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FEASIBILITY REPORT ON ENVIRONMENTAL INDICATORS FOR SURFACE WATER PROGRAMS

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ABSTRACT

This report presents the results of a feasibility study on six environmental indicators of the nation's surface waters: designated use support and attainment of "fishable/swimmable" goals, shellfish harvest area classifications, trophic status of lakes, toxics in fish and shellfish, biological community measures, and pollutant loadings from point sources. The use of these and other environmental indicators is becoming an increasingly important evaluation tool for State and federal environmental managers. Important applications of environmental indicators include identifying trends over space and time, evaluation program effectiveness, targeting resources to highest-risk problems, targeting resources to activities achieving greatest risk reductions, and communicating results to the public and legislators. This report represents the second phase of a three-phase project conducted by the Office of Water Regulations and Standards (OWRS) and the Office of Policy, Planning and Evaluation (OPPE) to identify, evaluate and determine applications for environmental indicators of the nation's surface water resources.

Following the introduction, separate chapters are devoted to discussing the feasibility of each of the six environmental indicators. Strengths, weaknesses and possible improvements for each of the indicators are contained in these chapters and summarized at the end of the report.Evaluation criteria included data availability, data consistency/comparability, spatial and temporal representativeness of data, utility in trend assessment, relationship to ultimate impact, scientific defensibility, sensitivity to change, relationship to risk, cost of data collection and analysis, relationship to existing programs and presentation value.

Important conclusions and recommendations from this study include: (1) The shellfish harvest area classification data available from the National Oceanic and Atmospheric Administration (NOAA) could be incorporated into an EPA indicator reporting process in the near term. (2) It would be most efficient and logical for OW to use the State 305(b) reports as the primary vehicle through which it develops data on indicators. (3) The consistent use of the Waterbody System and of individual reach numbers by the States should be encouraged. (4) In the long-term, there are some additional monitoring and coordination activities that the Agency, other Federal agencies, and the States might consider in order to develop more meaningful indicators. (5) EPA should actively encourage State programs designed to implement measures of biological community well-being.

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ACRONYMS

BIOS	A component of STORET which stores biological data
BMAN	Benthic Macroinvertebrate Ambient Network
BOD	Biochemical Oxygen Demand
BSC	Biological Stream Classification system
CWA	Clean Water Act
DDT	Dichloro-Diphenyl-Trichloro-ethane
DMR	Discharge Monitoring Report
EDS	Effluent Data Statistics
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
EPT	total number of Ephemeroptera, Plecoptera and Trichoptera in a sample
FDA	Food and Drug Administration
FWS	Fish and Wildlife Service
GAO	Government Accounting Office
GIS	Geographic Information System
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IWB	Index of Well-Being
MBI	Macroinvertebrate Biotic Index
NASQAN	National Stream Quality Monitoring Network
NAWQA	National Water Quality Assessment program
NCBP	National Contaminant Biomonitoring Program
NCC	National Computer Center
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NSSP	National Shellfish Sanitation Program
NST	National Status and Trends program
OPPE	Office of Policy, Planning and Evaluation
ORD	Office of Research and Development
OW	Office of Water
OWRS	Office of Water Regulations and Standards
PAHs	Polycyclic Aromatic Hydrocarbons
PC	Personal Computer

ACRONYMS (Continued)

PCBs	Polychlorinated Biphenyls
PCS	Permit Compliance System database
PIBI	Potential Index of Biotic Integrity
POTW	Publicly Owned Wastewater Treatment plants
RTI	Research Triangle Institute
SIC	Standard Industrial Classification
STORET	STOrage and RETrieval (EPA's computerized water data base)
STPs	Sewage Treatment Plants
TBS	Temple, Barker & Sloane, Inc.
TOC	Total Organic Carbon
TOXNET	TOXicology data NETwork
TRI	Toxic Release Inventory
TSI	Trophic Status Index
TSS	Total Suspended Solids
USGS	United States Geological Survey
WBS	Waterbody System
WQI	Water Quality Index

I. INTRODUCTION

This report presents the results of a study on the feasibility of six measures identified as potential environmental indicators of the quality of the nation's surface waters. The feasibility analysis is the second portion of a three-phase project jointly managed by the Office of Water Regulations and Standards (OWRS) and the Office of Policy, Planning and Evaluation (OPPE) at EPA. The first phase consisted of identifying and describing a series of potential indicators for freshwater, estuarine and coastal environmental quality, and holding a workshop of federal and State personnel to review, revise and narrow down the candidate indicator list. Three reports were completed in Phase One: Resource Document for the Workshop on Environmental Indicators for the Surface Water Program (March 28-29, 1989), Workshop on Environmental Indicators for the Surface Water Program (March 28-29, 1989), and Results: Workshop on Environmental Indicators for the Surface Water Program (July 1989). In the second phase, contractors and EPA personnel assessed the feasibility of reporting on the set of indicators selected at the workshop. These were selected as most meaningful and practical for one or more of the following purposes: status and trend reporting; overall water program evaluation, and evaluation of the effectiveness of individual program components (e.g., point source regulation, or toxic chemical controls). The present report addresses questions relating to data availability, and the degree to which the proposed measures meet the criteria of a "good" indicator, and which of the possible "uses", described further below, is met by the measure. In the third phase of the project, EPA and State personnel will develop options and recommendations for specific applications of the indicators by States, Regions, or EPA Headquarters.

Purpose of the Project

The use of environmental indicators is becoming an increasingly important evaluation tool for federal and State environmental programs. Carefully chosen indicators of surface water quality can help answer two fundamental questions:

- What is the quality of surface waters, and
- How are we doing in our efforts to improve it?

Environmental managers at EPA and elsewhere can use indicators for several specific purposes related to these general questions, including:

- Identifying trends over time and space;
- Evaluating program effectiveness;
- Targeting resources to areas with greatest environmental impact;
- Targeting resources to areas of potential or developing problems; and
- Communicating results to the public and legislators.

I. INTRODUCTION

A primary goal of this project is to identify existing data sets that can be used to develop indicators of surface water quality. If Samuel Taylor Coleridge were describing the plight of the modern day water quality manager, he might say that there are data, data, everywhere, but not a trend to see. There is a large amount of water quality information gathered by EPA, State Agencies and other Federal Agencies. However, as EPA's Office of Water (OW) reported in its 1987 study; Surface Water Monitoring: A Framework for Change, it is not collected or stored in a way that facilitates its use to identify trends. Ward refers to this as a "data-rich but information-poor" syndrome (Ward 1986), noting that there has not been a sufficient linkage between water quality monitoring and the related management activities.

The historical problems that EPA has had in making use of data available from all of its monitoring programs have been addressed in a number of reports (see for example GAO, 1986). A number of Agency activities are underway to resolve these problems. There are currently several workgroups active at OWRS to develop technical guidance to aid States in their efforts to improve the collection of biological monitoring data and to help State managers use this information. In addition, the Agency is actively working to make data more readily available at the national level through scheduled improvements to the STORET database and to BIOS, a component of the STORET system which will be used to store biological data, and through implementation of the Waterbody System (WBS), the computerized database recently developed to facilitate State reporting of information in biennial 305(b) reports to Congress.

The development and identification of useful indicators from this project could complement these activities through the identification of specific measures for which data collection should be encouraged. This information could provide a framework to help steer future monitoring activities and allow EPA officials to reach a consensus on the ways to report information in water quality reports. A similar approach is being used in the development of the Environmental Monitoring and Assessment Program (EMAP), a program that is being designed by the EPA's Office of Research and Development (ORD) to periodically assess the country's ecological resources in all ecosystems (terrestrial and aquatic). EMAP program activities include the evaluation, development, and testing of environmental indicators and the design and evaluation of indicator-based monitoring programs for collecting status and trend data. Major differences in the proposed EMAP program and the current Surface Water Indicators development project are timing and the relationship of the programs to on-going monitoring activities. EMAP is intended to be a national, rigorous statistically designed monitoring program to begin several years from now. The Surface Water Indicators project intends to identify types of information already available or available with relatively minor modifications, from existing monitoring activities. Reporting on these indicators could begin very soon, and in some cases will already be occurring. Eventually EMAP data would supplement these indicators.

Background

OWRS has long been involved in the process of providing Congress and water quality managers, at EPA and elsewhere, with information on the quality of aquatic resources. In the 1987 Surface Water Monitoring study, OW recommended that EPA and the States should take actions that would meet the following objectives:

- Enhance State and EPA capabilities to carry out characterization, problem identification, and trend assessment in inland, estuarine, and marine waters;

- Increase ambient follow-up monitoring to evaluate the effectiveness of management decisions; and

- Promote the use of available water-related data in EPA and State decision-making.

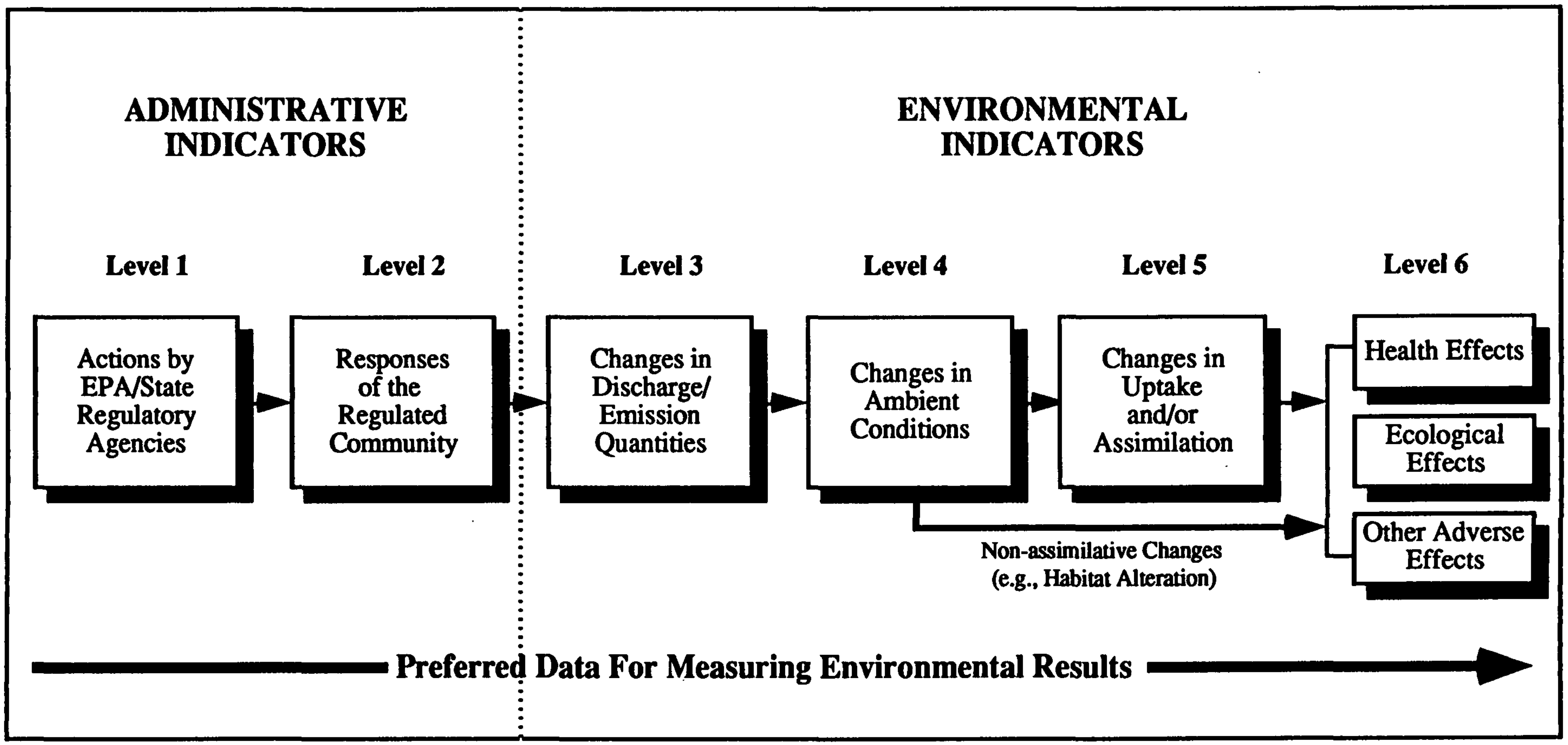
The use of a select group of environmental indicators could help respond to these concerns. Environmental indicators are appropriately applied to the first objective, of supporting problem identification and trend assessment. Systematic monitoring for indicators of ambient conditions will improve feedback to program managers regarding the effectiveness of their decisions, thus fulfilling objective 2. Developing these indicators will both promote and benefit from the third objective, taking advantage of existing data sets.

The Office's interest in developing environmental indicators has been recently enhanced by the Agency-wide emphasis to adopt true environmental measures of progress. This new emphasis is part of EPA Administrator William Reilly's risk reduction and strategic planning process designed to increase the focus of EPA programs on environmental results. As the Administrator noted in the May 1989 issue of the EPA Journal,"[the good news is] based on my years in the environmental movement, as well as my first four months as EPA Administrator, I believe EPA has the most talented, most dedicated, hardest-working professional staff in the federal government. What's more, I think this Agency does an exemplary job of protecting the nation's public health and the quality of our environment. Now the bad news: I can't prove it." In developing its strategic plans, each EPA program area is being asked to identify environmental goals and to select appropriate indicators that will allow the Office to track progress in meeting those goals.

There is a continuum of types of information, ranging from administrative or activity measures to the evaluation of true health or environmental effects, that can provide a framework against which the utility of various measures can be evaluated. The various levels of potential indicators are shown in Figure I-1 below. Each type of indicator is valuable for certain purposes. For example, indicators at level 1 and 2 may be more appropriate for evaluating the efforts of governmental managers than say those at level 3 or 4 because of the time necessary for any changes to be reflected in environmental results. Data are more likely to be readily obtained for Level 3 and 4 indicators than for Levels 5 and 6. Ideally, measures would be available at levels 5 and

Figure I-1

Continuum of Indicators



6 since the government and the public are most interested in seeing positive results at these levels.

Barriers to the Use of Indicators

Despite widespread acceptance of the concept of using environmental indicators, their actual application is limited. There are a number of reasons for this. States do not have excess financial or personnel resources that can be dedicated specifically for the purpose of developing and reporting on environmental indicators. In the absence of sustained management emphasis and central Agency coordination for reporting and using environmental indicators, it has often appeared that the costs of monitoring, analyzing, and reporting on the measures outweigh the potential benefits. The paucity of legislative mandates to collect and report on environmental results contributes to this perception. Managers and scientists are often hesitant to use available data, or data from other sources, recognizing the difficulties in simplifying and summarizing the information for use as an indicator. Finally, managers may fear that they will be held accountable for changes in environmental conditions that they cannot control, and they may therefore resist developing indicators.

Through EPA's new strategic planning process, some of these barriers may be overcome. In particular, top management emphasis on environmental results-based planning will provide strong support for indicator reporting. And a process encouraging the use of environmental indicators to understand program results, and to influence program planning, without a negative component involving evaluating personal performance, will hopefully diminish resistance due to fear of accountability.

Use of Indicators in EPA Surface Water Programs

The 305(b) reporting mechanism provides OW with a State-driven information system that already serves as a source of indicator data and can be improved upon for use in the future. If desired by OW, and agreed upon by the States, changes in the reporting system could allow for more uniform collection of information needed to develop selected environmental indicators. One of the major problems facing various Offices at EPA in developing indicator programs will be in finding ways to compile and analyze the information available from various sources. OW, through the biennial 305(b) reports and the computerized waterbody system (WBS), already has such a system in place.

As part of the 305(b) reports, States assess and report on their waterbodies according to their ability to support the designated uses established for all waters in their water quality standards. States determine whether the designated uses are supported by compiling and interpreting data on a variety of physical, chemical and biological measures. Chemical and physical measures, corresponding to properties for which water quality criteria have been adopted in State standards, are the most common measures to evaluate use support, while biological measures are becoming more common. In addition to the use support information, EPA also encourages the States to report on the extent to which their waters are meeting the fishable and swimmable goals of the Clean Water Act and to provide other information including shellfish harvest area closures, and waters affected by fish kills and incidents of waterborne disease. EPA aggregates and summarizes the State reports into a single national assessment which it submits to the Congress.

In reporting on designated use support, States set water quality goals and measure progress in meeting them. In addition, information provided on the causes and sources of pollution allows managers to identify emerging and existing problems so that they could potentially target their resources more effectively. As well as its use in a national report to Congress, information reported is used by the States in identifying problems, monitoring compliance actions, and setting control priorities.

Unfortunately, the current value of the 305(b) reports as a source of environmental indicator data is severely limited. There are very large inconsistencies among States in how water quality data are generated, analyzed, and reported. States assess different subsets of their waters from one year to the next. In some instances, States even change their accounting of total waters from one year to the next. One problem in using this information for national reporting purposes stems from the considerable discretion that States have under the law in developing their own water quality standards. These standards establish environmental goals for individual water segments, the designated use, and numeric or narrative criteria designed to ensure protection of the use. As a result of these differences among States and in the type of information they provide to EPA in their 305(b) reports, making comparisons between States or trying to assess national status and trends is essentially impossible. And the inconsistencies in sampling design from year to year make it difficult to assess trends even within individual States.

EPA currently does not require that States use reach numbers or other geographic locators to identify specific water body sections in the 305(b) reports. If more States provided this information, it would allow for cross-referencing with other data sets, such as STORET, and would allow for information on pollution stress factors, such as population, to be correlated with the site-specific information.

OW is working with the States to improve the reporting process and as noted above, the 305(b) reports can provide an excellent framework for the future reporting of indicator information. First, EPA is working to improve the consistency in designated use support information and in the way States assess their total waters. In WBS, States must establish a consistent set of water segment boundaries and continue to use this segmentation scheme in subsequent reports. This should allow accurate trend analyses based on subsets of the data that are spatially consistent from year to year. The new computerized WBS has the capacity to generate statewide summary reports of use support status for waterbodies and also to provide more detailed reports on sources and causes of impairment for waterbodies. The standardized use of this system by all States would also provide EPA with more flexibility in providing summary documents on a nationwide basis. For example, States are asked to include assessment dates and whether the assessment is based on monitored (collected data) or evaluated (visual assessments or opinions of water quality professionals) information. Trend data based only on systems that had been monitored since the last report might prove to be a more valuable tool than that which can be derived from the statewide summary reports, which include many sites that haven't been investigated over the time period for which the trend is being determined.

Characteristics of a Good Indicator

The identification of those criteria that comprise a "good" indicator will depend to a large degree on the specific purposes for which the indicator might be used. For example, an indicator designed to provide information on nationwide status and trends may have different characteristics than one designed to evaluate the effectiveness of a specific, localized program. The following list identifies many of the criteria by which indicators can be evaluated. They are not in any specific order of importance, but in differing circumstances some are clearly more important than others. In section II-VII of this report we will evaluate the feasibility of the various indicators and will discuss each one in terms of the characteristics noted below as well as other aspects of data quality and availability.

- Indicator is a measure of environmental conditions rather than administrative actions
- The indicator is national in scope
- The indicator is spatially and temporally representative
- Indicator is based on information that is relatively easy and inexpensive to obtain (which often means it uses data that are already being collected, or collected partially, or collected in some locations, etc.)
- Indicator is understandable to nontechnical users including Congress, the news media, and the general public
- The indicator can show incremental changes
- The indicator is scientifically defensible, sufficiently consistent across its areas of use, and is relevant to the system on which it is used.

This list represents the conclusions reached at a workshop held in March of this year regarding appropriate criteria for indicators of surface water quality. Additional information on that workshop and the conclusions reached there are presented in the next section.

Activities Leading to the Feasibility Study

As noted earlier, this feasibility study is the end of the second phase of this three-phase project.

The first phase of the project involved the identification of existing data bases, at EPA and elsewhere, that could be utilized to develop indicators. Information on more than two dozen potential indicators was compiled into a report entitled: Resource Document for the Workshop on Environmental Indicators for the Surface Water Program (March 28-29), which provided the substantive basis for a workshop held on March 28-29, 1989. This document contains brief descriptions of each measure and a discussion of its major advantages and disadvantages, its applicability to different categories of waterbodies, and the availability of data to support it. In addition, a workbook entitled: Workshop on Environmental Indicators for the Surface Water Programs (March 28-29 1989) helped to focus participants in their discussions.

At the workshop, participants representing State governments, EPA Regional Offices, EPA headquarters and other organizations shared their views on the strengths and weaknesses of potential indicators. The participants were divided into three workgroups that attempted to answer the same questions, focusing on their particular area of concern. Each workgroup attempted to define the following, focusing on the use of indicators for reporting status and trends, for evaluating program effectiveness or for evaluating the impacts of specific sources of pollutants:

- The audience for whom the indicators were being developed
- The objectives of the type of indicator that was being addressed;
- Specific criteria that applied to indicators that would meet these objectives; and
- An identification of the particular indicators that met the objectives and responded to the concerns of the identified audience.

A complete summary of the results of the workshop is presented in a document entitled Results: Workshop on Environmental Indicators for the Surface Water Program (July 1989). Table II-1 highlights the recommendations of each of the groups.

In the second phase, OWRS and OPPE reviewed the workshop recommendations and selected the seven most highly rated indicators from the workshop for further evaluation and inclusion in the feasibility study. The seven chosen measures are:

- Designated use support and attainment of fishable/swimmable" goals
- Shellfish harvest area classifications
- Trophic status of lakes
- Toxic contamination in fish and shellfish
- Biological community measures
- Pollutant loadings from point sources

Table I-1
WORKSHOP RESULTS

	GROUP 1 *National Status/Trends*	GROUP 2 *Program Effectiveness*	GROUP 3 *Sources Of Pollution*
Audience	Government Public/Media Scientific Community Environmental Groups	EPA, Congress and other Federal Agencies The Regulated Community Public/Media Environmental Groups States	Decision-makers (Federal and State) Public Regulated entities
Objectives	Program Mangement Outreach/Education Problem Identification Agency Accountability	Evaluate overall water quality programmatic success on national and state basis Targeting Evaluate success of programs in all environmental media that affect water quality Evaluate specific programs	Data checks on permits Measures program effectiveness Correlate problems with sources Targeting resources
Criteria	National in Scope Accurate Understandable Relevant Timely	1. Generally applicable across all objectives: Timely Reference (background) values available Consistent across area of concern Flexible 2. Applicable for some objectives: Direct measure of environmental conditions Understandable to public Sensitive to incremental changes Flexible: information from various collecting agencies can be used	Provides quantitative correlation between source and pollution Understandable Relevant Predictive
Potential Indicators	4 TIERED APPROACH *Tier: Representative Indicator* Integrated: Designated Use Chemical/Physical: WQI Biological: Measure of community *structure/function* Administrative: Beach Closures	3 CATEGORIES *Category: Representative Indicators* General Program Evaluation (Ecological Protection): Biological Community Index; Toxics in Fish; Designated Use Support General Program Evaluation (Human Health): Toxics in Fish Tissue; Shellfish Closures; Contact Recreation Closures Program-Specific Indicators: Chemical/Physical Properties; Loadings; Ambient Water Toxicity	Did not identify an indicator that would link pollution to a specific source: more research is necessary

- Water quality indices based on physical/chemical data

This report presents results of that study for six of the seven recommended indicators. The seventh indicator, water quality indices based on physical/chemical data, is being evaluated by OWRS in a separate study.

In the third and final phase of the project, the contents of this report will be reviewed by OW, OPPE, EPA Regional Water Divisions, States, and other interested parties with a particular emphasis on identifying specific applications for the various indicators. A final report will then be prepared that describes options and recommendations for the use of indicators by States, Regions or EPA Headquarters.

II. DESIGNATED USE SUPPORT AND ATTAINMENT OF "FISHABLE/SWIMMABLE" GOALS

SUMMARY

Description of the Indicator

This indicator uses information provided by the States to EPA on the status of their waterbodies. The information, included in reports required under section 305(b) of the Clean Water Act (CWA), describes to what degree individual waterbodies are meeting their designated uses. State and local governments assign designated uses to waterbodies and determine the criteria by which they will be evaluated as part of their water quality standards.

States also report to EPA on the extent to which their waters meet the "fishable and swimmable" goals of the CWA. This differs from designated use support in the types of information each State considers adequate to allow a determination (e.g. monitored versus professional judgement).

Possible Applications

The State data are currently used in the development of a national assessment of water quality. This is the States' and EPA's primary vehicle for informing Congress of the state of the nation's waters. At the March 1989 workshop on developing surface water indicators, the workgroup on status and trends recommended that "designated use support" be used as a "high visibility" indicator to generate attention and solicit questions about the underlying results.

Strengths	National data collection and reporting system is already in place and used by all States (Recently Computerized). "Fishable/Swimmable" reporting provides information on goals of primary interest to the public and is easily understood by general public.
Weaknesses	Since State reporting is inconsistent and not standardized, measures cannot be used to evaluate trends. Within a State, inconsistencies exist from one reporting cycle to the next.
Possible improvements	Increase use of the Waterbody System to allow EPA to aggregate results; Increase use of reach numbers or other geographic identifiers to facilitate trend assessments; Increase systematic ambient monitoring by States (e.g. returning to certain subsets of waters regularly to establish trends).

EVALUATION CRITERIA

Data availability	**Good**-States currently collect information on a biennial basis and report it to EPA through the 305(b)reports.
Data consistency/comparability	**Poor**-No consistent basis for monitoring sampling design from State to State and water quality standards vary.
Spatial representativeness	**Fair/Poor**-Although the same waters are not assessed from one cycle to the next, the identified bodies are representative of those types of waters within a State.
Temporal representativeness	**Fair/Poor**-It is primarily based on physical-chemical data which are transient.
Utility in trend assessment	**Poor**-Since the same waters are not assessed from one cycle to the next, it is impossible to determine trends. Waterbodies can be reported as evaluated, meaning the data from the last cycle is sometimes just repeated in the next report.
Relation to ultimate impact	**Good**-For Fishable/Swimmable since the degree to which these goals are met is the ultimate impact. **Fair**-For designated use since the exact impact of the chemical/physical data are not known; Better if biological community data are included in the use attainment determination.
Scientific defensibility	**Fair/Poor**-Methodologies vary from State to State, therefore, the degree to which designated use and fishable/swimmable determinations are defensible as true measures of water quality is also variable.
Sensitivity to change	**Poor**-Categories are too broad to detect incremental changes.
Relationship to risk	**Fair/Poor**-The relationship is tenuous for both ecological and human health risks. The link from chemical/physical to actual environmental damage is ill-defined. Changes in fishable/swimmable do relate to potential human health risk, but the connection with designated use is less strong.
Cost to collect and analyze data	**Low**-States already engaged in data collection; Improved collecting/reporting would require incremental cost increases.

EVALUATION CRITERIA

Relationship to existing programs	**Good**-Required as part of 305(b) CWA requirements.
Presentation value	**Good**-Fairly easily understood by the general public; Can be presented using maps and graphs.

DISCUSSION

Background

At present, the primary mechanism by which EPA assembles and reports on the nation's surface water quality is through the biennial State reports called for under Section 305(b) of the CWA. As part of these reports, States assess and report on a variety of designated uses. Under each State's water quality standards program, the State designates uses for waterbodies and establishes numeric and narrative water quality criteria the State determines are needed to protect each use. The extent to which the assessed waters meet or fail the established criteria determines whether or not, and to what degree, the designated use is considered to be met. States also report on whether the use support decision is based on actual monitoring data or more subjective evaluations.

Surface waters may be designated for one or more uses including, but not limited to: domestic water supply; aquatic fish and wildlife support; recreation; agriculture; industrial use; navigation; and nondegradation waters. States report on the degree to which assessed waters are: "fully supporting", "fully supporting but threatened", "partially supporting", or "not supporting" their designated uses. EPA also encourages States to report on the extent to which the waters meet the "fishable" and "swimmable" goals of the CWA. This determination can take into account information different from that used in use support assessments, for example fishery closures. A smaller set of waters would be expected to support fishable and swimmable goals than to support their designated uses, because some designated uses are less demanding than full support of CWA goals (e.g., industrial use).

Uses of the Indicator

At the March workshop, the workgroup charged with recommending indicators that could be used to report on status and trends in the nation's waters identified the need for a "high visibility" indicator that would lead people to ask questions and would generate attention. The workgroup felt it was not essential that such an indicator be able in itself to provide answers to the questions. With some reservations concerning the lack of consistency among States in the assignment and evaluation of designated uses, the workgroup recommended that a "designated use" measure be used for this high visibility, integrative indicator.

The primary audience for this nationwide measure includes the Congress, for whom EPA must aggregate all the State 305(b) reports into a national assessment known as the "National Water Quality Inventory", and the general public. The major benefit of this nationwide measure is its ability to provide information in a similarly expressed and relatively easily understood manner on the status of all of the nation's assessed surface waters. In addition, States and EPA Regional Offices can use the individual State 305(b) reports to highlight potentially threatened waters and to provide additional information on the causes and sources of "non-attainment" of uses. The 305(b) report thereby serves as a management tool for identifying problems and setting control priorities.

Characteristics of the Indicator

As noted above, these nationally applicable measures can provide the Congress, the press, and the general public with some indication of the quality of the nation's surface waters and a measure of progress toward attainment of the fishable/swimmable goals of the Clean Water Act. However, inconsistencies and the lack of standardization among the States, and within States from one year to the next, in how water quality data are collected, analyzed, and reported make it difficult to use the data as an indicator of national status and trends.

States typically conduct surveys of different waters each year, creating uncertainty when analyses of statewide or nationwide trends are attempted. As can be seen in Table II-1, the total river miles assessed can vary from year to year and in some instances decreases from one year to the next. Even the accounting of the total river miles existing in a State is sometimes changed from year to year due to natural or human modifications of river reaches or differences in reporting procedures.

States have considerable discretion to develop water quality criteria for waters in various use categories, and to define when their waters are "fishable" and "swimmable". Moreover, States vary in the quantity, type, and quality of the data they compile and the methods they use to interpret the data in determining whether each waterbody is supporting its uses or the CWA goals. Since appropriate assessment tools will, in fact, vary from one situation to the next, the differing methodologies for determining the extent of use support is in some cases appropriate. However, it does make comparisons between States uncertain.

Data Availability

One of the major advantages of this indicator is the commitment of the EPA to continuing and improving the 305(b) reporting process and the resultant surety that this type of information will continue to be collected. In addition, EPA has developed a data system for managing water quality information to support 305(b) reporting for specific waterbodies, the Waterbody System (WBS). Both mainframe and PC versions of the WBS exist. The WBS has the capability to generate statewide summary reports of "use support" status for each of seven waterbody types, and once a State develops a segmentation scheme for its waterbodies, it will be expected to use the same segmentation in all future reporting. Beginning with the 1990 reporting cycle, all States will be asked to use the WBS or submit their assessments in a WBS compatible format and designated use data will therefore be available on a more consistent basis in the future. The WBS will allow EPA and the States to generate individual summary reports listing assessment types and dates, "use support" status, and sources and causes of impairment for each waterbody.

