	17	0	315
Dioxin and Dioxin-like Compounds	0	8	0.0266	0.0263	0.0000	0.0261	0.0004

POLLUTION PREVENTION
SOURCE REDUCTION



Indicator: Responsible Care Measures

Information on programs that reduce the amount of toxic chemicals used by industry, and influence the manner, in which toxics are used, can be used to ascertain the state of pollution source reduction efforts in general.

The American Chemistry Council (ACC) is a chemical industry group that represents those chemical companies in the United States that produce roughly 90% of all the chemicals produced in this country. Their stated mission is "Creating an environment that fosters economic growth, continuous environmental, health and safety improvement, and societal advancement through the business of chemistry." (ACC website) As part of developing their mission the ACC has initiated an industry self-monitoring program called Responsible Care. The Responsible Care program lists a number of guiding principles including the following:

- To provide chemicals that can be manufactured, transported, used and disposed of safely.
- To make health, safety, the environment and resource conservation critical considerations for all new and existing products and processes.
- To provide information on health or environmental risks and pursue protective measures for employees, the public and other key stakeholders.
- To work with customers, carriers, suppliers, distributors and contractors to foster the safe use, transport and disposal of chemicals.
- To operate our facilities in a manner that protects the environment and the health and safety of our employees and the public.
- To support education and research on the health, safety and environmental effects of our products and processes.
- To lead in the development of responsible laws, regulations and standards that safeguard the community, workplace and environment.

In adherence to these principles the program collects an array of data from ACC member companies to monitor chemical releases, risk prevention efforts and production efficiency data. So far such data has been reported only voluntarily, but beginning in January 2003 the ACC will begin to require that all member companies collect and report a specific set of information. The required measures, which will reflect progress towards environmental goals, are tentatively set to include the following:

- Toxic Release Inventory (TRI) reporting of air, land and water releases per pound of production
- The tons of carbon dioxide equivalent (carbon dioxide, methane, nitrous oxides, HFC, PFC and SF6) emitted per pound of production
- Total BTUs consumed per pound of production
- System is in place and publicly available for assessing and re-assessing potential environmental, health and safety risks for chemicals in commerce
- Percentage of products re-evaluated per documented environmental, health and safety assessment procedures
- Percentage of commitments achieved on schedule for chemical evaluation programs
- Document process for characterizing and managing product risk, and provide a summary of the process to the public
- Communicate results of the risk characterization and management process in an effort to facilitate public knowledge.

Once these measures are in place the data they produce could be used to develop several indicators of toxic releases and prevention by the chemical industry.

Source: American Chemistry Council website. 20 September 2002. Available online at: http://www.americanchemistry.com

Notes: The FSU Program for Environmental Policy and Planning Systems would like to thank Dell Perelman and David Clarke for their assistance in providing up to date information on the ACC's plans for further development of the Responsible Care program.

Data Characteristics and Limitations: The ACC will begin collecting a full set of responsible Care Program data from all member companies beginning in January 2003, however, at this time all existing data has been collected on a voluntary basis. When the full data set becomes available further limitations may become apparent, but at this time the only obvious limitation is that all data will be reported by the chemical industry to a chemical industry organization with little outside oversight.

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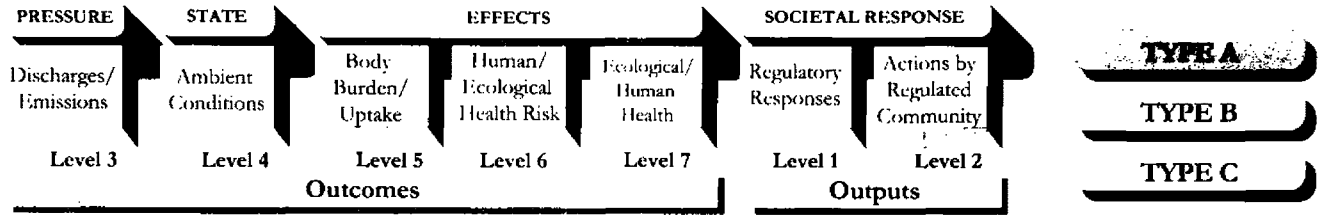
Perelman, Dell. Personal communication concerning plans for further development of Responsible Care monitoring program. 7 August 2002.

POLLUTION PREVENTION
SOURCE REDUCTION

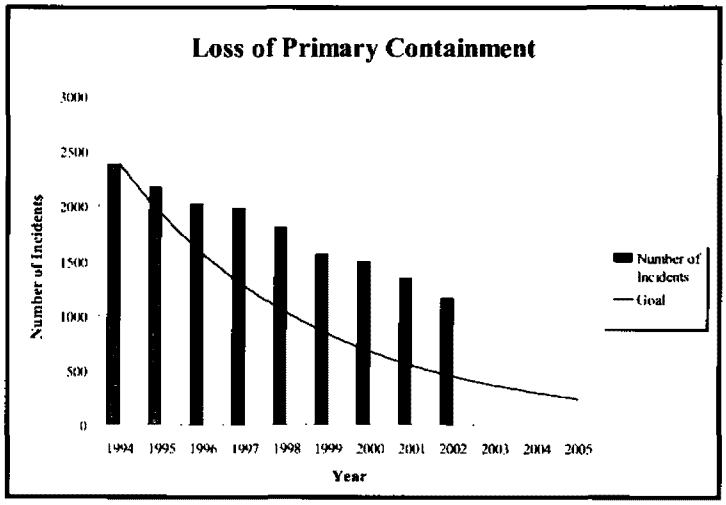


Indicator: Dow Chemical Company's Efforts as an Example of Pollution Prevention

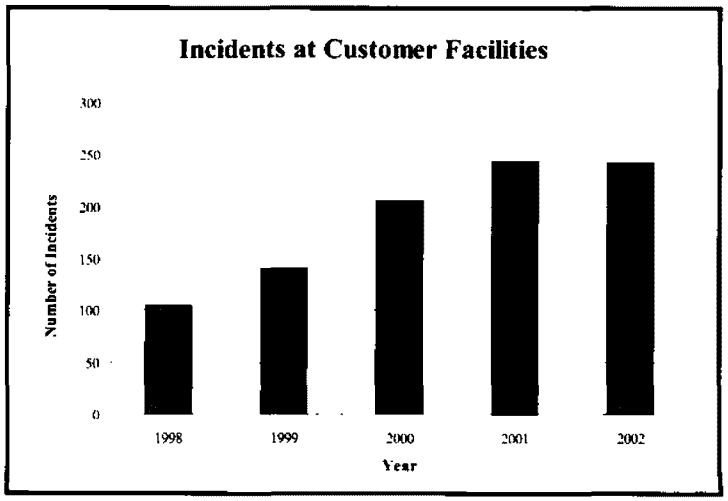
Information on programs that reduce the amount of toxic chemicals used by industry, and influence the manner in which toxics are used, can be developed into an indicator of pollution source reduction efforts in general.

