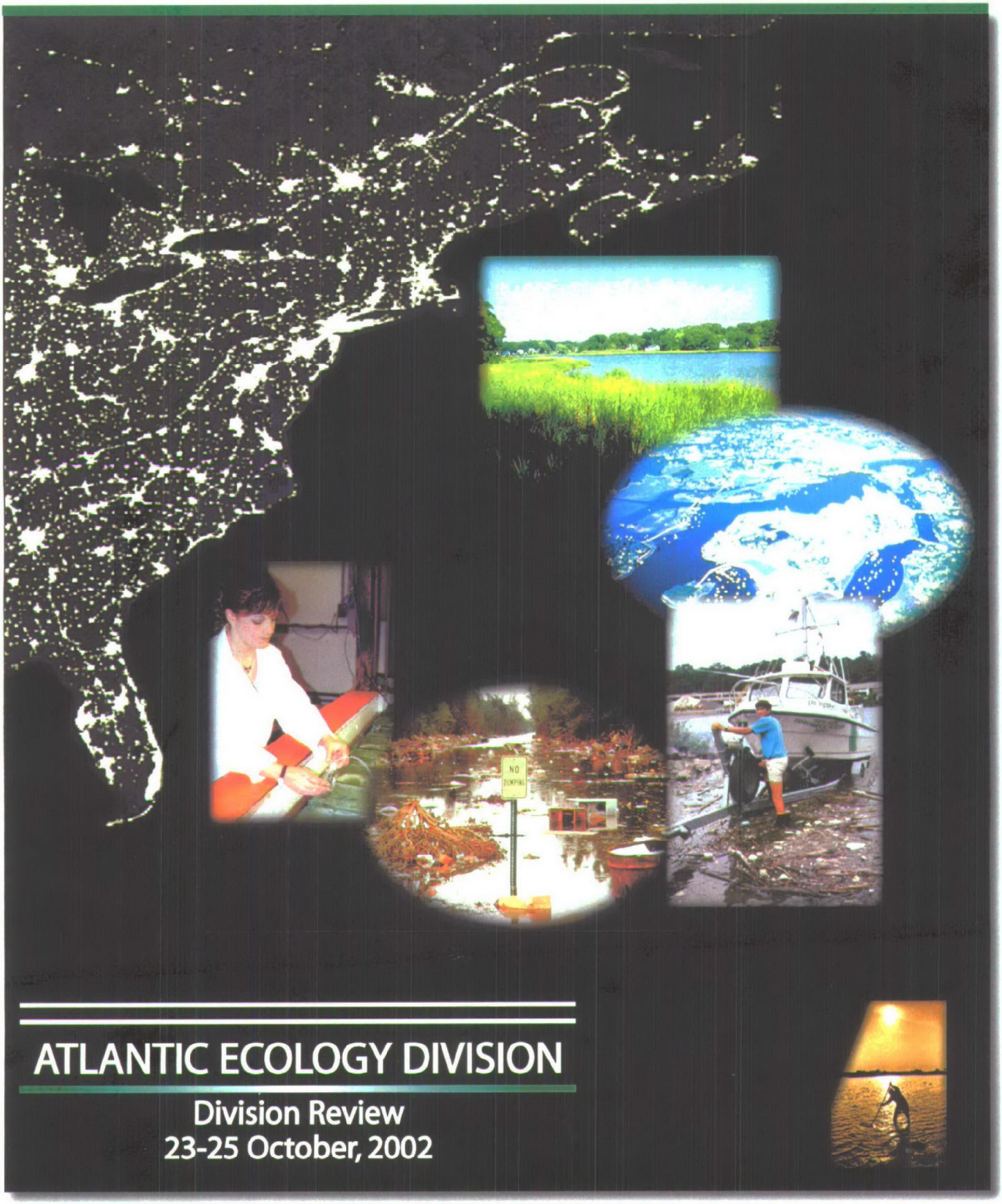
United States Environmental Protection Agency
Office of Research and Development
National Health and Environmental Effects
Research Laboratory

EPA
Atlantic Ecology Division
Narragansett, Rhode Island



ATLANTIC ECOLOGY DIVISION

Division Review
23-25 October, 2002

Agenda

Atlantic Ecology Division
National Health and Environmental Effects Research Laboratory
Office of Research and Development
Divisional Peer Review
23-25 October 2002

Agenda

Tuesday, 22 October

7 00 pm	Executive Session with NHEERL Leadership Bay Voyage Inn	

Wednesday, 23 October *U.S. EPA Main Building, 27 Tarzwell Drive, Narragansett, RI*

8·30 am	Introductory Remarks	Larry Reiter, NHEERL Director
8 35	Welcome and Logistics	Jonathan Garber, AED Director
9:00	Overview of AED	Jonathan Garber
9·30	AED's Science Program	Wayne Munns, AED Associate Director for Science
10 00	AED Resources and Infrastructure	Sheila Meuse, AED Associate Director for Program Operations
10 30	Questions, Clarifications and Discussion	
11 00	Facilities Tour	
12 00	Working Lunch in Executive Session	

<u>Characterizing Environmental Condition</u>

1 00 pm	Overview of Monitoring, Assessment and Diagnosis Research	Barbara Brown, Chief of ERB
1 30	Assessing the Condition of Estuaries and Streams (GPRA Goal 8)	Gerald Pesch
2 00	Identifying Ecological Impairment (GPRA Goal 8)	Matthew Nicholson

2·30	Diagnosing Causes of Ecological Impairment (GPRA Goal 2)	Kay Ho
3·00	Poster Session (Room 130)	various presenters
4·30	Questions, Clarifications and Discussion	
5·00	Adjourn	

Evening no planned event

Thursday, 24 October *U S EPA Main Building, 27 Tarzwell Drive, Narragansett, RI*

Ecological Effects Research to Support Risk Management
Extrapolating Effects to Populations

8 30 am	The Wildlife Research Strategy	Tim Gleason, Acting Chief of IDB
9·00	Population Modeling to Support Ecological Risk Assessment (GPRA Goals 4 and 8)	Matthew Mitro
9 30	Wildlife Risk Assessment - The Loon/Hg Demonstration (GPRA Goal 2)	Diane Nacci
10 00	Poster Session (Room 130)	various presenters
11·30	Questions, Clarifications and Discussion	
12 00	Work Lunch in Executive Session	

Developing Stressor-Response Relationships

1:00	A Framework for Assessing Effects of Aquatic Stressors	Charlie Strobel, Acting Chief of EASB
1.30	Stressor-Response Relationships for Nutrients (GPRA Goal 2)	Jim Latimer
2 00	Stressor-Response Relationships for Habitat Alteration (GPRA Goal 2)	Cathleen Wigand
2:30	Effects of Contaminated Sediment (GPRA Goals 2 and 5)	Barbara Bergen
3.00	Poster Session (Room 130)	various presenters

4 30	Questions, Clarifications and Discussion	
5 00	Adjourn	

Evening no planned event

Friday, 25 October *U.S EPA Main Building, 27 Tarzwell Drive, Narragansett, RI*

Integration Research

9 00 am	Integrating Ecology, Human Health and Socioeconomics (GPRA Goal 8)	Wayne Munns/ Dan Campbell/Sherry Brandt-Williams
10 00	General Questions, Clarifications and Discussion	
10:30	Review Program Adjourns Panel Meets in Executive Session Working Lunch	
2:30	Panel Interview with NHEERL and Division Management	
	Panel Departs	

AED Peer Review Panel

AED PEER REVIEW

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CHARGE TO REVIEW PANEL

U. S. EPA NATIONAL HEALTH AND ENVIRONMENTAL EFFECTS RESEARCH LABORATORY
ATLANTIC ECOLOGY DIVISION
PEER REVIEW OCTOBER 23-25, 2002

CHARGE TO THE PEER REVIEW PANEL

OVERALL GOAL

The National Health and Environmental Effects Research Laboratory (NHEERL) conducts a peer review of each of its Divisions on a four-year cycle The primary goal of the peer review is to provide Senior Management with guidance for the planning and implementation of research and the allocation of resources over the next five years. The review is conducted to evaluate 1) the quality of the science within the Division, and 2) the responsiveness of the Division's science on Agency needs and problems. Each of these two dimensions is to be assessed relative to the research, advisory, and leadership roles of the Laboratory To assist you with your review, sample questions relative to each of these roles are tabulated on page 6.

RESPONSIBILITIES

Panel members are encouraged to bring their own laptop computers for use during the sessions. A computer, printer, and photocopier also will be available on site. Use of WordPerfect 9 is preferred, but converters are available for other word processing software.

Please note that the review panel is not an advisory committee The objective is not to come to a consensus regarding the Division's program; rather, the report should represent a summation of individual critiques, opinions, and viewpoints.

PANEL CHAIR

In addition to his own writing assignments, Dr. Greg Biddinger will serve as the Editor-in-Chief for the panel report and will draft the Executive Summary.

ALL PANEL MEMBERS

Each panel member has been assigned the role of primary and secondary reviewer for the various research areas of the Division's program. The proposed writing assignments are listed on the next page Modifications to the proposed assignments can be accommodated within the panel Specified assignments do not preclude reviewers from evaluating other research areas; in fact, such efforts are encouraged, especially when disciplines cross research areas.

Writing Assignments

Executive Summary ..... Greg Biddinger
Progress Since Last Review ..... Greg Biddinger

Research Area	Primary Reviewer	Secondary Reviewer	Agenda
Assessing Condition of Streams and Estuaries	James Karr	Michael Newman	Wednesday afternoon
Identifying Ecological Impairment	Charlie Menzie	James Karr	
Diagnosing Ecological Impairment	Denise Breitburg	James Karr	
Wildlife Risk Assessment - Loon/Hg Case Study	Charlie Menzie	Peter Kareiva	Thursday morning
Population Modeling	Peter Kareiva	Charlie Menzie Michael Newman	
Nutrient Effects	Denise Breitburg	Carl Hershner	Thursday afternoon
Habitat Alteration	Carl Hershner	Denise Breitburg	
Contaminated Sediment Effects	Michael Newman	Greg Biddinger	
Integrated Research	Carl Hershner	Greg Biddinger	Friday morning

What should be written prior to the on-site visit

Primary Reviewers:
Primary reviewers for each of the assigned Research Areas in the above table are asked to bring to the on-site meeting a written critique based upon the materials provided in this notebook. The critiques should provide an analysis of 1) the Division's research (with an evaluation of the quality of the research and its impact both on scientific understanding and on Agency needs), 2) the extent to which the Division provides advice and assistance to the scientific community and EPA, and 3) leadership exhibited by the Division.

A suggested format for your critique is outlined on page 5, and the table on page 6 will assist you in preparing these critiques. **Significant accomplishments, strengths, and weaknesses** should be highlighted. Please note that reviewers are <u>not</u> asked to evaluate individual members of the AED staff.

A hard copy of your critique should be given to the Peer Review Coordinator during the Executive Session on October 22. Copies of these critiques will be distributed to all panel members for discussion during the site visit.

Secondary reviewers:
All panel members have secondary writing responsibilities in which brief written statements or bullets on the research areas should be prepared. These statements/bullets will be given to the primary reviewers at the meeting for incorporation into the overall review.

What should be written on-site

Primary reviewers:
Primary reviewers should edit and amend their critiques as necessary based on observations made during the site visit and the comments of secondary reviewers.

Secondary reviewers:
Secondary reviewers should amend their initial comments based on observations made during the site visit; this information should be given to the appropriate primary reviewer.

PLEASE BE AWARE THAT WE MUST HAVE A DRAFT REVIEW REPORT BEFORE YOUR DEPARTURE ON FRIDAY, OCTOBER 25.