Table II-1
Designated Use Support - Rivers 1986 & 1988 (37 States)

State	Total River Miles	Miles Assessed	Fully Supporting	Partially Supporting	Not Supporting
Alabama '86	40,600	12,101	10,835	804	462
AL '88	40,600	11,174	10,118	625	431
Changes	0	-927	-717	-179	-31
Arizona '86	17,537	1,412	615	391	406
AZ '88	6,671	2,279	1,583	207	489
Changes	-10,866	867	968	-184	83
Arkansas '86	11,438	11,438	5,914	5,524	0
AR '88	11,508	4,107	1,714	29	2,364
Changes	70	-7,331	-4,200	-5,495	2,364
California '86	26,959	9,627	6,163	1,518	335
CA '88	26,970	9,885	6,578	2,219	1,088
Changes	11	258	415	701	753
Connecticut '86	8,400	880	597	232	51
CT '88	8,400	880	582	239	59
Changes	0	0	-15	7	8
Deleware '86	579	516	309	184	23
DE '88	500	467	280	156	31
Changes	-79	-49	-29	-28	8
Florida '86	9,320	6,575	4,448	1,670	457
FL '88	12,659	7,943	5,287	2,021	635
Changes	3,339	1,368	839	351	178
Georgia '86	20,000	17,000	16,185	458	357
GA '88	20,000	20,000	19,443	383	174
Changes	0	3,000	3,258	-75	-183
Illinois '86	14,080	3,395	1,861	1,457	77
IL '88	14,080	12,970	5,783	172	186
Changes	0	9,575	3,922	-1,285	109
Iowa '86	18,000	4,365	72	3,077	1,216
IA '88	18,300	8,235	69	6,503	1,663
Changes	300	3,870	-3	3,426	447
Kansas '86	20,600	4,495	3,512	359	435
KS '88	19,791	6,888	3,994	760	2,134
Changes	-809	2,393	482	401	1,699
Kentucky '86	40,000	5,683	3,130	1,877	675
KY '88	18,465	8,653	6,176	878	1,599
Changes	-21,535	2,970	3,046	-999	924
Louisiana '86	14,180	2,500	1,240	800	460
LA '88	14,180	8,483	5,730	2,146	607
Changes	0	5,983	4,490	1,346	147
Maine '86	31,672	31,672	30,695	513	464
ME '88	31,672	31,672	31,278	0	394
Changes	0	0	583	-513	-70
Maryland '86	9,300	7,440	6,852	449	139
MD '88	9,300	9,300	8,635	504	161
Changes	0	1,860	1,783	55	22
Massachusetts '86	10,704	1,676	802	572	302
MA '88	10,704	1,646	713	598	335
Changes	0	-30	-89	26	33
Michigan '86	36,350	36,350	35,696	0	497
MI '88	36,350	36,350	35,567	0	783
Changes	0	0	-129	0	286
Mississippi '86	10,274	10,274	9,260	1,014	0
MS '88	15,623	15,623	13,850	1,331	442
Changes	5,349	5,349	4,590	317	442
Missouri '86	20,536	20,536	10,390	10,075	71
MO '88	19,630	19,630	10,147	9,445	38
Changes	-906	-906	-243	-630	-33

Sources: 1986 1988 305(b) Reports

Table II-1 (Continued)
Designated Use Support - Rivers 1986 & 1988 (37 States)

State	Total River Miles	Miles Assessed	Fully Supporting	Partially Supporting	Not Supporting
Montana '86	20,532	19,505	12,184	6,934	387
MT '88	20,532	19,505	12,261	6,630	614
Changes	0	0	77	-304	227
Nebraska '86	24,000	4,794	2,717	1,135	942
NE '88	10,212	5,690	3,244	1,202	1,244
Changes	-13,788	896	527	67	302
New Hampshire '86	14,544	1,320	981	259	80
NH '88	14,544	1,331	950	210	171
Changes	0	11	-31	-49	91
New Mexico '86	3,500	3,500	3,140	360	0
NM '88	3,500	1,151	576	554	22
Changes	0	-2,349	-2,564	194	22
New York '86	70,000	3,400	2,667	246	487
NY '88	70,000	69,988	53,394	8,087	8,507
Changes	0	66,588	50,727	7,841	8,020
North Carolina '86	37,359	37,359	25,156	10,171	1,867
NC '88	37,378	33,275	22,375	9,152	1,748
Changes	19	-4,084	-2,781	-1,019	-119
Ohio '86	43,900	6,628	4,048	1,977	603
OH '88	43,917	7,045	2,256	1,501	3,288
Changes	17	417	-1,792	-476	2,685
Oregon '86	90,000	11,855	9,665	1,915	275
OR '88	90,000	27,738	12,546	8,497	6,695
Changes	0	15,883	2,881	6,582	6,420
Pennsylvania '86	50,000	6,225	3,332	1,242	1,651
PA '88	50,000	13,242	9,642	1,770	1,830
Changes	0	7,017	6,310	528	179
Rhode Island '86	724	724	655	34	35
RI '88	724	581	489	14	78
Changes	0	-143	-166	-20	43
South Carolina '86	9,679	2,442	2,127	194	121
SC '88	9,900	3,795	2,824	395	576
Changes	221	1,353	697	201	455
South Dakota '86	9,937	3,987	1,865	1,130	992
SD '88	9,937	3,750	1,387	1,260	1,103
Changes	0	-237	-478	130	111
Tennessee '86	19,124	5,748	3,794	1,118	847
TN '88	19,124	9,428	5,976	2,484	968
Changes	0	3,680	2,182	1,366	121
Texas '86	80,000	15,942	14,966	0	976
TX '88	80,000	13,998	12,169	0	1,829
Changes	0	-1,944	-2,797	0	853
Vermont '86	4,863	1,167	882	269	16
VT '88	5,162	5,162	4,534	379	249
Changes	299	3,995	3,652	110	233
Virginia '86	27,240	4,716	948	1,536	2,232
VA '88	27,240	3,532	1,210	1,401	921
Changes	0	-1,184	262	-135	-1,311
West Virginia '86	22,819	18,244	10,225	6,631	1,388
WV '88	28,361	14,301	2,862	10,107	1,332
Changes	5,542	-3,943	-7,363	3,476	-56
Wyoming '86	19,655	19,655	17,386	297	1,972
WY '88	19,437	19,437	16,080	3,350	7
Changes	-218	-218	-1,306	3,053	-1,965
Total '86	908,405	355,146	272,006	66,422	21,298
Total '88	875,371	469,134	332,302	92,838	44,795
Changes	-33,034	113,988	60,296	25,616	23,497

Sources: 1986 1988 305(b) Reports

Improving the Indicator

As well as implementing the WBS, EPA is also working to improve consistency in designated use reporting and in State definition of total waters. The lack of consistency among the States is the greatest impediment to effective use of the national designated use measure to give an accurate picture of the nation's water quality and to show temporal trends in this evaluation. In addition, EPA is reviewing trend assessment methodologies used by States and others and hopes to develop recommendations on future trend reporting. Work on other measures that can be used by States to assess their waters, such as the biological measures or water quality indices discussed elsewhere in this report, could also help States make more meaningful assessments. Encouraging the uniform use of reach numbers or other forms of geographic locator, to identify waterbodies for trend analysis and to correlate information from other sources, would greatly increase the efficiency with which State data could be analyzed and used.

Presentation of the Indicator

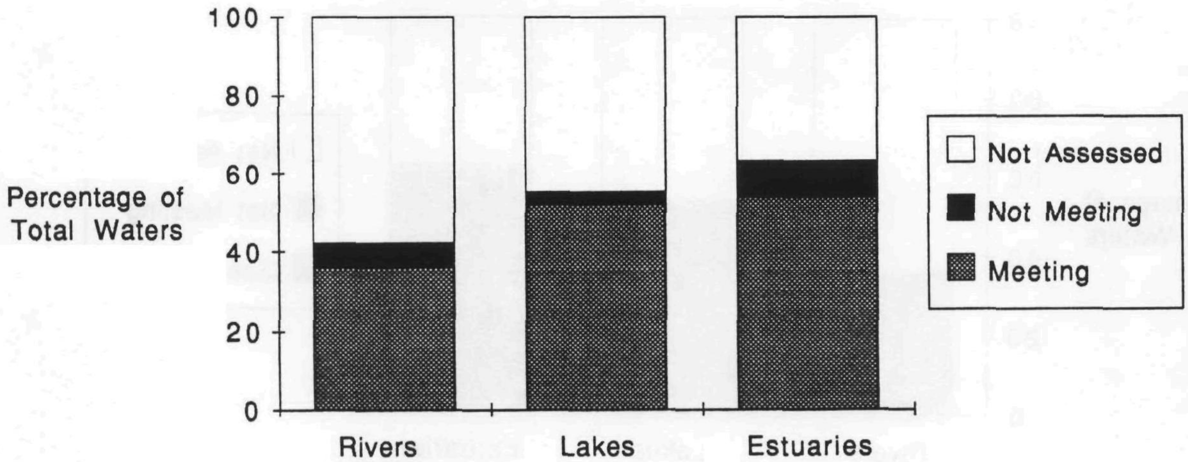
The following figures demonstrate different ways in which information on designated use and the meeting of fishable/swimmable goals can be shown. Figures II-1 and II-2 show the degree to which the nation's assessed waters were meeting the fishable and swimmable goals expressed as a percentage of the total waters. Figure II-3 shows similar data for rivers, lakes, and estuaries in 1988 for designated use support. One could develop similar graphs for 1986 and earlier years for comparative purposes. However, given the uncertainties noted earlier in comparing these data from one year to another, this kind of graphical analysis may be misleading.

Designated use and fishable/swimmable information can also be presented in terms of the actual river miles and number and area of lakes and estuaries assessed. Figure II-4 shows the 1988 assessments for river miles assessed in Region 4. This type of bar graph conveys the greatest amount of information, showing the amount of each water type assessed as well as the results of the assessments. However, when there is a large discrepancy in the total river miles assessed in various States within a region, the resultant differences in the height of the bars may make the graphic difficult to read.

Another way to present the national data is with a shaded map. Figures II-5 and II-6 show, for each State, the percentage of assessed river miles that are fishable and swimmable respectively. The two maps can highlight differences among States. For example, in New York, a larger percentage of waters are "swimmable" than "fishable"; while the reverse is true for Iowa. Figure II-7 shows, in 1988, for each State, the percentage of assessed river miles that fully supported their designated use.

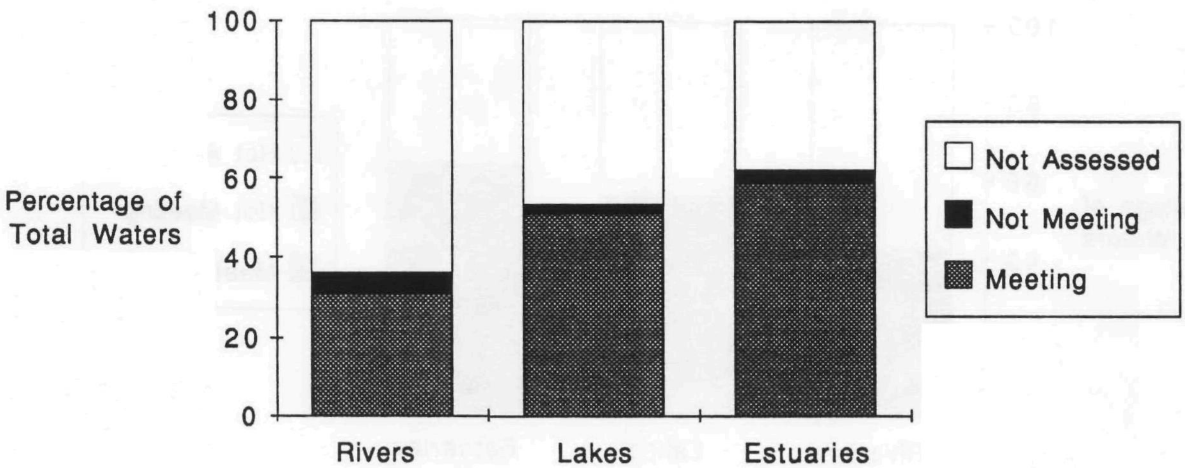
Since States do not assess all of their waters, it is important to note what percentage of their waters are included in the assessments. Figure II-8 provides this information for 1988 and, by the use of arrows, indicates if this is an increase or decrease in assessment activities from 1986 levels. Finally, one could show trends in designated use attainment, (again acknowledging the caveats preventing use of data prior to the present date for trend analyses) by placing arrows on a map to indicate whether a later year's data represented an increase or a decrease in the percentage of waters supporting designated use, when compared to an earlier year. While there are not sufficient data to support this now, it may be appropriate for the future. Figure II-9 shows how this might look, using 1986 and 1988 data for rivers in Region I.

Figure II-1
Nationwide Summary of CWA Fishable Goal 1988



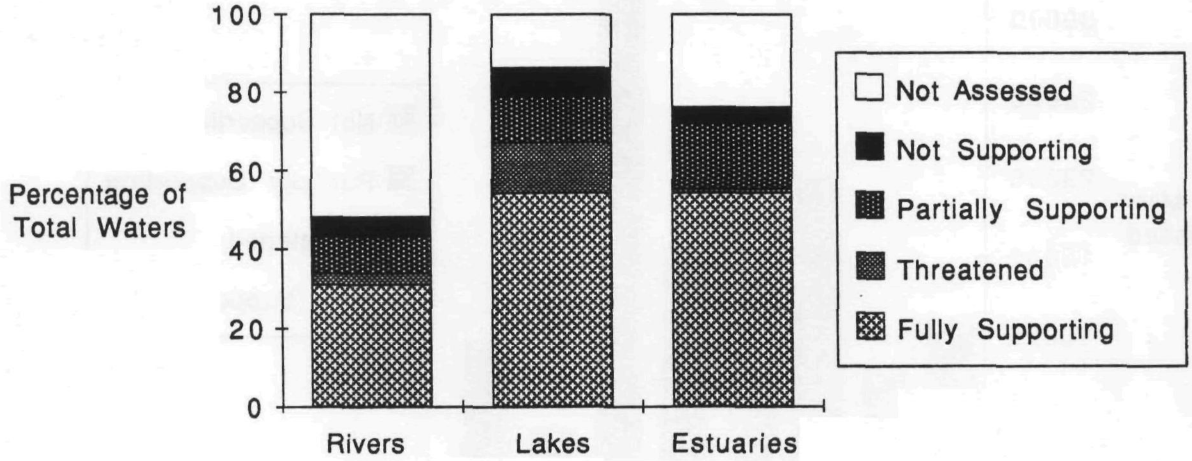
Source: 1988 305(b) Reports

Figure II-2
Nationwide Summary of CWA Swimmable Goal 1988



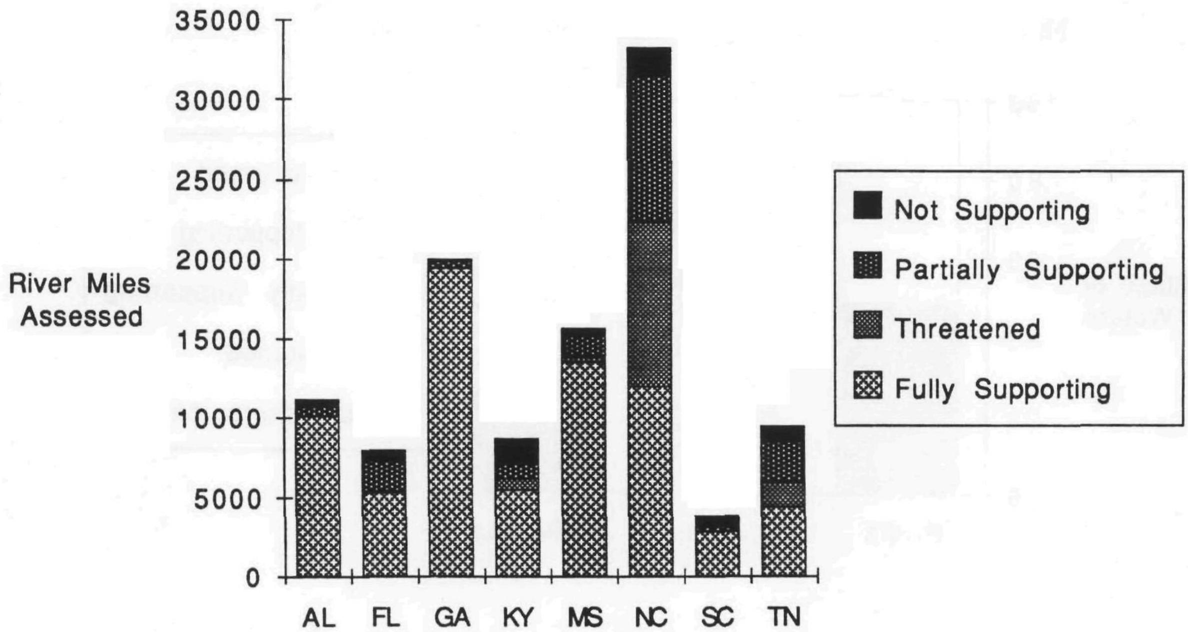
Source: 1988 305(b) Reports

Figure II-3
Nationwide Designated Use Support 1988



Source: 1988 305(b) Reports

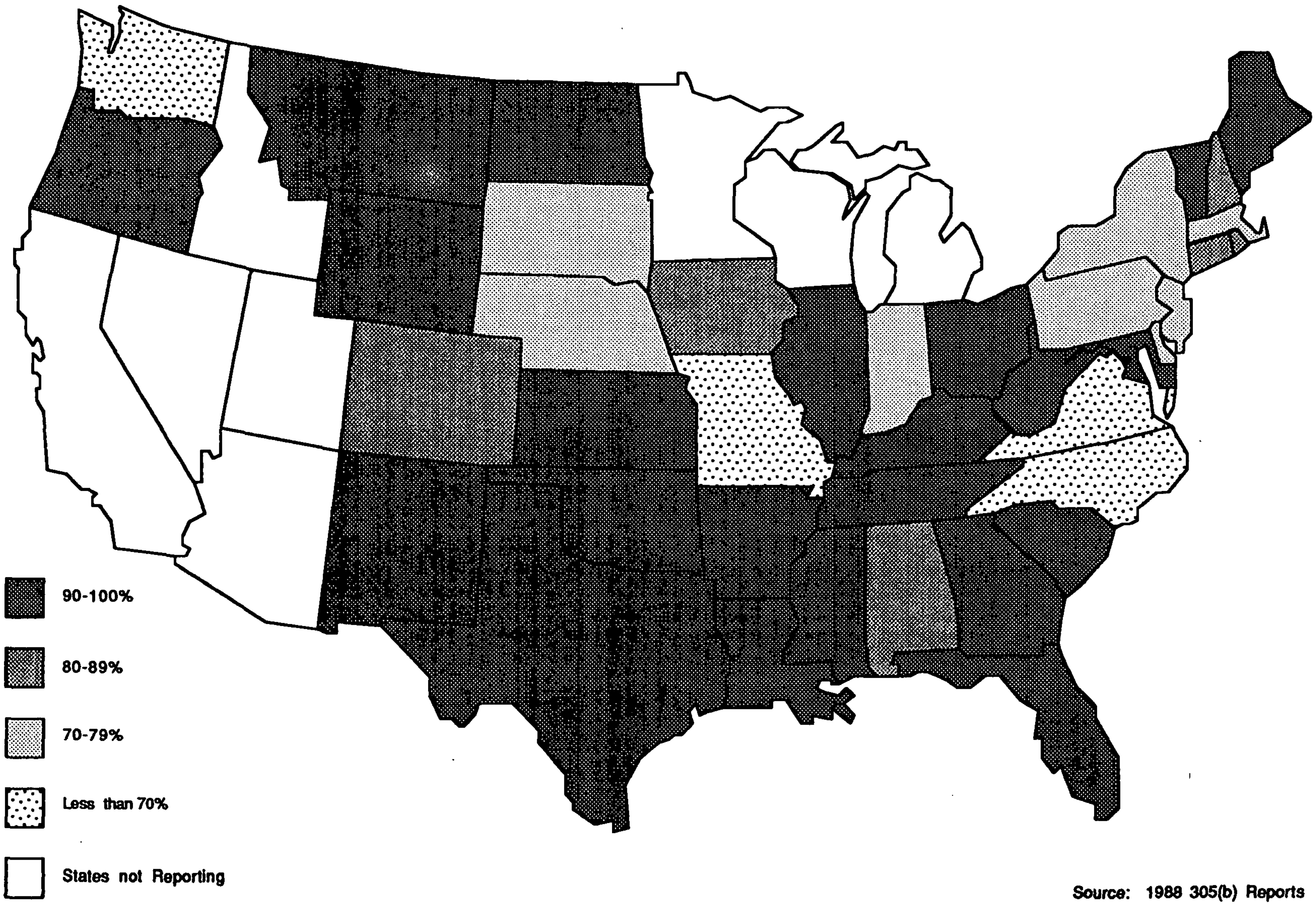
Figure II-4
Designated Use Support - Rivers (EPA Region 4)



Source: 1988 305(b) Reports

Figure II-5

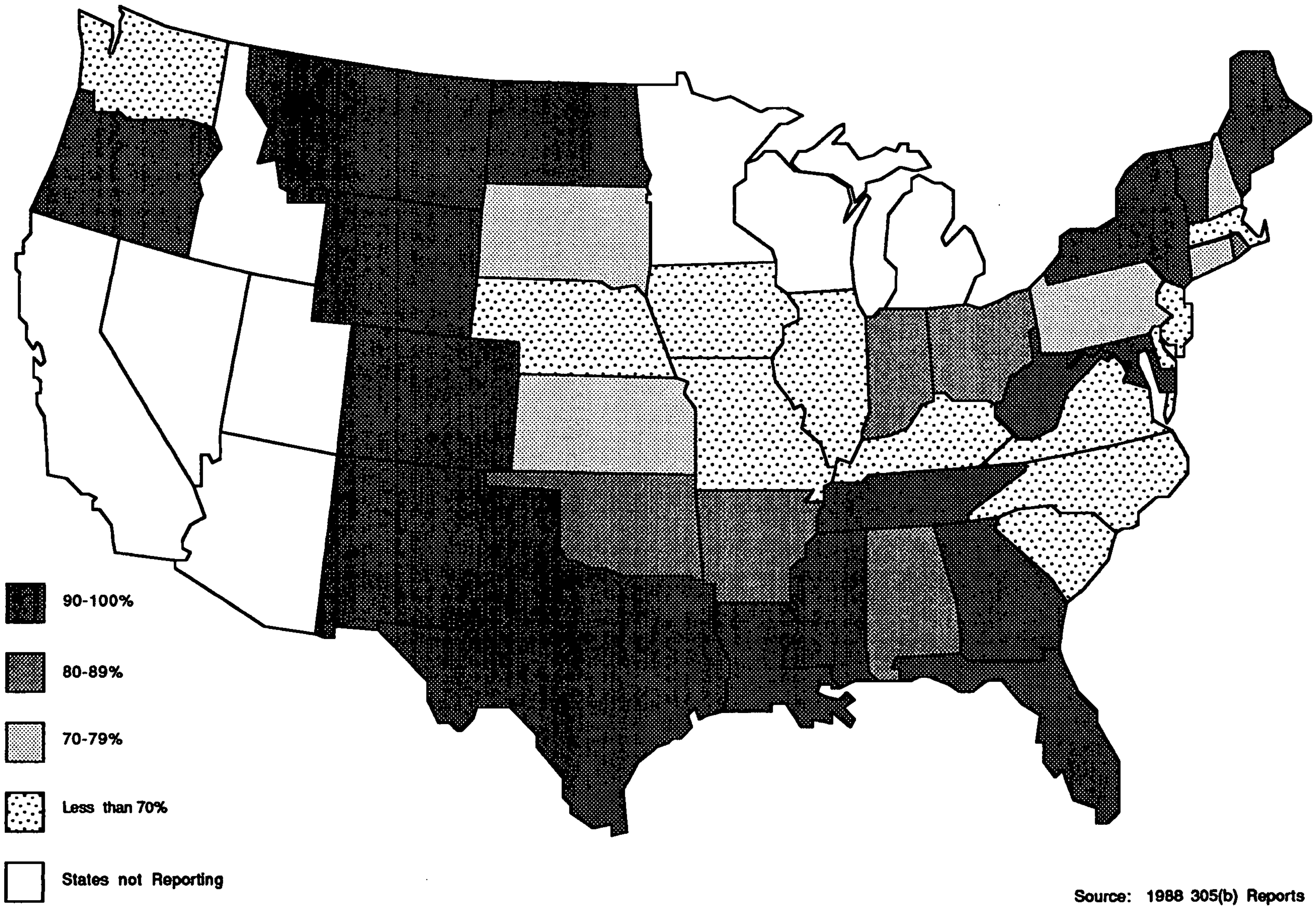
Percentage of Assessed River Miles Per State Meeting CWA Fishable Goal in 1988



Source: 1988 305(b) Reports

Figure II-6

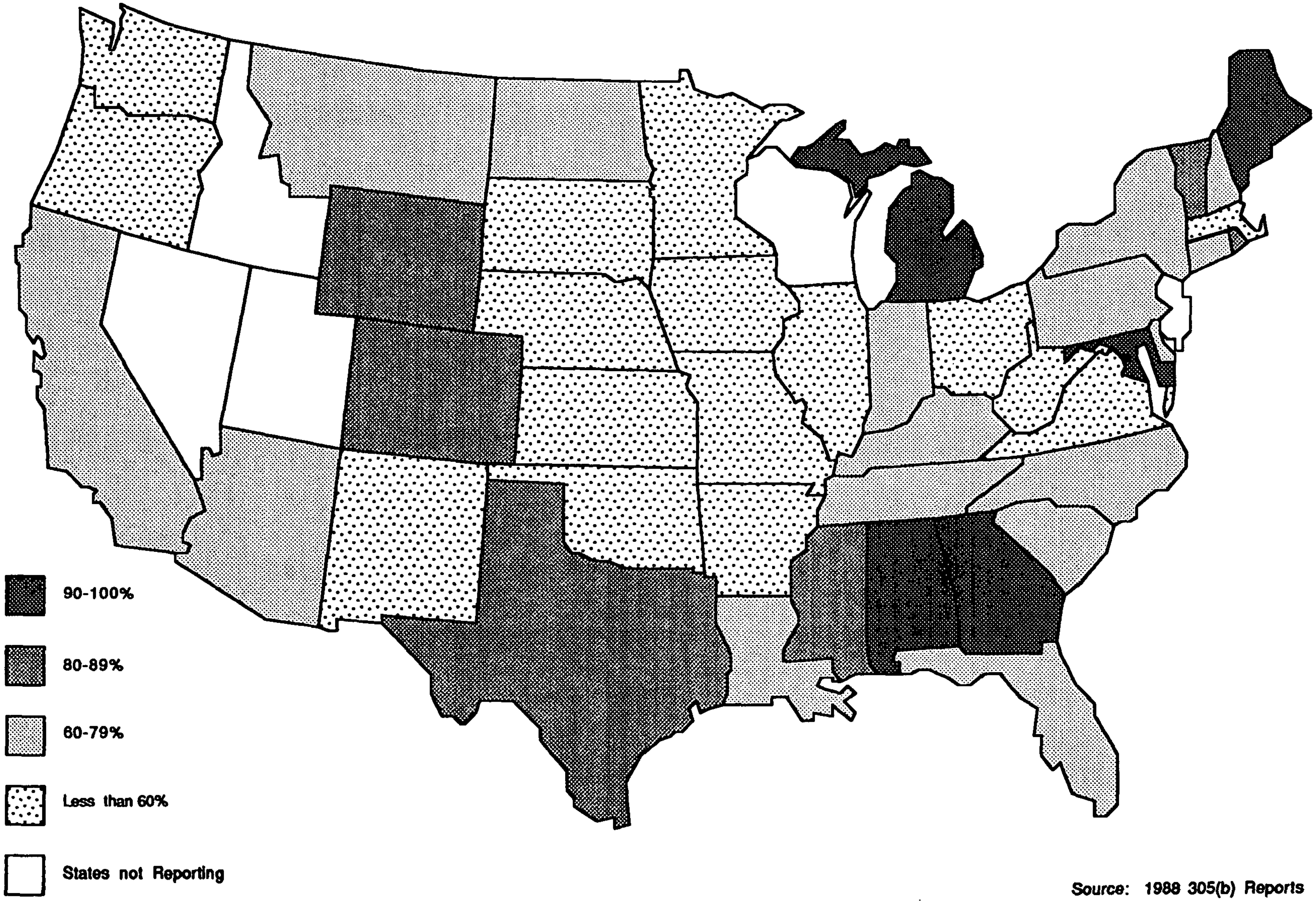
Percentage of Assessed River Miles Per State Meeting CWA Swimmable Goal in 1988



Source: 1988 305(b) Reports

Figure II-7

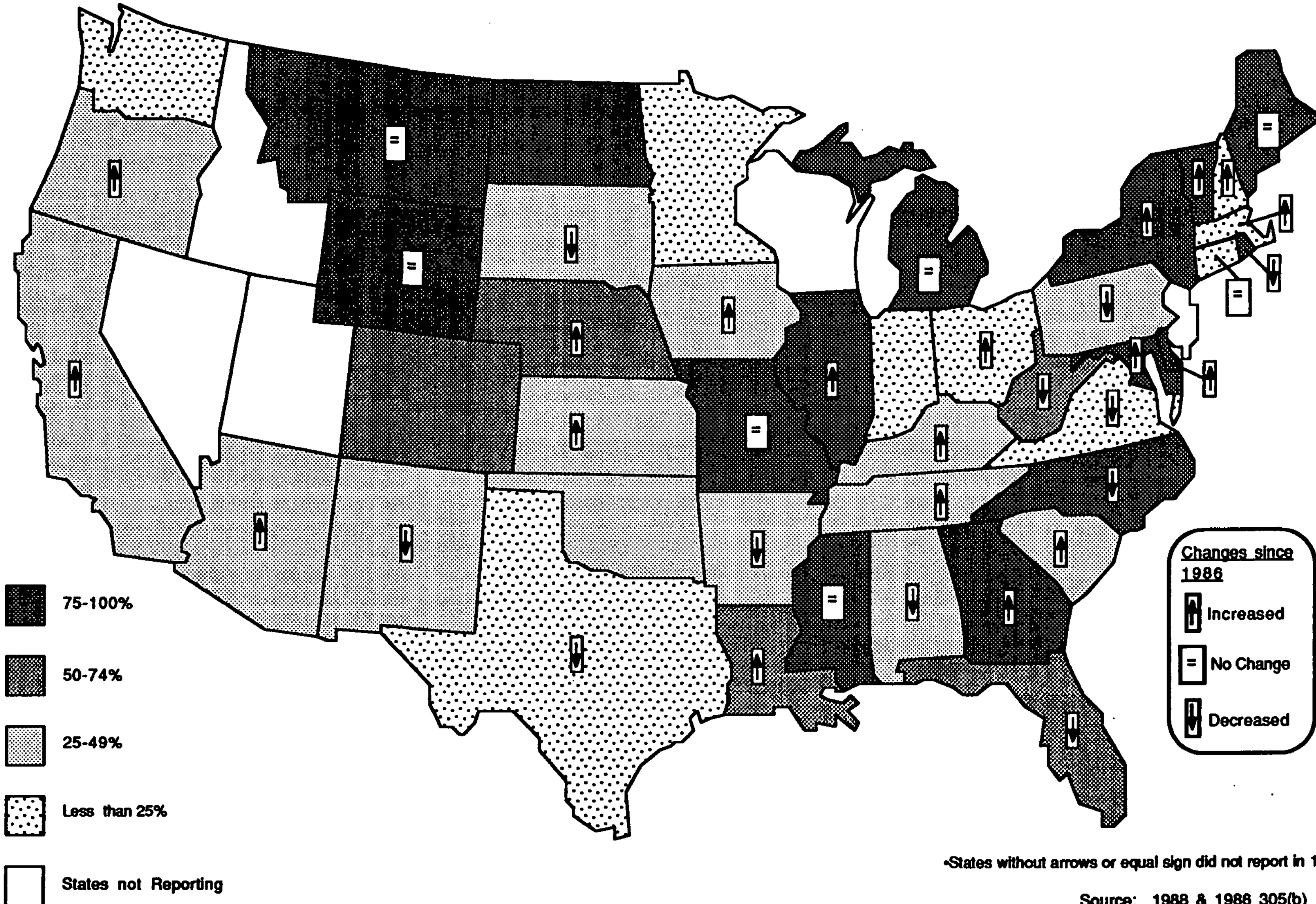
Percentage of Assessed River Miles Per State Fully Supporting Designated Use in 1988



Source: 1988 305(b) Reports

Figure II-8

Percentage of Total River Miles Assessed Per State in 1988*



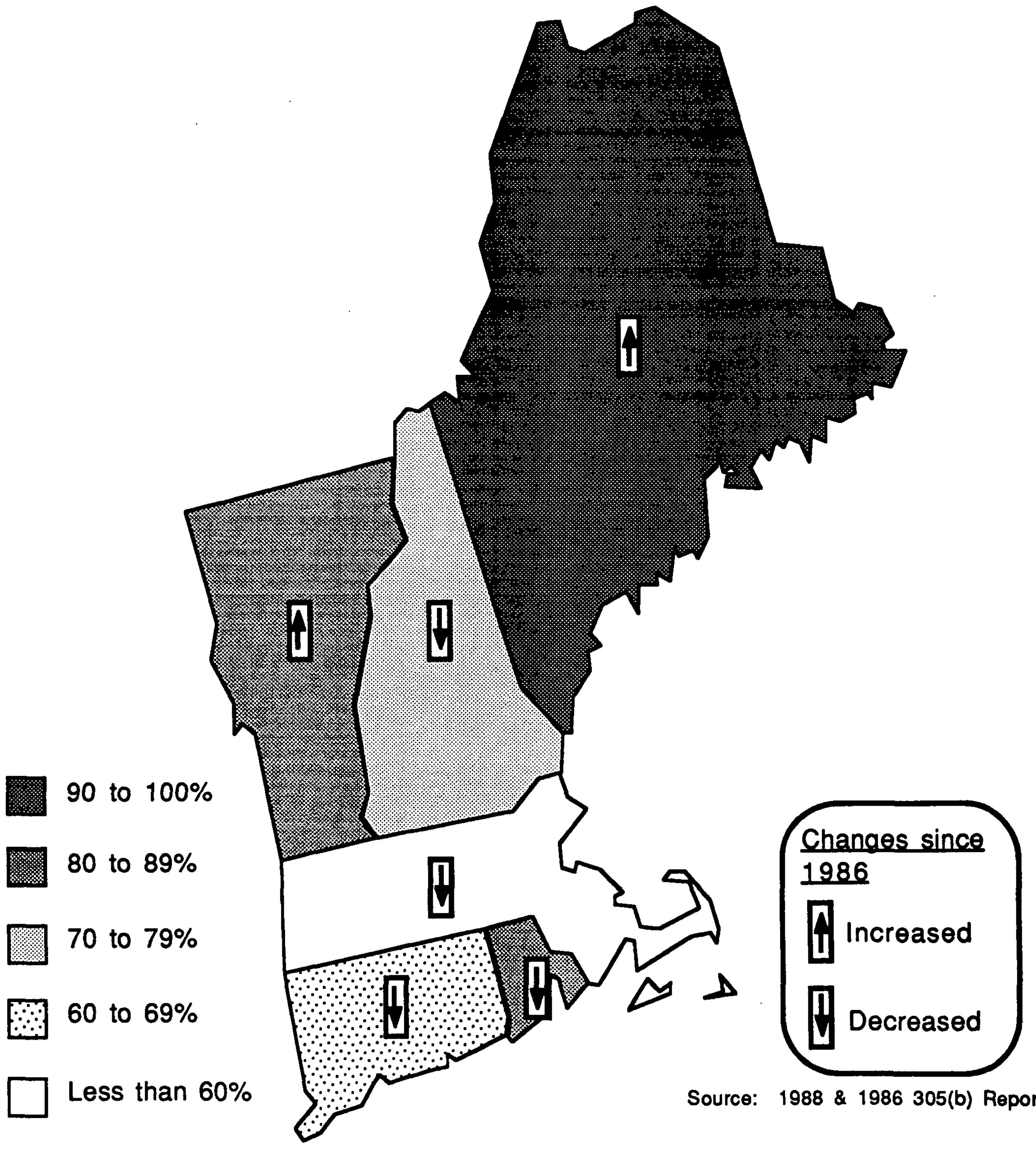
•States without arrows or equal sign did not report in 1986

*Year-to-year comparisons are for illustrative purposes only.