As one of the nation's largest chemicals manufacturers, Dow Chemical Company's practices are an example of how industry can reduce environmental harm. Dow states in a company publication that it is committed to "no harm to the environment, to our people or to any people that we touch in the value chain". In working toward realizing this commitment, Dow has joined the American Chemical Council industry self-monitoring program called Responsible Care. Responsible Care is a voluntary initiative within the global chemical industry to safely handle products from inception in the research laboratory, through manufacture and distribution, to ultimate disposal, and to involve the public in the decision-making processes. Dow has also set a list of goals for the year 2005 which are aimed at increasing corporate responsibility and accountability, preventing environmental health and safety and incidents, increasing resource productivity, and increasing business accountability. The following metrics compiled by Dow summarize company data on loss of primary containment, number of incidents at customer facilities, chemical emissions, priority chemical emissions, waste emissions and wastewater emissions and give an idea of the corporation's progress toward meeting its pollution prevention based goals.

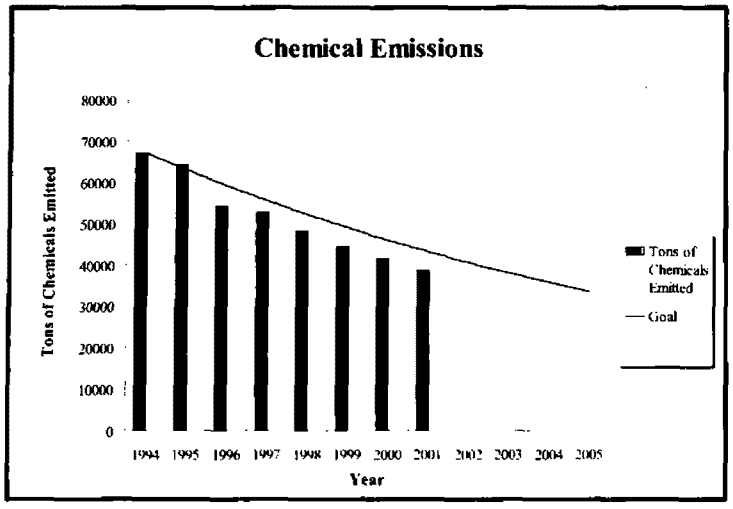
- Primary containment refers to the actual vessel, package, tank or line that holds the material of concern. Secondary containment may contain any leaks or spills.
- Frequency of loss of primary containment incidents generally declined by 52% from 1994 to 2002.



- The number of incidents at customer facilities increased significantly between 1998 and 2002.
- Dow attributes this increase to better reporting rather than an increase in the number of incidents.



- Chemical emissions declined by approximately 42% from 1994 to 2001.



- Priority Compounds include persistent, toxic and bioaccumulative compounds (PTBs), known human carcinogens, selected ozone depletors, and high volume toxic compounds:

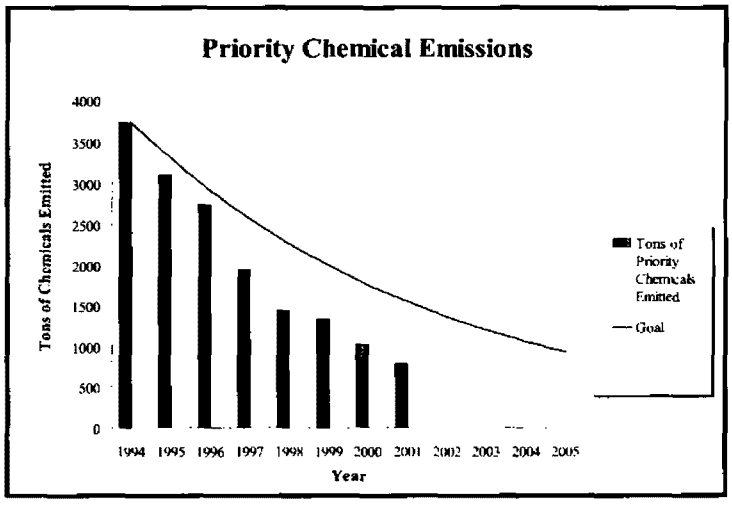
  PTPs: Hexachlorobenzene, mercury compounds

  Known Carcinogens: Benzene, Vinyl Chloride, Nickel Compounds, Chromium Compounds, Arsenic Compounds, Asbestos

  Selected Ozone Depletors: Carbon tetrachloride, 1,1,1-trichloroethane, CFC-11, CFC-12, CFC-113, CFC-114, CFC-115, CFC-123, CFC-500, CFC-502, CFC-1301, H2402

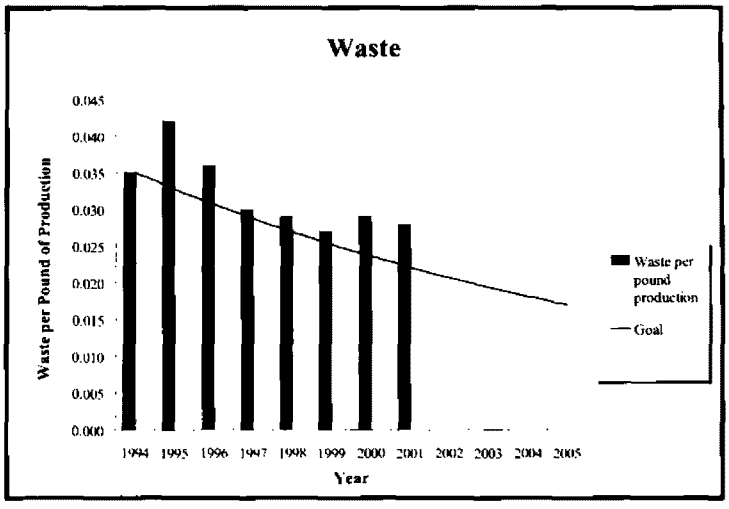
  High Volume Toxics: Propylene Oxide, 1,2 Dichloropropane, 1,2 Dichlorethane (EDC), 1,3 Butadiene, Chloroform, Epichlorohydrin, Ethylene Oxide, Formaldehyde, Acrylonitrile.