Prior to adjournment, the Panel shall present its key findings to the NHEERL Director, the acting Associate Director for Ecology, the Division's Management Team, and the Peer Review Coordinator.

Post-meeting obligations

The Panel Chair, with assistance (if needed) from the Peer Review Coordinator, will complete the draft report and circulate it to all members of the panel for their approval A final Peer Review Report will be presented by the Panel Chair to the NHEERL Director no later than **November 29, 2002.**

SCHEDULE

All panel members are urged to arrive Tuesday, October 22, in time to attend a 7.00 PM meeting with NHEERL's Director, Dr Larry Reiter; the acting Associate Director for Ecology, Dr. Steve Hedtke; the acting Director of the Research Planning and Coordination Staff (RPCS), Dr. Bill Russo, and the Peer Review Coordinator, Virginia Houk The meeting will be held in the "Commons Room" at the Bay Voyage Inn where you have your room reservations.

Upon arrival, the preliminary evaluations prepared by each panel member will be collected by the Peer Review Coordinator. The material will be duplicated and distributed to all panel members to facilitate discussions and consolidate evaluations.

On October 23-25, the Division's program will be presented through oral and poster presentations. Ample time has been set aside for the reviewers to confer with Division staff and each other. These interactions will allow reviewers to obtain more detailed information on the Division's program, to query researchers, and to clarify outstanding issues.

A portion of October 25 will be devoted to preparing the draft peer review report. During this writing session, primary reviewers will modify, as necessary, their preliminary critiques to reflect observations made during the site visit and to incorporate input from secondary reviewers Time also has been set aside on this day for the chair and panel members to summarize and discuss major findings and recommendations with the NHEERL and AED senior managers

The timeline can be summed up as follows:

- **Approximately 4 weeks prior to review (mid-September):** Panel members receive review package
- **Prior to arrival at on-site meeting:** Reviewers prepare preliminary text of review
- **Evening before review (October 22):** Reviewers meet in Executive Session with Laboratory Director, Associate Director, RPCS Director, and Peer Review Coordinator
- **On-site review (October 22-25):** Division discusses program with reviewers
- **Last half day (October 25):** Reviewers modify preliminary evaluation as needed; panel chair and members hold exit interview with the Laboratory Director, Associate Director, RPCS Director, Division senior staff, and Peer Review Coordinator
- **Within approximately one month following site visit (November 29):** panel chair and members edit document and present final peer review report to the Laboratory Director

The Peer Review Coordinator, Virginia Houk, will work with you throughout the peer review process. Questions concerning the review should go directly to her (phone: 919.541-2815; fax: 919 541-4324; e-mail. houk virginia@epa.gov) We ask that there be no contact between you and the staff of the Atlantic Ecology Division regarding the review, but you may contact the Division's Associate Director for Science, Dr. Wayne Munns, at 401.782-3017 for information regarding local arrangements (hotels, transportation).

GUIDELINES AND FORMAT FOR PREPARING THE REVIEW REPORT

The following outline for the review report is suggested. Parties responsible for the different pieces are included in parentheses. Please use the table on page 6 for guidance in preparing the sections on Individual Research Areas.

- ❑ **Executive Summary (Dr. Biddinger, with input from individual reviewers)**
  Description and evaluation of overall program, along with specific panel recommendations and suggestions.

- ❑ **Individual Research Areas (primary reviewer, as assigned, with input from secondary reviewer and others, as appropriate)**
  Evaluation of research areas based upon the material in the review notebook, poster sessions, oral presentations, and discussions.

  - ■ **Introduction**
    Brief description of Research Area

  - ■ **Research**
    Assessment of strengths and weaknesses, suggestions for improvement, evaluation of future directions
    Quality of the Science and its Impact
    Responsiveness to Agency Needs

  - ■ **Advice and Assistance**
    Critique of Division's role in providing advice/assistance to the scientific community and EPA
    Quality
    *Responsiveness to Agency Needs**

  - ■ **Leadership**
    Critique of Division's leadership role in the scientific community and within the Agency
    Quality
    *Responsiveness to Agency Needs**

  - ■ **Summary and Recommendations**
    Overall evaluative statement and recommendations

- ❑ **Progress Since Last Review (Dr. Biddinger, with input from individual reviewers)**
  Critique of Division's responsiveness to the last Division review, taking into consideration the former panel's recommendations and the Division's Response to Comments, and steps taken to improve the program. Has the Division made satisfactory progress on the panel's recommendations? Where do reviewers see room for improvement?

*We in NHEERL acknowledge the difficulty for a panel of this kind to evaluate the Division's "Advice/Assistance" and "Leadership" roles within the Agency However, please comment to the extent possible in these 2 areas

GUIDANCE FOR DIVISIONAL REVIEW

	Research	Advice/Assistance	Leadership
Quality of the Science	*Division's approach to a given environmental problem* Examples • has the Division identified major uncertainties and appropriate research priorities? • are approaches scientifically sound? • in what ways has the Division advanced scientific understanding of the problem? (Has it had an impact?) • are future directions sound? *Division's resources (assume fixed numbers)* Examples • are Division's resources effectively and strategically allocated across problems (appropriate depth and breadth)? • is the skill mix optimized for the scientific direction taken? • does workforce maintain cutting-edge knowledge and skills? *Mechanisms and extent to which findings / products are disseminated to scientific audience in timely fashion*	*Extent to which Division's assistance is sought by or provided to the scientific community* Examples: • do scientists serve on national/ international workgroups, symposia, professional societies, publication boards? • are they members of research review boards (e g , study sections) for other organizations? • do they provide scientific or technical guidance to local, state, tribal, and international governments	*Division's leadership role in the scientific community (influence on agendas, decisions, priorities of other researchers / organizations)* Examples • do scientists lead collaborative research efforts at the national / international level? • do they serve on advisory boards of other major agencies / organizations? • are they invited to chair major committees? • do they organize major conferences, symposia? • do they receive awards / honors for scientific contributions?
Responsiveness to Agency Needs and Problems	*Division's responsiveness to Agency needs* Examples • is research driven by Agency priorities? • does the research address the critical issues within EPA's mission? • is the Agency using the Division's data / products? • does the Agency adopt approaches or methods developed by the Division? • does the Division provide information necessary for EPA users to meet statutory requirements or other policy needs? • what problems has the Division solved for the Agency? *Balance between core and problem-driven research* *Mechanisms and extent to which findings / products are disseminated to Agency in timely fashion*	*Extent to which Division's advice / technical support is sought by the Agency* (Program Offices, Regional Offices)* Examples • does Division staff participate on major within-Agency workgroups? • do Division scientists assist the Agency in developing testing guidelines, interpreting research advances, reviewing Program Office or Regional documents? *We acknowledge the difficulty of evaluating the Division's "Advice/Assistance" roles within the Agency However, please comment to the extent possible	*Division's leadership role in the Agency* (influence on research planning efforts, decisions, and priorities of the Agency)* Examples • does Division staff lead research planning and coordination efforts across Divisions, Agency Labs, and Offices? • do scientists represent ORD/Agency on workshops or workgroups addressing major risk assessment or environmental issues? • do they receive major Agency awards/ honors? *We acknowledge the difficulty of evaluating the Division's "Leadership" role within the Agency However, please comment to the extent possible

SUPPLEMENTAL QUESTIONS

Provide suggestions for improvement in any of the above areas What can be said about the adequacy of the Division's resources and facilities for meeting its scientific commitments? Given the available resources, are productivity and efficiency optimized within the Division?

ORD/NHEERL Overview

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) was established in 1970 in response to growing concerns over polluted air, unclean rivers, unsafe drinking water, endangered species, and careless waste disposal. EPA was given the responsibility for implementing a broad set of federal environmental laws, which have contributed in the intervening years to significant improvements in environmental quality. Currently, EPA has jurisdiction over more than a dozen statutes enacted to protect public health and the environment (e.g, the Safe Drinking Water Act and the Clean Air Act).

EPA is both a regulatory and a scientific agency; it is one of only a few federal organizations that operates in this capacity. The environmental laws that form the legal basis for the Agency's regulatory activities also authorize its research efforts. It is this research that provides the foundation for scientifically defensible environmental policies, programs, and regulations. EPA research is housed chiefly in the Office of Research and Development (ORD), which includes the National Health and Environmental Effects Research Laboratory (NHEERL).

EPA's Mission

Protect human health and safeguard the natural environment – air, water, land – upon which life depends.

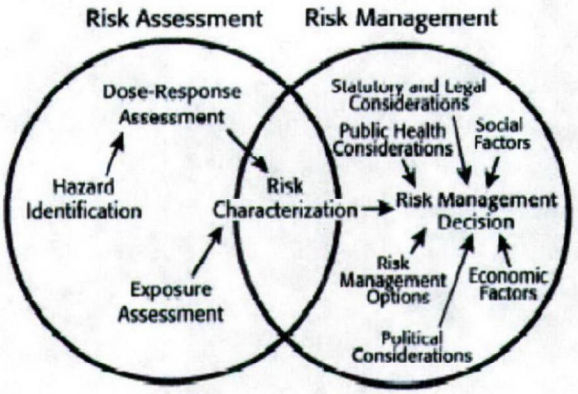
EPA's OFFICE OF RESEARCH AND DEVELOPMENT (ORD)

ORD is the principal research arm of EPA. Its role is to provide the critical science for environmental decision-making. Unlike much of the Agency, ORD has no direct regulatory function; rather, its responsibility is to inform the regulatory process. Through the development of technical information and scientific tools, ORD's research strengthens EPA's science base, providing the Agency's Program Offices and Regional Offices with sound data for use in developing and implementing tenable environmental policies, regulations, and practices. Comprising five national Laboratories and Centers across the country, ORD's broad scope encompasses both human health and ecology.

ORD is organized around the principles of **risk assessment and risk management**. These principles not only help shape and prioritize ORD's research agenda, they also are an inherent part of its organizational structure. A diagram of risk assessment and its relationship to ORD's Labs and Centers is depicted in Figure 1 on the next page. The paradigm in Figure 1a historically has applied to human health risk assessment, while the framework in Figure 1b, which conceptually mirrors the health paradigm, has been used for ecological risk assessment. Simply put, risk assessment is the process of evaluating the nature, magnitude, and likelihood of an adverse effect following exposure to a stressor(s), such as pollution or habitat loss. For health risk assessment, the process involves hazard identification, dose-response assessment, exposure assessment, and risk characterization.