Source: 1988 & 1986 305(b) Reports

Figure II-9

Percentage of Assessed River Miles Fully Supporting Designated Use in 1988 EPA Region 1*



Source: 1988 & 1986 305(b) Reports

*Year-to-year comparisons are for illustrative purposes only.

III. SHELLFISH HARVEST AREA CLASSIFICATIONS

SUMMARY

Description of the Indicator

The indicator identifies potential contamination of coastal waters by investigating the degree to which State governments close off or limit access to shellfish harvesting areas. The State agencies classify different areas based on water quality monitoring (not shellfish tissue monitoring). The resulting information constitutes one of the nations largest consistently collected water quality data bases. States report this information to NOAA as part of the National Shellfish Sanitation Program (NSSP), which provides well-defined guidelines to the States. States do, however, vary in their interpretation of the guidelines. This measure is one of five indicators chosen by NOAA in its state of the marine environment report.

Possible Applications

Shellfish harvest areas are the most commonly monitored feature of coastal waters and data are readily available. On both a nationwide and regional level, data provide a good indication of the general status of marine waters and, with continued improvements, can be used to assess trends.

Strengths	Data collection has been consistent for over 20 years on a nationwide basis using National Shellfish Sanitation Program (NSSP) guidelines. National standards developed by FDA are used by all States. Indicator is easily understood by public and policy makers.
Weaknesses	Variations in State to State decision-making on classifications limit nation-wide comparisons somewhat; Reclassifications are not always due to water quality changes, but in past have reflected changes in areas monitored; Only fecal coliform levels are monitored (which are not bacteria of concern, but are indicators of pathogens); The indicator is not well reported for open coastal (as opposed to estuarine) waters.
Possible Improvements	Greater consistencies in classifications would allow for nationwide comparisons; Correlating with other data, such as sediment and shellfish tissue contamination would provide a more complete indicator of surface water quality.

EVALUATION CRITERIA

Data availability	**Good**-NOAA publishes the National Shellfish Register covering all continental coastal States approximately every five years. Some States include shellfish information in their 305(b) Reports.
Data consistency/comparability	**Fair**-Even with inconsistencies in classifications the data are consistently presented. NOAA personnel visit States and take into account State-to-State differences to standardize the data for the national report. Physical and administrative differences limit comparability of different regions (East Coast-West Coast).
Spatial representativeness	**Good**-The majority of estuarine areas are classified as shellfish growing waters (approximately 95% of East Coast estuarine areas), and are consequently covered by the indicator. (Open coastal waters are not very well represented.)
Temporal representativeness	**Good**-Most stations sample at a minimum of 5 times annually (conditional classifications more often), therefore, seasonal variation is taken into account. Reasonably consistent data sets exist for most areas since the 1970's.
Utility in trend assessment	**Fair**-Data are available to assess trends, however, not all changes in classification are the result of water quality changes. NOAA does distinguish changes which are the result of water quality from those due to changes in areas monitored for Northeast, Mid-Atlantic, and West Coast. These data will allow for trend assessments.
Relation to ultimate impact	**Fair**-Relationship between shellfish harvest area classification and ultimate impact is limited because only fecal coliform levels are monitored. Coliform levels do not relate directly to human health impacts, rather they are an indicator of the possible presence of pathogens.
Related factors	**Important**-To have a more useful indicator, the ancillary data on pollutant sources should be used. (NOAA began collecting these data in the mid-1980's.)

EVALUATION CRITERIA

Scientific defensibility	**Fair**-Not all classifications are the results of monitoring; Coliform levels are only an indicator of pathogens; Quality of sampling varies among states.
Sensitivity to change	**Good**-Can get immediate reading of change in coliform levels.
Relationship to risk	**Fair**-Difficult to relate coliform levels directly to health risk, but indirect qualitative relationship definitely exists; Monitoring primarily coliform levels excludes factors other than sewage pollutants related to risk; Not relevant to ecological risk.
Cost to collect and analyze data	**Moderate**-State monitoring programs vary in size and cost though reporting to NOAA is well established and consistent; Due to high cost, States only monitor fecal coliform levels, monitoring actual pathogens would be prohibitively expensive.
Relationship to existing programs	**Good**-NOAA's National Shellfish Register presents shellfish harvest area classifications and assesses status, trends and pollution sources. States use classifications to assess designated use support, and to target sewage treatment plant and combined sewer overflow upgrade activities.
Presentation value	**Good**-Shellfish harvest area classifications are understandable to government decisionmakers and the public. Status and trends can be easily presented on graphs and charts.

DISCUSSION

Background

To ensure that shellfish are safe for human consumption, coastal State agencies (health or water quality) monitor and classify their potential shellfishing areas, using national criteria and standards developed under the interagency National Shellfish Sanitation Program (NSSP). (NOAA, FDA and EPA have played varying roles in the NSSP since the 1970's.) Under the NSSP, FDA establishes standards for the growing, harvesting and processing of shellfish, and using these standards, States conduct sanitary surveys of shellfish growing waters. The classifications have been conducted for over 15 years and States base them on water quality data, and not on shellfish tissue contamination. While States do vary in their application of these standards, NOAA is working hard to improve the consistency of the reporting. NOAA maintains a national data base of the State data, the National Shellfish Register, and prepares periodic reports presenting comprehensive data on shellfish harvest area classifications nationwide. The information constitutes one of the nation's largest consistently collected water quality data bases. NOAA's most recent report, published in 1985, included data from 20.6 million acres of shellfish growing waters in all 22 coastal States.

The main criterion used to evaluate the different areas is the presence of coliform bacteria, which are normal to the digestive tracts of humans and all warm-blooded animals. The presence of these coliforms may indicate the presence of human sewage and act as a surrogate for other pathogens, which do cause disease in humans and which are more difficult to detect than the coliforms. However, the presence of coliforms does not prove the presence of pathogens. Rather, it simply means they might be present.

States classify shellfish growing waters into one of four categories: approved, meaning water quality permits harvesting at all times; conditional, meaning that water quality is sometimes degraded and harvesting is allowed only when conditions are safe (e.g. when it has not rained for several days); restricted, meaning that water quality is degraded, but fishing is allowed if safety measures are taken (such as placing the harvested shellfish in bacteria free water for a sufficient period of time prior to marketing); or prohibited, meaning that water quality is too degraded for harvesting at any time.

States also report on the significant pollution sources that affect harvesting potential, by acre, for harvest-limited areas (those classified as: conditional, restricted or prohibited), and in many cases, multiple sources may be reported. Pollution sources listed in various reports include: sewage treatment plants (STP's), combined sewer overflows, raw sewage discharges, septic systems, agricultural/urban/suburban runoff, and boating. This information can help States target regulatory activities to meet the most pressing needs.

NOAA has also recognized the value of this measure as an indicator of marine water quality. Shellfish harvest area classification is one of five indicators recently identified by NOAA for inclusion in its "State of the Marine Environment" report.

Uses of the Indicator

As noted above, States collect data on potential shellfish contamination to reduce the risk of human disease from consumption. These shellfish can bioaccumulate large concentrations of pollutants from the water column, often without suffering significant harm (depending on the types of pollutants). They do, however, pose risks to humans eating the shellfish. By far the most common health impact from contaminated shellfish is gastroenteritis. Other far more serious illnesses are transmitted by shellfish on occasion, including hepatitis and cholera. Impacts from toxic chemicals may occur, but exposure and effects data are not readily available.

The identification of the presence of pollutants in the water column also provides valuable information on the general state of the water resource. Much of the potential shellfishing areas occur in estuaries, among the most productive ecological areas in the world. The inclusion of information on the causes of water quality degradation is extremely helpful to water quality managers. These data, highlighting the causes for shellfish closures across the country in 1988, are shown in figures III-1 through III-5. This information can help managers identify problem sources and priority rank regulatory and monitoring activities.

Information on shellfish harvest area classifications and causes of impairment or improvement will provide EPA with a valuable, though not complete, measure of status and trends in coastal environments.

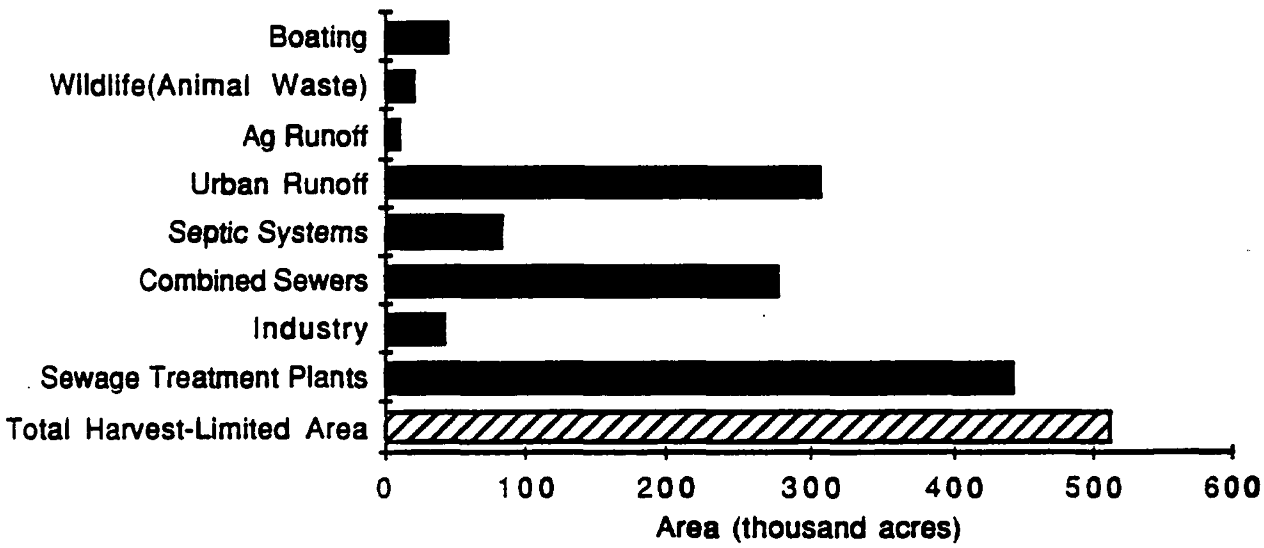
Characteristics of the Indicator

States base their shellfish harvest area classifications on uniform national standards. However, administrative decisions on how to apply the classification scheme vary from State to State. For example, west coast States only classify "productive" shellfish waters, while half of the approved shellfish waters on the East coast are "nonproductive". This might account for much of the difference between the East and West Coasts in the percentage of growing areas classified as approved.

States may also classify harvest-limited areas as "prohibited" because of resource restraints. The conditional classification is sometimes not used because the State must allocate additional resources to develop an area management plan. The plan would include procedures to monitor sources of pollution and to prevent illegal harvesting. States might choose not to classify waters as restricted due to the high cost to the State and the fishing industry of purifying the shellfish before marketing (NOAA 1985).

Since changes in classifications may occur due to improved monitoring efforts rather than to changes in water quality it has been difficult in the past to assess trends in the water quality of classified waters . Between 1971 and 1985, less than half of the changes in classification in the Northeast and Mid-Atlantic subregions could be related to changes in water quality (NOAA 1989). In addition, some States have added new waters that raise questions about the validity of comparisons with prior surveys. The presence of a baseline number of acres assessed per State would improve the ability to develop trend data. Realizing these difficulties, NOAA now identifies changes in

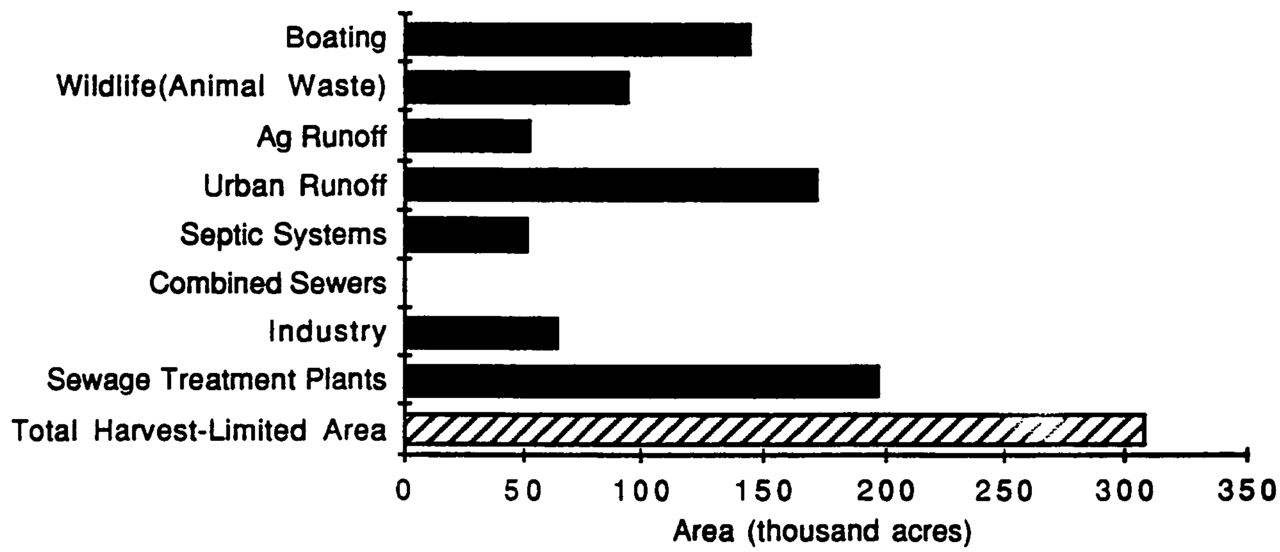
Figure III-1
Shellfish Harvest Area Affected by Pollution Sources
Northeast Region (1988)



Note: •Total harvest-limited area includes: Conditional, Restricted and Prohibited waters.
•Multiple pollution sources are often identified for a single harvest-limited area, therefore the sum of the area affected by sources in an estuary is usually greater than the amount of harvest-limited area.

Source: NOAA

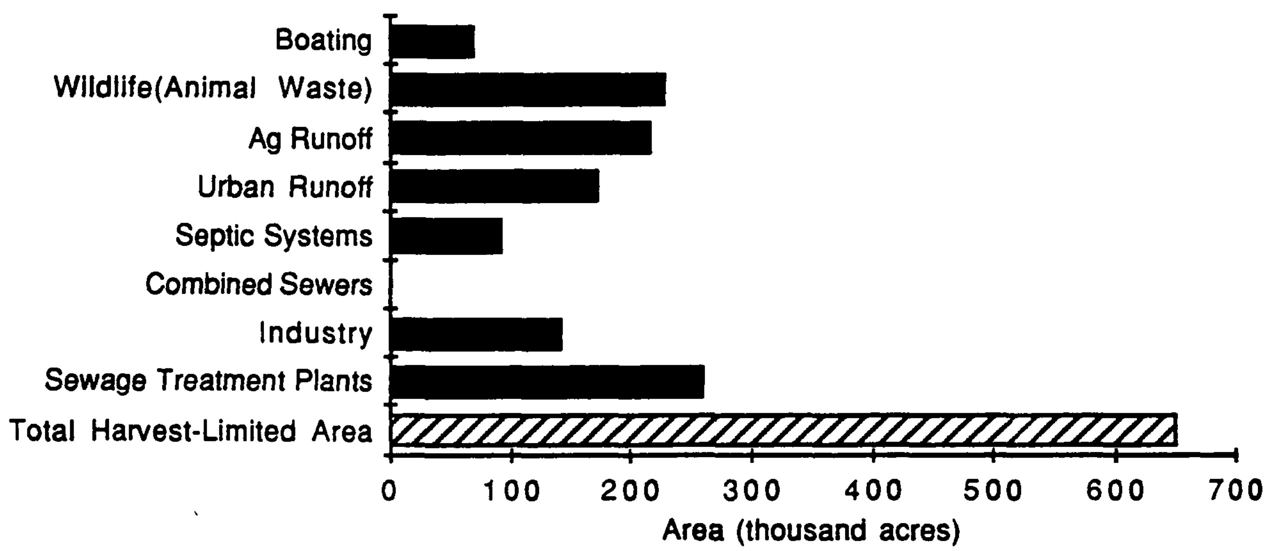
Figure III-2
Shellfish Harvest Area Affected by Pollution Sources
Mid-Atlantic Region (1988)



Note: •Total harvest-limited area includes: Conditional, Restricted and Prohibited waters.
•Multiple pollution sources are often identified for a single harvest-limited area, therefore the sum of the area affected by sources in an estuary is usually greater than the amount of harvest-limited area.

Source: NOAA

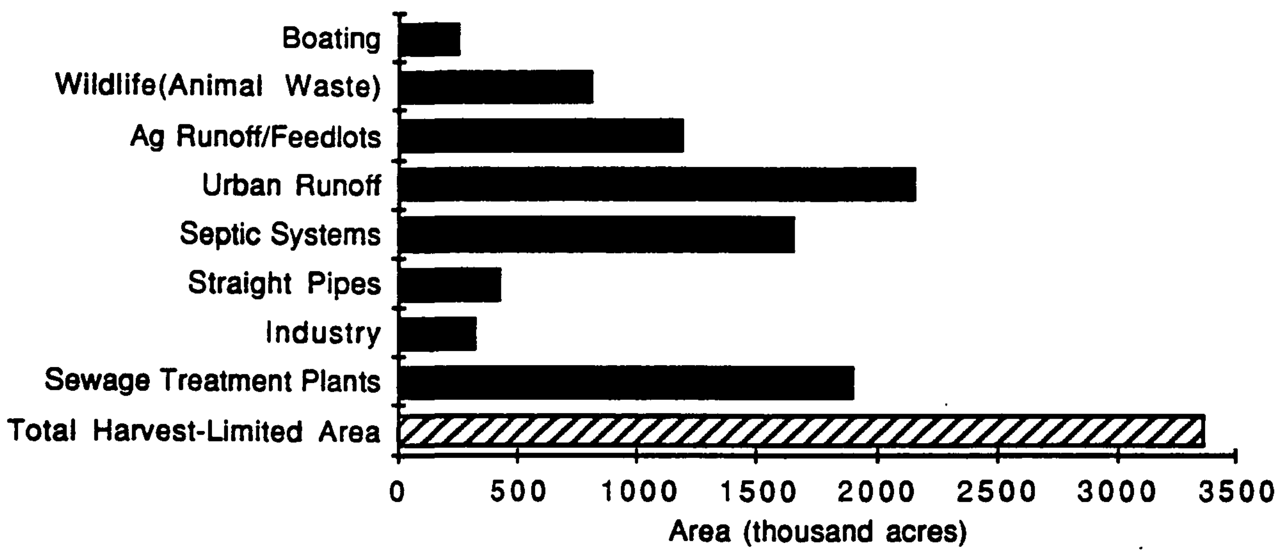
Figure III-3
Shellfish Harvest Area Affected by Pollution Sources
Southeast Region (1988)



Note: •Total harvest-limited area includes: Conditional, Restricted and Prohibited waters.
•Multiple pollution sources are often identified for a single harvest-limited area, therefore the sum of the area affected by sources in an estuary is usually greater than the amount of harvest-limited area.

Source: NOAA

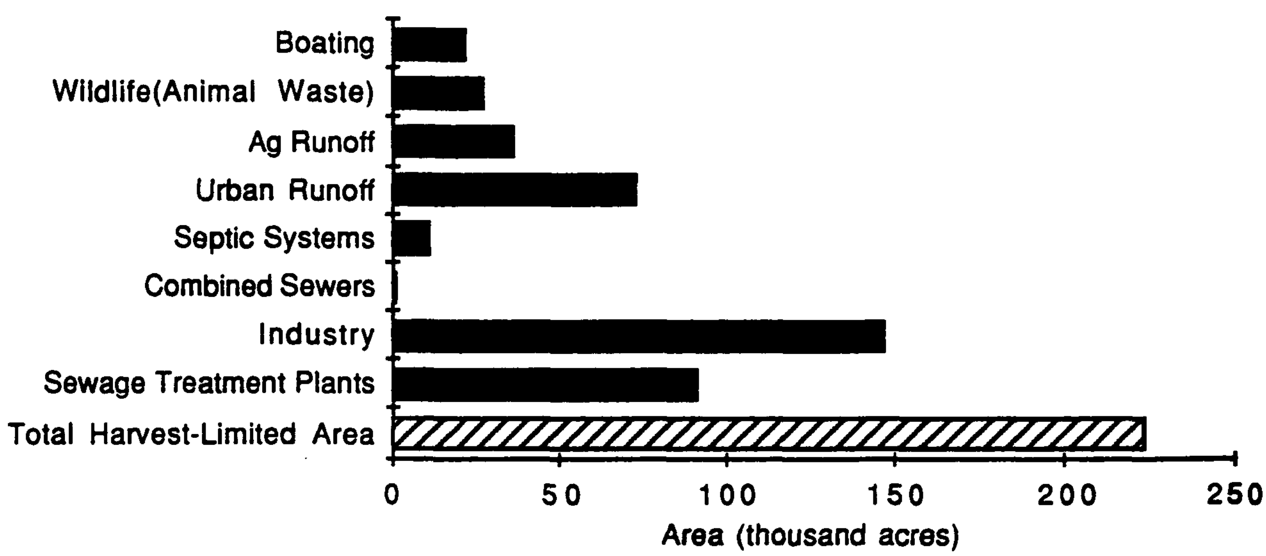
Figure III-4
Shellfish Harvest Area Affected by Pollution Sources
Gulf of Mexico (1988)



Note: •Total harvest-limited area includes: Conditional, Restricted and Prohibited waters.
•Multiple pollution sources are often identified for a single harvest-limited area, therefore the sum of the area affected by sources in an estuary is usually greater than the amount of harvest-limited area.

Source: NOAA

Figure III-5
Shellfish Harvest Area Affected by Pollution Sources
West Coast Region (1988)



Note: •Total harvest-limited area includes: Conditional, Restricted and Prohibited waters.
•Multiple pollution sources are often identified for a single harvest-limited area, therefore the sum of the area affected by sources in an estuary is usually greater than the amount of harvest-limited area.

Source: NOAA

classification due to water quality changes from purely administrative changes. This will greatly improve the ability to develop trends.

Shellfish harvest area classifications are not a very exact measure of potential risk to humans. Some harvest-limiting classifications are the result of potential rather than actual pollution sources (for example, STP's have buffer zones in which waters are prohibited even though the coliform levels may be acceptable). In other cases, coliform bacteria from animal wastes (e.g., runoff from livestock and wildlife areas, waterfowl nesting areas) can lead to restrictions where human pathogens are not present.

The NSSP provides data collection guidelines and standards that are well-defined. If followed, the standards should account for temporal variations caused by rainfall or seasonal population changes. Since the early 1980's, NOAA personnel have visited each coastal State in preparing the periodic Shellfish Register reports, so the agency can now ensure that State-to-State differences in monitoring and classifying are taken into account in preparing the national report. As a result, it is expected that trend assessments will be more defensible.

Data Availability

NOAA collects data on shellfish harvest area classifications nationally and compiles and maintains the data on an agency computer system. Periodic reports are released containing information on the East Coast, Gulf of Mexico, and West Coast, and interim data may be available directly from the NOAA data base. Starting in 1990, status and trend data will be available on a Geographic Information System (GIS).

In addition to NOAA's national report, many States report on shellfish harvest area classifications in their 305(b) reports. This reported State data is later compiled in EPA's "National Water Quality Inventory." At the State and local level, maps of shellfish harvest area classifications and coliform bacteria monitoring data are maintained (not necessarily computerized) by the responsible organizations, usually State or local public health agencies.

Improving the Indicator

Due to limited resources, shellfish sampling stations only monitor fecal coliform bacteria levels as an indicator of pathogens. Pathogens, however, are not the only threat to human health. This information by itself is not as valuable as it could be if combined with data on toxic chemicals in shellfish. Perhaps these data could be combined with information on shellfish contamination by toxics from NOAA's Status and Trends reports, that are discussed in section V.

States often classify waters they do not monitor (due to resource constraints) as prohibited. Therefore, it is possible that increased monitoring could lead to reclassification of some waters. It is likely that States already monitor all highly productive areas so that this change would lead to increased information on marginally or non-productive areas.

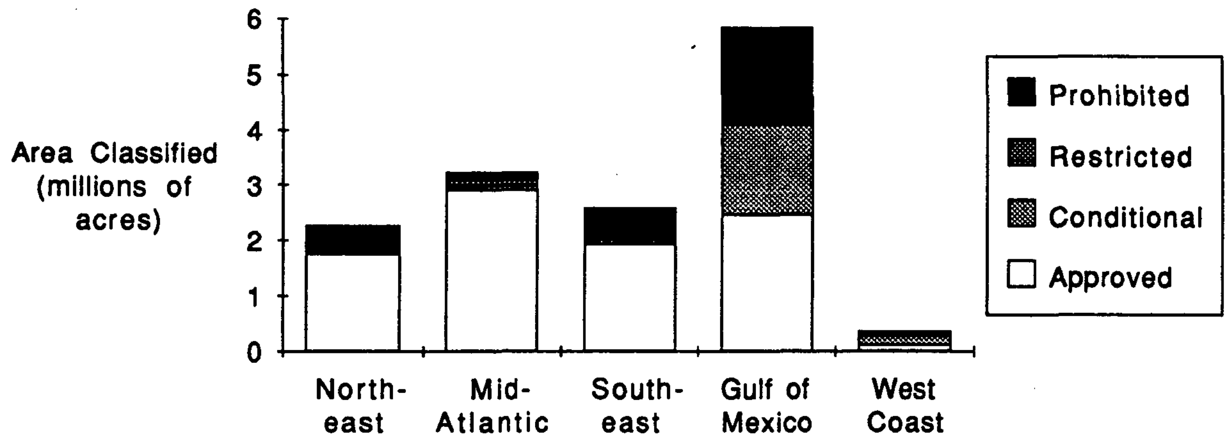
Presenting the Indicator

Figure III-6 presents the 1985 national shellfish harvest area classifications subdivided by regions. The relatively low figure for the West Coast reflects the fact that much of the region has highly exposed, deep coastal waters rather than estuaries, which are the primary commercial shellfish habitat. As well as regionally, the classifications could also be presented on a State level or for individual estuary systems.

As noted, NOAA now identifies reclassifications in shellfish growing acreage due specifically to water quality changes. Table III-1 shows losses, gains, net change and the reasons for change for each major estuary listed in the Northeast. The data used for this table consist of reclassifications occurring between 1971 and 1985. Figure III-7 is a graphical representation of Table III-1, with the left side representing losses due to various pollution sources and the right side representing gains from controlling various pollution sources. Figures III-8 and III-9 show the same thing for the Mid-Atlantic and the West Coast.

Within each major estuary, data are available for smaller subregions. An example of these subregions is shown in Table III-2 using Buzzards Bay, MA. Presenting the data at this level provides useful information to State and local policy makers.

Figure III-6
1985 National Shellfish Harvest Area Classifications
(Subdivided by Regions)



Source: 1985 NOAA Data

Table III-1
Shellfish Harvest Area Reclassifications Due to Water Quality Changes
Northeast Region (1971-1985)

Source of Reclassification:

	Losses							Gains					
AREA/ESTUARY	Develop.	STP	Source	Septics	Boating	WQ change	T.Losses	STP	Septics	Source	Sewage	T. Gains	Net Change
Passamaquoddy Bay	-290	-22	0	0	0	0	-312	0	28	0	0	28	-284
Englishman Bay	-257	0	0	0	0	0	-257	142	0	222	0	364	107
Narraguagus R	0	0	0	0	0	0	0	0	0	86	0	86	86
Blue Hill Bay	-48	0	0	0	0	0	-48	510	0	0	0	510	462
Penobscot Bay	-9,587	-179	-123	0	0	0	-9,889	280	333	1,586	3,870	6,069	-3,820
Muscongus Bay	-43	0	-578	-202	0	0	-823	504	79	0	0	583	-240
Sheepscot Bay	-248	-120	0	0	0	0	-368	148	5,777	108	0	6,033	5,665
Casco Bay	-2,600	0	0	0	0	0	-2,600	2,048	942	158	0	3,148	548
Saco Bay	-20	-618	0	0	0	0	-638	1,807	0	0	275	2,082	1,444
Great Bay	0	0	0	0	0	0	0	0	327	0	0	327	327
Merrimack R	0	0	0	0	0	0	0	216	0	0	0	216	216
Massachusetts Bay	0	0	-1,097	0	0	0	-1,097	251	0	0	0	251	-846
Cape Cod Bay	-118	-136	0	0	-1,568	0	-1,822	0	0	0	0	0	-1,822
Buzzards Bay	-612	-707	0	-33	-273	0	-1,625	0	0	1,524	118	1,642	17
Narragansett Bay	0	-210	0	0	-368	-3,315	-3,893	0	0	0	10	10	-3,883
Long Island Sound	0	-341	0	0	-79	-66	-486	310	239	1,815	0	2,364	1,878
Gardiners Bay	-152	0	0	0	0	0	-152	0	0	0	0	0	-152
Hudson/Raritan	0	0	0	0	0	-4,448	-4,448	0	0	0	0	0	-4,448
TOTAL	-13,975	-2,333	-1,798	-235	-2,288	-7,829	-28,458	6,216	7,725	5,499	4,273	23,713	-4,745

SOURCES OF RECLASSIFICATIONS

Losses:

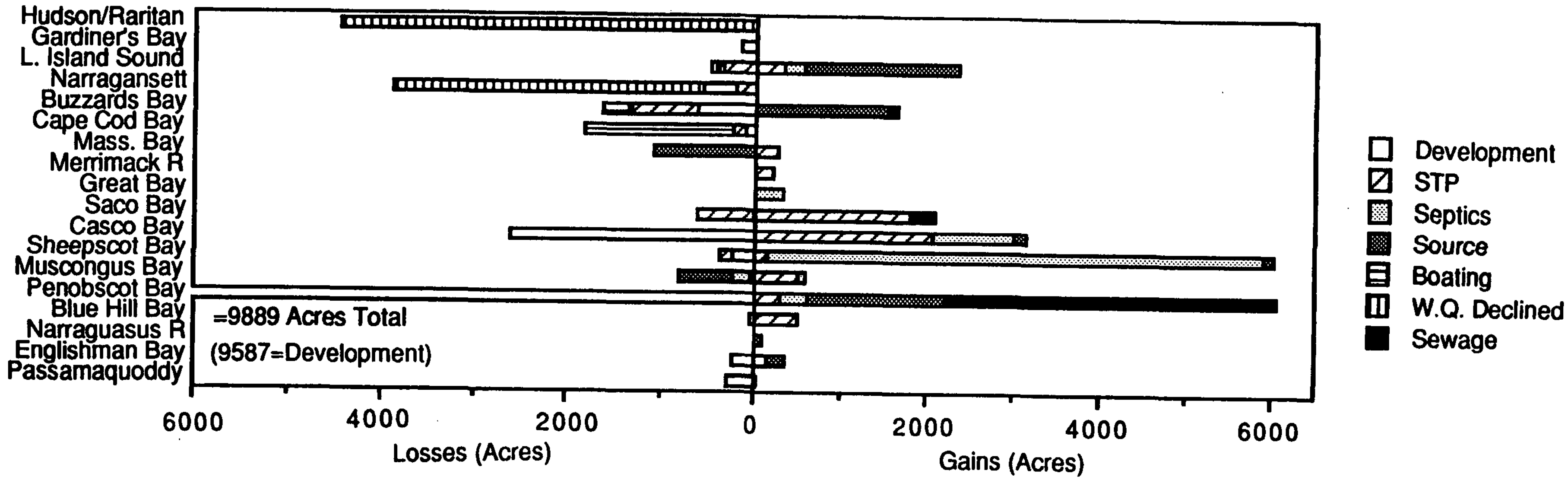
Develop.=Shore Development and population increases resulting in degraded water quality.
STP=Sewage Treatment Plants having discharges of inadequately treated effluent or a new STP buffer zone.
Source=Local point sources of water pollution (ex. fish processing-Massachusetts Bay)
Septics=Malfunctioning septic systems.
Boating=Increased boating activity.
WQ Change=Declining water quality usually the result of non-point runoff from increasing development.