- Emissions of priority compounds declined by 73% between 1994 and 2001.



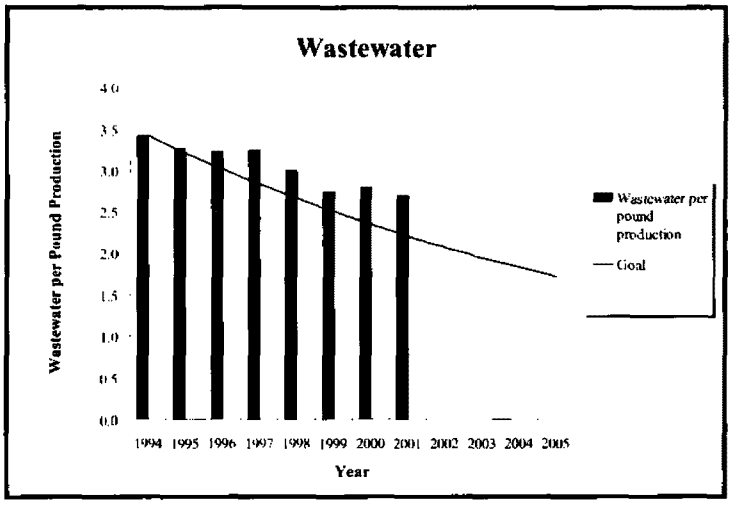
- Dow reduced the waste to production ratio by 18% over the 1994-2001 time frame.

- Process wastewater is water that comes into contact with process chemicals and is treated to remove the chemicals and purify the water before discharge.



- Dow treats 93% of this water itself; the rest is treated by off-site facilities.

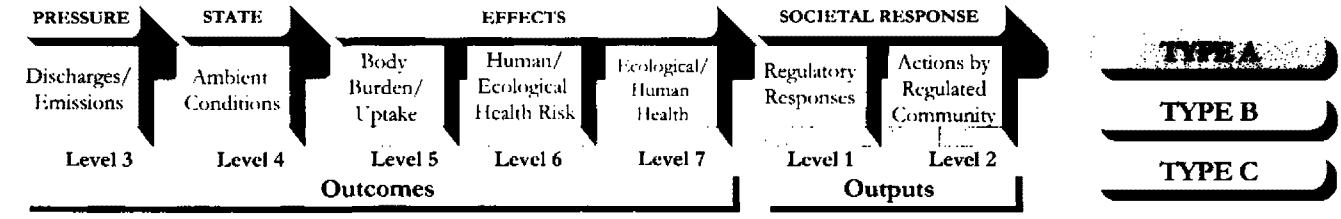
- Between 1994 and 2001 the wastewater to production ratio generally decreased by 21%.



Source: The Dow Chemical Company Environmental Health and Safety Performance Report. July 25, 2002. The Dow Chemical Company Website. http://www.dow.com, January 27, 2003.

Data Characteristics and Limitations: As with any industry reported data, the information above reflects the most favorable possible analysis of Dow's environmental performance and relies on the company to accurately report all of the data.

POLLUTION PREVENTION
SOURCE REDUCTION

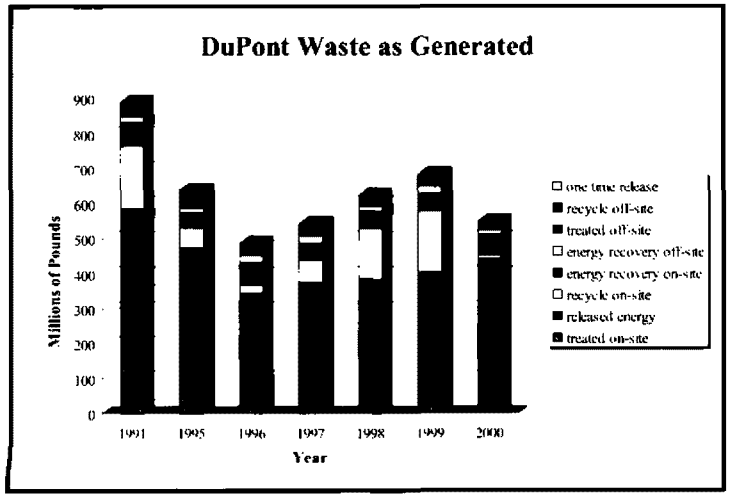


Indicator: DuPont Chemical Company's Efforts as an Example of Pollution Prevention

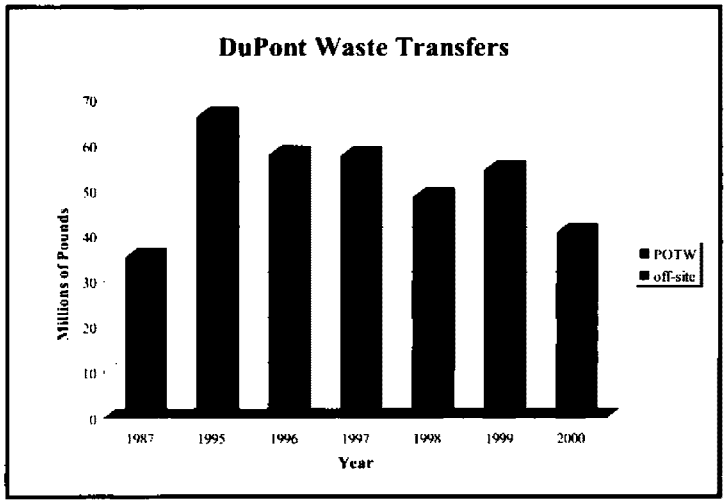
Information on programs that reduce the amount of toxic chemicals used by industry, and influence the manner, in which toxics are used, can be developed into an indicator of pollution source reduction efforts in general.