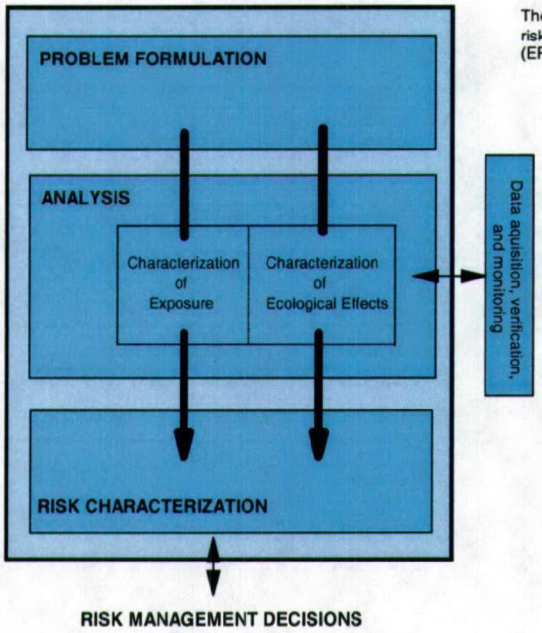
Figure 1. Risk Assessment and ORD

a. Health Paradigm



*Adapted from:
Risk Assessment in the Federal Government: Managing the Process. National Academy of Sciences. 1983.
Science and Judgement in Risk Assessment. National Research Council. 1994.

b. Ecology Framework



The US EPA ecological risk assessment framework (EPA, 1992)

c. Alignment of ORD Labs / Centers with Risk Paradigm

National Exposure Research Laboratory	**National Health and Environmental Effects Research Laboratory**	National Center for Environmental Assessment	National Risk Management Research Laboratory	National Center for Environmental Research
Research to measure, characterize, and assess exposures and to support compliance with environmental regulations and policies	**Research to identify hazards, formulate the problem, and characterize response**	Risk characterization and research on risk assessment methods	Research and technology transfer to prevent, mitigate, and control pollution	Extramural program - grants, fellowships, and national centers of excellence - to complement ORD's intramural program

Ecological risk assessment, on the other hand, involves problem formulation, exposure and effects analysis, and risk characterization. Once risk has been characterized, that information, together with factors such as economic considerations, is used to make decisions on how to manage risk. Figure 1c shows how ORD's institutional structure is aligned to comport with the risk paradigm, with each of ORD's Labs and Centers focusing on a different aspect of risk assessment. NHEERL's singular focus is upon potential effects of environmental stressors. Our role is to develop the methods, models, and data to better identify, characterize, and quantify the risks associated with stressors that adversely impact human and ecological health.

ORD cannot address every problem in the environmental arena. It must be selective when deciding which problems to tackle. Some research is required by law; other research is initiated in response to specific environmental exigencies or opportunities. Thus, research in ORD can be broadly viewed from two perspectives: **scientific and programmatic**. This is an important distinction because it reflects the dual responsibility of ORD to advance environmental science frontiers while remaining responsive to the program needs and priorities of the Agency. ORD research must be scientifically relevant, but it also must be responsive to those in the Agency tasked with making regulatory and policy decisions.

The framework for organizing research within ORD (and NHEERL) is drawn from **EPA's Strategic Goals**, summarized in the box to the right. These Goals identify the overall environmental results, such as cleaner air, that EPA is working to attain. We use these goals to systematize the way in which we prioritize, plan, and implement our research, report our research findings and products, and budget our programs. Of EPA's 10 national environmental goals, the first eight involve research. Each goal is linked to key environmental statutes. For example, *Goal 2: Clean and Safe Water* is arrayed with the Clean Water Act and the Safe Drinking Water Act. Accordingly, research performed under a particular goal supports the regulatory actions mandated by the corresponding legislation.

EPA's Strategic Goals

1. Clean Air
2. Clean and Safe Water
3. Safe Food
4. Preventing Pollution and Reducing Risk in Communities
5. Better Waste Management
6. Reducing Global Risks
7. Expansion of American's Right to Know About their Environment
8. Sound Science
9. Greater Compliance with the Law
10. Effective Management

Goal 8, Sound Science, deserves some explanation due to its confusing nomenclature. This goal is unique because of the relevance of its research across media and for multiple EPA offices. This category is where our core research falls (core is similar to basic research, and is described more fully on page 6). As opposed to problem-driven research, which addresses specific environmental problems, core research improves our fundamental understanding of complex environmental and human health issues. The information and tools gleaned from this research are the kind that can apply to a wide variety of environmental problems, including prospective environmental hazards. An example of "Sound Science" research is our study of the unique susceptibilities of infants and children to toxic substances, the results of which are far-reaching and can be used to address age-related issues in many problem areas.

All research performed in ORD (and, therefore, in NHEERL) is driven by one of these strategic

goals. For each of the goals, ORD's Labs and Centers have committed to reaching certain milestones and delivering specific products within a given time period, thus providing a mechanism for measuring tangible progress toward completion of long-term objectives. This explicit accountability grew out of the Government Performance and Results Act (GPRA) passed by Congress in 1993; consequently, these Agency goals are sometimes referred to as "GPRA Goals."

THE NATIONAL HEALTH AND ENVIRONMENTAL EFFECTS RESEARCH LABORATORY (NHEERL)

Organizational Structure. NHEERL is the largest research organization in ORD, employing over 700 federal employees at various facilities across the country. The current organizational structure is diagramed in Figure 2. Based in Research Triangle Park, NC, NHEERL has nine divisions that specialize in different facets of human health or ecology research. Our Health Divisions are centrally located in Research Triangle Park and Chapel Hill, NC. Our Ecology Divisions are based in Gulf Breeze, FL; Duluth, MN; Corvallis, OR; and Narragansett, RI, each location representing a significant regional ecosystem (Gulf of Mexico, Great Lakes, Pacific Coast, and Atlantic Seaboard, respectively). Table 1 on the next page lays out the research focus for each NHEERL division.

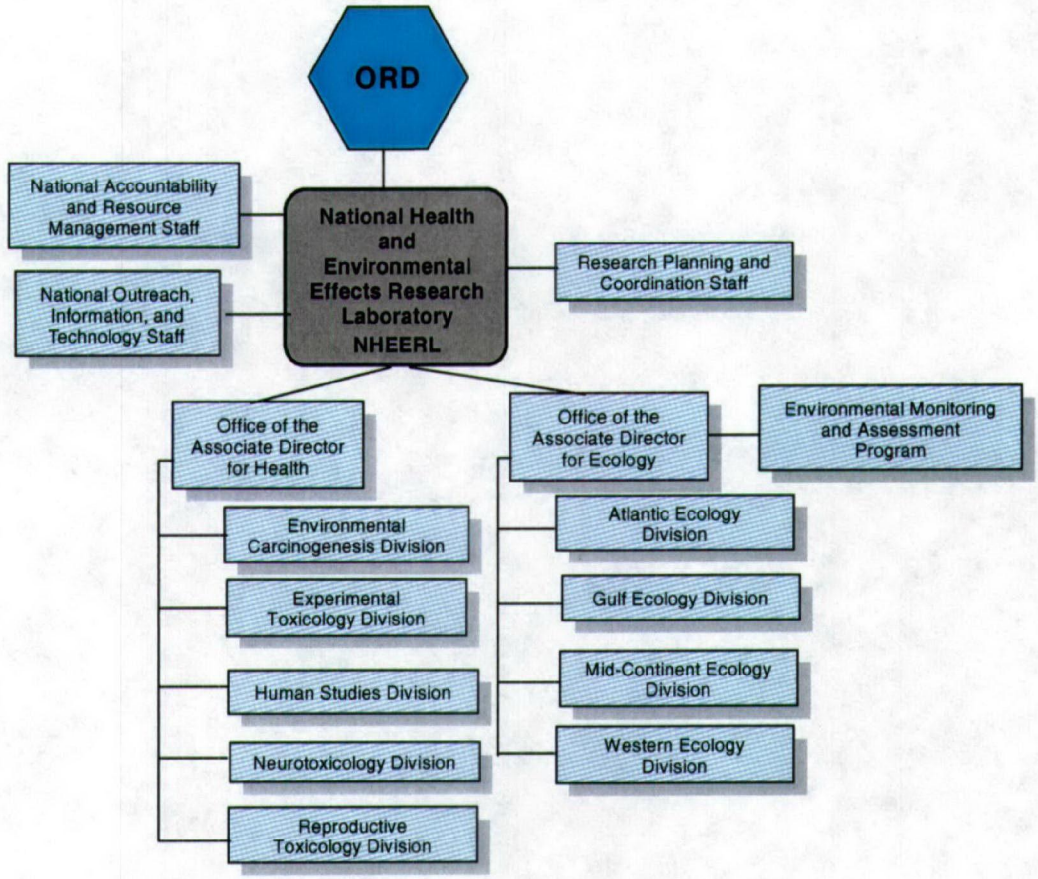


Figure 2. Organizational Structure of NHEERL

Table 1. Overview of NHEERL's Health and Ecology Divisions

DIVISION	LOCATION	RESEARCH FOCUS
Atlantic Ecology Division (AED)	Narragansett, RI	Studies the environmental effects of anthropogenic stressors on marine, coastal and estuarine water quality, with an emphasis on the coastal waters and watersheds of the Atlantic seaboard. Areas of research specialization include modeling cumulative effects of multiple stressors on coastal ecosystems, developing methods for assessing the ecological effects of contaminated marine sediments, analyzing the role of biogeochemical processes on effects, and conducting geographic-based ecological assessments for the Atlantic coast.
Environmental Carcinogenesis Division (ECD)	Research Triangle Park, NC	Performs research to assess potential carcinogenicity of environmental chemicals. The aim is to reduce uncertainty in cancer risk assessment models by developing mechanistic data underlying chemical carcinogenesis for agents of environmental concern (including mixtures). This approach is enhanced by developing and applying biomarkers of response for predicting cancer outcomes and by incorporating information gained from structure-activity and molecular modeling approaches.
Experimental Toxicology Division (ETD)	Research Triangle Park, NC	Performs research to determine the health effects of environmental pollutants and cause-and-effect relationships at pollutant concentrations that mimic those in the environment. Investigations center on the pulmonary and cardiovascular systems; the immune system; and susceptibility to infectious, allergic, and neoplastic disease. Focal point for pharmacokinetic studies to elucidate dose-response relationships for systems susceptible to pollutants.
Gulf Ecology Division (GED)	Gulf Breeze, FL	Assesses the ecological condition of estuaries, coastal wetlands, coral reefs, and other critical habitats of the Gulf of Mexico. Determines cause(s) of affected and declining systems; predicts future risk to populations, communities, and ecosystems from aquatic stressors; and supports the establishment of criteria to protect critical habitats.
Human Studies Division (HSD)	Chapel Hill, NC	Conducts an interdisciplinary program of clinical and epidemiologic research that provides critical data for health risk assessment. Clinical studies determine the pharmacokinetics, dosimetry, and effects of pollutants in controlled exposure studies of healthy and susceptible individuals. Epidemiologic studies evaluate the relationship between real-world exposures and observed health effects in populations of interest. The program focuses on the effects of pollutants in air and water on the pulmonary, cardiovascular, and neurobehavioral systems.
Mid-continent Ecology Division (MED)	Duluth, MN Grosse Ile, MI (field station)	Develops methods for predicting and assessing the effects of anthropogenic stressors on freshwater ecological resources, including the Great Lakes and Great Rivers. Conducts cause-and-effect research on the effects of nutrients, clean sediments, climate change, and toxic chemicals on lake, stream, and wetland ecosystems, as well as aquatic life and wildlife communities and populations. Wildlife and aquatic life toxicology research, conducted in collaboration with human health-based research performed in NHEERL's health divisions, establishes advanced animal and dose-response extrapolation models to support integrated risk assessments.
Neurotoxicology Division (NTD)	Research Triangle Park, NC	Performs research to provide the scientific and technological means to predict the neurotoxicity of environmental agents in humans. Human neurotoxic disease is modeled in laboratory animals, and data are collected in animals to make predictions about possible neurotoxic risk. Studies range from the molecular level to the whole organism and include neurobehavioral, neurochemical, neurophysiological, and neuroanatomical approaches. Major emphasis on the study of sensitive subpopulations and developmental neurotoxicity.
Reproductive Toxicology Division (RTD)	Research Triangle Park, NC	Performs research on the effects of environmental pollutants on reproduction and development. Develops biological indices for assessing germ cell maturation, embryonic development, and adult reproductive capacity and endocrine status, integrating information into biologically based dose-response models. Major research emphasis on assessing modes of action for endocrine disrupting chemicals and drinking water disinfection by-products in order to reduce uncertainties in the risk assessment of associated adverse reproductive outcomes.
Western Ecology Division (WED)	Corvallis, OR Newport, OR (field station)	Studies estuarine, terrestrial and watershed ecology with a focus on the Pacific Northwest region. Research emphasizes marine, coastal, and inland ecosystem functions and response to stress. Areas of specialization include ecological theory for spatial and temporal analysis of regional environmental data; developing methods for assessing regional-scale condition of ecological resources; and assessing the effects of changes in habitat and land use on terrestrial systems; and modeling of estuarine systems.