Gains:

STP=New Sewage Treatment Plants or improved plants caused a reduction of inadequately treated effluent.
Septics=Abatement of Septics.
Source=Abatement of local point sources (ex. recovery from oil spill-Buzzard's Bay).
Sewage=Sewage abatement or area became sewered.

Source: NOAA

Figure III-7
Shellfish Harvest Area Reclassifications Due to Water Quality Changes
Northeast Region (1971-1985)*



*This Figure is a graphical representation of Table IV-1.

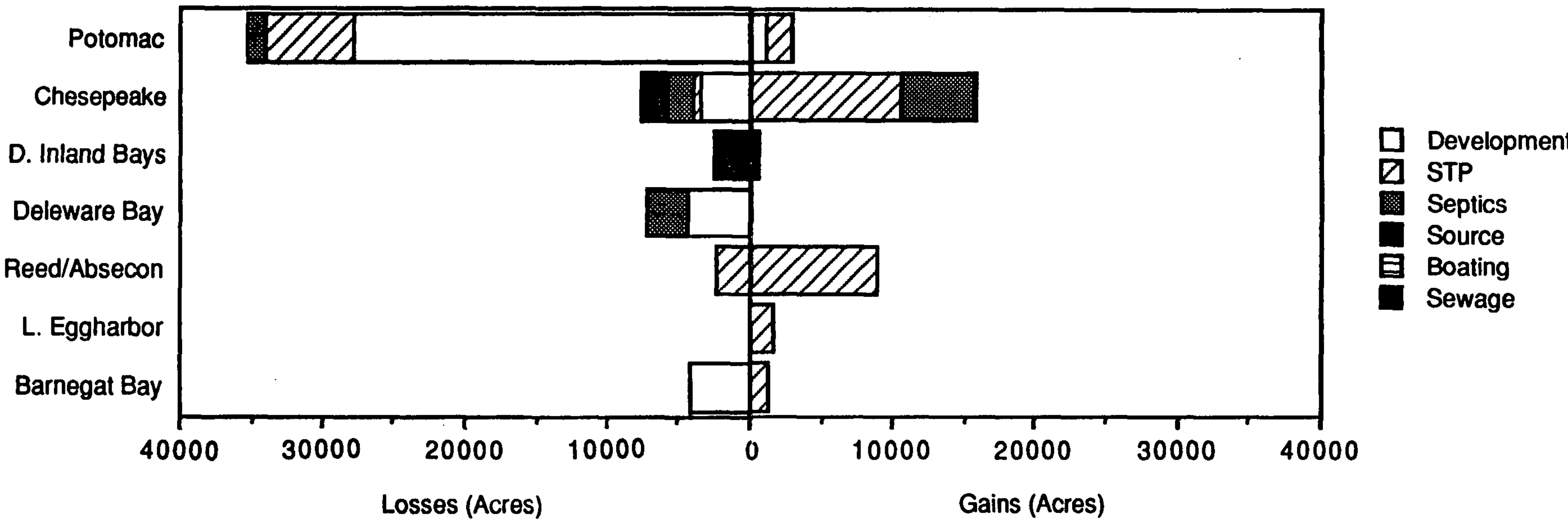
SOURCES OF RECLASSIFICATIONS

Losses:
Development=Shore Development and population increases resulting in degraded water quality.
STP=Sewage Treatment Plants having discharges of inadequately treated effluent or a new STP buffer zone.
Source=Local point sources of water pollution (ex. fish processing-Massachusetts Bay)
Septics=Malfunctioning septic systems.
Boating=Increased boating activity.
WQ Change=Declining water quality usually the result of non-point runoff from increasing development.

Gains:
STP=New Sewage Treatment Plants or improved plants caused a reduction of inadequately treated effluent.
Septics=Abatement of Septics.
Source=Abatement of local point sources (ex. recovery from oil spill-Buzzard's Bay).
Sewage=Sewage abatement or area became sewered.

Source: NOAA

Figure III-8
Shellfish Harvest Area Reclassifications Due to Water Quality Changes
Mid-Atlantic Region (1971-1985)



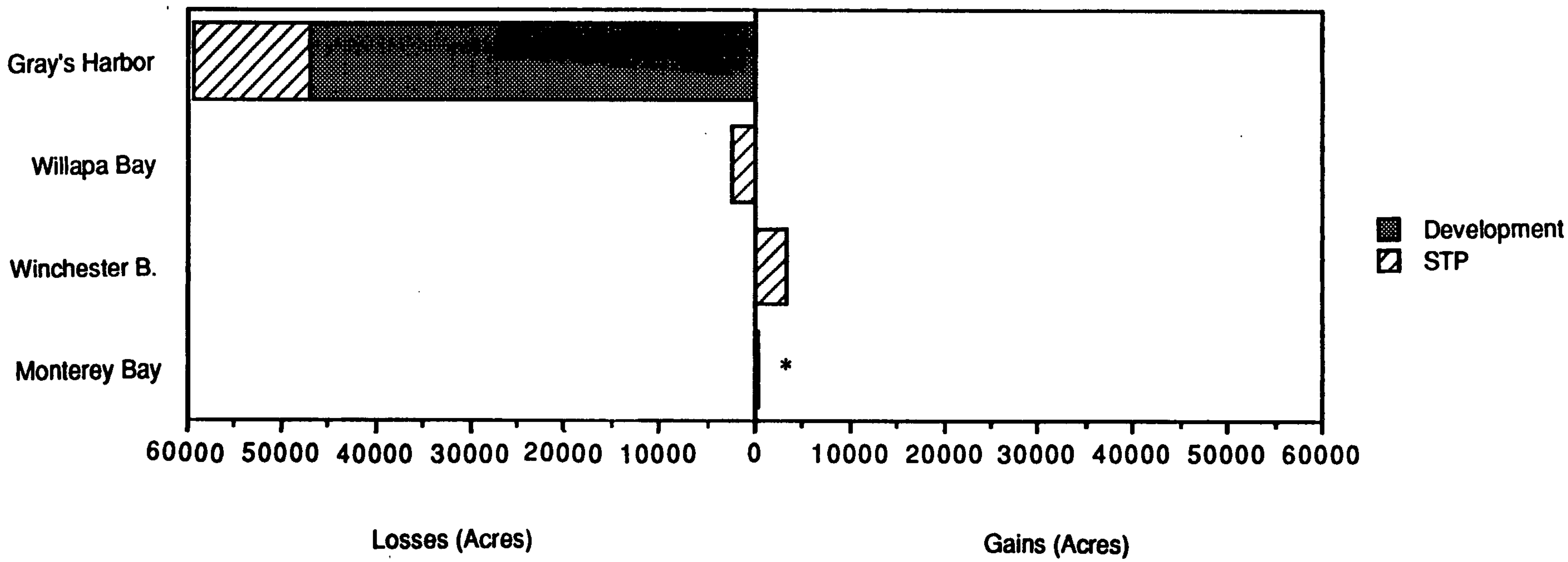
SOURCES OF RECLASSIFICATIONS

Losses:
Development=Shore Development and nonpoint sources resulting in degraded water quality.
STP=Sewage Treatment Plants having discharges of inadequately treated effluent or a new STP buffer zone.
Source=Local point sources of water pollution (ex. seafood processing wastes-Delaware Inland Bays)
Septics=Malfunctioning septic systems.
Boating=Increased boating activity.

Gains:
STP=New Sewage Treatment Plants or improved plants caused a reduction of inadequately treated effluent.
Septics=Abatement of Septics.
Sewage=Sewage abatement or area became sewered.

Source: NOAA

Figure III-9
Shellfish Harvest Area Reclassifications Due to Water Quality Changes
West Coast Region (1971-1985)



* =139 acres, due to STP upgrade.

SOURCES OF RECLASSIFICATIONS

Losses:
Development=Shore Development and nonpoint sources resulting in degraded water quality.
STP=Sewage Treatment Plants having discharges of inadequately treated effluent or a new STP buffer zone.

Gains:
STP=New Sewage Treatment Plants or improved plants caused a reduction of inadequately treated effluent.

Source: NOAA

Table III-2
Shellfish Harvest Area Reclassifications Due to Water Quality Changes Subregions of Buzzards Bay, MA (1971-1985)

BUZZARDS BAY,MA.	Classification		Areas Changed		Reason for Change
Estuary/Area	1971	1985*	Losses	Gains	
West Falmouth	p	a	0	1500	Recovery from oil spill
Cataumet	a	c	-36	0	Expanding marina
Back River	a	p	-74	0	Development
Buttermilk Bay	a	p	-538	0	Development
Wareham	p	a	0	118	Area became sewered
Sippican Harbor	a	c	-166	0	Increased boating
Sippican Harbor	p	a	0	24	Mercury Problem cleaned up
Smiths Neck	a	p	-707	0	STP outfall
Cuttyhunk Pond	a	p	-33	0	Increase in houses on septics
Cuttyhunk Pond	a	c	-71	0	Increased boating
Total			-1625	1642	Net Change= 17

p-prohibited
a-approved
c-conditional

Source: NOAA

IV. TROPHIC STATUS OF LAKES

SUMMARY

Description of the Indicator

Trophic status is the most commonly used measure of status and trends lake water quality. Eutrophication is a process by which a waterbody becomes rich in dissolved nutrients, filled with detritus, and seasonally deficient in dissolved oxygen to the extent that aquatic life is impaired. Eutrophication can result from the slow, natural aging of a lake or can be accelerated by excessive enrichment of nutrients (primarily phosphorus) from pollution sources such as fertilizer, sewage and detergents. States report the trophic status of publicly owned lakes in their 305(b) reports and some States report into the Waterbody System (WBS). States vary in their methods of determining trophic status with the majority using Carlson's Trophic Status Index (TSI). As a result of the different reporting methods, EPA must slightly modify the data of some States to achieve a nationwide comparison of trophic status.

Possible Applications

Eutrophication data provide a measure of the quality of lakes and support State program managers in targeting specific monitoring or enforcement activities. The rapid eutrophication of a lake signals a pollution problem and can serve as a warning system.

Although inconsistencies and data gaps in monitoring and reporting limit nationwide evaluations, the indicator does present some useful qualitative information regarding the nation's lake water quality.

Strengths	Reporting the trophic status of publicly owned lakes is required by Clean Water Act (CWA) 314(a); Provides a scientifically defensible measure of the ecological health of lakes.
Weaknesses	Regional geographic and hydrologic differences in lakes may limit national comparisons. A eutrophic condition does not necessarily mean that a lake does not support its designated use(s). The number of lakes evaluated by trophic status fluctuates, making trend analysis difficult. Seasonal fluctuations in trophic status are not always taken into account.
Possible Improvements	Establish a baseline number of lakes to determine trends; Record seasonal fluctuations; Report both number of lakes and lake acres.

EVALUATION CRITERIA

Data availability	**Good/Fair**-Reported in 305(b) reports, Clean Lakes List and in the Waterbody System (WBS). Currently six States put trophic data in the WBS, although the number is expected to increase in the future. EPA can compare results from States using different methods.
Data consistency/comparability	**Good/Fair**-The majority of States use Carlson's TSI. Others use methods suited to individual needs. Some States only report trophic status by number of lakes and not acreage.
Spatial representativeness	**Fair**-States only assess a portion of their total lakes.
Temporal representativeness	**Fair**-There is no consistent accounting for temporal fluctuations.
Utility in trend assessment	**Fair**-The number and frequency of lakes monitored and assessed is not consistent enough to assess trends. If a baseline number of lakes assessed were established then utility in trend assessment would be good.
Scientific defensibility	**Good**-Carlson's TSI is a scientifically defensible measure. Other methods such as professional judgements may be not entirely consistent, but are often technically sound in their own right. They are not necessarily less valid for purposes of the indicator program.
Sensitivity to change	**Good**-TSI in particular has a range of 1 to 100 and can show incremental changes.
Relationship to risk	**Good**-For ecological risk rapid eutrophication is strongly related. This indicator is not directly relevant to human health risks.
Cost to collect and analyze data	**Low**-Monitoring and analysis systems are already in place and budgeted at the State level, and the measurements are relatively inexpensive compared to other water quality measures (e.g. toxics).
Relationship to existing programs	**Good**-Trophic status is reported in 305(b) reports, Clean Lakes classification report, and used in State management programs.
Presentation value	**Good/Fair**-Eutrophication is not as easily understood by the public as other indicators but can be explained. Presentations can consist of national maps, accepting comparability of varying State results.

DISCUSSION

Background

The identification of trophic status is the most commonly used indicator of lake water quality and provides a scientifically well understood, if not complete, measure of the status of that water resource. Despite its well-sounding prefix, a eutrophic lake is often one with poor or declining water quality. When a lake is eutrophic, the presence of excessive quantities of nutrients leads to algal blooms which can, when decayed, deplete the waterbody of oxygen, rendering it unsuitable for aquatic life. While eutrophication is a natural aging process, it can be accelerated by nutrient enrichment from sewage discharge and run-off from agricultural fertilizers, feedlots, detergents and other sources. In most cases, phosphorus is the primary nutrient which affects algal production. Of the total phosphorus discharged into the nation's lakes, approximately one-half comes from agricultural runoff, one-fourth from detergents, and one-fourth from all other sources.

States report on the trophic status of publicly owned lakes in their 305(b) reports, and this information is also contained in Clean Lake Classification reports that States file under Section 314 of the CWA. The trophic status of a waterbody is generally, though not uniformly, reported in the following categories, in order of increasing eutrophication: oligotrophic; mesotrophic; eutrophic; hypertrophic; or dystrophic (low in nutrients, but colored with dissolved humic organic matter). EPA asks the States, in compiling their 305(b) reports, to describe how they determine trophic status, whether by applying professional judgement or by employing a more quantitative measure such as Carlson's TSI. Understanding how each State determines trophic status can help EPA evaluate the comparability of information from different areas. As a general rule, and for purposes of this indicator project, EPA is inclined to accept and rely on whatever methodology a State employs.

Uses of the Indicator

Eutrophication data provide a measure of the quality of the lake resource and State program managers can use this information to target specific lakes for regulatory action. Although a eutrophic condition does not always represent a problem, rapid eutrophication of a waterbody signals a pollution problem and can serve as a warning system of water quality problems. A return to a less eutrophic state is typically taken to indicate success in mitigating a lake's pollution problems.

To use the indicator on a national level, EPA will combine information from individual States, according to their assigned trophic status. Some States, however, do not report on trophic status or lake quality precisely in this manner. To include information from these States in a national indicator, EPA will have to modify it slightly. This issue is described in more detail in the later section entitled Presenting the Indicator.

Characteristics of the Indicator

Trophic status can be determined in a variety of ways. The majority of States use Carlson's TSI, a technical measure based on the interrelationships of Secchi disk transparency (the distance over which a white disk is visible), concentrations of chlorophyll-*a* (an indicator of algal productivity), and total phosphorus. TSI is based on the assumption that as phosphorus levels increase, chlorophyll-*a* also increases and as a result, Secchi disk transparency will decrease. Increasing TSI values indicate increasing eutrophication. For example, a lake with a score under 40 is generally considered to be oligotrophic, between 40 and 50 is mesotrophic, between 50 and 70 is eutrophic and over 70 is hypertrophic. When necessary, some States use additional parameters in conjunction with TSI to more completely evaluate trophic status. For example, Indiana measures seven additional variables (dissolved phosphorus, organic nitrogen, nitrate, ammonia, dissolved oxygen, plankton and light transparency).

States use lake classification methods that best suit their particular environmental requirements, since hydrological and ecological differences between geographic regions necessitate different trophic evaluations. The use of Carlson's TSI, while generally widespread, is not applicable to some lakes or some ecoregions. In areas with lakes that are turbid from erosion or with lakes that have extensive weed problems, it is not a valid measure of trophic status. In some regions, lakes would be classified as eutrophic using standard classification systems, even though the lakes are healthy, so that having a high percentage of lakes classified as eutrophic does not always mean that these lakes are not meeting their designated uses.

Consequently, States have used alternative methods to determine trophic status or lake quality, including best professional judgement, an assessment of lake uses, known pollution sources, and other subjective information. Other quantitative indices have also been developed in various ecoregions, such as Brezonik's index which specifically matches the characteristics of Florida lakes and takes into account situations where nitrogen rather than phosphorus may be driving algal growth (EPA 1988).

Due to inconsistencies in the frequency and extent of lake assessments, data on trophic state may not presently support in-State trend assessments. For example data from the 1986 and 1988 305(b) reports (see Table IV-1) show in many cases a large discrepancy in the number of lakes assessed between those two years. States rarely assess all their lakes and in some instances only rarely assess any lakes. In its 305(b) report, for example, Georgia notes that most of the trophic status data comes from studies conducted before 1981. When monitoring is done in response to a suspected problem, there could be a bias in the results towards eutrophic lakes.

Further limiting the development of in-State trends, many lakes have been sampled infrequently during the past 15 years and the range of seasonal and annual fluctuations in key parameters has not been well documented. Lakes experience higher levels of eutrophication during the summer months, and in order to perform meaningful status and trend analyses, detailed documentation of time of day, time of year, and depth of sample are necessary. If not properly accounted for, these factors can limit the ability to develop trends from these data.

Table IV-1
Trophic Status of Lakes 1986 & 1988 (22 States)

State	# Assessed	Oligotrophic	Mesotrophic	Eutrophic*	Other**
Connecticut 86	70	8	44	18	0
CT 88	160	34	78	17	31
Changes	90	26	34	-1	31
Florida 86	135	36	22	18	38
FL 88	91	57	19	13	2
Changes	-44	21	-3	-5	-36
Illinois 86	36	0	4	32	0
IL 88	412	2	25	385	0
Changes	376	2	21	353	0
Indiana 86	554	0	55	499	0
IN 88	404	75	144	67	118
Changes	-150	75	89	-432	118
Iowa 86	107	0	0	107	0
IA 88	114	0	0	114	0
Changes	7	0	0	7	0
Kansas 86	154	0	29	125	0
KS 88	193	0	68	125	38
Changes	39	0	39	0	38
Kentucky 86	92	14	28	50	0
KY 88	92	14	27	51	0
Changes	0	0	-1	1	0
Massachusetts 86	462	124	276	62	0
MA 88	478	133	289	56	2,381
Changes	16	9	13	-6	2,381
Michigan 86	160	19	113	28	0
MI 88	682	98	367	217	0
Changes	522	79	254	189	0
Minnesota 86	12,034	1,203	3,009	7,822	0
MN 88	12,034	1,203	3,009	7,822	0
Changes	0	0	0	0	0
Mississippi 86	34	0	5	29	0
MS 88	127	0	0	33	94
Changes	93	0	-5	4	94
Nebraska 86	24	0	2	22	0
NE 88	23	0	1	22	0
Changes	-1	0	-1	0	0
New Hampshire 86	418	141	158	76	43
NH 88	415	161	172	82	0
Changes	-3	20	14	6	-43
New York 86	3,340	85	132	84	3,039
NY 88	3,340	85	132	84	3,039
Changes	0	0	0	0	0
North Carolina 86	25	2	13	10	0
NC 88	144	11	21	34	78
Changes	119	9	8	24	78
Pennsylvania 86	26	0	3	23	0
PA 88	37	1	29	7	0
Changes	11	1	26	-16	0
Rhode Island 86	113	7	52	17	37
RI 88	54	4	41	9	0
Changes	-59	-3	-11	-8	-37

Source: 1988 and 1986 305(b) Reports

Table IV-1 (Continued)
Trophic Status of Lakes 1986 & 1988 (22 States)

State	# Assessed	Oligotrophic	Mesotrophic	Eutrophic*	Other**
Tennessee 86	64	10	18	36	0
TN 88	119	21	33	65	0
Changes	55	11	15	29	0
Vermont 86	223	118	80	25	0
VT 88	719	19	72	28	600
Changes	496	-99	-8	3	600
Virginia 86	220	10	64	61	85
VA 88	248	20	49	120	59
Changes	28	10	-15	59	-26
Washington 86	140	58	24	45	13
WA 88	140	58	24	45	13
Changes	0	0	0	0	0
Wisconsin 86	2,925	605	1,518	802	0
WI 88	2,153	605	746	802	0
Changes	-772	0	-772	0	0
TOTAL 86	21,356	2,440	5,649	9,991	3,255
TOTAL 88	22,179	2,601	5,346	10,198	6,453
NET CHANGE	823	161	-303	207	3,198

*Contains Lakes Listed as Eutrophic and Hypereutrophic
**Contains Lakes Listed as Unknown and Dystrophic

Source: 1988 and 1986 305(b) Reports

Data Availability

EPA encourages States to report on the trophic status of all publicly owned lakes in their 305(b) reports. However, as noted earlier, not all States do so. States may provide trophic status data through the waterbody system (WBS). In 1988, only six States (and the District of Columbia and Puerto Rico) used the WBS to report on trophic status. However, this number is expected to increase significantly in 1990. Some States, such as New Jersey, West Virginia, New Mexico, Arizona, South Dakota, and Missouri do not present trophic status information in their reports. Others, including Ohio, Wyoming, Georgia, Maine and Texas do provide information on the trophic evaluation of some of their lakes, but not in a manner that is consistent with other States. For inclusion as part of the nation-wide indicator, EPA will have to manipulate this data (see Table IV-2 for more details).

Louisiana does not use standard trophic categories in assessing its lakes, since many lakes would all be classified as eutrophic, even though they are quite productive. Rather, the State uses a classification system based on the best professional judgement of lake users, and assigns the lakes differing values based on this Lake Condition Index.

Improving the Indicator

States can report on trophic statue using number of lakes or by total acreage, and the use of both allows a more complete view of lake conditions at the State level. Figures IV-1 and IV-2 illustrate this point, using four States chosen at random. While it appears, by looking at the number of lakes, that a significant portion of the lakes in Vermont are of unknown status, the total acreage of these lakes is minimal. Although the State's portion of mesotrophic lakes is small, mesotrophic acreage is the largest classification due to the inclusion of 142,033 mesotrophic acres of Lake Champlain (1988 VT 305(b)). When examined together, the two measures provide a more comprehensive picture of trophic status within a State.

Presenting the Indicator

As noted, Figures IV-1 and IV-2 illustrate usefulness of reporting both number of lakes and lake acreage for each trophic classification. National data can also be displayed. Maps shown in Figures IV-3 and IV-4 provide some national view on States' trophic status, using information that comes largely from state 305(b) reports. However, as discussed above, some States did not report trophic status or did so differently other States. In these cases, TBS has estimated the values for inclusion on these maps. For example, Louisiana classified its lakes by assigning values relating to their productive use, as determined by users perception. In compiling this map, TBS has taken these classifications and assigned them to categories of various trophic states. Table V-2 provides more detailed information on the actual methods used by these States and manipulations to their data done by TBS. Figures IV-3 and IV-4 also illustrate the relatively few States that provide trophic status based on total acreage as opposed to number of lakes.

The identification of trophic status does provide a good indicator of lake quality. However, inconsistencies in the frequency and extent to which lakes are assessed limit EPA's ability to draw national or State-wide trends. As States report on trophic status in a more consistent manner, and provide information on the acres assessed as well as the number of lakes, this measure will become a more useful, nationally comparable indicator.

Table IV-2
States Using Different Trophic Status Reporting Methods

Georgia:	**Reporting**: Lakes were classified in one of 3 categories: A, highest need for restoration; B, moderate need for protection; and C, few water quality problems. **Mapping Assumptions**: All lakes in categories A and B were included in the eutrophic category.
Louisiana:	**Reporting**: As a result of geological and hydrologic processes, all Louisiana lakes are considered eutrophic. Therefore, Louisiana has developed a Lake Condition Index, based on users perception of lake health. Using Total Organic Carbon(TOC) as the only measured parameter, because of its correlation to user perception, lakes are categorized as Excellent to Poor; Good to Acceptable; Acceptable to Marginal; Marginal to Very Poor. **Mapping Assumptions**: the number of Acceptable to Marginal lakes were used to determine the percentage of eutrophic lakes.
Maine:	**Reporting**: The State reports trends in trophic state rather than actual trophic states. They categorize lakes according to water quality trends (deteriorating, stable or improving) and whether or not the lake experiences algal blooms (ex. "Those with deteriorating water quality and culturally-induced algal blooms.") **Mapping Assumptions**: Any lakes assessed as a priority problem due to periodic algal blooms and lack of transparency were considered eutrophic for use in the map.
Wyoming:	**Reporting**: The vast majority of lakes were classified as unknown. **Mapping Assumptions**: Only lakes with trophic status were considered (oligotrophic=62, mesotrophic=12, and eutrophic=28).

States Not Reporting

New Jersey:	Only very limited monitoring and assessment of lakes has been conducted in the past 5 to 8 years.
W. Virginia:	The trophic condition of the State's lakes has never been officially documented or scientifically determined.
South Dakota:	No current data available.
Arizona:	No current data available.
New Mexico:	Many lakes were surveyed prior to October 1, 1982, no current information available.
Missouri:	No current data available.

Figure IV-1
Trophic Status of Lakes By Number of Lakes Assessed
(1988)

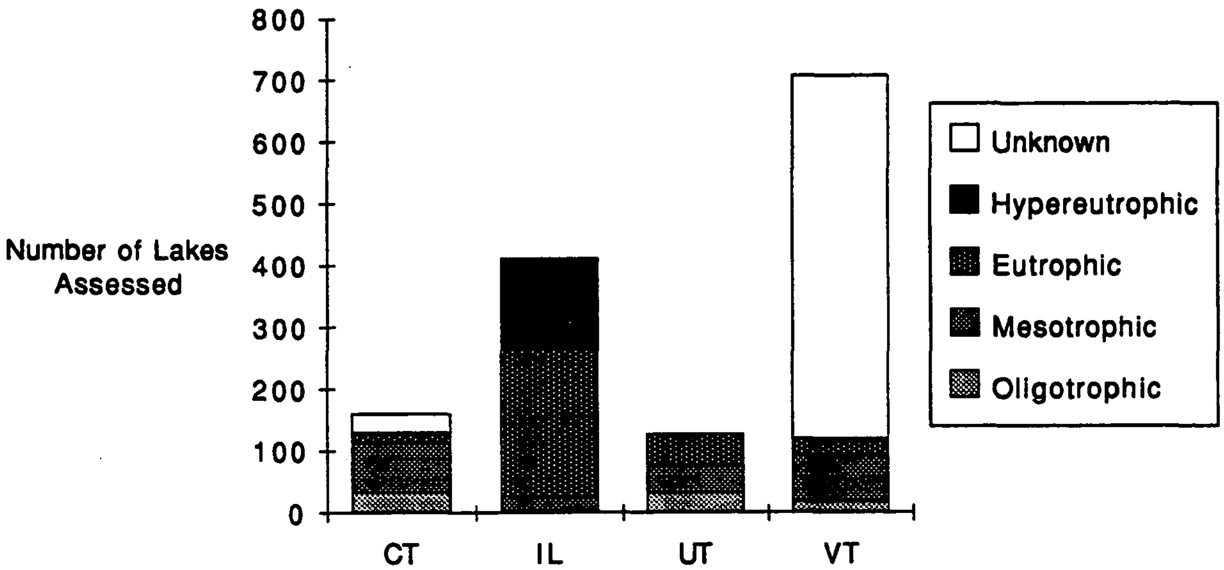
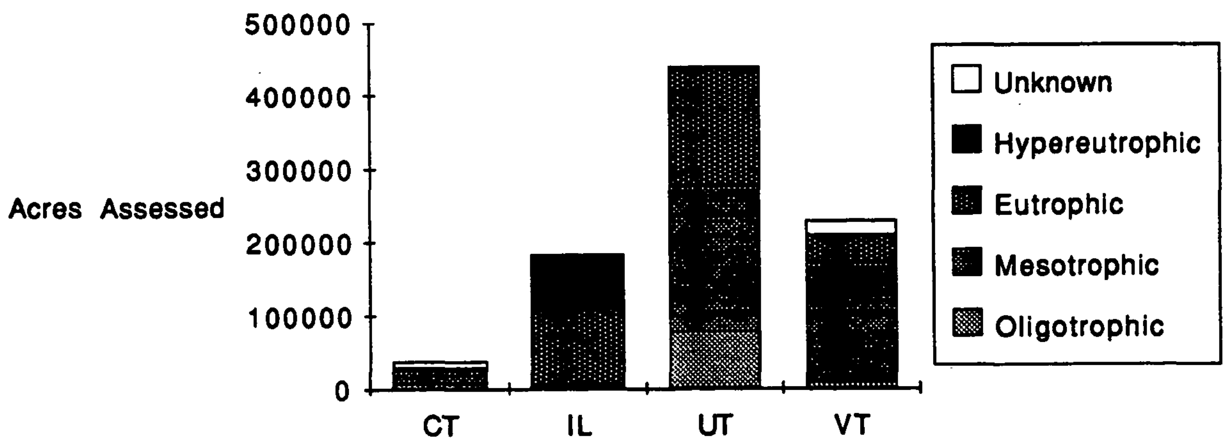