As one of the nation's largest chemicals manufacturers, DuPont Chemical Company's practices are an example of how industry can reduce environmental harm. According to the DuPont Company website they have set the ambitious goal of driving "toward zero waste generation at the source." Materials will be reused and recycled to minimize the need for treatment or disposal and to conserve resources. Where waste is generated, it will be handled and disposed of safely and responsibly." DuPont supports the chemical industry's Responsible Care initiative as a key program to achieve this commitment. Responsible Care is a voluntary initiative within the global chemical industry to safely handle our products from inception in the research laboratory, through manufacture and distribution, to ultimate disposal, and to involve the public in our decision-making processes.

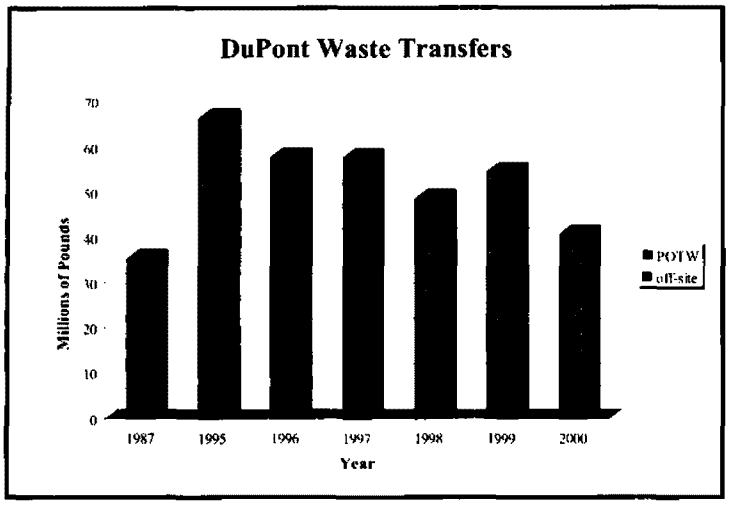
The following metrics compiled by DuPont give an idea of their progress toward meeting their pollution prevention based goals.



- Total waste generation by DuPont declined 38% between 1991 and 2000.
- Released energy declined 68%, energy recovered on-site declined 12%, energy recovered off-site increased 3%, waste recycled on-site declined 95%, waste recycled off-site declined 62%, waste treated on-site increased 6%, waste treated off-site declined 2% and one time releases decreased 83%.



- Total waste transfers increased 15% between 1987 and 2000.
- POTWs are Publicly Owned Treatment Works; public wastewater facilities.



- Total waste releases declined 76% between 1987 between 1987 and 2000.
- Releases to air declined 76% and deepwell disposal declined 84%, but Releases to water increased 395% and releases to land increased 693%.

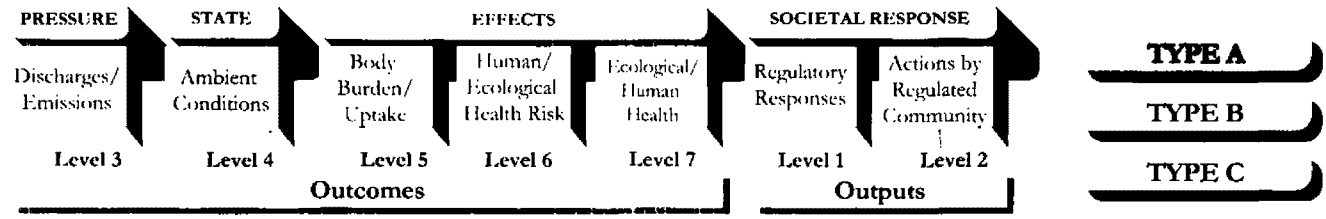
Source: DuPont- Sustainable Growth 2001 Progress Report

Data Characteristics and Limitations:
As with any industry reported data, the information above reflects the best possible analysis of Dupont's environmental performance and relies on the company to accurately report all of the data.

References

Sustainable Growth 2001 Progress Report. DuPont Chemical Company. 1 Novermber 2002. Available online at: http://www.dupont.com

POLLUTION PREVENTION
SOURCE REDUCTION



Indicator: Drycleaning Industry Perchloroethylene Decline

The drycleaning industry provides garment cleaning, as well as pressing and finishing services. The process is considered dry because it uses little to no water. It does, however, use a liquid solution composed of solvents. For this reason, the industry represents one of the largest chemical users that come into contact with the general public through more than 30,000 commercial establishments nationwide. (USEPA).

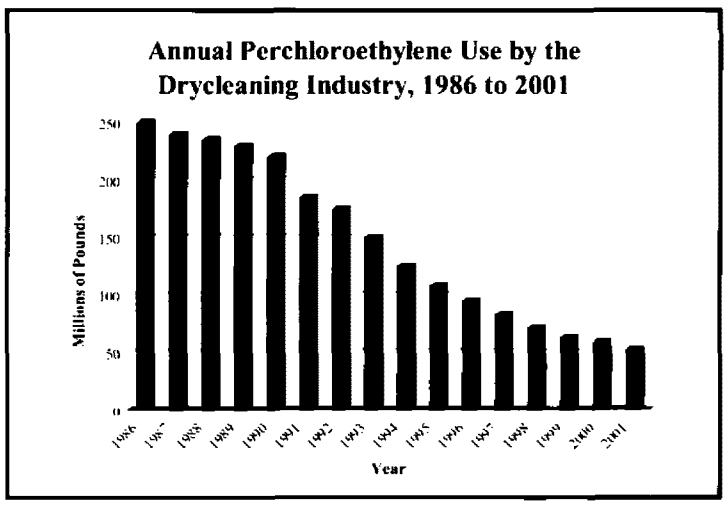
Historically, petroleum-based compounds were the most widely used solvents used for drycleaning. However, since its introduction in 1934, perchloroethylene (also known as tetrachloroethylene, "perc" or PCE) steadily rose to become the predominant chemical of choice as early as the 1960's. (Linn 2002) Though estimates vary, it is generally accepted that perc usage today represents as much as 90% of the industry.