NHEERL's Mission. NHEERL is a problem-solving organization. We are EPA's focal point for research on the adverse effects of contaminants and environmental stressors on human health and ecosystem vitality. Our mission is to:

- perform high quality ***effects-based research*** to identify, understand and solve current and future environmental problems;
- provide ***leadership*** in addressing environmental issues; and
- provide ***scientific and technical assistance*** at the local, state, federal, and international level.

These three elements, discussed separately below, interface squarely with the missions of EPA and ORD.

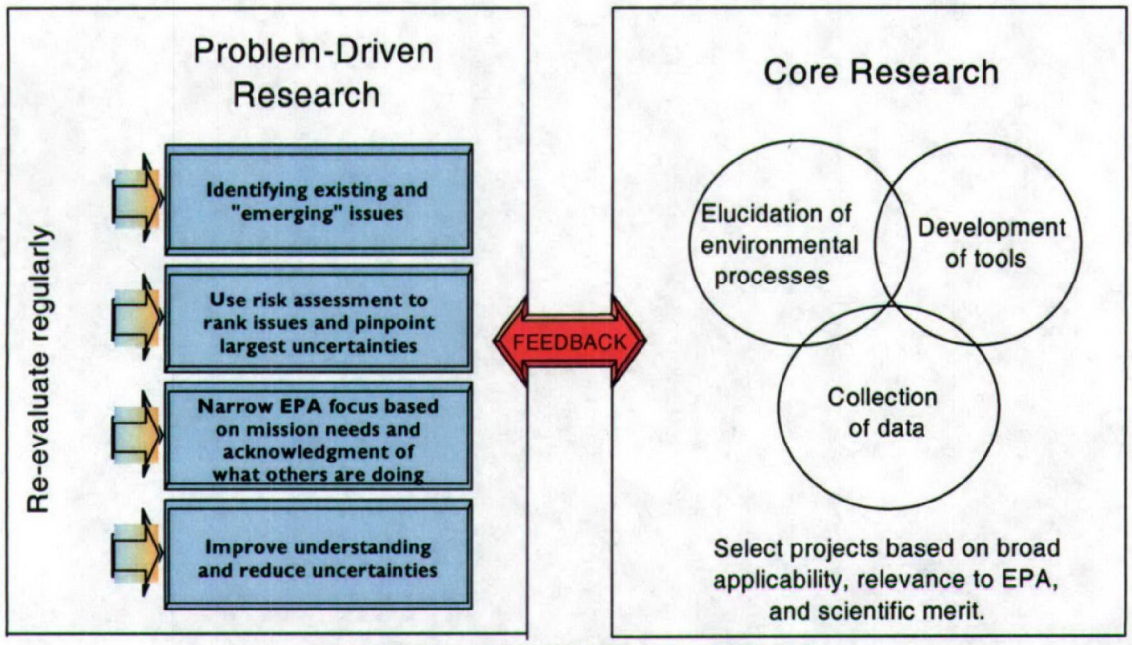
Research. Research provides EPA with the necessary information and technologies for detecting, abating, and avoiding environmental problems. NHEERL's approach to research, in accordance with ORD, is founded on principles of risk assessment. Our research is designed, within a risk assessment context, to answer scientific questions and reduce major uncertainties about the effects produced by pollutants and human activities on health and the environment. As shown in Figure 1, our research focuses on two components of the risk assessment paradigm: *problem identification /formulation* (does the contaminant or stressor cause the adverse effect?) and *dose-response / stressor-response analysis* (what are the relationships between the contaminant or stressor and the extent of injury, disease, or damage?).

Rather than characterize our research as basic or applied, we use the terms core and problem-driven. **Core research** (supporting EPA's Strategic Goal 8: Sound Science) seeks to produce a fundamental understanding of the key biological, chemical, and physical processes that underlie environmental systems, thus forging basic scientific capabilities that can be applied to a wide range of environmental problems. Core investigations address questions common to many EPA programs, and they provide the preparedness needed to confront unforeseen environmental problems. Examples of this type of research include NHEERL's multidisciplinary efforts to improve human health and ecological risk assessment, in which issues such as susceptibility and extrapolation of response are addressed, and the Environmental Monitoring and Assessment Program, designed to develop the science needed to describe the condition of our nation's ecological resources. **Problem-driven research** (supporting EPA Goals 1-7), on the other hand, focuses on specific environmental problems. Studies in these areas respond to explicit Agency needs and may be motivated by regulatory requirements or court-ordered deadlines. This type of research is exemplified by our Particulate Matter research program, in which the relationships between airborne particles and increases in morbidity and mortality are being studied to address critically important human health questions. Another example is our Aquatic Stressors Program, in which we are developing stressor-response models to advance our understanding of the effects of nutrients, habitat alteration, sedimentation, and toxic chemicals on aquatic ecosystems, as well as techniques to diagnose cause of ecosystem impairment.

Core and problem-driven research are similar, but not equivalent, to basic and applied research. Their complementary nature enhances NHEERL's ability to address diverse environmental issues. Scientists often pursue both types of research simultaneously, and cross-fertilization is encouraged.

Figure 3. The Relationship between Problem-Driven and Core Research

(adapted from NRC, 1997)



FRAMEWORK FOR ENVIRONMENTAL RESEARCH

Of course, core and problem-driven research are not entirely separable; in fact, they are highly complementary and interactive, each informing the other (see Figure 3). An example can help illustrate this. As previously mentioned, one of the issues under our core research program is the unique susceptibilities of infants and children to toxic chemicals: how does age influence health effects? This is a fundamental question in risk assessment, and the results of this research may be far-reaching, providing useful information to other studies, such as those conducted under Goal 2: Clean and Safe Water. Here, under Goal 2, we are studying the reproductive and developmental effects of disinfection by-products found in drinking water, and because this is an age-related susceptibility issue, results from our core program readily feed into this research (and vice versa). Thus, susceptibility research takes place in both areas (under Goal 8 and Goal 2), but the target question is different. In our core program (Goal 8: Sound Science), the question relates to the rudimentary principles of age-related differences; in Goal 2 (Clean and Safe Water), the question is how disinfection by-products *per se* impact an organism during its developmental stages. This blend of core and problem-driven research yields a robust research portfolio that couples a stable core effort with research focused on the mission needs of the Agency.

NHEERL's current core and problem-driven research topics are listed in Table 2 on the next page. Relative emphasis in each of these topics may change as ORD priorities shift, as new data surfaces, as court-ordered deadlines are met, or as budgets grow and shrink. However, substantial efforts are made by NHEERL to build and maintain research programs that are both relevant to the scientific problem and responsive to Agency needs. The objective is to create an integrated and coherent program, not a collection of disconnected projects. There are three principal types of research

product:

- *methods* for detecting and characterizing hazard (e.g., new bioassays or ecological indicators);
- *predictive models* for understanding and predicting relationships between stressors and response (e.g., biologically based dose-response models or computer models that predict the effects of climate change); and
- *data* designed to fill information gaps and address limitations associated with risk assessment (e.g., toxicological or epidemiological data).

Table 2. NHEERL's Core and Problem-Driven Research Programs

CORE	PROBLEM-DRIVEN	
Goal 8: Sound Science ▸ Human Health Risk Assessment • Harmonizing Cancer/Noncancer Risk Assmt. • Cumulative/Aggregate Risk • Susceptibility ▸ Research to Improve Ecosystems Risk Assessment ▸ EMAP ▸ Endocrine Disruptors	**Goal 1: Clean Air** ▸ Particulate Matter ▸ Air Toxics **Goal 2: Clean, Safe Water** ▸ Drinking Water ▸ Aquatic Stressors **Goal 3: Safe Food** ▸ Effects of Pesticides **Goal 4: Reducing Risk in Communities** ▸ Human Health Effects and Susceptible Subpopulations ▸ Ecosystem Effects	**Goal 5: Safe Waste** ▸ Contaminated Sites **Goal 6: Global Risks** ▸ Global Climate Change **Goal 7: Right-to-Know** ▸ Chemical Information Databases

Leadership. NHEERL provides vital leadership in the environmental research arena, and its scientists are proactive in the scientific community at many levels. Within the Agency, we help shape the research agenda by contributing to research planning and coordination exercises, and we participate in the development of ORD Research Plans and Strategies. Our scientists represent the Agency on workshops and task forces addressing major risk assessment, public health, and environmental issues. Outside EPA, we influence the direction and priorities of environmental research worldwide. We steer collaborative research efforts at the national and international level, we are members of international planning committees and research review panels, we serve on advisory boards of other major agencies and organizations, and we serve as adjunct faculty members at major universities across the nation.

Scientific and Technical Assistance. As part of our mission, NHEERL responds to diverse requests for scientific advice and technical consultation, both within and outside EPA. We provide technical support to the Agency by advising EPA Program Offices and Regional Offices on scientific matters, by participating on Agency workgroups, and by helping develop testing and risk assessment guidelines. We bring our expertise to bear at the national and international level by organizing scientific workgroups and symposia, and by serving in professional and scientific societies and on publication boards. We provide guidance to local, state, tribal, and international governments and

other federal agencies, informing them on issues of environmental importance and enabling them to implement more effective environmental programs. We work to establish partnerships with the corporate, public, private, and educational sectors and assist them in setting and achieving environmental goals. We provide technical training and developmental opportunities for the senior scientist as well as the post doctoral candidate and the student. By sharing our skills and knowledge, we enhance the ability of other organizations to protect public health and the environment, and we serve as an important catalyst for scientific and technological progress.

PRIMER ON RESEARCH PLANNING AND RESOURCE ALLOCATION WITHIN NHEERL

Certain functions and operations within NHEERL are expressly governed by federal law. For example, explicit limitations and constraints are placed upon the way in which we obligate research funds. In other instances, NHEERL sets its own policies and procedures, consistent with Agency and ORD guidance. The information below is designed to present the ways in which NHEERL operates with respect to two important responsibilities: research planning and resource allocation.

Research Planning. EPA's research agenda is determined by means of a research planning process involving every organizational level within the Agency. Figure 4 is a simplified diagram of the inter-relationships that exist in research planning. Long-term guidance for research direction is provided by several sources, the most important being **Strategic Plans**. These Plans focus on both organizational issues and research. EPA's Strategic Plan is broad in scope, articulating EPA's mission and its 10 national environmental goals ("GPRA Goals") and offering a framework for effective planning. ORD's Strategic Plan and NHEERL's complementary Organizational Strategy, in turn, are specific to each organization's role within the Agency, though they naturally adhere to the principles and long-term objectives contained in EPA's Strategic Plan.