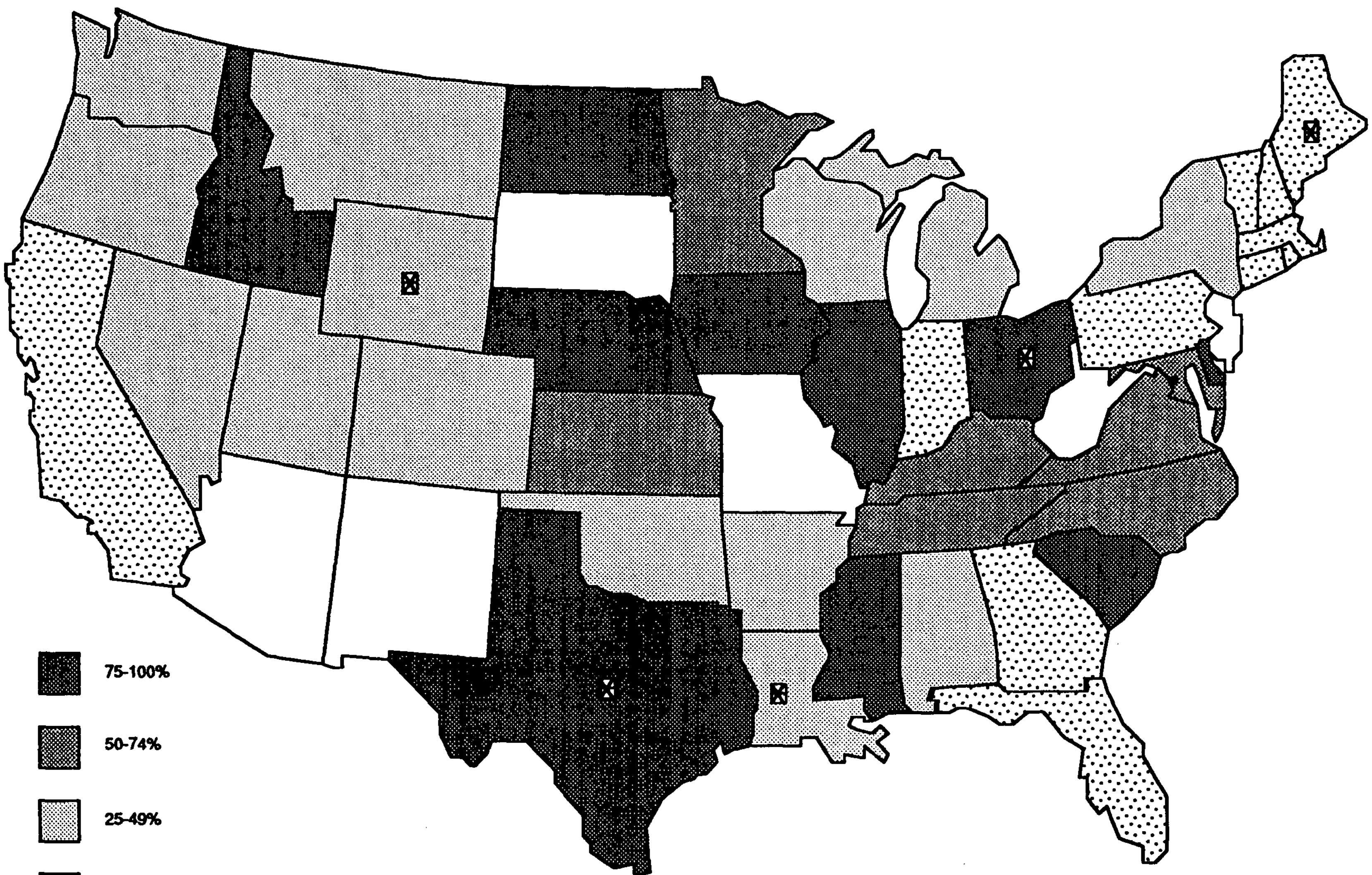
Figure IV-2
Trophic Status of Lakes By Lake Acreage Assessed
(1988)



Source: 1988 305(b) Reports

Figure IV-3

Percentage of Assessed Lakes Per State Classified as Eutrophic (1988)



75-100%

50-74%

25-49%

0-24%

States not Reporting

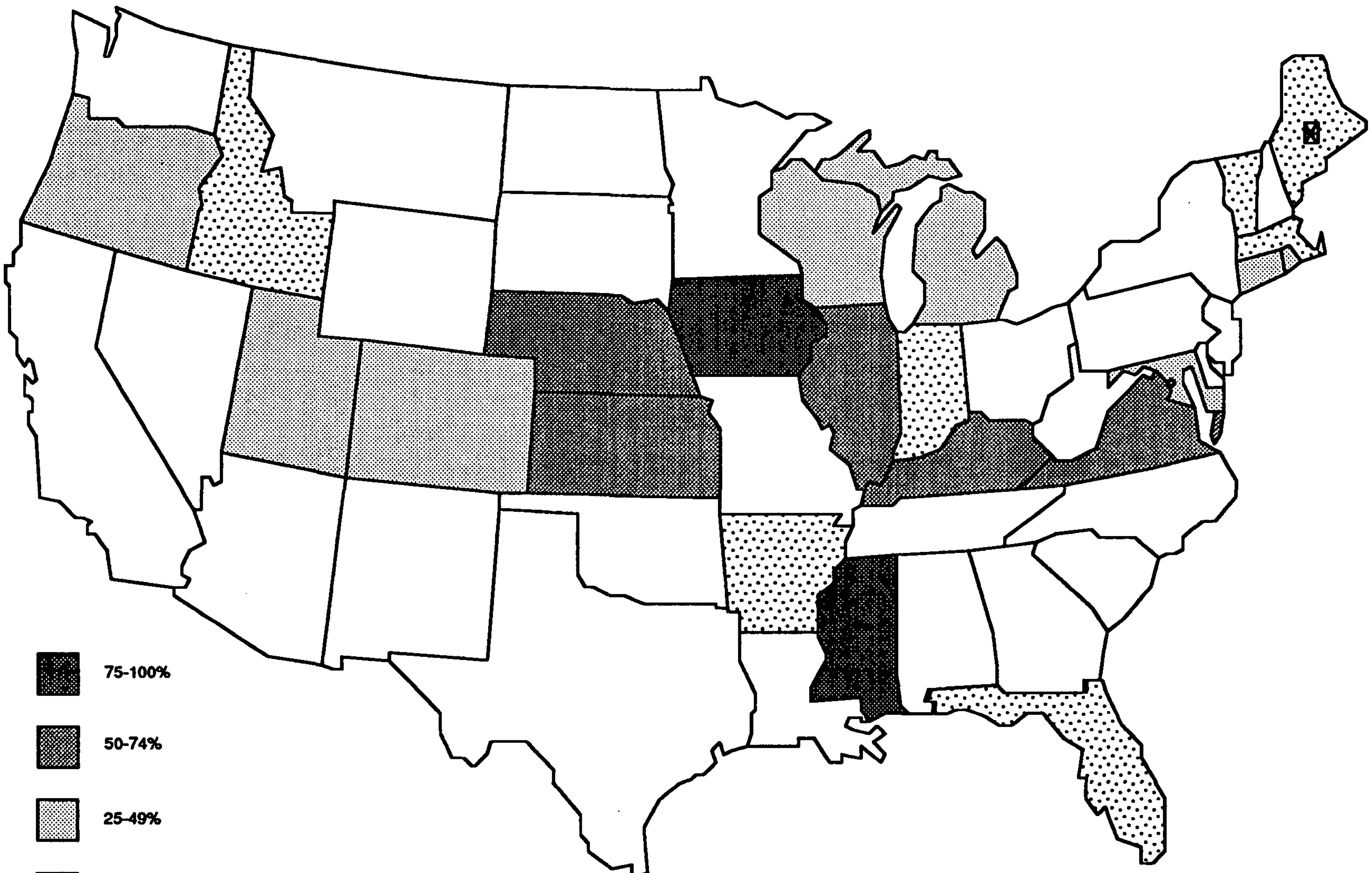
•Hypereutrophic Lakes are included in eutrophic %.
•Only the total number of lakes with trophic classsifications were considered.
(i.e.-Lakes with unknown trophic status were not taken into account for the total number of assessed lakes.)

Source: 1988 305(b) Reports

☒ Do not determine trophic status in manner consistent with other states; See Table V-2.

Figure IV-4

Percentage of Assessed Lake Acreage Per State Classified as Eutrophic (1988)



75-100%

50-74%

25-49%

0-24%

States not Reporting

•Hypereutrophic acreage is included in eutrophic %.
•Only the total acreage with trophic classsifications were considered.
(i.e.-Lakes with unknown trophic status were not taken into account for the total number of assessed acreage.)

Source: 1988 305(b) Reports

☒ Do not determine trophic status in manner consistent with other states; See Table V-2.

V. TOXICS IN FISH AND SHELLFISH

SUMMARY

Description of the Indicator

This proposed indicator measures the accumulation of pesticides and other toxic chemicals in fish and macroinvertebrate tissue. Currently, several Federal Agencies including the Fish and Wildlife Service (FWS), the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA), as well as many State Agencies collect these data. States commonly use the information to help develop fish consumption advisories. FWS and NOAA studies are ongoing and can provide status and trend information on a regional level. The State programs vary in the type of animals tested, the amount and quality of the testing done, the chemicals that are analyzed and the way the results are used. To use on a national level the State data will require better data storage and accessibility. FWS and NOAA data are typically for whole-fish or liver samples, and thus indicative of ecological risks but not human health risks. EPA and State data are often for edible tissue fillets, and thus can be used to estimate potential risks to human consumers.

Possible Applications

The FWS and NOAA data can be used directly to support regional status and trend identification for river and marine systems. EPA will have to decide how it wants to use the State data in a regional or national assessment program. The Agency might be able to develop trend data for selected States and sites if it were to ask States to provide data from locations that are part of ambient monitoring systems.

Strengths	The accumulation of toxicants in fish and shellfish tissue can provide an indication of the general quality of the water resource, at least with regard to specific chemicals and the implications of their presence. Some nationally consistent data sets exist. Many States collect tissue contamination data. There is a lot of interest among the general public, especially with regard to any human health risks associated with toxic contamination of fish and shellfish.
Weaknesses	The actual ecological implications of fish and shellfish contamination are a subject of controversy. There is a lot of variability among States in the chemicals tested for and in the quality of the analysis. State data are hard to retrieve if they are put into STORET.
Possible Improvements	Increase in the use by States of BIOS as central repository for storage and retrieval of data; Have States include more information in their 305(b) reports; Greater coordination among various federal agencies (FWS, NOAA and EPA) in site selection and identification of chemicals to be tested; Possible extension of EPA Bioaccumulation Study.

EVALUATION CRITERIA

Data availability	**Good**-For FWS and NOAA data; Available in periodic reports and from computerized databases; Also, data should be readily available from EPA's bioaccumulation study. **Fair**-State data are maintained on State databases which may or may not be automated. Some States put data into STORET, but retrieval of information from that system is difficult.
Data consistency/comparability	**Good**-For EPA Bioaccumulation Study and FWS and NOAA studies, consistent analytical methods are used throughout the country. Although different fish species are, by necessity, used in different regions, the differing samples can be used for comparison purposes. **Fair/Poor**-States have a lot of variability in the type of chemicals tested for, species tested, and the quality of the analysis.
Spatial representativeness	**Good**-FWS sites were chosen to provide national information on status and trends. Benthic surveillance and mussel watch sites are located near urbanized areas so as to be representative of the general areas in which they are located. **Fair**-Bioaccumulation study; Some sites were randomly chosen, others were located in undisturbed areas, areas of important fisheries and at problem areas. Each type of site could be representative of similar sites around the country. **Variable**-State information is better in States with ambient monitoring networks.
Temporal representativeness	**Good**-The presence of contaminants in fish and shellfish tissue is more temporally consistent than measuring for the chemicals in the water column, since they are less transient. In the National Contaminant Biomonitoring program (NCBP), sampling always occurs in the fall to increase temporal comparability and similarly bivalves are always tested in the fall in NOAA's status and trends program. **Variable**-The State testing results vary not only between States but may also change within a State from one year to the next, affecting temporal comparability.

EVALUATION CRITERIA

Utility in trend assessment	**Good/Fair**-The FWS study is designed specifically to measure trends for specific contaminants in fish tissue. NOAA data will also support trends as monitoring continues into the future. The state data that is done at fixed monitoring stations would be useful for trend monitoring. However, a lot of monitoring is done for "special studies" and would not support the development of trends.
Scientific defensibility	**Good**-FWS and NOAA studies use well-defined and accepted study protocols as does the EPA Bioaccumulation study. State activities are much more variable.
Sensitivity to change	**Fair**-However, the utility of this measure to detect changes in the toxic load would depend to a great extent on the species involved and their tendency to accumulate particular chemicals. The FWS study demonstrated the decline in the use of certain pesticides. The pesticides were still being found long after their use was discontinued, which is important in demonstrating continued impact, but shows that natural response lags will slow down the ability to demonstrate environmental results. Non-linear relationships of loads to ambient concentrations in tissues mean that modest incremental changes in pollutant inputs will not always be distinguishable from tissue monitoring.
Relationship to risk	**Fair**-For bivalves and where fish fillets are analyzed the measure provides information relevant to human health risks. The measure is directly related to ecological risk. However, quantitative information on the actual environmental impacts of the accumulated toxicants is usually not available.
Cost to collect and analyze data	**Moderate/High**-Costs for tissue toxicity tests and their evaluation can be high. Accordingly, studies such as EPA's Bioaccumulation study may not be repeated.
Relationship to existing programs	**Good**-Several Federal Agencies are already doing testing as are States in conjunction with FDA. States can report findings in the 305(b) reports.
Presentation value	**Good/Fair**-The information is understood by the public and can in certain instances be well displayed on maps. However, given the wide range of variables in different studies, it is difficult to get a "nationwide" view from State studies.

DISCUSSION

Background

The accumulation of toxic chemicals, pesticides, or other industrial chemicals in fish and shellfish tissue can serve as an indicator of the quality of the water resource in terms of potential ecological and human health risks. This kind of data, showing status and trends as well as information about impacts of specific pollution sources, is of great interest to the general public as well as to government resource managers.

A number of federal agencies collect data on tissue contamination. Of particular interest to the EPA are the efforts of FWS and NOAA. Since 1967, the FWS has been collecting data on chemical residues in freshwater fish under the NCBP. There are 112 sampling sites in the fish monitoring network and the whole fish samples are tested for organochlorine pesticides, PCBs, and seven metals. NOAA collects data on the concentrations of a large suite of toxic chemicals in marine bottom fish and benthic organisms at specific locations, as part of its National Status and Trends (NST) Program.

EPA is also conducting its own study (the National Bioaccumulation Study) to determine the extent to which pollutants are bioaccumulating in fish and to identify contaminant sources. In addition, many States include some level of fish tissue analysis in their biological monitoring activities. According to a survey conducted in 1987 that assessed biomonitoring activities at 65 State and Federal Agencies (EA Engineering 1987), 55 of the respondents indicated some level of tissue residue analyses. A more recently completed review indicated that 46 States monitor tissue residues in fish in rivers and streams, 25 in lakes, and 13 in coastal and estuarine areas (RTI, 1989). There is, of course, a great deal of variability among the States in the frequency of the testing, the species examined, and the chemical parameters examined. At present, some States store their data in STORET, though the information is hard to retrieve easily. EPA is planning to include tissue data storage and retrieval in improvements to BIOS, which will improve the utility of the data.

Uses of the Indicator

FWS program managers and other State and federal agencies use the NCBP data as a general measure of status and trends of certain pesticides and other toxicants in waterways.

The FWS regularly issues reports on the results of their analyses. Reports on the 1984 data will be available in the fall of 1989. Results from the data collected in 1986 will be available in the fall of 1991 and by that time, the Agency will have established trends at 80% of their stations. Analysis of the 1988 samples, which are currently frozen, will then focus on the remaining 20% of the stations for which the trends have not been established (Steffick 1989).

The analyses have yielded useful information. Data from 1976 through 1981 show a statistically significant decline in DDT, PCBs, and dieldrin, reflecting the effectiveness of the EPA's bans on these substances. The data also showed the geographic spread of PCB's and toxaphene over the same period (LaRoe 1987). As well as providing insights on status and trends, the data are used as a targeting tool, helping to determine where additional research and clean up activities should be undertaken. The results can also serve as a reference against which results at known contaminated sites can be compared. At EPA, this information may be of particular utility to those dealing with non-point sources of pollution, for which ambient monitoring data are sometimes hard to come by.

The Benthic Surveillance component of NOAA's NST program measures the concentrations of toxicants in bottom fish and sediments, and the same chemicals are measured in bivalves under the Mussel Watch program. Benthic Surveillance and Mussel Watch program data are maintained on a mainframe computer at NOAA and can be down loaded onto PC databases and transferred to EPA. Results are periodically presented in NOAA reports. NOAA uses the information to rank the most contaminated areas and as a screen for areas that warrant more intensive monitoring. The information will be very useful to assess national trends, but cannot be used to evaluate specific regulatory actions since it would be difficult to identify any single activity or source responsible for the observed contamination at a single monitoring station.

Characteristics of the Indicator:

The 112 sites in the NCBP program were originally sampled every year but have recently been sampled every two years. At each site, samples are taken from bottom dwelling fish and from a predator species such as a trout or black bass. Since the Agency uses whole fish samples and not fillets, the results are not good indicators of human health risk, because toxicants are typically concentrated in organs such as the liver that are not generally consumed. One drawback of a national monitoring system is the need to use different species at different locations around the country. However, the FWS reports that as long as samples are adjusted for lipid content, valid comparison can be drawn (LaRoe 1987). The sites were chosen to provide information on status and trends at a regional and, when combined, at a national level. The stations were selected with the USGS as part of the USGS National Stream Quality Monitoring Network (NASQAN) to represent sub-basin characteristics.

Collection and analysis activities at the sites conform to strict technical standards. Sampling occurs in the fall so the data are temporally as well as spatially comparable. The results of analyses noted above demonstrate the ability of the indicator to track changes as they occur.

At present, the NCBP sampling sites are located only in rivers or streams. However, as the program is re-evaluated, the Service hopes to include estuaries and wetlands in their monitoring scheme.

NOAA collects data for a number of chlorinated synthetic compounds, PAHs, and trace elements for the Benthic Surveillance program at around 50 sites around the country. Each site is visited every other year. As opposed to the NCBP program which analyzes whole fish tissue, the NOAA program analyzes individual liver tissue since the liver is the organ that accumulates the greatest concentration of toxic chemicals. As with the NCBP program, the data are not useful to determine human health risk.

NOAA collects information at about 150 sites around the country in the Mussel Watch program and intends to study each site annually in the future. Thirty-seven of the sites were chosen to allow comparison with data collected by EPA as part of a mussel watch program it ran from 1976 through 1978. The sites for the Benthic Surveillance and Mussel Watch programs are located near urbanized areas but not near specific discharges, so as to be representative of the general areas in which they are located (with a few exceptions due to early problems in sampling design). This differs from other programs such as the California Mussel Watch program which collects data from bivalves located or placed at specific discharges. Collection and analysis methods for the NST data are subject to uniform quality assurance protocols. To ensure temporal comparability, bivalves are examined only in the winter. While the data will clearly be very useful for looking at temporal trends as time goes on, some questions remain as to whether spatial comparisons are appropriate. Since some stations are closer to specific pollutant sources than others, the data from these station may not represent the overall water quality of the study area.

Data Availability

Results of the NCBP analyses are stored on a mainframe computer in Columbus, Missouri and are available through the FWS by downloading onto a PC. The NOAA data are maintained on a mainframe computer in Rockville, Maryland and can also be downloaded onto a PC. The FWS and NOAA data are also made available periodically in reports.

Improving the Indicator

The FWS is currently reevaluating the NCBP program. It is investigating the possibility of including new types of bioassessment criteria and expanding the study to include some new chemicals and types of waterbodies. Moreover, FWS is considering including some of NOAA's mussel watch program in the NCBP and identifying new sites with the USGS's National Water Quality Assessment (NAWQA) program (Andraison 1989). The FWS is interested in coordinating its monitoring efforts with those of other agencies. This would be a good time for EPA to get involved in the new program design to ensure that chemicals or waterbody types that it felt were important were included.

In a report that examined historical data on contamination in fish and shellfish, NOAA has recommended that "a nationally centralized and easily accessible PCB and pesticide database should be completed and used to receive and process new data from State and federal programs (NOAA 1988)." The proposed modifications to BIOS might help fill this need and allow for data from a number of agencies to be stored in one central location. However, the large amount of variation in methodologies, species tested, chemicals examined, and the purposes for which the data are collected, dictate that a great deal of caution be exercised in drawing inferences from data collected by different agencies.

Increased coordination among FWS, NOAA, EPA and other interested federal agencies to help establish parameters for species to be examined, chemicals to be tested, and areas to be investigated would greatly improve the value of this measure as an indicator of water quality.

Presentation of the Indicator

EPA could try to take the raw data from the NCBP and NOAA programs and derive their own presentations, or it could just use the presentation techniques used by FWS and NOAA in their reports. In the short-term, it may be more appropriate to use the data as it is analyzed and presented by FWS and NOAA. Among the ways that the NCBP data can be displayed are shown in Figures V-1 and V-2. In Figure V-1, the regional distribution of PCBs in freshwater fish is shown graphically while in figure V-2, the nationwide decline in the concentration of DDT and its homologs from 1969-1981 is shown.

The Benthic Surveillance data could be displayed on maps as shown in Figure V-3 showing the level of DDT in livers of estuarine fish in 1984. These maps could be modified to show trends over time.

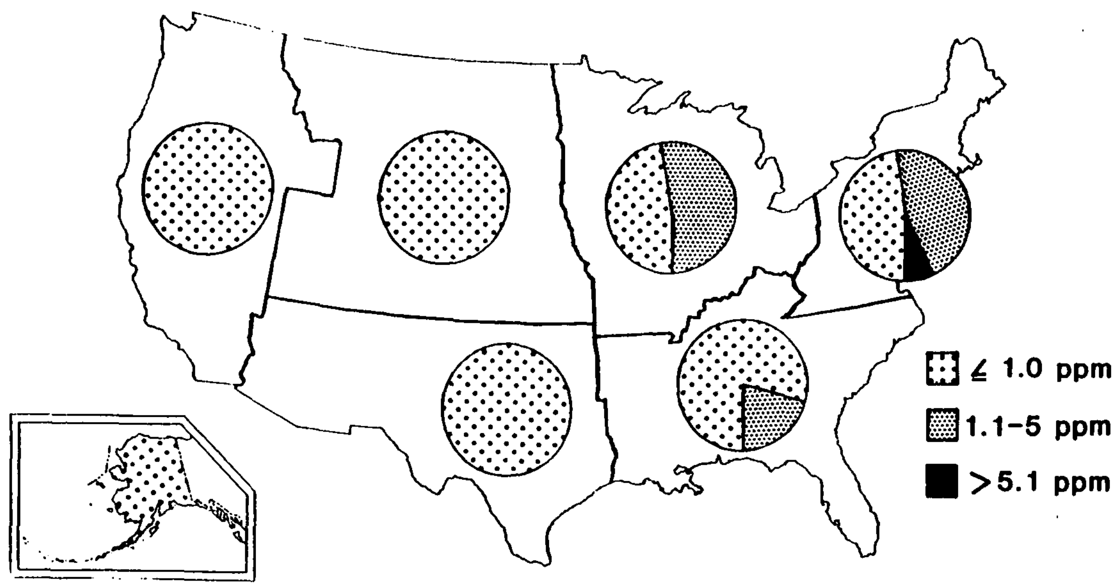
Mussel Watch data might be shown as in Figure V-4, with levels of specific chemicals (e.g., PCBs) in tissue at the same sites over time. This figure shows the 20 highest ranking sites for PCBs in bivalves, for the three-year period from 1986 through 1988. It is important to use care in looking at this data to try to ascribe trends. Since three years of data are shown, a trend might be inferred when the movement has been consistent for all 3 years. However, NOAA has indicated that a trend only occurs when there is a significant difference among the years' data and the three-year change is in one direction. As seen in Table V-1, only at three sites (Hudson River, Boston Harbor, and Elliott Bay), could trends be determined according to this definition. In each of those cases, major improvements have occurred, with PCB concentrations decreasing markedly. However, additional data would be needed to establish any national trend.

EPA'S BIOACCUMULATION STUDY

The National Bioaccumulation Study is designed to test the accumulation of toxic chemicals in fish and to relate this accumulation to specific sources. One of the recommendations of the workshop group that looked at potential indicators that could be related directly to specific sources was that new site specific studies be initiated. Monitoring sites for the one-time EPA study, which could serve for such site-specific studies, were selected with assistance from EPA Regional Offices and covered the following:

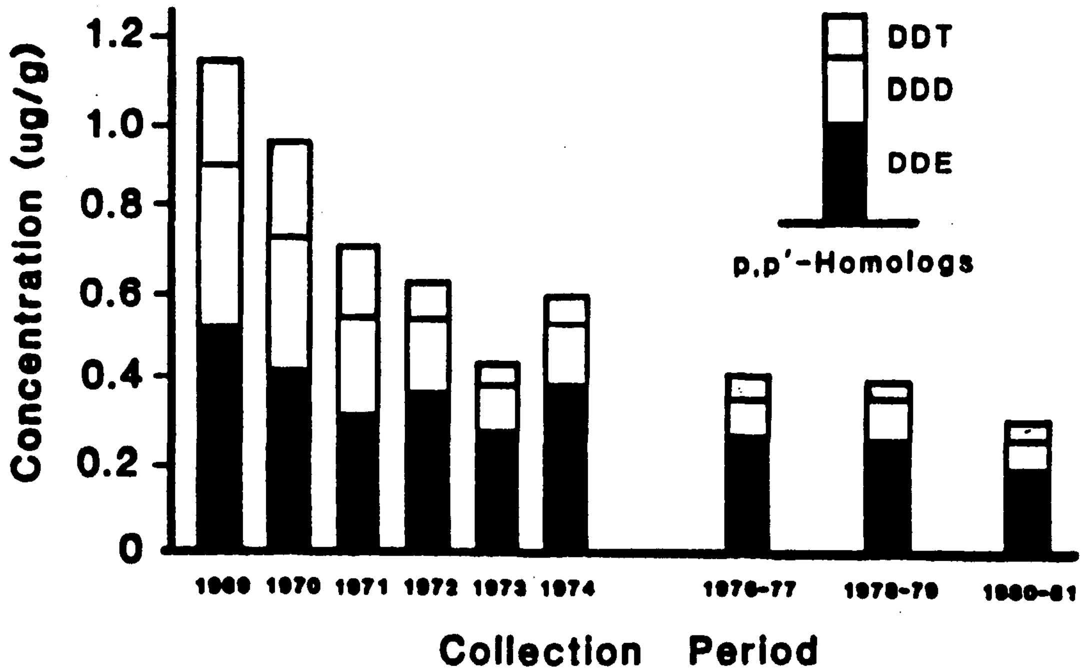
- Problem sites with significant industrial, urban, or agricultural activity (with special attention given to bleach kraft pulp mills)

Figure V-1
National Contaminant Biomonitoring Program (NCBP)-PCB Residues in Freshwater Fish (1980-81)



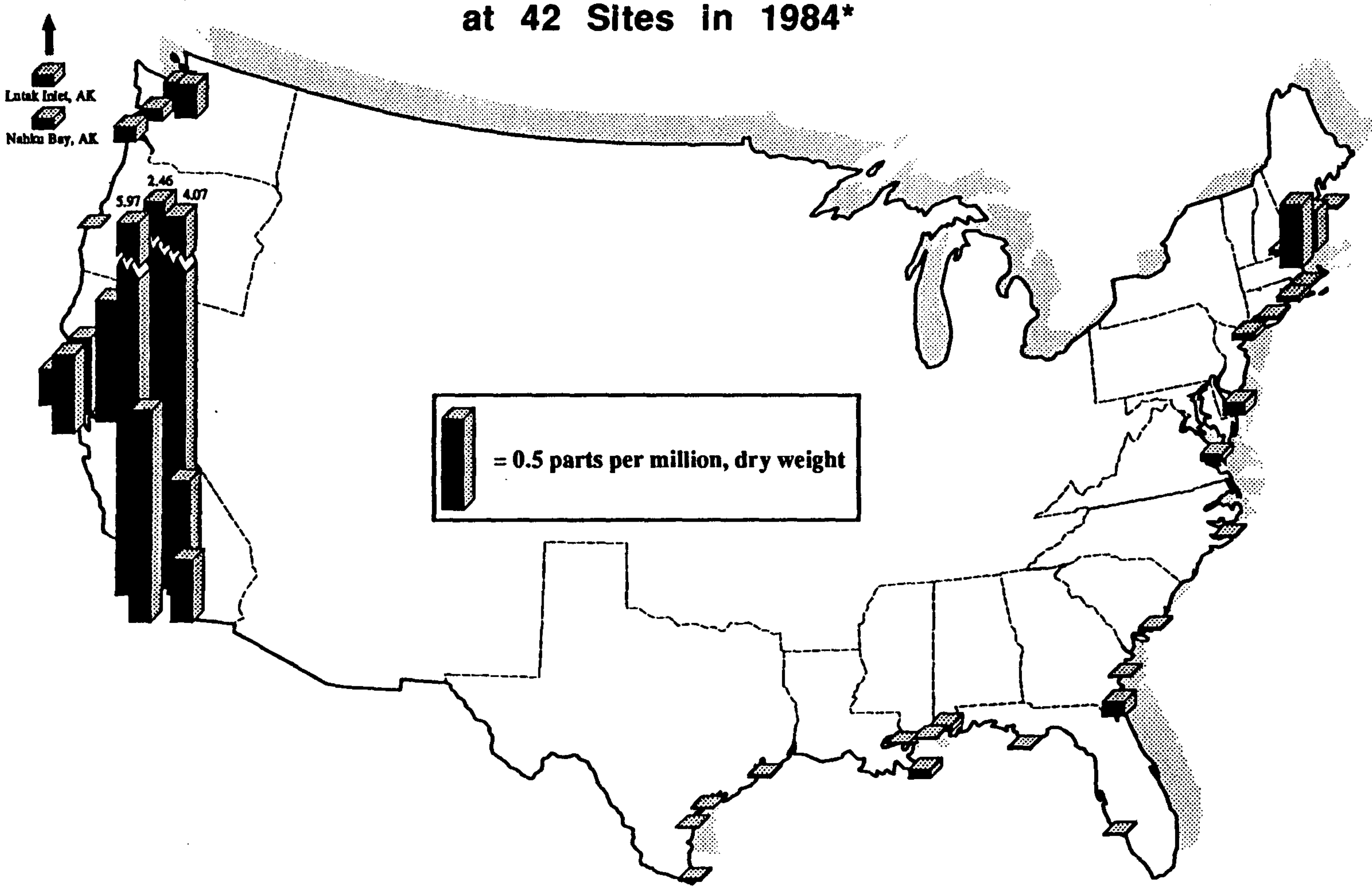
Source: FWS

Figure V-2
National Contaminant Biomonitoring Program (NCBP) - Geometric Mean Concentrations of p, p'-DDT Homologs in Fish Samples (1969-81)



Source: FWS

Figure V-3
Total DDT in Livers of Estuarine Fish Composites Collected at 42 Sites in 1984*



*Computed from original data for the 1984 NOAA Status and Trends Program.