As is the case with all chemicals, health effects from perc exposure depend upon the dose, frequency, and duration. Data are inconclusive, but perc is considered by the Environmental Protection Agency to be a possible human carcinogen. Additionally, the chemical is associated with mild symptoms such as dizziness, fatigue and skin irritation, as well as more serious side effects that include liver damage and respiratory failure. (USEPA)

Though the decline in perc usage, charted below, is certainly a positive trend, it must be viewed with caution. It does not account for the overall decline in drycleaning that has occurred in the 1990's due to the increase in business casual dress codes in the workplace. Industry estimates place this decline at approximately 5 to 15 percent.

Additionally, it should be noted that the source reduction is directly related to upgrades in the early 1990's to more efficient machinery. The evolution of technology has been such that so-called first-generation drycleaning machines used 82 pounds of perc per 1,000 pounds of clothes cleaned, in contrast to the newest fourth and fifth-generation machines that use no more than 10 pounds of perc for the same amount of clothing. (National Clothesline 2002)

- Since 1986, the perc usage has decreased dramatically, from 250 to 52 million pounds in 2001. This represents a 79% drop.



Source: Textile Care Allied Trades Association (TCATA) annual perchloroethylene usage survey.

Data Characteristics and Limitations: TCATA data are collected annually and the 2001 data were collected by Industry Insights, Inc. Results represent reporting from four primary producers and importers of perc for use in the drycleaning industry: Dow Chemical Company, ICI (now INEOS Chlor Americas), PPG Industries; and Vulcan Chemicals.

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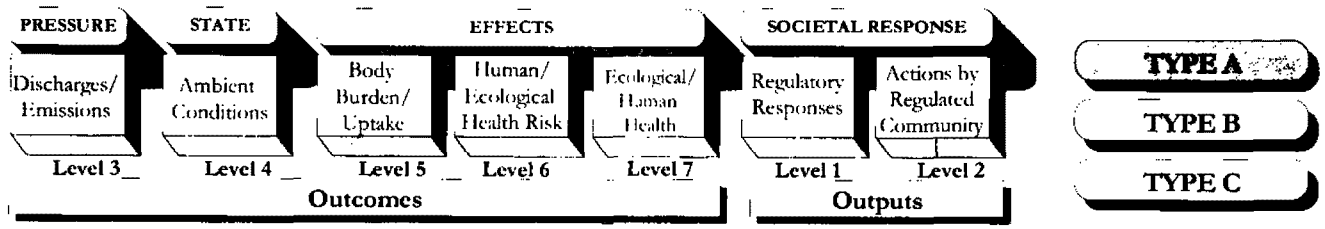


Indicator: Toxicity of Releases and Managed Waste per Dollar of Economic Output Index

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating a toxicity score for each chemical. The toxicity score is multiplied by the pounds of chemical released or managed in waste; the toxicity of each chemical release and waste stream can be aggregated to provide an estimate of the total toxicity of releases and managed waste for a given year.

This measure can have implications for both human and ecological health, with declining trends in the total toxicity of chemical releases and managed waste implying potential for a more healthful environment. The measure also has implications for the success of governmental pollution prevention programs and for activities conducted by the private sector to improve pollution related efficiencies.

However, increases in total toxicity of releases may reflect increased levels of economic production, rather than increasing pollution per se. In periods of accelerated production, the total toxicity of releases and waste can increase (due to increasing volumes) even if pollution efficiencies are being maintained or even improved. The United States has been in a period of accelerated economic production for over a decade. Since 1991, the gross domestic product (GDP) has increased by $200 to $300 billion each year.

To control for the effect of economic activity on the levels and toxicity of pollution, the total toxicity estimate is divided by the reported gross product for the economic sectors covered by TRI (gross product estimate in chained 1996 dollars). This calculation provides a measure of ecological efficiency by estimating the toxicity of releases and waste for each dollar of economic activity.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unitless measure of toxicity. These measures can only be interpreted relatively: to display trends and to make comparisons of toxicity over time. For this indicator, the toxicity of releases and waste per dollar of economic output was adjusted to create an index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the estimate of toxicity of releases and waste per dollar of economic output for the baseline year was adjusted to equal a value of 100; subsequent estimates reflect changes from that baseline of 100. If industries are maintaining or improving pollution efficiencies, regardless of their level of economic output, then the index should display constant or declining trends.

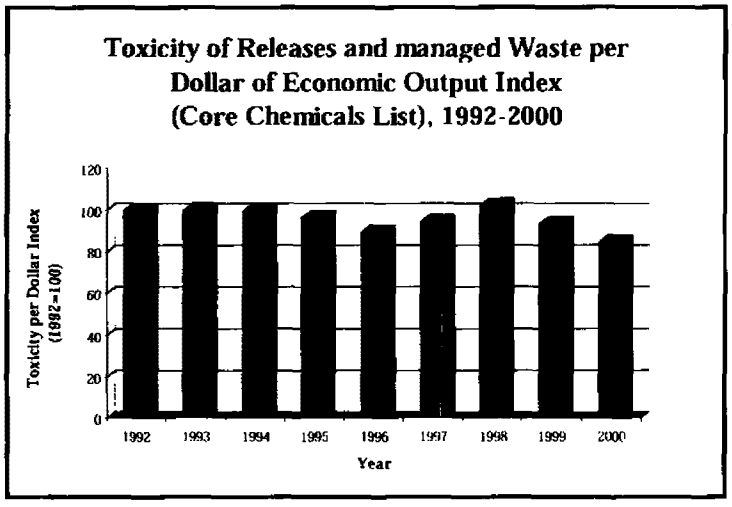
Since TRI includes only a subset of chemicals to which people are exposed, this indicator is not a complete measure of the total toxicity of releases into the environment and managed chemical waste. It can be inferred, however, as a measure of the relative gains the U.S. is making in pollution prevention and improving pollution efficiencies.

There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal.