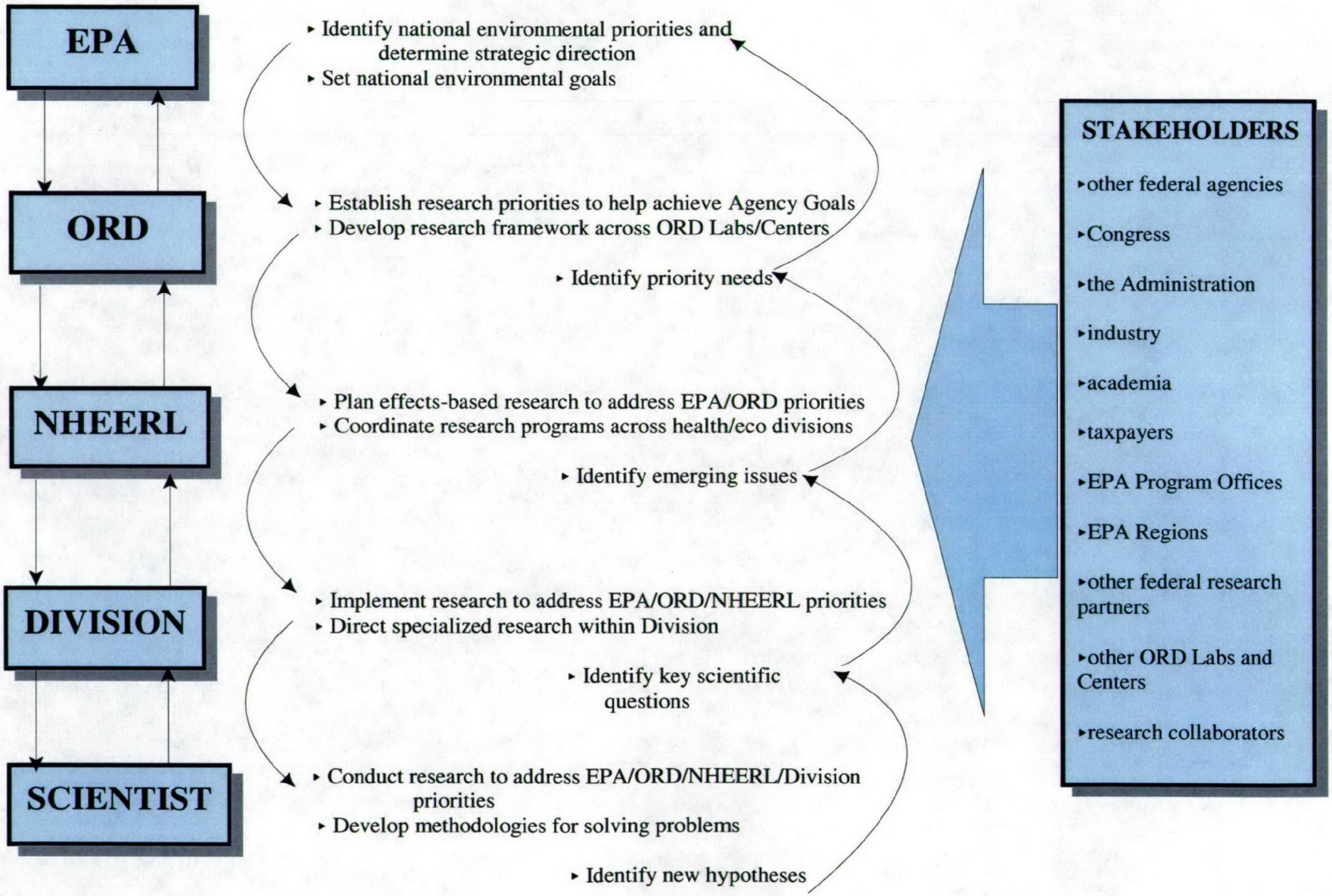
ORD's first Strategic Plan, published in 1996, was pivotal to the research planning process. It instituted a new system, founded on a risk-based approach to decision-making, for determining research priorities. The system uses the risk paradigm to shape the research agenda. Using this risk-based process, ORD has identified areas of greatest potential risk to human health and the environment (see box to right). The selection of these high-priority research topics was conducted in partnership with ORD's many stakeholders, including the external scientific community (EPA's Science Advisory Board, the National Research Council, other government agencies, and the private sector) and the Agency's Program and Regional Offices and scientific staff.

High Priority Research Areas

- Particulate Matter
- Drinking Water
- Clean Water (Aquatic Ecosystems)
- Global Change
- Ecological Risk Assessment
- Human Health Risk Assessment
- Endocrine Disruptors
- Pollution Prevention and New Technologies

Once identified, these high-priority areas have become the strategic targets for ORD research. For each of these topics (plus several other high-profile areas), ORD develops **Research Strategies** and **Multi-Year Plans**. *Research Strategies* provide the conceptual framework for the research, identifying the salient scientific questions associated with each environmental issue.

Figure 4. Research Planning



NHEERL provides input to these strategies when effects-based research is needed by the Agency for which NHEERL can offer its expertise and technical capability. *Multi-Year Plans*, in contrast, are more detailed, specifying the research approaches to be applied to the problems and integrating research across ORD. These Plans are developed with input from all of ORD's Labs and Centers, and NHEERL and its staff play a lead role in their development. From these Multi-Year Plans, NHEERL then develops its own *Implementation Plans* that bring the planning process to the operational level. Implementation Plans are developed by a steering committee made up of representatives from each Division as well as representatives from appropriate EPA Offices. ORD's research strategies and plans are available on the Internet at http://www epa gov/ORD/WebPubs/final.

The preceding description of our long-range planning process and the accompanying documents that serve as blueprints for research is meant to illustrate the interconnectedness of EPA's environmental goals, ORD's research priorities, and the course set by NHEERL to address these priorities. This process establishes research direction for a 5- to 10-year period. We are held accountable for meeting the commitments made under this exercise, and certain measures are put into place to gauge our progress. Table 3 shows more clearly how NHEERL's research is aligned with, and linked to, ORD priorities and EPA goals.

Annual research planning also takes place within the Agency as part of the federally mandated planning and budgeting process. Annual planning in ORD is driven largely by the commitments laid out in the process described above, but in addition, pressing needs may be identified by the Program and Regional Offices and ORD's scientific staff. These needs are then prioritized by Agency-wide teams (called Research Coordination Teams). Special attention is paid to research required to fulfill a legislative mandate, court order, or Agency GPRA commitment; priority setting also takes into consideration scientific feasibility, the status of ongoing research, budgetary constraints, and ORD's ability to make a contribution relative to other research institutions that may be working in the same area The objective is to focus on environmental problems that pose the greatest risks to people and the environment (using criteria such as severity, permanence, scale), on uncertainties in risk assessment that can be effectively reduced, and on areas that clearly help the Agency fulfill its regulatory mandates. These research needs become the priorities for ORD and, in turn, for NHEERL.

While the problems NHEERL is tasked to solve are defined by the above process, the research agenda for solving these problems is determined by NHEERL and its staff (see the Implementation Plans description above). NHEERL structures a coherent research program around the problem areas, with its various divisions playing specified roles. Divisions are held accountable for implementing research activities within the program and for addressing the priorities established through the ORD planning process. Divisional scientists identify the critical paths for research to resolve the key scientific questions and are often the first to raise new questions and recommend new methods for problem-solving. Their suggestions and ideas are fed back into the planning process by several means, the most common being discussions with the appropriate NHEERL Associate Director and Assistant Laboratory Director (ALD) and through the steering committee process, as shown in Figure 4.

Resource Allocation. Each year, EPA develops a budget that defines the funding required to accomplish its goals and objectives. EPA provides its funding targets to ORD, and ORD provides a funding target to NHEERL. When approved by the President and Congress, the enacted budget serves as the blueprint for all Agency activities.

TABLE 3. Alignment of NHEERL's Research with ORD's Research Priorities and EPA's Strategic Goals

ORD RESEARCH PRIORITY	NHEERL RESEARCH TOPIC	EPA Goal 1 CLEAN AIR	EPA Goal 2 CLEAN AND SAFE WATER	EPA Goal 3 SAFE FOOD	EPA Goal 4 SAFE COMMUNITIES	EPA Goal 5 BETTER WASTE MANAGEMENT	EPA Goal 6 REDUCING GLOBAL RISKS	EPA Goal 7 RIGHT-TO-KNOW	EPA Goal 8 SOUND SCIENCE
		1	2	3	4	5	6	7	8
Particulate Matter*	Particulate Matter	●							○
Air Toxics	Air Toxics	●							○
Drinking Water*	Drinking Water		●						○
Water Quality*	Aquatic Stressors		●		○	○			○
Safe Food	Effects of Pesticides			●	○				○
Safe Communities	Health/Ecosystem Effects				●				○
Contaminated Sites	Contaminated Sites		○			●			○
Global Change*	Global Climate Change						●		○
Right-to-Know	Chemical Info. Databases							●	○
Ecosystem Assessment*	Ecosystems Research		○		○	○	○		
Human Health Risk Assmt*	Human Health Research	○	○	○	○		○		
Endocrine Disruptors*	Emerging Risks (EDCs)		○	○	○	○		○	

*ORD's highest research priorities

● Directly contributes to meeting Strategic Goal

○ Supports achievement of Strategic Goal

It is important to note that NHEERL research planning assumes a flat overall budget from year to year. However, when fluctuations occur, resource allocation is adjusted accordingly. Although the funding priority of a research area within NHEERL may shift over time as research is completed or as new problems emerge, NHEERL's overall resources have remained more or less fixed in the recent past. This means that if expenditures (and research) are allowed to grow in one area, spending (and research) in another area must shrink. (As an aside, it should be noted that a limit on NHEERL FTEs is imposed by EPA, and each Division is required to operate with an FTE ceiling.)

In addition to salaries and benefits, travel, and operating expenses (e.g., equipment, equipment maintenance, supplies, training, etc.), NHEERL's resources include those required to sustain our in-house research capabilities, which are generally referred to as "research support" or "infrastructure," and those that augment or leverage our in-house efforts, referred to as "above infrastructure." Above-infrastructure resources become available to the Laboratory through the ORD planning process as the result of initiatives for research in specified high-priority areas. In certain cases, an internal competition is held within the Laboratory for these funds, which are then awarded to investigators whose research proposals are meritorious based on reviews for scientific excellence and programmatic responsiveness. These above-infrastructure resources may be used to provide funding for:

- support contracts (used, for example, for technical support, analytical services, information technology, and animal care);
- competitive cooperative agreements (used, for example, to train post-doctoral candidates); and
- interagency agreements (used to fund collaborative research across federal agencies).

Most resources are managed by the Divisions themselves. However, the management of certain support services, such as computer support and animal procurement and care, is location-based: such services are centrally managed in Research Triangle Park for our health divisions, while the ecology divisions manage these activities themselves due to their geographically separate locations.

It is important to realize that there are explicit limitations – mandated by law – on spending and obligating funds. The law states that spending (by <u>any</u> agency) cannot exceed the amount appropriated by Congress. This means that NHEERL cannot apply for grants from other agencies or institutions, and we cannot increase our permanent technical support staff through the use of external resources. However, NHEERL scientists are encouraged to collaborate both within the Agency (within Divisions, across Divisions, across Laboratories) and outside of EPA. In such cases, external resources may become available. Examples include Interagency Agreements, which foster research across federal agencies, and Cooperative Research and Development Agreements, which allow us to work with industry partners on issues of mutual interest.

NHEERL does <u>not</u> have its own extramural grants program. EPA research grants are handled by ORD's National Center for Environmental Research and are not administered by NHEERL. However, funds may be targeted to topics of importance to NHEERL, thereby expanding the Agency's science and technology base and leveraging our own research.