Source: NOAA: A Historical Assessment Report 1988

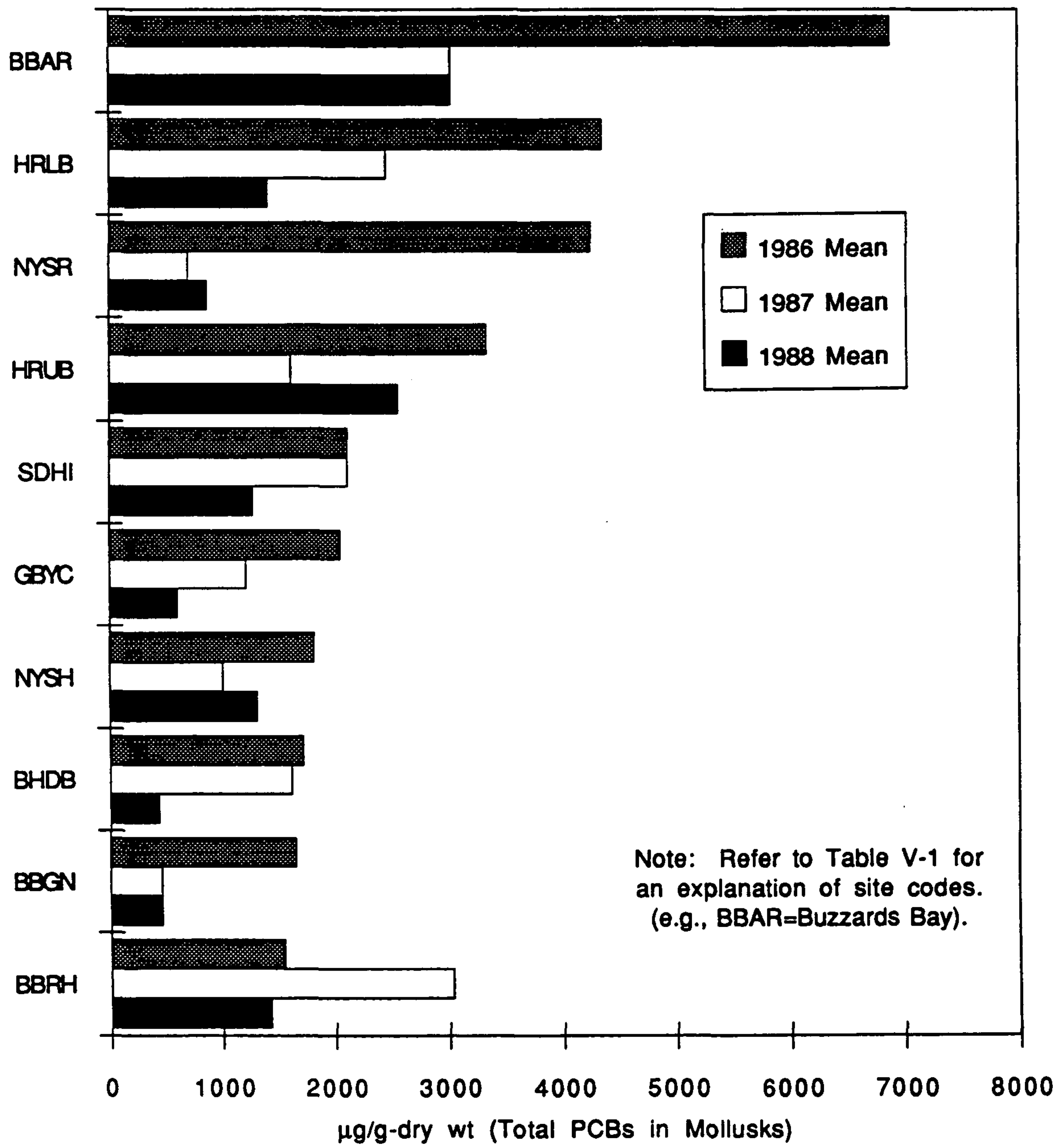
Table V-1
Total PCBs in Mollusks - Top 20 Sites for 3-Year Period (1986-1988)

				RANKING					
Code	Location	State	Sp.	1986	1987	1988	Overall	Signif. Diff.	Trend
BBAR	Buzzards Bay	MA	me	1	1t	1	1	no	no
HRLB	Hud./Rar. Est.	NY	me	2	3	3t	2	yes	d
NYSR	N.Y. Bight	NJ	me	3	17t	11	6	no	no
HRUB	Hud./Rar. Est.	NY	me	4	5t	2	3	no	no
SDHI	San Diego Bay	CA	me	5	4	5t	5	no	no
GBYC	Galveston Bay	TX	cv	6	8t	16	10t	no	no
NYSH	N.Y. Bight	NJ	me	7	12	5t	7t	yes	no
BHDB	Boston Hrb.	MA	me	8	5t	<	10t	no	no
BBGN	Buzzards Bay	MA	me	9	<	<	14	no	no
BBRH	Buzzards Bay	MA	me	10	1t	3t	4	no	no
BHDI	Boston Hrb.	MA	me	11t	19	<	13	yes	d
LITN	Long Is. Snd.	NY	me	11t	8t	7t	9	no	no
EBFR	Elliott Bay	WA	me	13	<	<	19t	yes	d
BHHB	Boston Hrb.	MA	me	14	13	<	18	no	no
HRJB	Hud./Rar. Est	NY	me	15	<	10	15t	yes	no
LINH	Long Is. Snd.	CT	me	16	<	19t	<	no	no
LIMR	Long Is. Snd.	NY	me	17	<	14t	<	no	no
SAWB	St. Andrew Bay	FL	cv	18	<	17t	<	no	no
LISI	Long Is. Snd.	CT	me	19	<	<	<	no	no
NYLB	N.Y. Bight	NJ	me	20	15	17t	19t	no	no
SFEM	San Fran. Bay	CA	me	-	5t	7t	7t	-	-
LIHH	Long Is. Snd.	NY	me	<	8t	<	17	yes	no
LIHR	Long Is. Snd.	CT	me	<	11	<	15t	yes	no
CBSP	Choctawhat. Bay	FL	cv	<	14	<	<	no	no
MDSJ	Marina Del Rey	CA	me	<	16	<	<	yes	no
BHBI	Boston Hrb.	MA	me	<	17t	<	<	yes	no
PBIB	Pensacola Bay	FL	cv	<	20	<	<	no	no
GBSC	Galveston Bay	TX	cv	-	-	9	12	-	-
APDB	Apalachicola Bay	FL	cv	<	<	12	<	yes	no
ABWJ	Anaheim Bay	CA	mc	<	<	13	<	no	no
SFSM	San Fran. Bay	CA	me	<	<	19t	<	no	no
LICR	Long Is. Snd.	CT	me	<	<	19t	<	no	no

Legend:
Sp.=Species:
me-Mytilus edulis, cv-Crassostrea virginica, mc-Mytilus californianus
Rankings:
- site was not sampled in the given year, t-sites tied in rankings, <-ranking was not among the upper 20
Signif. Diff.
yes-there was a significant difference among the three years of data
no-there was not a significant difference among the three years of data
- data was insufficient to make a determination
Trend
i-increasing concentrations of total PCBs, d-decreasing concentrations of total PCBs

Source: NOAA

Figure V-4
Total PCBs in Mollusks -
Top 10 Sites for 3-Year Period (1986-1988)



Source: NOAA

- Randomly located sites
- Relatively undisturbed areas, and
- Areas of important fisheries.

Uses of the Indicator

Since EPA does not currently intend to replicate this study, it is obviously of little value for national trend analyses. There are two main objectives of the study:

- To identify sites with potential sources of contamination (point or nonpoint) in need of further investigation and possibly stricter pollution controls; and
- To determine what potentially hazardous levels of accumulation in fish relate to specific types of industries or land uses.

The data will be used primarily by water quality managers at the State and regional level as a targeting tool.

Characteristics of the Indicator

The data collection and sampling methods follow well-defined and scientifically defensible practices developed by EPA's Environmental Research Laboratory in Duluth, Minnesota. The one-time investigation is not temporally representative and the non-random selection of sites around specific areas of concern limits the spatial representativeness of the data. As in the NCBP, whole fish samples (a composite of the same species of fish captured at each site) are used. However, edible fillets were analyzed as well, so that some preliminary analysis of human health implications at a screening level is possible. Study results will be available during the fall of 1989.

Improving the Indicator

EPA now needs to consider whether portions or all of the monitoring done in the Bioaccumulation Study should be repeated. This could allow for follow-up analysis of those sites identified in this round as requiring additional pollution controls. Further testing could demonstrate the impacts of regulatory actions on the levels of contaminants in fish.

Some of the sites, such as the randomly chosen ones, could possibly be incorporated into the FWS's revisions to the NCBP. Data collection might also be continued by individual States as part of their water quality monitoring activities and EPA could help provide guidance as to specific chemicals that would be most worthwhile to monitor.

Presentation of the Indicator

EPA is now producing a document to present the results of the study and the report will include a number of graphical presentations. The results for a specific chemical (such as PCBs or chlordane) could be displayed by site category (indicating the concentrations found across the country around specific types of industrial outfalls) or geographically.

STATE TISSUE RESIDUE TESTING

As noted earlier, a large number of States collect some information on bioaccumulation in fish. On rivers and streams, 37 States conduct tissue residue sampling through intensive surveys while 16 employ some fixed station monitoring (RTI 1989). These data are most often used to help develop fish consumption advisories, usually in conjunction with State public health agencies. The data may also be used by the States in determining designated use assessments for reporting purposes in the 305(b) reports. As might be expected, there is a great deal of variability among the States with regard to species investigated, the amount of testing done, how it is done, what chemicals are analyzed, and how the results are used. From year to year, States can change the goals of the monitoring and, therefore, the types of data collected. Many States put their tissue data into STORET, as well as maintaining it on State computer systems. As noted earlier, it is not easy to retrieve the information from STORET in a meaningful form. It can be done, however, and Figure V-5 shows results of a retrieval using a program specially designed by the State of Illinois.

Improving The Indicator

EPA is engaged in an effort to improve the BIOS component of STORET and include in the upgrade a file for tissue toxicity data; which does not currently exist in BIOS. The BIOS upgrade will, hopefully, allow for easier access and retrieval of tissue data. In response to a needs assessment questionnaire, 32 States indicated an interest in using BIOS for tissue residue data (EA Engineering 1987). Once the improved data system is available, EPA might be able to use it to determine status and trends with regard to tissue data. For example, the Agency might be able to see the levels of a specific contaminant (such as PCBs) in certain types of fish (top feeders for example) and track changes over time. For this to allow for trend or nationwide analysis, EPA and the States would have to agree upon some criteria for the types of species and chemicals to be analyzed and the types of sites to be included in the database.

A more useful reporting mechanism for purposes of the indicator project would be for States to include more information in their 305(b) reports. If the EPA agrees that information on tissue residues should be reported on separately, as an indication of water quality, the Agency might ask the States to provide more information on the results of their tissue residue analyses in their 305(b)s. The current guidance, in the section on public health/aquatic effects, asks for information on the number of exceedances of FDA standards in tissue data, the pollution of concern, its source, and the size of the waterbody affected. This can be useful information, and as part of a section on "indicators" in the 305(b) reports, EPA could ask for more details including actual levels

Figure V-5
Example of a Translated STORET Retrieval

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY **** COOPERATIVE FISH CONTAMINANT MONITORING PROGRAM
EXCURSIONS OF FDA ACTION LEVELS NOTED BY *

STATION: K 98 MISS R E HANNIBAL RM 310 T4S R8W NE18 COUNTY: PIKE BASIN: MISS NO CEN STATUS: PERMANENT

DATE	LAB	FISH	F OR W	WEIGHT LBS	LIPID %	CHLOR-DANE PPM	DIEL-DRIN PPM	HEPT. EPOX. PPM	TOTAL DDT PPM	TOTAL PCBS PPM	MER-CURY PPM	OTHER PPM
860904	IEPA	CARP	W	2.84	13.0	0.048	0.220	0.042	0.039	0.20	.	T= 1
860904	IEPA	CHCF	W	0.77	11.0	0.110	0.250	0.049	0.070	0.39	.	T= 1
860904	IEPA	WHCR	W	0.71	5.8	0.022	0.088	0.015	0.049	0.23	.	T= 1
860904	IEPA	CARP	F	2.84A	3.3	0.038	0.069	0.010	0.033	0.14	.	T= 1
860904	IEPA	CARP	F	4.18A	11.0	0.110	0.220	0.038	0.032	0.19	.	T= 1
860904	IEPA	CHCF	F	1.76A	3.4	0.036	0.072	0.012	0.021	0.15	.	T= 1
860904	IEPA	WHCR	F	0.83A	0.1	0.020K	0.010K	0.010K	0.020K	0.10K	.	T= 1
86MEAN-WHOLE						0.060	0.186	0.035	0.053	0.27	.	
86MEAN-FILET						0.051	0.093	0.017	0.026	0.14	.	
%EXCURSIONS-FILET						0.0	0.0	0.0	0.0	0.0	.	

As reprinted in "Preliminary Final Requirement Statements For Toxicity Testing and Tissue Residue Components of BIOS."
Washington Battelle Programs.
September 12, 1989.

of specific contaminants found in the species tissue, the specific tissue impacted, and the reach number or some geographic identifier of the area in which the contamination was found. This would allow for some trend identification. Moreover, since some EPA Regions and States now conduct health risk assessments for consumption of contaminated fish (usually for a range of possible consumption rates, representing average and high-consuming fish eaters), the Agency could ask that the results of those studies be provided in addition to FDA action level exceedances. This would respond to two problems not currently addressed using action levels: estimating high risks to consumers, and evaluating the significance of contamination for the large number of chemicals for which action levels have not been developed.

It would also be helpful if States would identify in their 305(b) reports monitoring sites which were part of a special study (around a potential discharge site or as part of a basin survey) and which were part of the State's ambient monitoring network. The narrative information included with the data could contain information on whether the site is being used to track non-point sources or a specific discharges. This tagging would allow EPA to more appropriately develop trend information on routine monitoring sites, and to note changes possibly related to program activities at special survey sites or ambient sites located near discharges.

VI. MEASURES OF BIOLOGICAL COMMUNITY STRUCTURE

SUMMARY

Description of the Indicator

The basic indicator is the health of the biological communities of water body segments, as measured by monitoring and abundance of species expected to inhabit that type of water (and in some cases, of species considered to be sensitive to polluted conditions). States use a variety of biological community measures, with the Index of Biotic Integrity (based on counts of fish species), other fish community indices, and several types of macrobenthic invertebrate indices being the most common.

To use this indicator at the national level, we will attempt to combine data on the health of biological communities in all monitored water bodies according to their qualitative rankings according to the various indices used for bioassessments. That is, we will use only the information on whether the biological community of a given segment was considered to be in excellent, good, fair, or poor condition, considering all segments with the same qualitative ranking as equivalent for the national evaluation. This approach was recommended by several State and regional biologists in the workgroup on program effectiveness evaluation at the March 1989 Surface Water Indicators Workshop, and was then voted one of the most highly rated potential national indicators by the workgroup as a whole.

Possible Applications

Because the specific types of biological monitoring (i.e., which types of animals or plants are counted) vary from State to State, only very qualitative reporting will be justified at the national level. Such qualitative information could be useful for Federal planning and targeting. It will not support site-to-site comparisons. However, the Agency believes that if spatial data availability issues can be worked out, this indicator may support comparisons of broad-scale trends in biological conditions among geographic regions, States, watersheds, etc.

At the State level, where consistent methods of monitoring and analysis can be assured, sophisticated analyses of biological community data are already being done. Such analyses can be used to support impact assessments for specific pollution sources, or to assess the results of pollution control upgrades at particular facilities.

Strengths

This indicator is the most direct measure possible of support of a Clean Water Act (CWA) goal, because maintaining biological integrity is one of the legislative mandates. The information is scientifically defensible, and also makes sense to the public and decision makers. Availability of data to assess the status of waters nationwide is moderately good, with data available for some waters in almost all States, provided that a decision is made to consider the various types of biological community measures as comparable to one another in a broad, qualitative sense.

Weaknesses

The variety of approaches to assessing biological community integrity means that no single approach will likely ever be embraced by all States. This means that only rough, qualitative comparisons of conditions from place to place will ever be likely using this approach. Also, biological monitoring is now often done in special studies rather than as part of ambient network monitoring, so that there are relatively few locations where temporal trends can be assessed.

Possible Improvements

More consistent monitoring in space and time, i.e., establishing more monitoring network locations that will be monitored repeatedly over time would allow trend assessments for a larger portion of the nation's waters than is currently possible.

EVALUATION CRITERIA

<u>Data availability</u>

Fair - Most States use biological community monitoring for at least a few critical water bodies, or for special one-time studies. A number of States have incorporated such monitoring into ambient monitoring networks, and additional States may do so in the future. The proportion of most States' assessed water bodies in which biological community monitoring is done is currently quite low. However, the positive response of most States to recent recommendations by State and federal agencies concerning the benefits of biological monitoring indicates that biomonitoring will probably be carried out for larger portions of many States' surface waters in coming years.

<u>Data consistency/comparability</u>

Fair - A variety of biological community measures are commonly used, which differ greatly in the type of organisms whose abundance is assessed, and in the complexity of procedures for combining data on various species' abundance. Some measures are formulated into sophisticated mathematical indices to take into account habitat features and other environmental factors (e.g., IBI based on ecoregions) while others are relatively simple weighted sums of a few key species. The great differences in the types of measures used means that data from State to State, and sometimes within States, will not support sophisticated ecological comparisons among sites or regions. This indicator development project is investigating whether biomonitoring experts concur with the sense of the March 1989 Surface Water Indicator Development Workshop that the biological community indices commonly used for water quality assessments are sufficiently comparable to be aggregated for <u>qualitative</u> national status and trend analyses.

<u>Ability to estimate</u>

Poor - The utility of biological community monitoring derives from its direct nature. One is monitoring the feature of the environment that water quality regulations seek to protect, so that one cannot be fooled into falsely believing the ecological protection goal of the CWA has been met, as can occur when physical and chemical measures are used. Attempting to infer what biological conditions are from non-biological measures would thus be contrary to the basic reason that biological community measures are desirable in the first place.

<u>Spatial representativeness</u>

Fair - Biological community assessments are done in most States, but often in only a small portion of the assessed waters. The major challenge in using these assessments to evaluate national status and trends will be working out spatial data availability issues. It will be necessary to identify segments where monitoring could be expected to be representative of the segment as a whole, rather than of

EVALUATION CRITERIA

small, high impact areas subject to intensive study (such as a point source discharge monitoring study).

While this issue of spatial representativeness is not a trivial one, biological community measures in fact present less of a problem than the chemical measures on which State use-support assessments are traditionally based. This is because biological communities tend to integrate water quality conditions over space and time.

<u>Temporal representativeness</u>

Good - Biological community health is more temporally consistent in a given location than water quality itself is, because water column conditions are transient while organisms remain.

<u>Utility in trend assessment</u>

Fair - Biological community monitoring is sometimes part of State monitoring networks designed for trend assessment, in which case monitoring is repeated at fixed locations over time. But other biomonitoring data are from one-time studies that do not support temporal trend assessments, and so would have to be excluded from a national assessment intended to look systematically at spatial and temporal trends.

<u>Relation to ultimate impact</u>

Good - Damage to biological communities is one of the ultimate impacts the CWA seeks to prevent. In relation to the "fishable goal", if the particular measure used assesses organisms other than fish (e.g., a benthic community index), then the measure is still a very good indirect indicator of impacts on fish, due to food web relationships.

<u>Related factors/ Ancillary information</u>

Important - Data on habitat and water body type are necessary to properly interpret biological community data, because the types of organisms composing a healthy community vary according to substrate, depth, flow, climate, etc.

<u>Scientific defensibility</u>

Good - Most biological community measures currently used by States have been developed, reviewed, and refined by academic and government scientists and are very sound technically. The concept of considering different measures or indices as qualitatively equivalent for national assessment purposes is tentatively considered sound by a selection of federal and State biologists, but requires testing and further expert evaluation.

<u>Sensitivity to change</u>

Good - Some particularly pollution-sensitive organisms are typically included in each biological community index, so that the biological community monitoring is an excellent method to identify pollution impacts when they first become ecologically significant.

EVALUATION CRITERIA

Relationship to risk	**Good** - Degradation of biological community structure is a direct measure of ecological impact.
Cost to collect and analyze data	**Moderate** - Biological monitoring can be more expensive than basic chemical monitoring for conventional pollutants, but it is often less expensive than toxic chemical monitoring as presently done, and is much less expensive than full-blown monitoring for all toxics of potential concern.
Relationship to existing programs	**Good** - States and EPA already have made provision for reporting and analyzing biological community data as part of the process for assessing use support and preparing 305(b) reports. Guidance on how to incorporate biological community parameters more explicitly into State standards will be refined by EPA in the next few years.
Presentation value	**Good** - The concept of balanced biological communities is well understood by decision makers and the public.

DISCUSSION

Background

One of the objectives of the CWA is the restoration and maintenance of the physical, chemical, and biological integrity of surface waters. Measures of the biological health of aquatic communities are an important component of any scheme designed to evaluate the quality of surface water resources. Still until recently, most water quality classification schemes have depended to a much greater degree on physical and chemical parameters than biological ones. There are several possible reasons for this, including the lack of easily defensible definitions of biological integrity, the perception that biological data were too costly to acquire, and the presumption that physical and chemical parameters were adequate surrogates of the health of the resource (Karr 1989).

Currently, these perceptions are viewed as misperceptions and there is a great deal of effort in place by State and federal agencies to encourage the increased use of biological community measures as part of States water quality evaluation activities. A workshop held last March by EPA's Region IV on Biomonitoring and Biocriteria evaluated current State efforts, reached a number of conclusions concerning the value of biocriteria and made recommendations for ways to improve the use of biocriteria in the Region. One of the recommendations of the workshop was that EPA should help develop a menu of various scientifically acceptable methods that could be used throughout the Region, as chosen by individual States (Region IV 1989).

At EPA, OW is actively engaged in a number of activities to help provide this kind of guidance to the States. OW is working on a policy statement for establishing biological criteria in water quality programs. One workgroup is working to develop technical guidance on appropriate biological criteria for evaluating monitoring data, while another is developing programmatic guidance that is directed more to State water quality managers on how to use the information.

Characteristics of the Indicators

The true value of the use of biological criteria stems from the ability of this information to integrate different physical, biological and chemical effects, thus providing the investigator with a summary perspective on a number of factors involved in water quality. A listing of some of the major advantages of biological community information to assess environmental quality are set forth in a report from the Ohio EPA (1988) and are quoted below:

- Some organism groups, particularly fish and many macroinvertebrates, inhabit the receiving waters continuously and as such are a reflection of the chemical, physical, and biological history of the receiving waters
- Resident biological communities are integrators of the prevailing and past chemical, physical, and biological history of the receiving waters, i.e. they

reflect the dynamic spatial and temporal interactions of stream flow, pollutant loadings, toxicity, habitat, and chemical quality that are not comprehensively measured by chemical or short-term bioassay results alone

- Many fish species and invertebrate taxa have life spans of several years (2-10 yrs. and longer), thus the condition of the biota is an indication of past and recent environmental conditions. Biological surveys need not be conducted under absolute "worse case" conditions to provide a comprehensive and meaningful evaluation of use attainment/non-attainment. A finding that biological integrity is being achieved not only reflects the current healthy condition, but also means that the community has withstood and recovered from any short-term stresses that may have occurred prior to the field sampling.

- Biological community condition portrays the results of water quality management efforts in direct terms, i.e. increases and decreases in community health (as reflected by structure and function abundance of certain species, etc.) is a meaningful measure of regulatory program progress and attainment/non-attainment of legislative goals

- Minimal manipulation of data using adjustment or uncertainty factors is necessary

- Biological assessment techniques have progressed to the point that incremental degrees and types of degradation can be determined and presented as numerical evaluations (e.g. Index of Biotic Integrity, Invertebrate Community Index, etc.) that have relative meaning to non-biologists."

There are several different types of biological community measures ranging from the simple observation of the well-being of a site to much more complex indices incorporating a number of parameters (or metrics). Biological community measures also differ in the types and numbers of the species analyzed. Classification schemes generally measure either fish or macroinvertebrate species, and neither type of assemblage is necessarily superior to the other. Each, however, has its advocates and potential advantages. Fish assemblages provide direct information on one of the CWA goals (fishability), and since they migrate, fish can integrate data from spatially separate areas. Moreover, the general public is very interested in the status of fisheries. Macroinvertebrates, some contend, are superior to fish since they are more easily collected and analyzed and are often more sensitive to potential pollutants, providing a better indicator of environmental stress and of water quality. James Karr, author of one of the primary indices of fish assemblages known as the Index of Biotic Integrity, (IBI) notes that biologists need to move beyond what he describes as taxa turf battles and recognize that fish are not necessarily better than benthic organisms or visa versa. Insights, he points out, come from both (Karr 1989).

Karr notes that the most important element of a biocriteria system is the development of a conceptual framework involving a number of metrics (parameters). The IBI consists of 12 different metrics which fall into three categories, species richness, trophic composition, and fish abundance and condition, each of which can be given a score of 1, 3, or 5. The cumulative scope for a stream segment (up to 60) can then be used to determine whether the stream conditions are excellent (58-60), good (48-52), fair (40-44), or poor (28-34). It is extremely important that in valuing the individual metrics, the results are assessed relative to regional expectations. These expectations would differ across different parts of the State and the use of ecoregions can help define these specific regional expectations. In Ohio, for example, an ecoregion approach is used with differing expectations if the stream segment is in a headwater or is part of a large or medium-sized river.

Indices also exist or can be adapted for macroinvertebrates such as the MBI (Macroinvertebrate Biotic Index) of Ohio's ICI (Invertebrate Community Index), for overall stream quality (Index of Well-Being) and for other types of waterbodies including lakes and estuaries. The value of an integrated system that depends on individual metrics is the ability it provides the scientist to look beyond a final number assigned to a segment to further investigate the underlying reasons.

Uses Of Biological Community Measures As Indicators

Recognizing that biological community measures cannot, by themselves, substitute for more comprehensive analyses of water quality that also include physical and chemical parameter evaluation and habitat analysis, one objective of this project was to begin to determine whether biological community measures, on their own, could serve as a national indicator of the quality of the water resource. We wanted to answer the question: "Can we take a State's determination of the biological well-being of a waterbody (stream, river, lake or estuary) and compare it with other states evaluations (based perhaps on completely different criteria) to develop a national picture of water quality?" To develop a national indicator, EPA is considering combining the various State qualitative rankings, considering all segments of the same qualitative rank (no matter how the State determined it) as equivalent.

TBS conducted a survey of a number of State program managers to discover, among other things, their views concerning this possibility of developing a national indicator based on qualitative State assessments. There was general consensus concerning the value of biocommunity data as an indicator of water quality. Some respondents did raise concerns about developing a national indicator, including the general paucity of State data, and the problems of comparing area beyond a regional perspective. Bob Hughes, EPA's Environmental Research Laboratory in Corvallis, questioned the use of State data in the absence of guidance from EPA regarding appropriate measures, metrics, and some idea of how to determine health. There is, in his view, too much variation in the quality of State programs at present to allow for their use as a national indicator.

Still, these concerns would exist regarding the use of virtually any State collected data as a national indicator and other respondents were very supportive of the qualitative national indicator. On the following page, Table VI-1 lists the responses received from several States to our informal survey.

Table VI-1
Comments Regarding the Utility of State Biocommunity Data as a National Indicator
Results of TBS Interviews

Massachusetts: They feel benthic macroinvertebrates are more valid on a national scale, fish are more variable geographically. Due to different methodologies, quantitative comparisons between States aren't valid, but conclusions reached can be compared. Biological or chemical information alone is not sufficient to assess water quality, therefore biological and chemical data should be used together.

New York: They view biocommunity measures as a valid national indicator. Rapid bioassessments were cited as one area where most States use comparable rankings.

Vermont: A nationwide biocommunity evaluation would be valuable for certain purposes, but poor interpretation can often lead to incorrect conclusions. Comparison of macroinvertebrate data are rather limited due to inconsistencies among States.

Texas: Macroinvertebrate and fish data should be comparable, but biocommunity data are not feasible as a nationwide indicator with the data currently available. They were opposed to nation-wide trends, due to the frequency with which stream water quality can change. In their opinion, it is not feasible to spend the resources necessary to assess all the waters on a regular basis.

Indiana: It is difficult to determine water quality based solely on biocommunity measures. They do not see how EPA could do it, because of the cost. Every State is doing biomonitoring slightly differently, and it would be tough to standardize.

Maine: Macroinvertebrates are better on a national level than fish, because States such as ME don't have many fish species.

Nebraska: A national biocommunity indicator is not possible (due to geographic differences), but it would be worthwhile on a regional level.

Kansas: They had limited knowledge regarding other States biomeasures, but felt a nationwide evaluation based on biocommunity measures would be worthwhile for administrators and congress.

Pennsylvania: Using biocommunities as a nationwide indicator is extremely worthwhile, although there would be some difficulties with standardization and interpretation.

Kentucky: Biocriteria are a very good idea. Sets of data work well together, but fish are sometimes a little misleading because streams don't cooperate.

South Carolina: Biomeasures should be utilized more. Their programs are fairly comparable with other region IV States.

Ohio: A national biocommunity indicator would be appropriate. Biocommunity data allow integration of a number of effects.

Data Availability

Data for this measure are collected by individual States and there is, of course, a lot of variation in the type and quality of the data collected. As an initial step in the effort to determine the feasibility of this indicator, we contacted 20 States to determine whether they collect biological community data, the uses to which the data are put and the availability of the data for use in the indicator. A list of the States and individuals contacted is included in Table VI-2. We were guided in our selection by discussion with parties from the March workshop, including Jim Harrison of EPA and Ed Rankin of the Ohio Environmental Protection Agency, as well as by a report recently completed for the EPA by Research Triangle Institute (RTI) that provides a comprehensive review of existing biomonitoring activities in various States (RTI 1989). Figures VI-1 and VI-2, from the RTI report, show the type of monitoring activity in the different States and the types of species evaluated. Our interviews were intended to complement rather than duplicate the RTI effort. For example, in our interview we asked program managers to identify how much of the river systems in their States could be characterized by biocommunity data. Few States could provide an estimate, and when given, the estimates were often small.

We wanted to determine the type of monitoring now being conducted in the State, the availability of the data (is it automated?) and whether the data could presently be mapped to provide an indication of State riverine quality.

Brief descriptions of the biological community activity in a number of the States we contacted is included below. The list is not inclusive but is meant to provide a representative picture of the types of activities that are being undertaken among the States.

Florida: The State uses the Shannon-Weiner diversity index which is based on macroinvertebrates, and the Beck's Biotic Index, a more qualitative index that is then associated with a specific river.

For purposes of the 305(b) reports, this information is used as part of an overall WQI. Unfortunately, few data are available. Of the almost 1,500 reaches in their WBS, there are biological data at about 100 of them -- and a fair amount are old data sets.

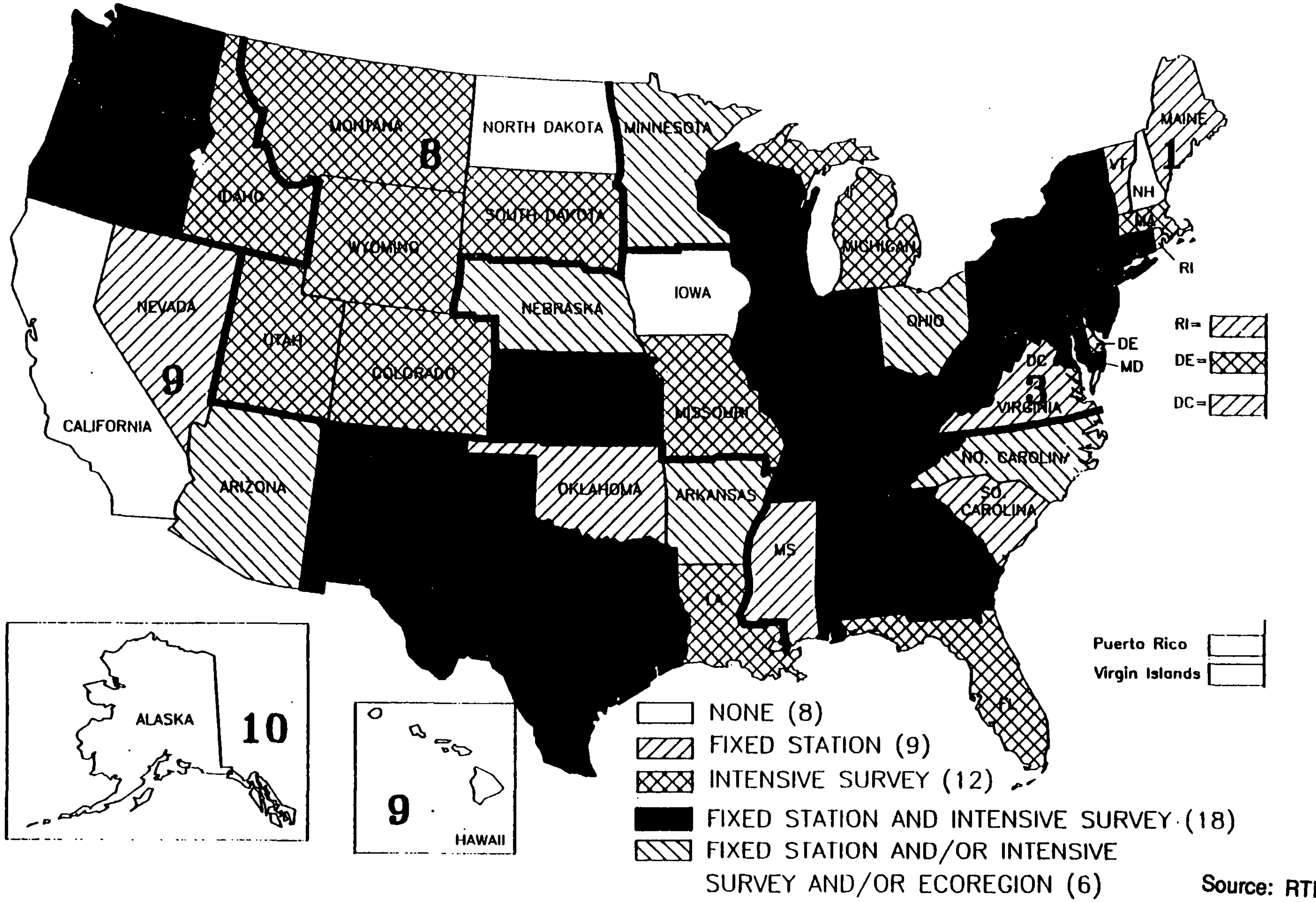
North Carolina: The State currently uses a macrobenthic index which characterizes the macroinvertebrate community at the site as excellent, good, fair, or poor, based on the degree to which the benthic community compares to the benchmark criteria established for its ecoregion. The monitoring system is a follow on to the Basic Water Monitoring Program that was first designed at the national level in 1978. Thirty-seven sites in the current system are part of an on-going ambient water quality monitoring program. The data is used for trend monitoring and in designated use determinations.