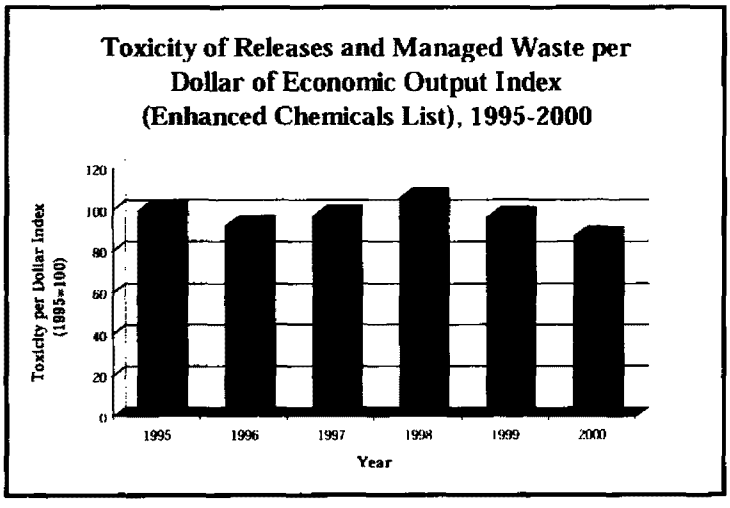
These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Two different subsets of TRI data are reflected in the presented charts. The first chart reflects data for a core list of chemicals that have been reported every year since the inception of TRI in 1988; however, the chart reflects data beginning in 1992, which is when recycling, energy recovery and treatment operations were incorporated into TRI. The second chart reflects data for an enhanced list of chemicals that have been reported every year from 1995 to 2000.

- For the core chemicals list, the index has decreased by 15 points from 1992 to 2000 – indicating that eco-efficiency is improving.



- For the enhanced chemicals list, the index has decreased 13 points since 1995 – indicating that eco-efficiency is improving.



Source: **Risk Screening Environmental Indicators,** Computer queries of national summary data prepared January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

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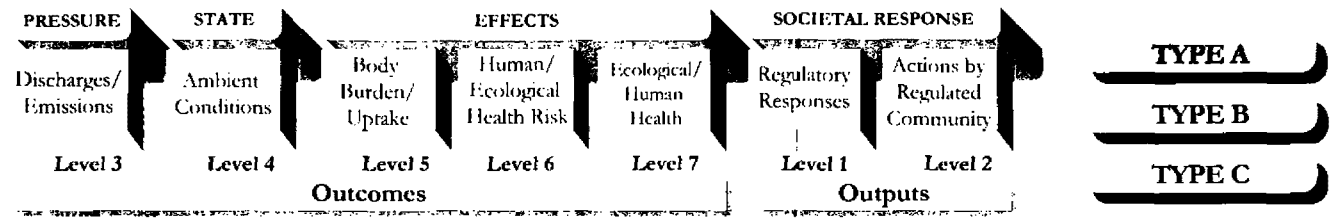

Indicator: Toxicity per Pound Index for Releases and Managed Waste

The Toxics Release Inventory (TRI) is a database that identifies annual amounts of chemicals released (in routine operations and in accidents) and managed on- and off-site in waste. TRI data are normally reported by volume of release or managed waste of a specific chemical or a set of chemicals. A limitation of this reporting system is that it does not account for the relative toxicities of the individual chemicals. These toxicities vary such that the many possible combinations of less toxic chemicals and highly toxic chemicals create a wide range of toxicity represented by a given volume of release. To redress this limitation, the EPA Office of Pollution Prevention and Toxics developed the Risk Screening Environmental Indicators. The Risk Screening Environmental Indicators expand the application of the TRI by incorporating a toxicity score for each chemical. The toxicity score is multiplied by the pounds of chemical released or managed in waste; the toxicity of each chemical release and waste stream can be aggregated to provide an estimate of the total toxicity of releases and managed waste for a given year.

This measure can have implications for both human and ecological health, with declining trends in the total toxicity of chemical releases and managed waste implying potential for a more healthful environment. The measure also has implications for the success of governmental pollution prevention programs and for activities conducted by the private sector to improve pollution related efficiencies.

However, decreases in the total toxicity of releases may not necessarily reflect the improvement of pollution efficiencies. A decline in the total toxicity of releases and waste could result from a decrease in the volume of chemical releases and waste (improvement in basic pollution prevention), but obscure an increase in the toxicity of chemical releases and waste (worsening pollution efficiency). To control for the effect of volume on the toxicity of pollution, the toxicity estimate is divided by the total volume of chemical releases and waste for the corresponding year. This calculation provides a measure of ecological efficiency by estimating the toxicity for each pound of release or waste.

The analysis available through the Risk Screening Environmental Indicators produces an unanchored or unitless measure of toxicity. These measures can only be interpreted relatively: to display trends and to make comparisons of toxicity over time. For this indicator, the toxicity per pound of release and managed waste was adjusted to create an index. It is conventional to present unitless data intended for temporal comparisons as an index (e.g., the Consumer Price Index). For this indicator, the estimate of toxicity per pound of release and managed waste for the baseline year was adjusted to equal a value of 100; subsequent estimates reflect changes from that baseline of 100. If industries are maintaining or improving pollution efficiencies, regardless of their volume of releases and wastes, then the index should display constant or declining trends.

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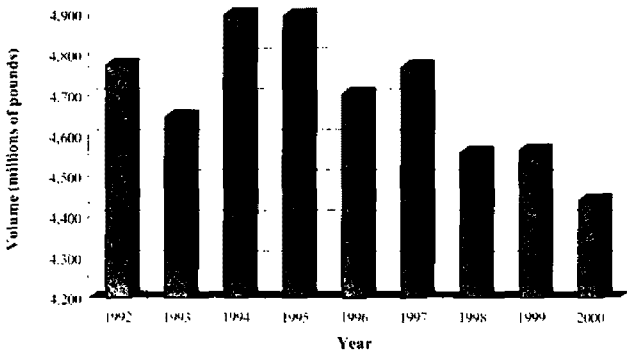
There are, however, efforts to move the TRI toward comprehensive coverage. Presently unreported in this indicator is a new expansion of the TRI which adds the reporting of releases and managed wastes from seven new economic sectors: electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal. These industries began reporting in 1998. Currently three years of data are available; however, do to publishing time constraints and the recent release of this data it is unable to be incorporated into this indicators. In future years, this will provide the baseline for standard TRI indicators and will provide a much more complete and accurate reflection of the scope and impact of releases into the environment and managed wastes.