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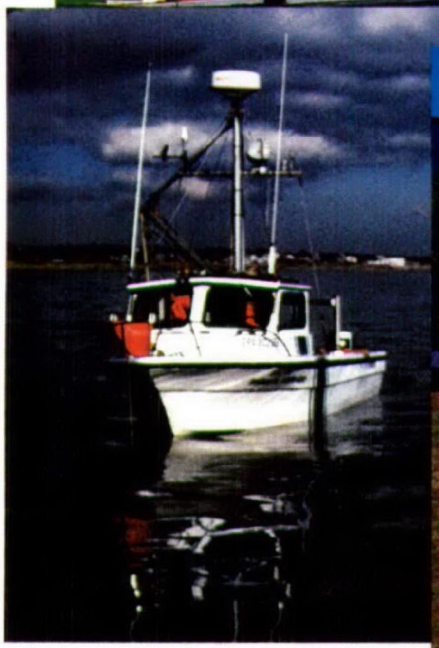
OVERVIEW OF THE ATLANTIC ECOLOGY DIVISION



Overview
of the
Atlantic Ecology Division

The U.S. EPA's Office of Research and Development (ORD) has a unique environmental mission focused at the juncture of core and problem-solving science. ORD's research must provide both a firm scientific understanding upon which to base environmental decisions, and methods to apply that knowledge to protect human and ecosystem health most effectively. To do this, four of ORD's national laboratories and centers focus on principal components of the risk assessment paradigm: exposure, human health and ecological effects, risk assessment, and risk management. A fifth national center provides extramural and quality assurance support. The Atlantic Ecology Division (AED) is one of nine divisions within EPA's National Health and Environmental Effects Research Laboratory (NHEERL). Five of the divisions address human health effects and the remaining four divisions, including the Atlantic Ecology Division, are focused on assessing, diagnosing, and predicting the ecological effects of anthropogenic stressors on the nation's ecological systems.

The research programs of NHEERL focus on the effects of environmental pollutants and other anthropogenic stresses on human health and the Nation's ecosystems. Long-term research at NHEERL is designed to reduce critical data gaps and uncertainties that hinder sound decision-making NHEERL scientists create and apply biological assays, toxicological assessment methods, monitoring and assessment techniques, population and ecological response models, and extrapolation methods needed to improve the scientific underpinnings of the Agency's risk assessments, policies, and regulatory decisions.

Research in each of NHEERL's ecology divisions emphasize particular ecosystem types, levels of biological organization, and areas of geographic focus. The geographical distribution of NHEERL's ecology divisions provides an efficient framework for the kinds of place-based research needed to answer ecological effects questions. Research at AED, located on Narragansett Bay in Rhode Island, focuses on the effects of human activities on the coastal waters and watersheds of the Atlantic seaboard, with particular emphasis on the effects of these activities on populations of fish, shellfish, and aquatic-dependent wildlife.

Within this context, AED supports the overall mission of the Agency in three ways: conducting scientific research, providing scientific and organizational leadership, and supplying technical advice to EPA Program Offices and Regions. AED's mission is to perform research to identify and quantify the ecological effects of anthropogenic stressors on coastal waters and watersheds of the Atlantic seaboard. Research conducted at the AED advances scientifically sound approaches needed to monitor trends in the ecological condition of the coastal water bodies and watersheds, identifies impaired watersheds, and diagnoses causes of ecological impairment. Research at the Division also develops stressor-response data and effects models for chemical pollutants and non-traditional anthropogenic stressors to reduce uncertainties in risk assessments and support the Agency's restoration and remediation decisions A third component of AED

research advances the scientific underpinnings of risk assessment by developing population risk assessment models and extrapolation methods. AED has the capability to sustain the major effort needed to attack significant Agency challenges and take on emerging issues as needs change and problems are solved.

History of the Research Facility at Narragansett

Today's Atlantic Ecology Division was originally founded as one of seven National Water Quality Laboratories authorized by Congress in 1961 to conduct water pollution research for the Pollution Control Administration of the Department of Interior. The laboratory began operations with a small staff temporarily assigned space at the University of Rhode Island. In 1966, the laboratory staff moved to temporary quarters in West Kingston, RI. During this period a modified barge moored at the head of Great Salt Pond provided wet laboratory space and flowing seawater needed to culture organisms and develop test methods. Re-authorization of the Federal Water Pollution Control Administration in 1970 created the U S Environmental Protection Agency and the Rhode Island laboratory was transferred to the newly formed agency. The laboratory, now designated the Environmental Research Laboratory–Narragansett, moved to its present location in 1974 in a laboratory that formerly housed a U.S. Public Heath Service Shellfish Sanitation Laboratory. Construction of new analytical laboratories, wet lab, and seawater systems, as well as major renovation of the building's existing facilities, were completed in 1977. In 1984, the Field Station in Newport, Oregon, was administratively assigned to the ERL-Narragansett. The basic organizational structure of the laboratory was established in 1989 when research activities were assigned to four research branches, three in Narragansett and one in Newport, Oregon, with an administrative support staff located in Narragansett. The Newport branch obtained new research laboratories, a library, and new seawater systems in 1990. Following the 1995 reorganization of EPA's Office of Research and Development, the facility in Narragansett was designated the Atlantic Ecology Division within NHEERL; the Newport field station was reassigned as a branch of NHEERL's Western Ecology Division in Corvallis, Oregon. Since 1995, AED has added a research greenhouse and office wing. The Division is currently in the initial planning phase for a 5-year multi-million dollar renovation of its wet and dry laboratory spaces.

Since its inception, the Division has been at the forefront of marine toxicological research, trace pollutant chemistry, and coastal marine ecology. Products of AED research over the history of the Division contributed to the scientific underpinnings for water quality criteria, effluent test methods, and risk assessment techniques needed by the Agency to identify and evaluate the effects of toxic chemicals in coastal waters. More recently, AED has made great strides in developing, testing, and transferring monitoring designs and indicators to assist coastal states monitor the condition and diagnose causes of impairment of coastal water bodies. Through research, leadership, and technical assistance, the Division has a long history of contributing to the protection of Nation's aquatic ecosystems.

The Integrated Mission of ORD, NHEERL and AED

The mission of the Atlantic Ecology Division is to provide scientific information that will be used by the Agency to assess and predict the effects of pollutants and other anthropogenic stressors on coastal ecosystems of the Nation's Atlantic Seaboard. The Division accomplishes its mission in partnership with counterparts within NHEERL, other ORD laboratories, EPA Program Offices and Regions. Partners in this endeavor include public and private research organizations, States, Tribes, other federal agencies and international organizations.

To meet the information needs of the Agency, ORD's national laboratories and centers strive to integrate problem-driven and core research programs. Problem-driven research aims at solving scientific problems arising from specific regulatory authorities, such as implementation of federal Clean Water, Clean Air, and Superfund legislation. As such, it is designed to strengthen and improve the scientific basis for regulatory approaches that have proven effective and may be currently employed by EPA Offices and Regions. Core research addresses cross-cutting, often multi-media, and future Agency challenges needed to advance the scientific basis for risk assessment. The core research program is designed to provide fundamentally new tools and approaches that take advantage of new and emerging knowledge and technical advances.

To support and complement areas of expertise in other NHEERL and ORD Divisions, AED's research activities primarily fall within the disciplines of coastal marine ecology, aquatic toxicology, and marine chemistry. Consistent with NHEERL's role and mission, AED's research is planned and executed as part of multi-organizational programs that are designed to improve the ability of the Agency, coastal States and Tribes to (1) monitor and assess the ecological condition of coastal ecosystems; (2) identify impaired waters and diagnose the causes of impairment, and (3) develop predictive models of population responses and ecological condition under varying stressor combinations and loads. Underlying the advancement of assessment, diagnostic and predictive capabilities is the development of stressor-response data that link chemical and non-chemical stressors to response and effects endpoints of high ecological or societal value.

Division Research Planning

Research planning at AED is hierarchical and takes place at several levels within the organization AED research scientists participate in planning for strategic, long-term programs within EPA and ORD that produce multi-year plans and issue-specific strategic research plans. As multi-year plans are developed, AED researchers participate in cross-divisional teams that organize and coordinate implementation of research efforts across NHEERL.

To facilitate research activities across the Laboratory, NHEERL has established a research and implementation process that links the broader strategic research directions identified by ORD's planning process to specific research activities conducted by each division's scientists. The goal of NHEERL's process is to improve the responsiveness of each Division's research to high-

priority Agency needs as well as coordinate research across Divisions. This planning effort involves appropriate research scientists and managers from multiple divisions The product of NHEERL's planning effort is a research implementation plan that highlights key uncertainties and the approach – the critical path – that will be taken across the Laboratory to attack key scientific questions over a 5- to 10-year time frame.

In response to the Government Performance and Results Act (GPRA), EPA established 10 strategic goals to guide its planning and against which to measure its progress. As noted in the Panel's Introduction to EPA's Office of Research and Development, AED's research planning is driven by a hierarchical process designed to address GPRA Goals and Objectives for the Agency. AED currently conducts research in support of five of these goals: Clean and Safe Water (Goal 2), Preventing Pollution and Reducing Risk in Communities (Goal 4), Better Waste Management (Goal 5), Reducing Global Risks (Goal 6) and Sound Science (Goal 8). AED's contributions to multi-year and cross-divisional research that addresses these strategic goals are provided in the table below.

GPRA Goal	Agency Problem	Primary ORD Research Focus	Research Implementation Focus for AED
2	Clean, Safe Water	Aquatic Stressors	Nutrient criteria Habitat criteria Clean sediment criteria Effects of toxic chemicals Diagnosing impairment
4	Safe Communities	Ecosystem Effects	Population modeling
5	Better Waste Management	Contaminated Sediments	Effects of contaminated sediment
6*	Reducing Global Risks	Global Climate Change	Long-term watershed response
8	Sound Science	Ecosystem Assessment Ecotoxicological Models Emerging risks	Assessing ecological condition Identifying ecological impairment Endocrine disruptor effects* Integrating ecological response and socio-economics

* 1 FTE or less of effort and not presented for review.

Once the direction of new research is determined through the development of Multi-Year Implementation Plans, Division teams design specific activities by prepare Divisional Research Implementation Plans. This document details the specific objectives, approach, products, time

line, quality assurance and quality control plans, as well as health, safety and animal care plans for the body of research.

AED's Branch Chiefs have primary responsibility for implementing assigned components of the Division's overall research program. These assigned components are defined by branch missions, guiding strategic planning documents, and the research priorities established by ORD's Research Planning Processes. Branch Chiefs provide leadership for the programmatic, organizational, and administrative aspects of scientific research planning, implementation, and technical transfer necessary to accomplish the Branch research mission. The Division's Branch Chiefs are responsible for organizing the research staff under their supervision in a manner that most effectively and efficiently accomplishes the Branch research mission and contributes to the Division's pursuit of NHEERL, ORD, and EPA Strategic Goals. As the Division's first line supervisors, Branch Chiefs are accountable to the Division Director for both the individual productivity and morale of the researchers under their supervision and, as members of the Division's Management Team, for the productivity and morale of the Division as a whole. Branch Chiefs will manage the scientific research within their branches with due consideration of established commitments, new opportunities, Agency priorities, staff and facility capabilities, career opportunities and available resources To accomplish this end, Branch Chiefs may employ more or less formal teams or ad hoc research groups formed under the technical leadership of staff scientists. Depending on the nature of the Branch's research assignment, a Branch Chief's expertise may be appropriate to include in Branch-level, Divisional, or inter-Divisional research efforts. Similarly, some matrixing of employee expertise across Branches and NHEERL Divisions may be necessary to complete a research assignment. Integration and coordination of the Division's research portfolio is the responsibility of the Branch Chiefs and Associate Director for Science, all of whom report to the Division Director as members of the Division's Management Team.

Division Research Program

The Division's research programs are organized, as reflected in this notebook, around three main themes and the strategic research plans that guide its current research. In addition, we will describe one important emerging area of work that is in its early stages of development. Research accomplishments since the last Divisional Peer Review in 1997 are highlighted as well as directions for future research.