The State occasionally produces special reports and can map high quality waters although this requires a lot of field work to test the limits to which the site-specific data can be extrapolated along the stream. The Benthic Macroinvertebrate Ambient Network (BMAN), report issued by the State includes maps which identify the sites and characterize them as good, excellent, etc.

Table VI-2
Biocommunity Contacts by State

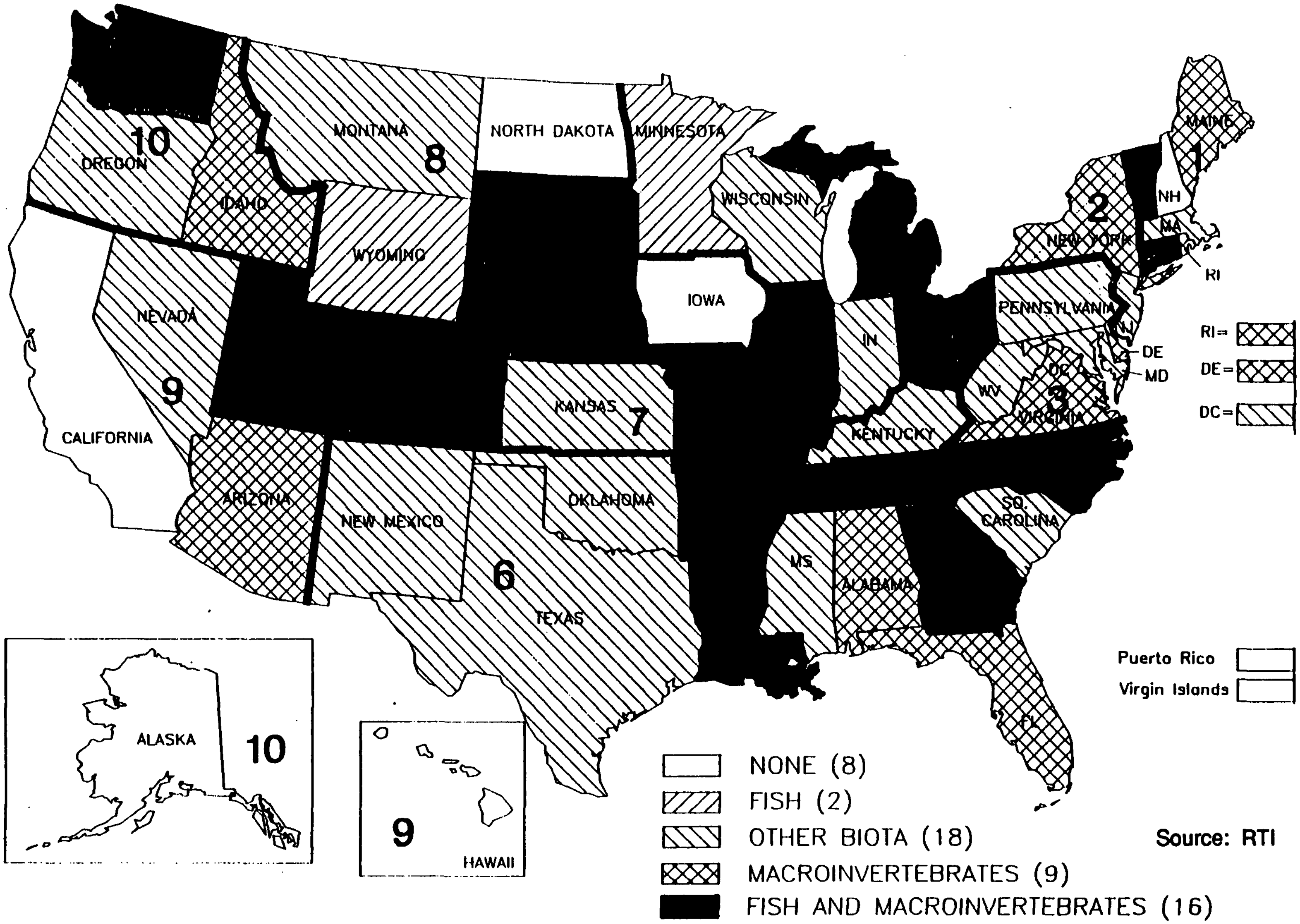
State	Contact	Telephone Number
Arkansas:	John Geyse	(501) 562-7444
Florida:	Landon Ross	(904) 487-2245
Illinois:	Joel Cross	(217) 782-3362
Indiana:	Lee Bridges	(317) 243-5030
Kansas:	Steve Cringan	(913) 296-5571
Kentucky:	Skip Call	(502) 564-3410
Maine:	Dave Courtemanche	(207) 289-3901
Massachusetts:	Arthur Johnson	(508) 366-9181
Nebraska:	Ken Bazata	(402) 471-2186
Nevada:	Marvin Burgoyne	(702) 789-0500
New York:	Bob Bode	(518) 432-2624
North Carolina:	Diane Reed	(919) 733-6946
Ohio:	Ed Rankin	(614) 466-3700
Oklahoma:	Derrick Smithee	(405) 271-2541
Pennsylvania:	Rod Kime	(717) 787-9633
Rhode Island:	Bob Richardson	(401) 277-6519
South Carolina:	Russell Sherer	(803) 734-5300
Tennessee:	Dell Recter	(615) 262-6327
Texas:	Dave Buzan	(512) 463-8471
Vermont:	Doug Burnham	(802) 244-5638

Figure VI-1
Approach Used in River Biosurvey Monitoring Programs (1989)



Source: RTI

Figure VI-2
Communities Sampled in River Biosurveys (1989)



The State is also working on the development of an IBI, but the program is still in the development phase.

Maine: The State's water quality classification law identifies narrative water quality standards for water quality classes, and designates a specific level of biological integrity that each class must maintain. The levels of integrity range from the need to maintain the structure and function of the aquatic community (Class C) to the need for the aquatic life to be as naturally occurs (Class AA and A). A specific set of definitions identifies ecological attributes (metrics) which may be tested to see if a given standard is being achieved. The system goes beyond the use of a single index by relying on a number of impact indices, "yes/no" decision that must be made on parameters.

The State uses the data in use attainment determinations and is in the process of classifying all its waters using the community information. This process will not be complete for a number of months.

Ohio: The State uses three biological indices, the Index of Well-Being (IWB), the IBI and the Invertebrate Community Index. The IWB and the IBI are modified so as to be appropriate to the specific ecoregion in which the sampling site is located. The data are put to a wide range of uses including determination of attainment of CWA goals, determination of designated uses, targeting, enforcement, and program evaluation. Ohio is planning to use the WBS in its next 305(b) reports and is now working to identify reach numbers for its stream segments, which will allow State-wide maps to be drawn in the future.

Illinois: The State uses both an IBI and a MBI and the data are available in the 305(b) reports with the reach number of the appropriate stream segment. As well as the IBI, they have developed a measure of the Potential IBI (PIBI) that is derived from habitat data at the site. The PIBI identifies the potential IBI score at that site based on the habitat information and can be used as an indicator of degradation.

The community data is used in designated use determinations and also as a targeting tool. The State has developed a program to guide use of construction use funds based on the community data.

The State has developed a stream classification system that integrates information on the IBI, the PIBI and the MBI at various river sites. A report on this system, with maps, is now at the printer and should be available in the next few weeks.

Arkansas: The State is in the process of developing a narrative fish community measure that will primarily be used on a site-specific basis to help managers judge if the community is being adequately protected. The IBI will be used as a standard against which to measure this. The State used to have a large ambient monitoring system on benthic data but they are moving away from this toward the use of fish. The State's plan is to increase the use of rapid bioassessment techniques around expected sources of toxicants.

Vermont: The State monitors both macroinvertebrate and fish communities, using a modification of Hilsenhoff's biotic index and an IBI for fish populations. Currently, only 40-50 sites are monitored annually either as part of regular monitoring and as special studies. The data are currently stored in State data bases and the State intends to use WBS identification numbers in the near future.

Texas: The State assesses both invertebrate and fish communities, primarily in rivers and streams. It is planning to begin use of an IBI for its fish community data. The primary use of the data is for permit evaluations, and determining potential stream uses. Currently, only about 5 percent of the State's stream miles are assessed for biocommunity data.

New York: The State conducts biomonitoring on macroinvertebrates, using five different parameters including: EPT values, species dominance and species diversity. A composite value of the five indices is used to characterized the waterway. The State currently monitors approximately 100 stations both ambient and special studies. The data are automated on State computers and the State may use BIOS in the future.

The results of the TBS interviews demonstrated, as expected, a lot of variation in the quality and type of biocommunity monitoring activity being undertaken by the States. In most cases, data are available on State databases and would presumably be available to EPA. As will be discussed later, EPA could more readily make use of the data, if it were stored in a common database, such as BIOS, or included in State 305(b) reports.

Presentation Of The Indicator

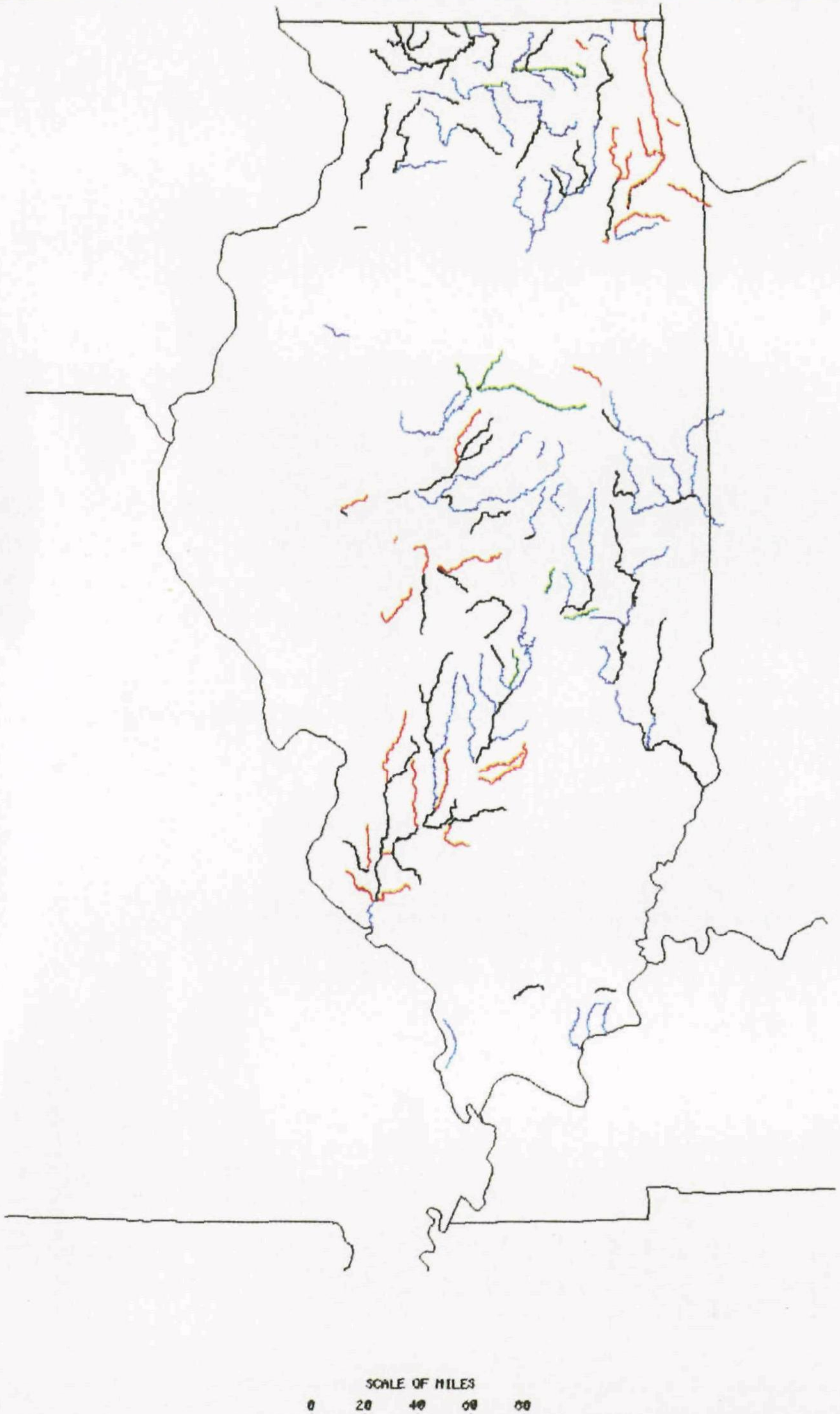
Data from the different States could be presented in a number of ways to reflect national status and, over time, trends. For example, bar charts could be developed showing how many miles, or what percentage of assessed miles, are evaluated as "excellent, good, or fair etc." Alternatively, a national map could be developed with the individual States shaded to indicate the percentage of their waters or their assessed waters that are in the various categories. The use of arrows on the State maps (similar to that demonstrated in earlier versions of this report) could show trends in the State data.

Another possible method of presentation for the indicator would be a series of maps, showing the biological quality rating of rivers and streams in the different States. In developing the maps, EPA could use the State's determination of whether the particular segment has "excellent", "good", "fair" or "poor" biological characteristics (or a similar 4-5 level rating scheme) without judging these determinations.

Figures VI-3 and VI-4 show how biological community data (IBI and MBI respectively) could be presented using data from the State of Illinois 305 (b) report. Using data available from the State's own database file, TBS created a file that identified an IBI or MBI measure for stream reach segments. TBS then assigned, using Illinois' descriptions of excellent, good, etc; valves to the different scores. The qualitative descriptions that go with the various scores are shown below.

	Excellent	Good	Fair	Poor
IBI	60-51	50-41	40-31	30-12
MBI	0-5	5-6	6-7.5	7.5-11

Figure VI-3
Illinois Streams Evaluated Using Index of Biotic Integrity (IBI) (1989)



Note: This is a color map: If Report is photocopied, use black and white map on next page for distribution. Color maps are available from the Environmental Results Branch, U.S. EPA (Phone (FTS/202) 382-4900)

ENVIRONMENTAL PROTECTION AGENCY

STORET SYSTEM

ILLINOIS REACHES
BIO-COMMUNITY DATA
NOVEMBER 14 1989
"IBI2.PRN"

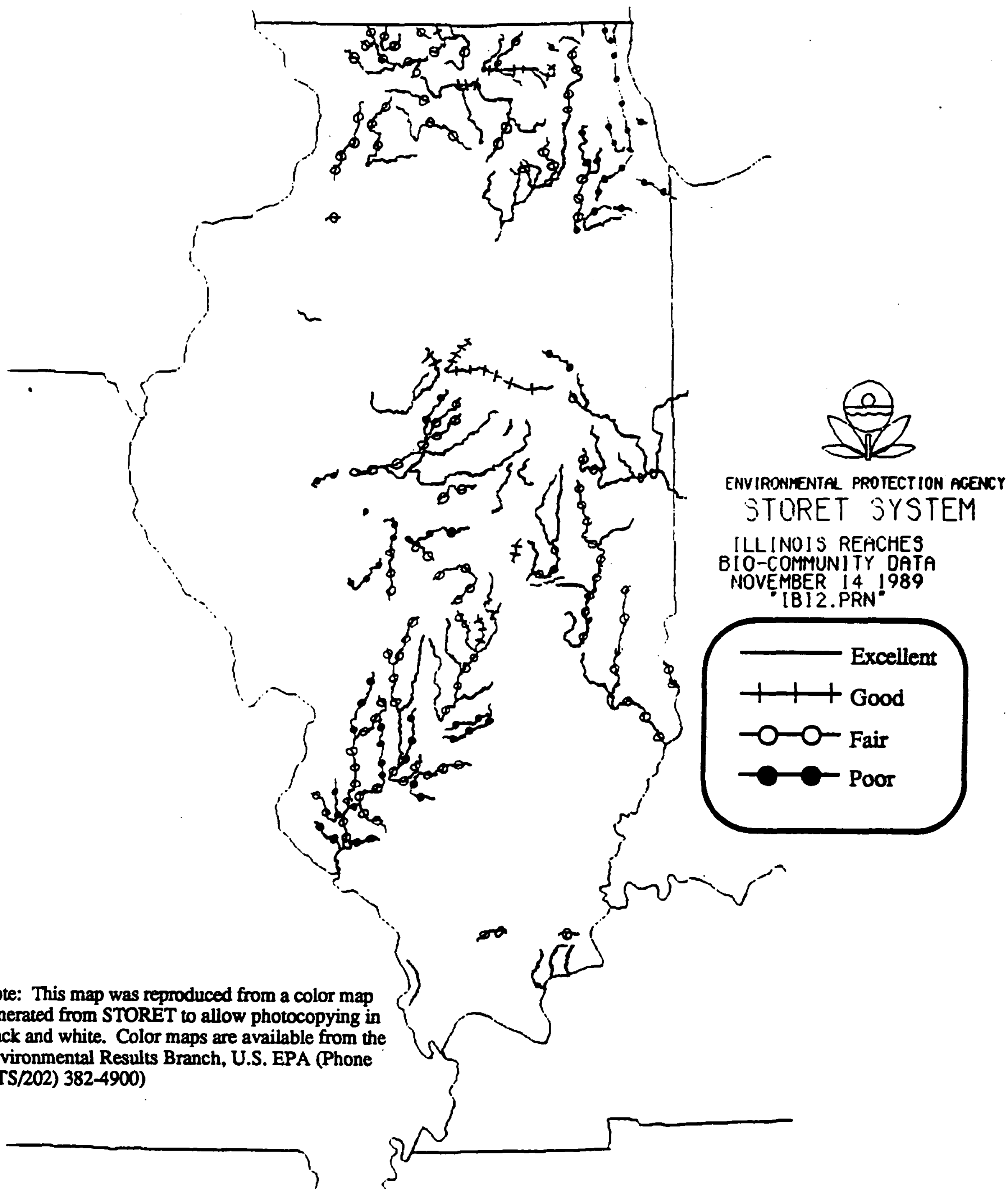
****

- 4=EXCELLENT
- 3=GOOD
- 1=FAIR
- 2=POOR

****

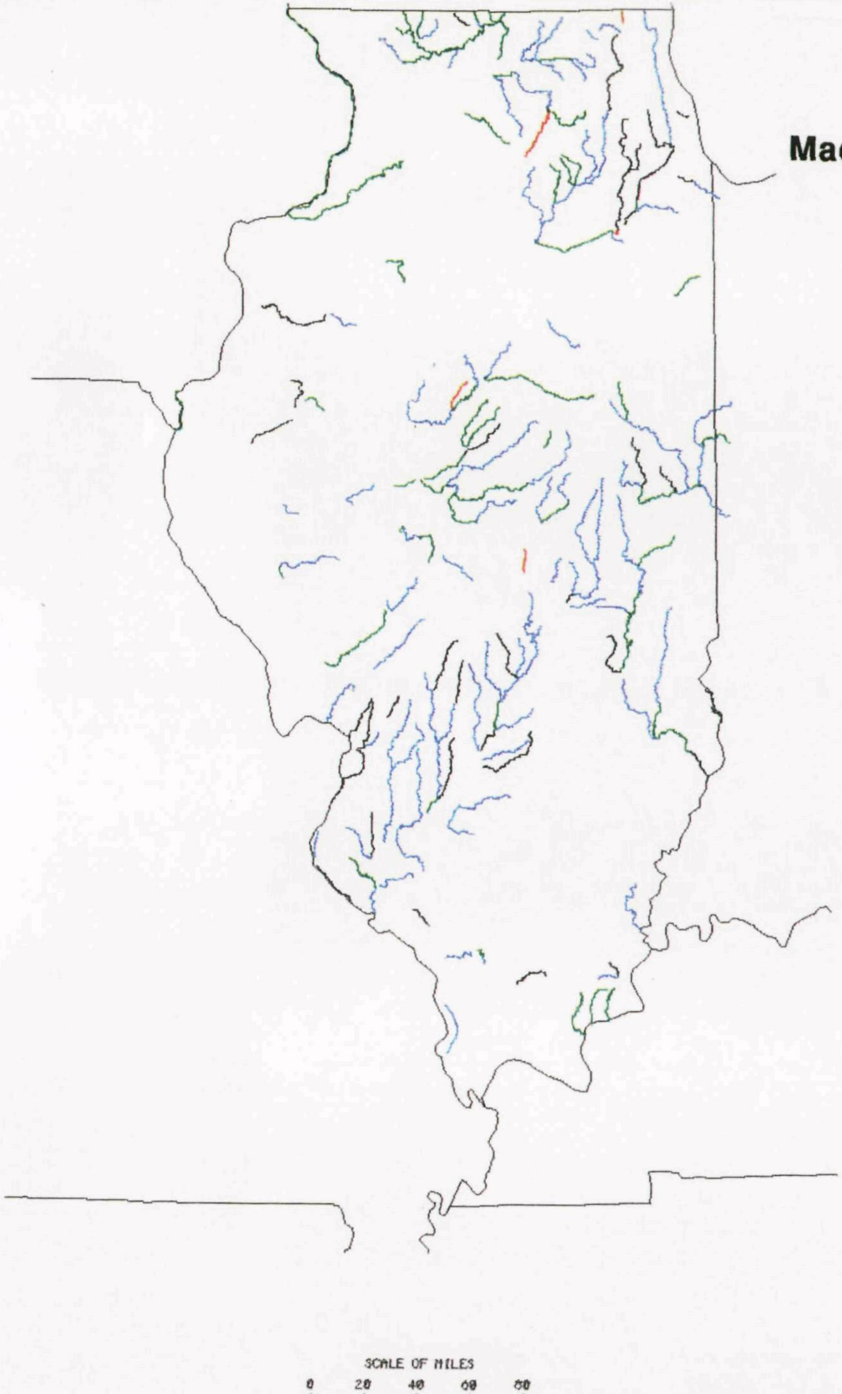
PROJECTION - ALBERS EQUAL AREA
SCALE 1:1048312

Figure VI-4
Illinois Streams Evaluated Using Index of Biotic Integrity (IBI) (1989)



Note: This map was reproduced from a color map generated from STORET to allow photocopying in black and white. Color maps are available from the Environmental Results Branch, U.S. EPA (Phone (FTS/202) 382-4900)

Figure VI-5
Illinois Streams Evaluated Using Macroinvertebrate Biotic Index (MBI) (1989)



Note: This is a color map: If Report is photocopied, use black and white map on next page for distribution. Color maps are available from the Environmental Results Branch, U.S. EPA (Phone (FTS/202) 382-4900)

ENVIRONMENTAL PROTECTION AGENCY

STORET SYSTEM

ILLINOIS REACHES
BIO-COMMUNITY DATA
NOVEMBER 14 1989
"MBI2.PRN"

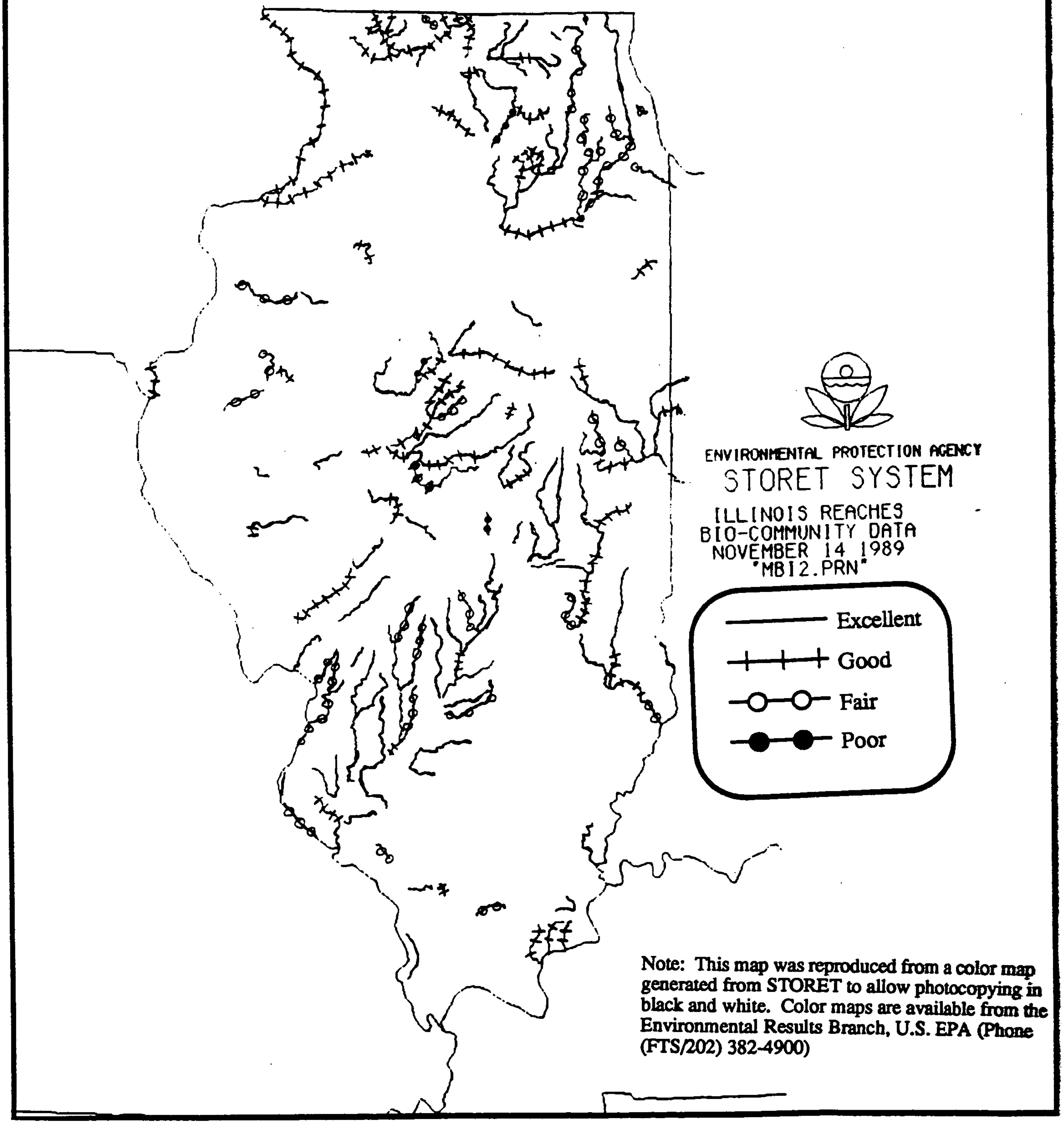
****

- 4=EXCELLENT
- 3=GOOD
- 1=FAIR
- 2=POOR

****

PROJECTION - ALBERS EQUAL AREA
SCALE 1:1048312

Figure VI-6
Illinois Streams Evaluated Using Macroinvertebrate Biotic Index (MBI) (1989)



Note: This map was reproduced from a color map generated from STORET to allow photocopying in black and white. Color maps are available from the Environmental Results Branch, U.S. EPA (Phone (FTS/202) 382-4900)

With the invaluable assistance of Tom Pandolfi of EPA's Office of Water, the data was sent through STORET which created the color maps. Similar maps could be developed for States that can provide reach numbers to correlate with their monitoring sites. Black and white versions of these maps are also included in the original reports to retain pertinent information after photocopying. Color maps may be ordered from the Environmental Results Branch, EPA Headquarters (phone FTS/202-382-4900).

It is interesting to note the differences that exist between the IBI and MBI evaluations of the stream's well-being. First, some stream reaches had only an IBI or an MBI score, but not both. In those reaches that did have scores for both, the IBI and MBI scores gave the same qualitative ranking only 32% of the time, however, the rankings were within one level of each other 80% of the time. Joel Cross, of the Illinois Department of Environmental Conservation pointed out that the different indices (IBI and MBI) measure different attributes of water quality and this would contribute to the differences. The discrepancies could be due either to the representativeness of the sample or to the nature of the index used. This is where professional judgment comes in. To address these differences, Illinois has developed a Biological Stream Classification (BSC) System that incorporates both biocommunity measures and water quality indices into one value. The State has recently mapped its waters using the BSC.

During our interviews, we asked the States about the feasibility of mapping their data. None of the States with whom we spoke had their information correlated with reach numbers that could be easily mapped through the use of STORET or BIOS, although the State of Ohio is in the process of trying to correlate their data with reach numbers. Without some type of geographical tag, mapping is not feasible. A number of States, including Indiana, New York, Pennsylvania, and Nebraska have latitude/longitude identifiers for their data and one might be able to map these. To do so, one would have to be able to estimate how far from the monitoring station the qualitative evaluation would apply.

Next Steps

EPA could get data from a number of State databases and incorporate it into a national indicator. However, obtaining individual State records would require a lot of time and effort. To develop an ongoing national indicator, the Agency could consider the following.

The 305(b) guidance document could include specific directions for the separate reporting of stream, river, lake and estuarine areas where biological community information is available (and what it is), and the degree to which it is being used in designated use determinations. Again, the use of reach numbers in the reporting would greatly enhance its utility. If this information were supplied, along with the assessment of the biological community health at the reach, then maps could be generated directly out of the waterbody system, and over time trends could be more easily demonstrated. In addition, the identification of the extent to which biological data have been used in use determination (measured in river miles for example) would provide an indication (albeit an administrative one) of the success that EPA has had in encouraging States to include this information in their water quality assessments.

VII. LOADING ESTIMATES FROM POINT SOURCES

SUMMARY

<u>Description of the Indicator</u>

This indicator shows the location, magnitude, type and timing of pollutant discharges into receiving surface waters. Although loading estimates do not directly reflect the quality of the water resource, they are a useful measure of the pollutant stress placed on the system and provide an indication of the effectiveness of regulatory programs in controlling pollutant discharges.

<u>Possible Applications</u>

Pollutant loading estimates can be used for evaluating progress made in some point source control programs, and targeting future point source regulation and enforcement activities. If time series of loads are available, trends in discharges can be depicted and correlated with changes in treatment technologies, land use management practices, service areas and production levels. Pollutant loading estimates are often the primary measures for evaluating enforcement programs.

<u>Strengths</u>

Data collection and reporting system is in place in all States. The data are spatially and temporally fairly consistent, with good correlation between pollutant loadings and water quality. Indicator is easily understood by public and policy makers and is closely tied to a major regulatory program.

<u>Weaknesses</u>

Availability and quality of data is limited, especially for toxic compounds. Current data management system (Permit Compliance System (PCS)) cannot be used reliably to compute loads. Additional data collection requirements are costly.

<u>Possible Improvements</u>

Require permitted facilities to report seasonal and annual loads; Modify PCS to allow computation of loads.

EVALUATION CRITERIA

Data availability	**Fair** - Discharge Monitoring Reports (DMR) data for majors are reported to PCS for all States, with varying levels of participation and quality control. Greatest amount of monitored data is available for wastewater volume, and conventional pollutants, with much less data available for metals and toxic organics. Availability and quality of data for minors is variable, but is generally much poorer than for majors.
Data consistency/comparability	**Good** - Analysis methods are generally standardized for permitted pollutants. Therefore, comparison of estimates among States or regions is reasonable.
Ability to estimate	**Fair** - All load estimates are approximations. When monitored data do not exist or are suspect, engineering estimates can be substituted, with substantial reduction in credibility.
Spatial representativeness	**Good** - Because all major point sources are included in PCS, data for majors is spatially representative. Data is less reliable for minors.
Temporal representativeness	**Good** - For major point sources, pollutant loadings are monitored on a daily, weekly or monthly basis. Therefore, monitoring data are reasonably representative of temporal variation. Monitoring for minors can be less frequent and therefore less representative.
Utility in trend assessment	**Fair** - It is impossible to assess trends on an individual facility basis where time series data exist. However, national trend assessment is difficult because PCS has not been fully supported in the past. With proposed improvements to the system, and better participation by States, capability to assess trends will improve in the future.
Relation to ultimate impact	**Fair** - Loading estimates do not directly relate to ultimate water quality impacts. However, correlations have been observed between load reductions and improvements in biological community structure and other measures of water quality.
Related factors	**Important** - For useful interpretation of loading trends, it is critical to collect ancillary data characterizing levels of industrial production, changes in treatment processes, increases in service areas, etc.
Scientific defensibility	**Good** - Load reductions have been correlated to improvements in water quality.