Two different subsets of TRI data are reflected in the presented charts. The first and second charts reflect data for a core list of chemicals that have been reported every year since the inception

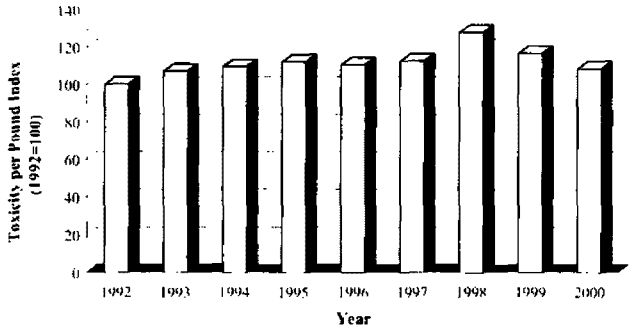
of TRI in 1988; however, the charts reflect data beginning in 1992, which is when recycling, energy recovery and treatment operations were incorporated into TRI. The third and fourth charts reflect data for an enhanced list of chemicals that have been reported every year from 1995 to 2000.

- The charts show that although the volume of releases and managed waste (for both the core chemicals and the enhanced chemicals lists) has declined, the toxicity per pound index has slightly increased. This indicates that improvements in pollution efficiency are lagging behind improvements in pollution prevention.

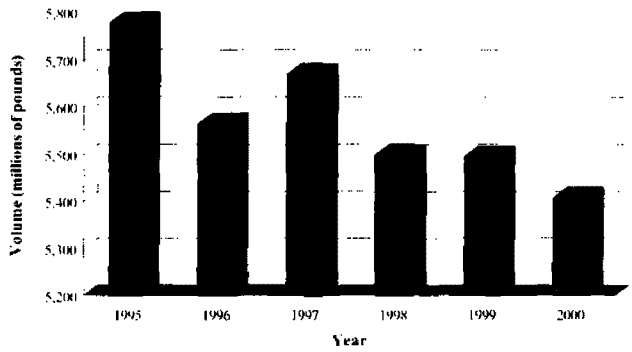
Annual Volume of Releases and Managed Waste (Core Chemicals List), 1992-2000



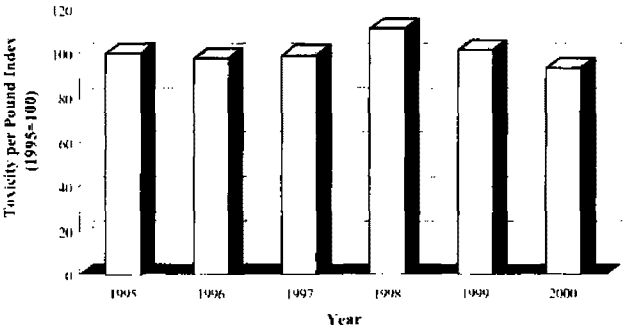
Toxicity per Pound Index for Releases and Managed Waste (Core Chemicals List), 1992-2000



Annual Volume of Releases and Managed Waste (Enhanced Chemicals List), 1995-2000



Toxicity per Pound Index for Releases and Managed Waste (Enhanced Chemicals List), 1995-2000



Source: **Risk Screening Environmental Indicators,** Computer queries of national summary data prepared January 2003.

Scale: Data from the TRI database can be viewed on the national level, as well as by EPA regions, states, counties, cities, and zip codes.

Notes: The Toxics Release Inventory (TRI) is capable of providing rich information on a variety of releases and transfers of a substantial number of chemicals at levels of aggregation that range from national totals to individual facilities. The TRI is used in a number of ways to inform the public about chemical contamination and is widely used as an indicator of environmental conditions. The TRI database, by itself, reports only the pounds of chemicals released or transferred and does not reflect human or ecological health impacts. The Risk Screening Environmental Indicators (RSEI) expands the potential use of the TRI by introducing two new dimensions: toxicity and health risk. The RSEI incorporates toxicity scores for individual chemicals and chemical categories and also models the fate and the potentially exposed population for releases (and some managed wastes). The result is a screening-level, risk-related perspective for relative comparisons of chemical releases and wastes. The flexibility of the model provides the opportunity not only to examine trends, but also to rank and prioritize chemicals for strategic planning, risk-related targeting, and community-based environmental protection

Depending on the concentrations and length of exposure, human health effects from toxics may include cancer and respiratory, developmental, and neurological conditions.

The data elements used to construct this indicator are: releases (air, water, land, underground injection, and disposal) and waste management (recycling, energy recovery, treatment, and transfers to publicly owned treatment works [POTWs]).

Data Characteristics and Limitations: A significant means by which chemicals enter the ambient environment is through their release to air, water and land from facilities. A release is an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, and releases from the facility to land and underground injection wells. Releases to air are reported either as fugitive (emissions from equipment leaks, evaporative loses from surface impoundments and spills, and releases from building ventilation systems) or stack emissions (releases from a confined air stream, such as stacks, vents, ducts, or pipes). Releases to water include discharges to streams, rivers, lakes, oceans, and other water bodies, including contained sources such as industrial process outflow pipes or open trenches. Releases due to runoff are also reported. Releases to land include disposal of toxic chemicals mixed with solid wastes in a landfill, land treatment application farming, and surface impoundment. Underground injection is the disposal of fluids by the sub-surface placement in a well.

Also included in the TRI are chemicals managed on- and off-site as waste. Waste management includes: waste recycling, which includes solvent recovery and metals recovery; energy recovery from waste, which entails combustion of toxic chemicals to generate heat or energy for use at the site of recovery; waste treatment (biological treatment, neutralization, incineration and physical separation), which results in varying degrees of destruction of the toxic chemical.

There are several limitations of the Toxics Release Inventory. The TRI captures only a portion of all toxic chemical releases. Facilities with fewer than 10 full-time employees and those that do not meet the chemical thresholds are not required to file reports. Prior to 1998, non-manufacturing sectors were not required to report. As of 1998, electric utilities, coal mining, metal mining, chemical wholesalers, petroleum bulk plants and terminals, solvent recovery and hazardous waste treatment, storage, and disposal are required to report. Toxic emissions from automobiles and other non-industrial sources are not accounted for in the TRI. Additionally, TRI mandates the reporting of estimated data, but does not require that facilities monitor their releases. Estimation techniques are used where monitoring data are not available. The use of different estimation methodologies can cause release estimates to vary. Also, some facilities may not fully comply with the reporting requirements, which can affect data accuracy and coverage. Another limitation is that there is an 18-month delay from data collection to current release patterns. It is important to recognize that release patterns can change significantly from year to year, so current facility activities may differ from those reported in the most recent TRI report. Lastly, TRI data can be beneficial in identifying potential health risks, but release estimates alone are not sufficient to establish adverse effects. Use of the Risk Screening Environmental Indicators model, however, can allow assessments of human and ecological health risks.