The research will be presented as follows:

Monitoring, Assessment, and Diagnosis Research

GPRA Goal 8	Condition of estuaries and streams
GPRA Goal 8	Identifying ecological impairment
GPRA Goal 2	Diagnosing ecological impairment

Extrapolating Effects to Populations

GPRA Goal 4 & 8	Population modeling
GPRA Goal 2	Loon/mercury demonstration

Developing Stressor-Response Relationships

GPRA Goal 2	Nutrient effects
GPRA Goal 2	Habitat alteration
GPRA Goal 2 & 5	Contaminated sediment effects

Integrative Research

GPRA Goal 8	Integrating ecology, human health and socioeconomics

Each of the first three of these major areas is introduced with an overview of the programmatic directions and major objectives of the research area.

Leadership and Advice

As explained above, in addition to conducting research, AED is responsible for providing leadership and technical advice to the Agency and broader community of environmental researchers and clients. Inventories of AED contributions in these areas are provided under separate tab in this booklet.

Ensuring Quality

AED is committed to producing high quality research products and has a system in place to ensure their quality. AED has an independent Quality Assurance (QA) Officer housed in the Office of the Division Director that is responsible for overseeing the Division's Quality Management System. The system includes three tiers of documentation:

- The Quality Management Plan (QMP), which outlines our commitment to quality and specifies how quality assurance issues will be addressed.

- Research Implementation Plans (RIPs), which document the research planning process and provide project-specific directions for obtaining the type and quality of environmental data needed for the intended use. RIPs also provide project – and activity – level quality assurance plans.

- Quality assurance (QA) records such as calibration records, laboratory notebooks and field data sheets, QA-related memoranda and narratives, and other records created at the bench level which document execution of the research. Researchers have the benefit of being able to refer to AED's collection of almost one hundred current or archived laboratory operating procedures to assist them with their routine activities.

We also maintain a comprehensive records management policy with provisions to link QA documentation to research products via the "Study File" concept. Together with regular QA reviews by Team Leaders, our Quality Assurance Officer, AED management, NHEERL's Quality Management System, and EPA's Quality Staff within the Office of Environmental Information, AED's quality system helps to ensure that our research products are of the highest quality necessary. In addition to technical systems reviews, AED routinely takes part in the annual laboratory inter-comparison exercises sponsored by the National Institutes of Standards and Technology and the National Research Council of Canada This annual performance evaluation demonstrates the continued capability and quality of our analyses.

To ensure that the research staff is aware of the Quality Management System and other QA issues, the QA Officer meets with each of the three AED Branches as necessary. The topics covered in each short presentation have included the AED Quality Management System, guidance on the treatment of laboratory and field notebooks, AED's on-line research planning tools documentation system, and a discussion of quality control responsibilities.

As part of AED's pursuit of continuous quality improvement, AED's Quality Assurance Committee receives input from bench level scientists from different disciplines within the Division The Committee's responsibilities are to assist in the review of the QMP, assist with QA reviews from time to time (if appropriate), and bring quality assurance issues up for discussion at Committee meetings and to the attention of the QA Officer. Recognizing that treatment of research organisms is a quality control issue, the most recent products of the Committee include AED's Animal Care and Use Policy document and AED's Animal Care and Maintenance Practices and Procedures.

Primary Clients and Types of Research Products

AED's research and staff support a wide community of environmental interests, including, over the past 5 years, such diverse users as environmental managers and scientists in EPA's Offices of Water, Pollution Prevention and Toxic Substances, Solid Waste and Emergency Response and Air, as well as several EPA Regions, numerous State agencies, the U.S. Navy, the U.S. Army Corps of Engineers, and a variety of international, academic and non-governmental organizations. AED research products, while having wide-spread implications and uses, also immediately respond to the needs of a few key clients. Given AED's mission, both past and present, it is not surprising that EPA's Office of Water (Office of Wetlands, Oceans and Watersheds and the Office of Science and Technology), as well as the EPA Regions bordering the Atlantic Coast (Regions 1, 2, 3 and 4), have come to rely on AED expertise to support technical aspects of their programs. Other agencies having mandates that include aquatic environments, such as the National Oceanic and Atmospheric Agency (NOAA), and the US Geological Survey (USGS), are also principal clients for the results of AED research.

As a research organization, AED contributes to the state of science through peer-reviewed journal articles, book chapters and workshop proceedings. Other types of products provided by

AED include

- sediment criteria benchmark and water quality criteria guidance documents
- risk assessment methods and case studies
- geographic information system (GIS) maps, posters, models, data and analyses
- environmental monitoring designs
- population and ecological simulation models
- environmental database and information management systems
- World Wide Web sites for distribution of environmental information, including the design and maintenance of the EMAP monitoring database and Web sites supporting interagency work in EPA Regions 2 and 3
- marine organism culture methods
- sediment toxicity identification evaluation (TIE) methods

Activities In Response to October 1997 Peer Review

AED outlined the initial steps it would take to build on the strengths recognized by the panel and address areas identified as weaknesses and opportunities in its written response to the 1997 Peer Review Report. Since 1997, AED has pursued a combination of strategic and tactical approaches in response to the Peer Review Report. Activities in five of the salient points raised in 1997 include:

1 Developing the skill mix needed to address a new mission by hiring ecologists, avoiding parochialism, and aggressively recruiting new staff.

Since 1997, staff attrition at AED has averaged about 3.5%, or about 2 positions per year, divided almost equally between scientific and administrative positions The Division has filled eight scientific positions that turned over during this period after nation-wide competitive searches. Of the eight recent scientific hires, all but one were targeted toward entry- or mid-level scientists with expertise in coastal ecology. In a manner consistent with the recommendations of the 1997 Panel, these scientists were hired to bring fresh ideas and expertise in the areas of wetlands ecology, benthic community ecology, nutrient dynamics, population modeling, spatial analysis, ecosystem theory and modeling. In addition to hiring ecologists and modelers, the Division has continued to align its scientific workforce to its ecological mission by supporting specialized and long-term training, participating in NHEERL-wide cross-divisional research, building vigorous pre- and post-doctoral programs, and developing collaborations with other Federal, State, academic, and private research establishments. In addition, AED encouraged and sponsored staff exchanges, visits and rotational assignments within and outside the Division.

2. Exploring alternate strategies to pursuing single-number criteria

The previous Peer Review Panel, citing the complexity of coastal ecosystems as a reality that demands sophisticated and realistic approaches to ecosystem protection, cautioned the Division against relying too heavily on research in pursuit of "magic number" criteria, indicators, and thresholds of ecological effects. Since 1997, AED's contributions to NHEERL's current research effort have been guided by strategic research plans for EMAP, Aquatic Stressors, and Wildlife Risk Assessment. These plans provide critical paths for research that specifically address the need to improve the scientific foundations of existing regulatory approaches, but also call for new methods, models, indicators and data that will lead the Agency beyond single-species, single-chemical, single-media criteria. AED's response to this need can be seen in contributions to the National Coastal Assessment, a nation-wide multi-factor assessment of the condition of the Nation's coastal waters, as well as development and application of spatially-explicit population models, habitat effects research, and the NHEERL-wide focus on a common set of risk assessment endpoints (populations of fish, shellfish and aquatic dependent wildlife) for its stressor-response work. In all this work, there is the explicit understanding that anthropogenic stressors are multi-dimensional and are expressed against a background of natural variability.

3. Developing strategic watershed studies linked to estuarine effects research and searching for the balance in intensive and regional studies.

In 1997, the Panel noted that although AED's mission calls for watershed-level studies, little work at that scale was actually underway. At the same time, the panel recognized that, given the size and skill mix of AED's workforce, the Division faced a dilemma in finding the ideal balance among laboratory-scale, locally-intensive, and regionally-relevant research. While the basic elements of this dilemma remain, AED has developed three approaches to achieve proper balance, responsiveness and "extrapolability" of its research to the coastal systems of entire Atlantic coast. The first, and perhaps most important, is the explicit recognition that AED research flows from and contributes to NHEERL's overall ecological research program. The overall program is national in scope, addresses multiple stressors at multiple spatial scales and habitats, and requires contributions and interactions across NHEERL divisions from multiple scientific disciplines. This means that AED's contributions to, for example, nutrient or habitat alteration effects research at the scale of sub-watersheds and small catchments in New England are part of an overall national program addressing similar stressors and assessment endpoints at different spatial scales in the Great Lakes, Gulf Coast and Pacific Northwest. The second approach, which is closely allied with the first, involves leveraging research conducted by partners and collaborators outside of NHEERL. For example, AED's Loon-Mercury case study in support of Wildlife Risk Assessment is a component of much larger multi-divisional effort that links spatially explicit population models being developed both at AED and WED with American kestrel feeding studies being carried out by the U.S. Geological Survey in Maryland and field data being collected by a host of academic and private organizations throughout the northeast. The third approach is to strengthen our ability and capacity to provide the Agency with environmental data. For example, AED's contributions to ORD's EMAP program has moved beyond developing and testing coastal probability-based monitoring designs and

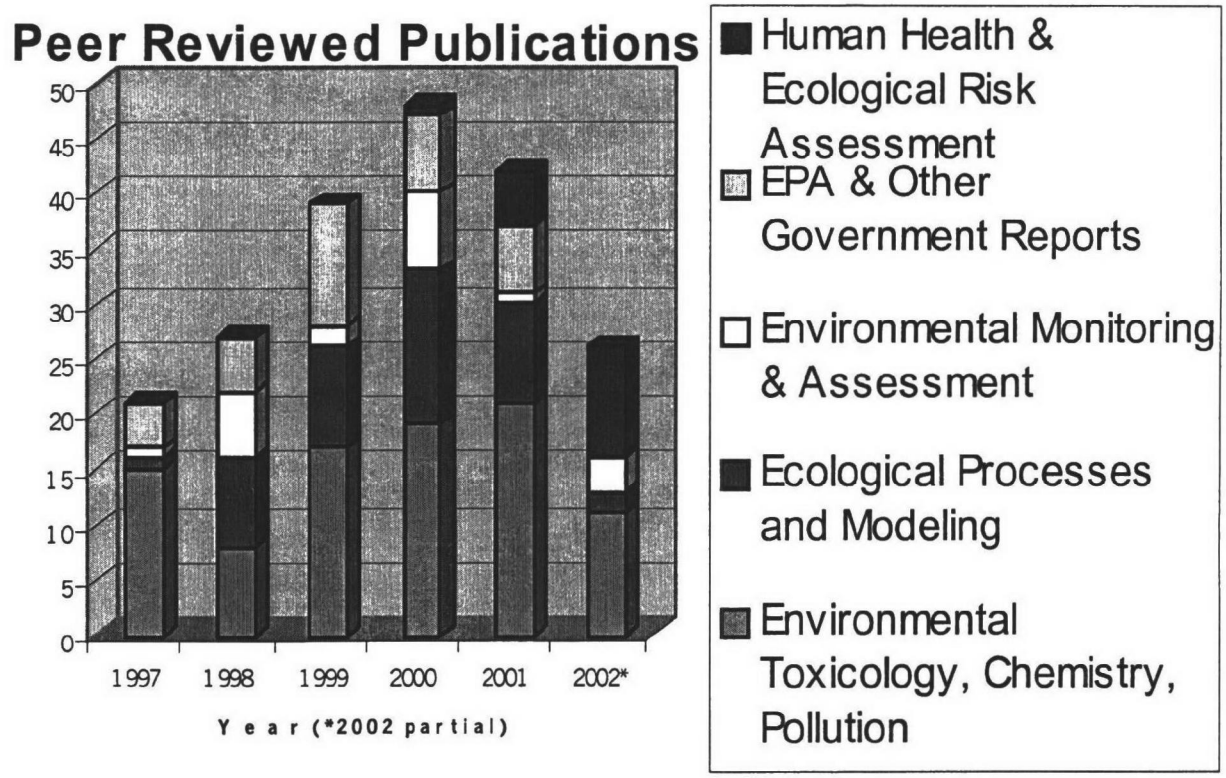
indicators toward much more sophisticated interactions with coastal States and their regulatory agencies. The Division now works closely with the States themselves to develop monitoring programs, assessment products, and local capacity for the States to meet their water quality monitoring and water body listing requirements under the Clean Water Act. Data generated by the States can then be used by the Division in the development of scientifically sound assessment products.