EVALUATION CRITERIA

Sensitivity to change	**Good** - Loads generally directly reflect changes in industrial production levels, improvements or failures in treatment, etc.
Relationship to risk	**Poor** - It is difficult to directly relate loads to risk. Monitoring data to support loading estimates for toxic compounds of greatest concern frequently are not available.
Cost to collect and analyze data	**Moderate** - Because self-monitoring and compliance monitoring systems for the National Pollutant Discharge Elimination System (NPDES) are already in place, monitoring and analysis costs are already budgeted by facilities and States. Increased toxics monitoring is expensive. PCS would have to be modified to allow computation of loadings.
Relationship to existing programs	**Good** - DMR reporting is well established, supported and continually being improved. There is a clear connection between load estimates and effectiveness of point source control programs.
Presentation value	**Good** - Concept of pollutant loadings is generally accepted and understandable to government decisionmakers and public. Status and trends can be graphically portrayed on charts and maps.

DISCUSSION

Background

Estimates of pollutant loads discharged to surface waters from point sources can be used to track changes in discharges over time resulting from modifications in treatment technologies, increases or decreases in populations served (in the case of municipal wastewater treatment plants), or changes in the production levels of industrial facilities. Although loading estimates are not a direct indicator of the quality of the water resource, they are a useful measure of the pollutant stress being placed on the system and provide an indication of the effectiveness of regulatory programs in controlling pollutant discharges. By the scheme presented in Chapter I, they are a level 3 indicator, considered "environmental" rather than "administrative", but less direct than other types of environmental indicators (see Figure I-1).

On a national level, there are at least two sources of information that can be used to make point source loading estimates. The first is EPA's PCS data base, which is used to track each facility's compliance with the effluent limitations included in its NPDES discharge permit. The monitoring data stored in PCS is taken from monthly or quarterly Discharge Monitoring Reports (DMRs) submitted by each facility, and represents averaged discharge values (usually based on a combination of daily, weekly, and monthly self-monitoring) for the pollutants specified in the permit.

The second source is EPA's Toxic Release Inventory (TRI). This computerized data base contains annual estimates of the amount of over 320 toxic chemicals released directly to water, air, or land. For 1987, estimates had to be reported by all manufacturing facilities that produced, imported, or processed 75,000 or more pounds of any of the TRI chemicals, or used in any other manner 10,000 pounds or more of a TRI chemical; engaged in general manufacturing activities (Standard Industrial Classification (SIC) categories 20 to 39); and employed the equivalent of ten or more employees. In subsequent years, the reporting requirements will include facilities handling smaller amounts of TRI chemicals, thus expanding the inventory.

Information from the TRI is already being used to some extent as a national environmental indicator. Results from the first year of data collection for TRI, released in the spring of 1989, have been used in reports by environmental groups and in news articles to show the national status of toxic chemical releases to all media, and highlight areas of the country where reported toxic releases are the highest. The Office of Toxic Substances, Economics and Technology Division has also published a report summarizing the information collected in the TRI for 1987. The report contains many tables, graphics, and national maps that present the release data aggregated by industrial activity, chemical class, and receiving media.

Strengths and weaknesses both sources of point source loading data are evaluated below.

Uses of the Indicator

Loading estimates are a measure that can be used to understand the type and magnitude of and change in pollutant inputs being discharged to surface waters. The concept of loadings is technically simple and easily understood by the general public. Trends associated with loadings, particularly if they can be presented along with a discussion of the factors influencing the changes portrayed (for example, a reduction in oxygen demanding materials discharged as a result of improved treatment), are straightforward concepts to which the public can relate. While it is important when presenting loading estimate not to simplify the relationship between discharges and water quality (for example, a trend showing a reduction in loading does not necessarily translate into measurably improved water quality), there exists a reasonable association between the amount of pollutant discharged and the impact on the receiving water.

Data Access and Availability

Both PCS and TRI are national computer data bases. They thus have the benefit for indicator development of being central storehouses of data that can be processed and aggregated using either existing or specially written computer programs.

PCS is maintained on EPA's National Computer Center (NCC) mainframe system in North Carolina. Access to PCS is generally restricted to selected EPA and State personnel. A series of computer programs has been written to enter and retrieve information from the data base.

TRI data is available from several sources. The official version of TRI is maintained on the NCC mainframe. An interface has been developed that allows a user to browse the data base and generate summary reports of the data. Although this system can be accessed by users outside of EPA, it is intended primarily for internal EPA use. A public version is available using the National Library of Medicine's TOXNET data base system. The interface developed for this system is both more powerful and easier to use than the NCC interface. Finally, the entire TRI data base can be placed in a commercial database management system such as DBASE or SAS for customized processing.

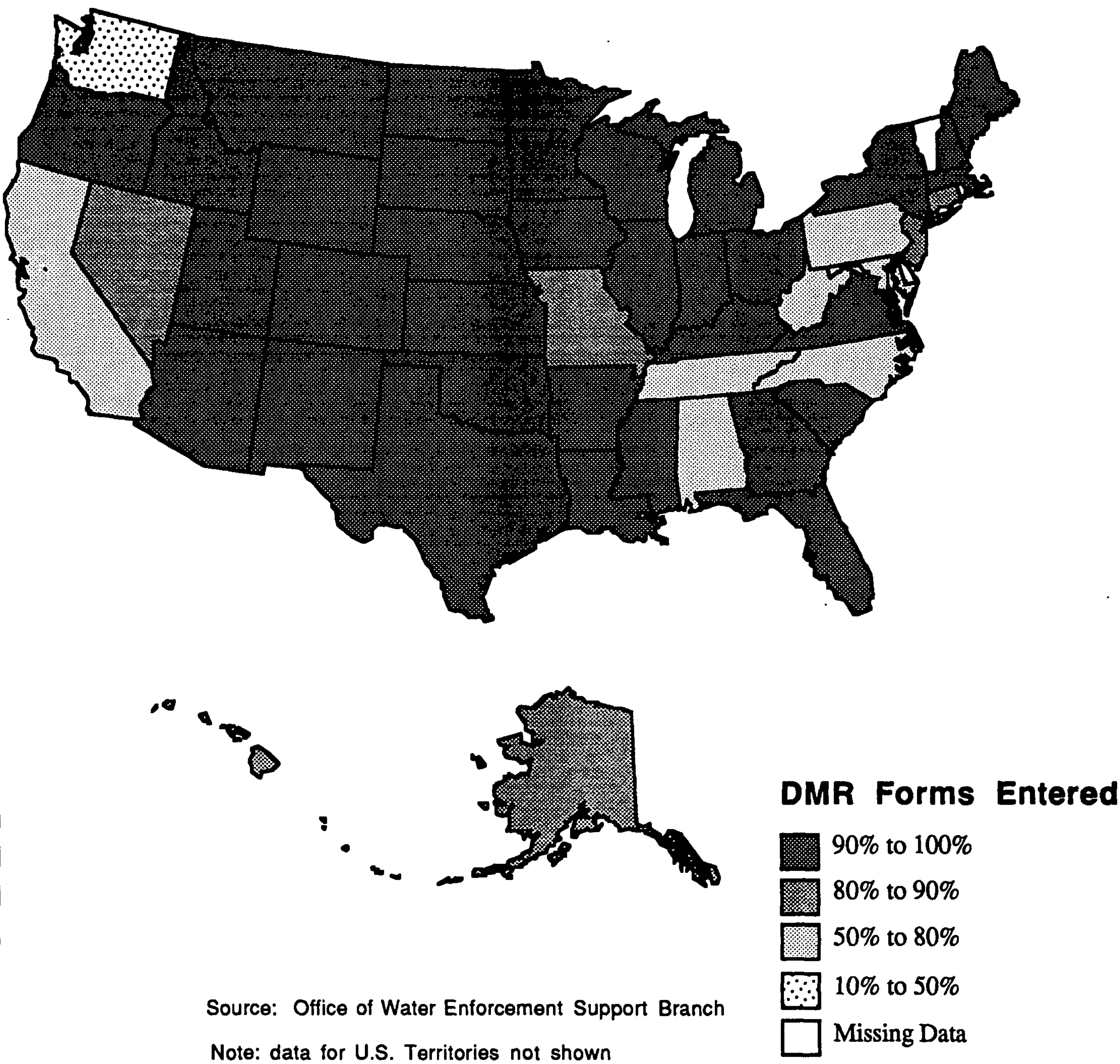
There are several issues related to data availability from PCS. The first concerns State participation in the PCS data base. In the past, some States have not participated in PCS, and others have participated only to a limited extent. Over the last few years, participation has increased as a result of EPA's efforts to provide States with improved telecommunications links and computer hardware. Figure VII-1 shows the level of participation in PCS reported for major facilities for the 4th quarter of FY 1989. During this period, 35 of the 50 States (70 percent) have DMR data entered for at least 90 percent of majors in their jurisdictions, and only two States, Vermont and Rhode Island, have no reports entered (Region 1 reports that within a year these two States will begin participating in the system). To develop a comprehensive set of national loading estimates, information from States with poor PCS participation would have to be obtained from individual State offices.

Figure VII-1

Availability of PCS Data for Making Point Source Loading Estimates

Percent of DMR Forms from Major Facilities Entered into PCS

(4th Quarter of FY 1989)



Source: Office of Water Enforcement Support Branch

Note: data for U.S. Territories not shown

The second issue relates to the availability of information for major and minor facilities. While PCS represents a comprehensive inventory for all permitted facilities regardless of major/minor designation, entry of DMR data is only required for major facilities. It is therefore not possible to make loading estimates for minor facilities. This is not a severe limitation because major facilities are, by definition, more important sources of pollutant discharge.

The third issue relates to the types of pollutant for which data are available. Facilities are required to report on only those pollutants that are listed on their permits. The pollutants for which monitoring is most frequently required (and hence for which the greatest amount of monitoring data are available) are wastewater volume, biochemical oxygen demand (BOD) and total suspended solids (TSS). Fewer facilities are required to monitor for nutrients, and thus less data are available. Much less monitoring is required for metals and toxic organics. Thus, PCS is most useful as a source of data for making national loading estimates for flow and conventional pollutants; it has much more limited utility as a source for loading estimates for nutrients, metals and toxic organics.

Data availability concerns also exist for the TRI. Currently there is about a 20 to 25 percent noncompliance rate for those facilities required to report releases to the database. This percentage is expected to decrease in the future as more facilities become aware of the reporting responsibilities and reporting requirements are enforced.

A potentially more important limitation is that data in the TRI do not represent a comprehensive inventory of point source discharges. This is because of the volume and industrial activity criteria used to define the facilities that must report releases. The most serious omission in this respect is for publicly owned wastewater treatment plants (POTWs). Although releases to POTWs are reported in the TRI, the ultimate amount of a substance released from a POTW, which is comprised of the portion of the TRI releases not removed during treatment plus the amount contributed from other sources (smaller industrial sources and residential/commercial sources), cannot be easily derived from the database. EPA is currently reviewing the need to expand the list of discharging activities required to report releases.

The availability of loading estimates for a large number of toxic pollutants is a strength of the TRI. The 320 plus compounds for which release estimates are required include metals, organic and inorganic acids, and many other toxic organic compounds. The TRI does not require reporting for some of the conventional water quality parameters such as BOD and TSS used to define acceptable levels of wastewater treatment, but comparisons could be made between TRI releases and loads estimates from PCS data for toxic compounds as a quality control check.

Data Quality

In general, the quality of data in PCS is reasonable. Depending on the State, there can be problems associated with missing data values, incorrectly entered monitored values and/or units, and uncertainty related to the methodology used for collection and analysis of the wastewater sample. Some of these problems can be identified, and to some extent corrected, by using various statistical techniques to screen the data. However, resolving these problems completely is extremely time consuming and frequently unsuccessful. Therefore, the user must be willing to accept some error in the loading estimates resulting from these data quality problems.

There are also potential data problems with the TRI. To date, the quality control efforts for TRI data have focused primarily on limiting data entry errors and correcting data incorrectly entered on the reporting form. Only a limited amount of analysis has been conducted to date to determine if the pollutants and volume of releases reported by facilities were reasonable given the size and industrial activity of the plant. However, an effort is underway to conduct facility inspections to verify reported releases. This effort, along with more quality assurance work is needed to ensure that the release amounts in the data base represent a realistic estimate for that pollutant and facility.

Data consistency/comparability

There are some consistency problems in PCS related to the units and form used to report monitored values. Between States, and even within some States, permit values are reported in different units. Additionally, some pollutants are reported as concentration values, others as loadings. Finally, some States require that facilities report permit average values only, some require permit maximums, and some require both. Before using the data, estimates have to be transformed to standardized units, concentrations have to be converted to loadings by multiplying by flow, and the type of value (permit or maximum) has to be determined. However, if these conversions and standardizations can be made, comparison of estimates among States or regions is reasonable because chemical analysis methods are generally standardized for permitted pollutants.

Because the TRI estimates are all reported on the same form (Form R), using standardized units, the consistency and comparability of these data are very good.

Ability to Estimate

National estimates of pollutant loadings from point sources have historically been difficult to obtain from PCS for several reasons already mentioned. There have been data availability and quality problems, and a lack of consistency in units and in the way in which monitoring results are reported. In addition, access to PCS is restricted, and any computation of loading estimates had to be performed by an external computer program.

However, over the last year staff at Region 2 have been developing a program utility called the Effluent Data Statistics (EDS) module that is part of the PCS data retrieval system. EDS can be used to analyze and graph Discharge Monitoring Report (DMR) data, generate loading estimates from this data, and aggregate the estimates for a specified time period by outfall, facility, city, county, state, or river basin. These estimates can be displayed on a three-dimensional map if latitude/longitude data are available in PCS.

While the load estimation component of this program is still in the developmental stages, it has the potential to be a very useful tool for compiling and presenting loading estimates on a national basis. Examples of the data and graphical output from this program are shown in Figures VII-2 and VII-3.

In the TRI, there is no need to manipulate the release estimates because they are already reported as annual loads. The capability to generate loading estimates from this data base is therefore very good, within the data availability limitations noted above.

Temporal representativeness

For major point sources in PCS, pollutant loadings are monitored on a daily, weekly or monthly basis. Therefore, monitoring data are reasonably representative of temporal variation. Monitoring for minors can be less frequent, and therefore is much less representative.

Data in TRI is only reported as annual releases. Because there is no information on the timing of the releases during the year, the temporal representativeness of TRI data must be considered poor.

Spatial representativeness

For States that participate in PCS, all major point sources are included. Therefore, data for majors is spatially representative.

For the SIC categories reporting in TRI, the estimates are spatially representative. However, as noted above, there are some serious omissions in types of facilities reporting to TRI, and therefore the data base has limitations on its spatial coverage.

Utility for Trend Analysis

The capability to depict national trends using data from PCS is dependent on the past level of State participation in the data base. As noted above, some States have not participated in the past, though this has improved in the last few years. Therefore, the present capability to generate trend data on a national level is limited. It should be noted that trend analysis within regions may be possible because some regions, for example, Region 5, have had close to one hundred percent participation for several years. In the future the ability to generate trend information should improve as participation in the data base increases.

For the TRI, 1987 release estimates are available. Estimates for 1988 are currently being entered into the system, so that in the near future there will be a limited capability to conduct some trend analysis. In the long term, there is good potential for trend analysis if consistent estimation methods and reporting approaches are used from year to year.

Figure VII-2
Example - PCS Point Source Loading Estimates for Carbonaceous Biochemical Oxygen Demand (CBOD) (1987-1989)

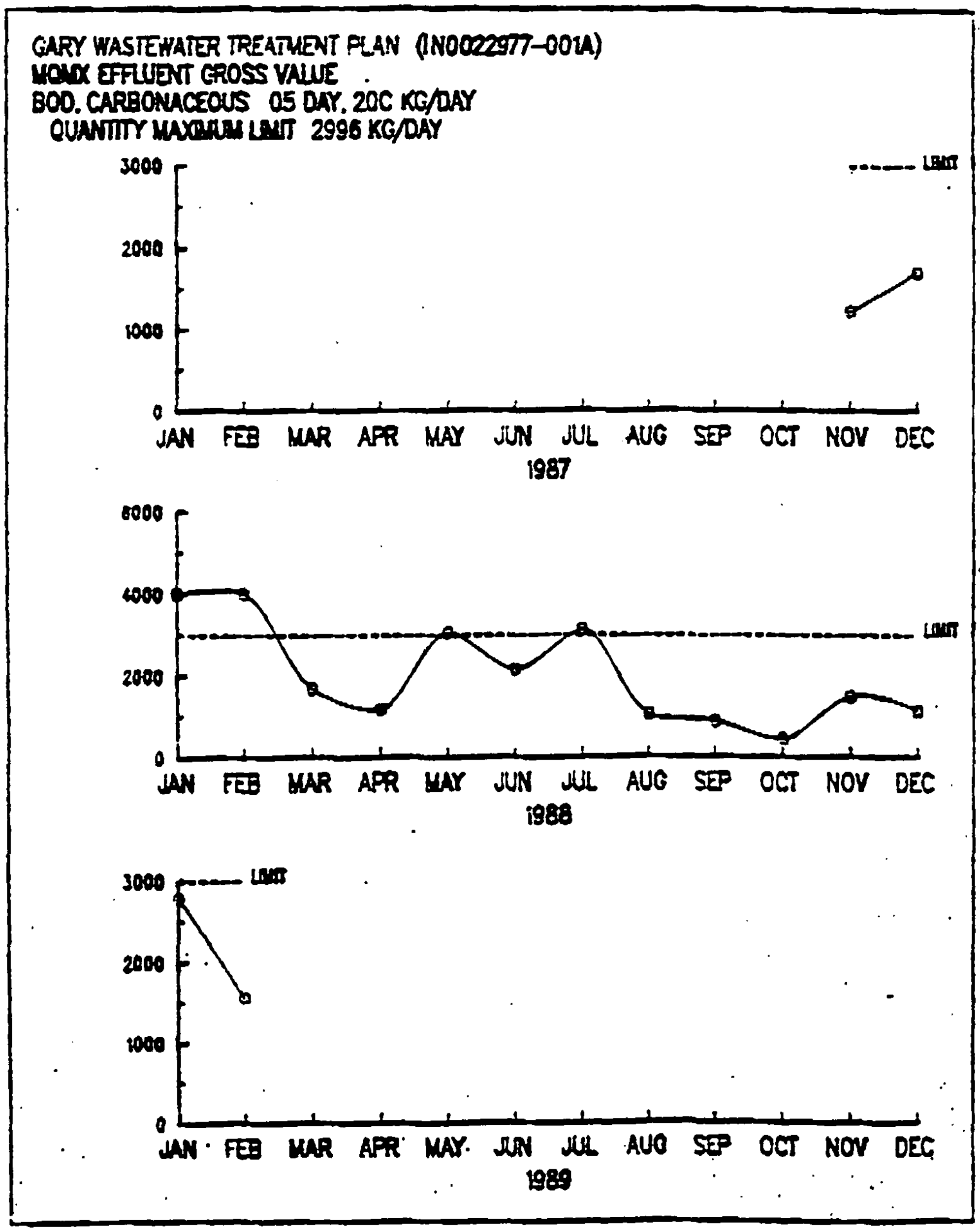
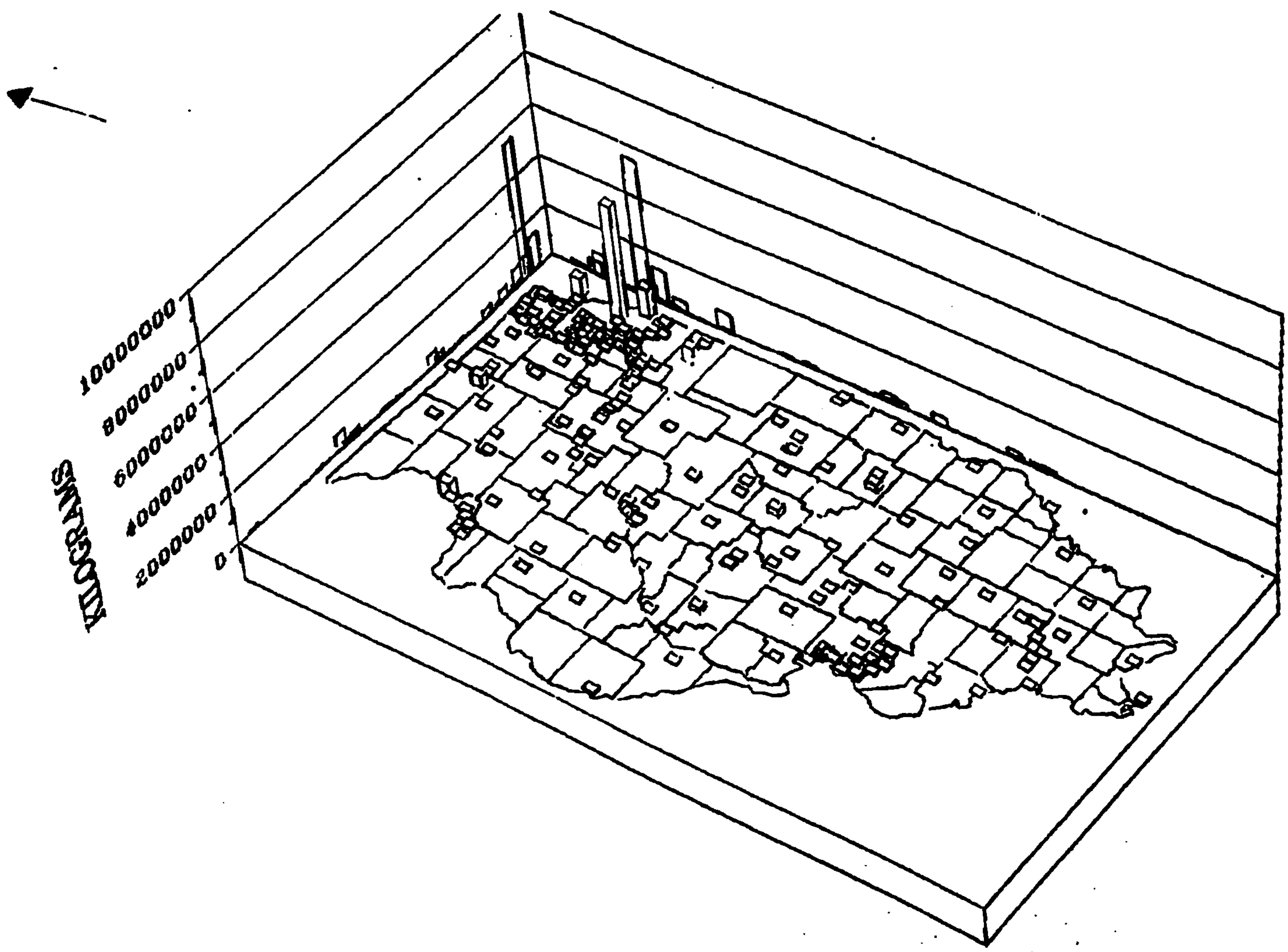


Figure VII-3
PCS Example - Three-Dimensional Map Displaying Total Suspended Solids (TSS) Loadings Across Illinois (1988)



Compounding factors

There are many external factors that can influence the amount and timing of pollutant discharges. These include changes in treatment technologies and the volume and composition of the wastestream treated as a result of increases or decreases in production levels or populations served. In compiling and presenting estimates of pollutant loadings, it is important to present this supporting information to help in the interpretation of the information shown.

Program applications

The loading estimates that can be developed from PCS data are generated as part of the self-monitoring requirement in the NPDES program. As such, they can be used as a measure of program effectiveness by demonstrating the reduction in loadings resulting from the implementation of more stringent control measures needed to meet permit requirements.

The release estimates in TRI are compiled as part of a program conducted by the Office of Toxic Substances, and thus do not have any direct bearing on the effectiveness of Office of Water programs. Estimates from TRI could be used as a check against the estimates made from PCS data. However, there is very little overlap between the two data bases for pollutants for which there is useful data.

Improving the Indicator

There are several improvements that could be made to increase the capability to make loading estimates from these data sources.

For estimates from PCS, EPA should take actions to ensure that DMR data for all States are available in the data base. As an interim step, it would be useful to have an assessment of the availability of pollutant data in the data base by State, region, year and industrial activity (SIC code or major industrial category). This information could be used to determine whether there were sufficient data to make it worthwhile using PCS to make loading estimates or perform trend analysis for a particular pollutant or type of discharge activity.

EPA should complete the development and testing of Region 2's EDS module of the PCS software.

EPA could require, as part of the NPDES Discharge Monitoring Report process, that facilities track and report their cumulative pollutant discharge for the year, and make some assessment of trend, such as indicating if there is an increase or decrease in discharge of the pollutant for the same time period in the previous year. As part of this cumulative loading reporting, the facilities could submit an annual summary of the loads discharged, which could be compiled by EPA and released as an annual report.

The TRI was designed to provide the public with information about toxic releases, and, as noted, it is potentially a very useful source for national indicator data.

Improvements could be made by expanding the types of facilities required to report releases, by implementing a rigorous quality assurance program for the data, and by requiring some additional information on the timing of the releases. One additional suggestion to improve the interpretation of the data would be to development some means to evaluate and portray the relative toxicity of the compounds. This type of approach would give the public a better understanding of the relative risk caused by the release of different substances.

VIII. SUMMARY AND CONCLUSIONS

EPA's long history of working to develop environmental measures for the surface water programs reflects the difficulties inherent in trying to define indicators that can adequately reflect even portions of this complex environmental system. The indicators that were identified at the March workshop and which are reviewed in this report can, with some changes in data collection and reporting procedures, begin to provide the Agency with the type of information needed to support reviews of our progress in addressing pollution problems of surface waters.

The measures included in this review could be useful at the national level as indicators of the status and trends of the nation's waters. At the State level, the same type of information can also be used for targeting purposes or for evaluating of the effectiveness of specific programs. This is usually not possible at the national level unless a nationally consistent survey such as the Bioaccumulation study (which is designed to look at some sites adjacent to suspected or known sources of contamination) is repeated.

Table VIII-1 summarizes the major advantages and limitations of the proposed indicators as well as identifying some areas in which the measures could be improved.

The shellfish harvest area classification data available from NOAA could be incorporated into an EPA indicator reporting process in the near term. While the indicator has some flaws nationwide (many areas are classified for reasons other than water quality), it does provide a useful indication of the quality of the coastal waters. Similarly, data available from the FWS National Contaminant Biomonitoring Program and NOAA's National Status and Trends Program could be immediately brought into an EPA indicator reporting program.

It would be most efficient and logical for OW to use the State 305(b) reports as the primary vehicle through which it develops data on indicators. Improvements in designated use, trophic status of lakes, toxics in fish and shellfish tissue, and biological community measures could all be realized through more specific directions for reporting in the 305(b) reports. These changes would place an increased burden on the States but would greatly improve the ability of the Agency and the States to identify the results of water quality protection programs. Much of the information is already being collected by the States and the additional burden is in many cases a reporting one; asking the States to make available through the 305(b) reports information that they already have, and to make it available in more useful consistent formats.

The consistent use of the Waterbody System and of individual reach numbers by the States should be encouraged. The computerized system provides EPA with the ability to synthesize data and design maps or other graphic presentations easily. The use of reach numbers would allow for comparisons of all types of data. Data in the Reach File could be related to "pollution pressure" information contained in other databases that track population densities or local land use practices. Using several environmental quality databases linked through the reach file would provide a comprehensive set of indicator information.

In the long-term, there is some additional monitoring activity that the Agency and the States might consider in order to develop more meaningful indicators. For example,

Table VIII-1
Summary Characteristics of Proposed Indicators

Indicators	Strengths	Weaknesses	Possible Improvements
Designated Use and Attainment of "Fishable/ Swimmable" Evaluation Goals	•Data collection system already in place •Computerized framework •Low cost to maintain and improve •Of primary interest to majority of public •Easily Understood	•At present, can not be used to evaluate trends •Inconsistencies and lack of standardization •Inconsistent within state from one reporting cycle to the next	•More consistency in definitions of use •Increase in use of reach number or other geo-referenced data element •Increase in the use of WBS
Shellfish Harvest Area Classifications	•Data collected for over 20 years •Data collection has been fairly consistent •Easily understood by general public	•Variations in state-to-state interpretation of classifications •Reclassifications for reasons not related to water quality changes	•Greater consistency in classifications •Correlating with other monitoring data (such as NOAA's Mussel Watch data)
Trophic Status of Lakes	•Data collection system already in place •Report required by CWA 314(a) •Scientifically defensible methods •Computerized framework	•Regional differences limit national comparisions •The number of lakes evaluated fluctuates •Lakes are monitored too infrequently to derive trends	•Establish baseline in order to be able to evaluate trends •Report seasonal fluctuations •In 305(b), report both number of lakes and lake acreage
Toxics in Fish and Shellfish USFWS NCBP	•L-T collection system in place •Trends established •Computurized data collection •Of major interest to FWS	•Only for rivers and streams •Limited number of chemicals tested •Actual ecological implications of fish and shellfish contamination are a subject of controversy	•Plan to expand to estuaries •Looking to include new toxicants •May include USGS sites and perhaps NOAA's Mussel Watch sites
NOAA NS&T Benthic Surveillance	•Consistent nationwide sampling •Good trend analysis •Have ancillary information on sediments at sites and fish abnormalities •Spatial and Temporally representative	•Different fish at different locations •Not useful for human health considerations •Not point source specific	•Coordinate data collection with other sources •Develop centralized database •Develop protocols on monitoring to increase comparablity with other sources data
NOAA NS&T Mussel Watch	•Consistent nationwide sampling •Can correlate info with sediment data •Spatial and Temporally representative	•Not point source specific	•Same as above
EPA National Bioaccumulation Study	•Located around known and suspected sources •Can draw conclusions on impacts •Can develop information on bioaccumulation	•One time only study •No trends •Not spatially or temporally rep.	•Repeat study to assess programs in place around sources and to further examine bioaccumulation •Identify sites to be re-tested as part of nationwide trend study
Tissue Residue Data Collected by States	•Being done at state level •Used in some use assessment •Related to health advisories	•Varies from state to state in species, location, chemicals, purpose and amount of testing •No data storage with easy retrieval	•Change in 305(b) to provide summarized results •Use Bios data system •Develop agreements on monitoring protocols to increase comparability
Biological Community Measures	•Fish integrate impacts over whole stream •Bivalves are excellent indicator of environmental stress •Heightened interest in states and regions •Community data is necessary complement to physical/chemical testing •Different states can use systems that are appropriate to their conditions	•Relatively limited amount of biomonitoring being carried on as part of water quality analyses •Resource constraints •No centralized database	•Increase guidance to state in terms of how to do community analyses and what to do with the information •Make identification of community analyses part of the 305(b) reports
Pollutant Loading Estimates from Point Sources	•Data collection and reporting in place •Spatially and temporally representative •Good correlation between pollutant loadings levels and water quality	•Limitations on availability and quality of data •Little data available for toxic compounds •Current data management system (PCS) can not compute loads •Additional data collection would be costly	•Require permitted facilities to report seasonal and annual loads •Modify PCS to allow computation of loads

EPA should consider whether it wants to repeat the testing conducted for the National Bioaccumulation Study. This could provide the Agency with data on the effects of specific programmatic actions (at the sites being surveyed) as well as information on trends at the "randomly chosen" sites. Coordination with the Fish and Wildlife Service's National Contaminant Biomonitoring Program or the new USGS National Ambient Water Quality Assessment program might offer some opportunities for interagency cost sharing or data sharing for such future work, although differences in data collection (e.g., whole fish versus edible tissue sampling) would have to be resolved.

EPA should actively encourage State programs designed to implement measures of biological community well-being. This information provides a better view of the quality of the water resource than can be obtained simply from the chemical and physical parameter testing that still forms the principal basis of most State water quality monitoring programs, and in particular can give a better indication of problems associated with non-point sources of pollution.

If it is desired that indicator data be used for national trend assessment, the Office of Water (OW) and State water quality agencies might reconsider a monitoring strategy in which each State returns to a subset of fixed monitoring stations on regular intervals to permit trend reporting on a few indicators. Since only a percentage of total waters is generally assessed, it is recommended that rotational monitoring be instituted so that the same fixed stations be monitored at set intervals (e.g., every third year).

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