References

1999 Toxics Release Inventory: Public Data Release. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, August 2000. Printed copies are also available and may be ordered online from: U.S. EPA / NSCEP, Attn.: Publication Orders, P.O. Box 42419, Cincinnati, OH 45242-2419, Fax: (513) 489-8695, Phone: (800) 490-9198. 31 January 2003. Available online at: http://www.epa.gov/tri/tridata/tri00/index.htm.

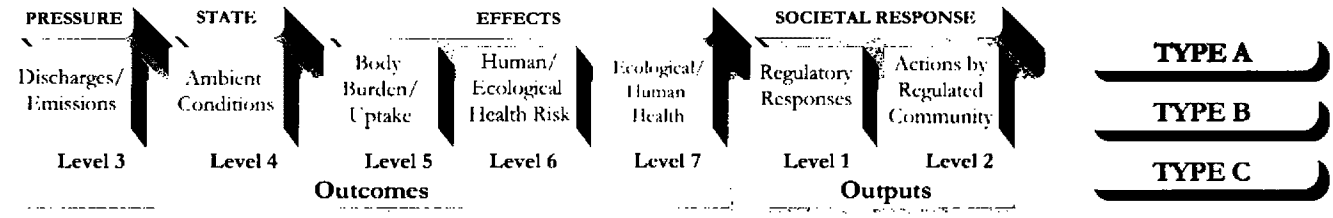
"Risk Screening Environmental Indicators," Fact Sheet, Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, October 1, 1999.

Toxics Release Inventory Relative Risk-Based Environmental Indicators Methodology, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, June 1997.

User's Manual for EPA's Risk Screening Environmental Indicators Model: Version 1.02, U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, November 15, 1999.

(These and other technical documents relating to Risk Screening Environmental Indicators, as well as other information relating to Risk Screening Environmental Indicators are available on at: http://www.epa.gov/opptintr/rsei/. 31 January 2003. To obtain a copy of the model, please contact: TSCA Assistance Information Service, (202) 554-1404, Tsca-hotline@epa.gov).

POLLUTION PREVENTION
ECO-EFFICIENCY



Indicator: Volume of RCRA Hazardous Waste Generated per Dollar of US Gross Domestic Product (GDP)

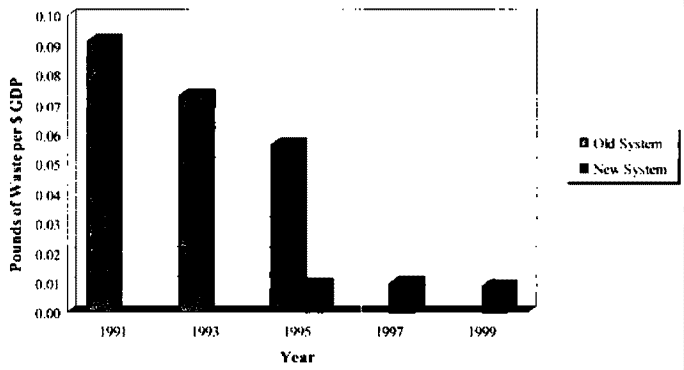
Hazardous waste is any waste that is ignitable, corrosive, reactive or contains certain amounts of toxic chemicals. Hazardous wastes are regulated "cradle-to-grave" by the Resource Conservation and Recovery Act (RCRA). The RCRA is a set of laws and standards for the production, storage, treatment and disposal of hazardous wastes.

Even with proper storage and treatment, there is always the potential for accidents that could result in: groundwater contamination, releases of toxic chemicals, or environmental transport of toxic vapors or liquid wastes. To minimize the risk of these hazards, the EPA has set a goal to reduce the quantity of hazardous waste generated in the U.S. This indicator tracks the progress toward that goal. It monitors the volume of RCRA hazardous waste generated, as reported through the Biennial Reporting System (BRS).

However, increases in volume of waste generated may reflect increased levels of economic production, rather than increasing pollution per se. In periods of accelerated production, the total volume of waste generated can increase even if pollution efficiencies are being maintained or even improved. To control for the effect of economic activity on volume of waste generated, the volume of waste generated is divided by the U.S. gross domestic product (GDP) for the corresponding year (GDP in billions of chained dollars[1], standardized to 1996). This calculation provides a measure of ecological efficiency by estimating the volume of waste generated for each dollar of economic activity.

- This indicator illustrates that the ecological efficiency of waste generation reported under the old system improved from 1991 to 1995 as the total number of pounds of waste generated per dollar decreased by 38%.
- Under the new system, there was a slight increase overall in the efficiency of output from 1995 to 1999. The total number of pounds of waste generated per dollar decreased by 6.25%.

Volume of RCRA Hazardous Waste Generated per Dollar of US Gross Domestic Product (GDP), 1991-1999



Notes: [1]A measure used to express real prices. Real prices are those that have been adjusted to remove the effect of changes in the purchasing power of the dollar; they usually reflect buying power relative to a reference year. Prior to 1996, real prices were expressed in constant dollars, a measure based on the weights of goods and services in a single year, usually a recent year. In 1996, the U.S. Department of Commerce introduced the chained-dollar measure. The new measure is based on the average weights of goods and services in successive pairs of years. It is "chained" because the second year in each pair, with its weights, becomes the first year of the next pair. The advantage of using the chained-dollar measure is that it is more closely related to any given period covered and is therefore subject to less distortion over time. (EIA, *Annual Energy Review 1999.)*

Chemical and Pesticides Results Measures II

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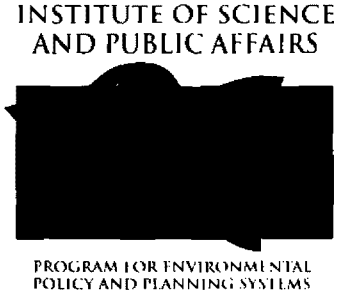

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