4. Developing greater visibility, impact, and leadership in coastal research by publishing in a wider variety of journals.

The 1997 Report observed that with AED's excellent research facilities, relatively stable resource base, and its committed and enthusiastic scientific workforce, the Division was poised to raise the bar both in terms of its visibility and impact in the area of coastal ecosystems research The panel made several suggestions that could improve the Division's leadership position, such as increasing overall productivity and reaching a broader scientific audience by publishing in wider range of journals – high-profile ecological journals, in particular. The breadth and depth of AED's leadership activities, technical support, and outside recognition are detailed elsewhere in this notebook. Here we highlight the Division's publication record which, as shown in the figure below, has improved substantially since 1997. In addition to increasing the number of peer-reviewed articles by AED authors, the distribution of the Division's contributions to the peer reviewed literature has also changed. Prior to 1997, although AED research had appeared in fairly wide range of journals, the majority of AED's contributions and professional affiliations were, as noted by the prior panel, to be found in a relatively small number of toxicology journals, especially *Environmental Toxicology and Chemistry*. Since then, research reports from AED authors have appeared in more ecological journals, including *Estuaries, Marine Ecology Progress Series, Limnology and Oceanography, Hydrobiologia, and Estuarine and Coastal Marine, Environmental Monitoring and Assessment*. In terms of both numbers and audience, AED has made significant progress toward reaching a broader scientific audience.

5. Focusing and integrating research within and outside the Division.

The 1997 Report highlighted the need for better integration and collaboration within and among what, at the time, were AED's four Research Themes. The Themes provided structure and direction during an important transition period for the Division and were designed with a 5-year planning horizon. As illustrated in the sections of this Briefing Book and the structure of the



supporting presentations and poster sessions, AED has further refined and focused its research activities in response to the top-down priorities of ORD's research planning process. AED's themes positioned the Division to move almost seamlessly into three main areas of NHEERL-wide research that now constitute the main thrust of its research agenda. Over the past 10 years, the number of research projects at AED has declined steadily from a high of 25-30 in the early 1990s, to the dozen or so activities that supported AED's Research Themes in the mid-1990s, to the nine research areas presented in this review. Even more important than the number of research areas is the fact that all but about 2 FTE of scientific effort in AED's research portfolio are conducting research that falls along the critical paths defined by only three NHEERL-wide research Strategies: Monitoring and Assessment (EMAP), Aquatic Stressors Research, and Wildlife Risk Assessment. These strategies, and the Agency problems they address, provide the focus, integration, and framework for outside collaborations for AED research.

Resources and Infrastructure

AED strives to provide the resources and infrastructure required to conduct outstanding research and develop quality research products. Infrastructure includes state-of-the-art laboratories, equipment and supplies, environmental data management and analysis systems, advanced communication systems, field sampling equipment (including boats), and the human resources (including those provided by extramural funding) needed to support the mission and program goals. The necessary support and infrastructure needed to accomplish the research is identified through AED's research implementation process. AED's management is committed to addressing human resource and infrastructure needs effectively and proactively.

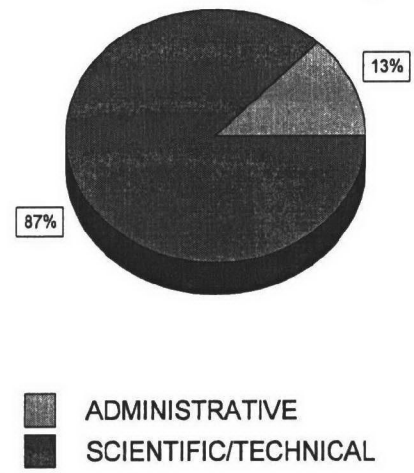
I. Human Resources

AED workforce demographics

The AED federal workforce is comprised of 82 employees, including 4 postdoctoral appointments. The mix of professional disciplines, administrative support, and other infrastructure positions (postdoctoral positions, ADP support, and physical plant) reflects the AED mission and program goals.

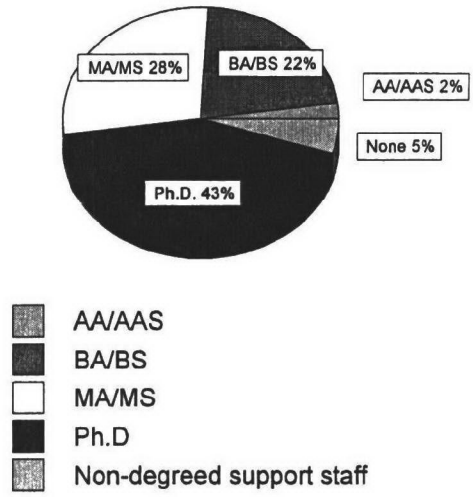
The diverse AED staff consists of permanent or term federal employees with diverse backgrounds. Most staff are full-time employees. Nearly all are in the three research Branches (Ecological Response, Ecosystem Analysis & Simulation, and Indicator Development), although several reside within Program Operations Staff or the Office of the Division Director. The vast majority of staff are assigned in the scientific and technical areas with a small proportion assigned to administrative and support functions. Figure 1 shows the relative percent of professional and scientific staff to administrative and support staff for the Division.

Figure 1. Ratio of administrative to scientific/technical staff



AED's staff are highly trained individuals from colleges and universities all over the country and the world. Over 95% of the federal staff hold degrees, with the following breakdown of highest degrees held: 43% hold Doctoral degrees, 28% hold Master degrees, and 22% hold Bachelor degrees (Figure 2).

Figure 2. Staff education level--highest degree held



The majority of staff hold degrees in Biological Sciences or Marine Science and Oceanography (Figure 3). As expected, over 50% of the staff are trained in the biological, physical or chemical sciences (58%). Thirty-percent received specialty training in Marine Sciences and Oceanographic disciplines. Thirty-five percent hold degrees in various related disciplines including Physics, Natural Resources Development, Aquaculture, and Fisheries. Table 1 lists staff members, highest degree attained, and field of study.

Figure 3. Degree fields of study

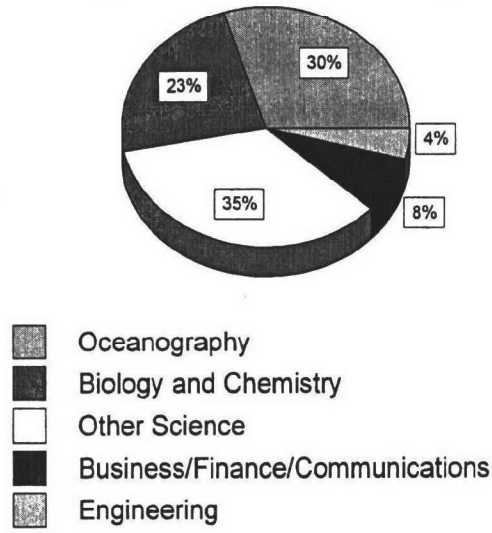


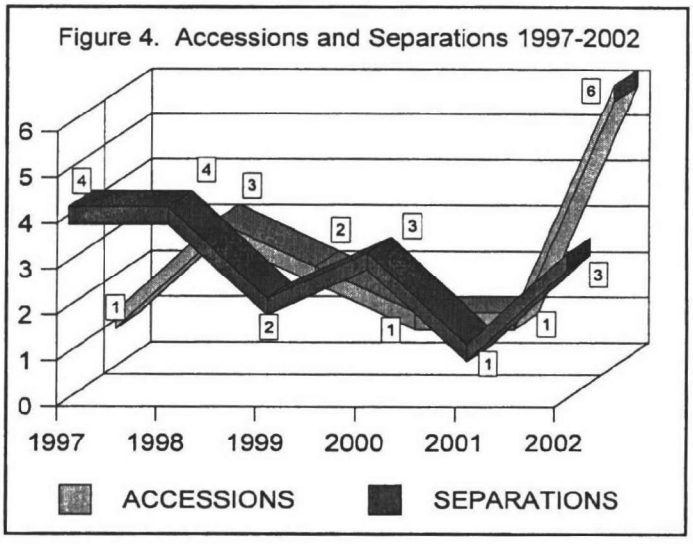
Table 1. Federal employees in AED's workforce

Last Name	First Name	Highest Education Degree	Major Field of Study
PHEIFFER	THOMAS	MS	AGRICULTURE
KUHN-HINES	ANNE	MS	AQUACULTURE NUTRITION
LUSSIER	SUZANNE	MS	AQUACULTURE SCIENCE
NACCI	DIANE	Ph D	BIOCHEMISTRY
NORWOOD	CURTIS	Ph D	BIOCHEMISTRY
ZAROOGIAN	GERALD	Ph D	BIOCHEMISTRY
BERRY	WALTER	Ph D	BIOLOGICAL OCEANOGRAPHY
CICCHETTI	GIANCARLO	Ph.D.	BIOLOGICAL OCEANOGRAPHY
HALE	STEPHEN	MS	BIOLOGICAL OCEANOGRAPHY
MELZIAN	BRIAN	Ph.D	BIOLOGICAL OCEANOGRAPHY
PESCH	GERALD	Ph D.	BIOLOGICAL OCEANOGRAPHY
GLEASON	TIMOTHY	Ph D	BIOLOGICAL SCIENCES
MILLS	LESLEY	MS	BIOLOGICAL SCIENCES
MUNNS	WAYNE	Ph D	BIOLOGICAL SCIENCES
NELSON	WILLIAM	Ph D	BIOLOGICAL SCIENCES
SANTOS	ANTELMO	Ph D	BIOLOGICAL SCIENCES
THURSBY	GLEN	Ph.D	BIOLOGICAL SCIENCES
DAVEY	EARL	Ph D.	BIOLOGICAL/CHEMICAL OCEANOGRAPHY
PESCH	CAROL	MS	BIOLOGY
ROCHA	KENNETH	BS	BIOLOGY
STROBEL	CHARLES	MS	BIOLOGY
TAGLIABUE	MARK	BS	BIOLOGY
BRADLEY	MARY	MS	BUSINESS
ZAMBRANO	ELLEN	AAS	BUSINESS
SAKIEWICZ	CAROL	MS	BUSINESS ADMINISTRATION
BURGESS	ROBERT	Ph D	CHEMICAL OCEANOGRAPHY
HO	KAY	Ph D	CHEMICAL OCEANOGRAPHY
LATIMER	JAMES	Ph D.	CHEMICAL OCEANOGRAPHY
PRUELL	RICHARD	Ph.D.	CHEMICAL OCEANOGRAPHY
BOOTHMAN	WARREN	Ph D.	CHEMISTRY
COBB	DONALD	BS	CHEMISTRY
JAYARAMAN	SAROJA	BS	CHEMISTRY
MCKINNEY	RICHARD	MS	CHEMISTRY
ABDELRHMAN	MOHAMED	Ph.D	CIVIL ENGINEERING
BROWN	BARBARA	MS	CIVIL ENGINEERING
MEUSE	SHEILA	Ph D	COMMUNICATIONS
MENG	LESA	Ph.D.	ECOLOGY
MITRO	MATTHEW	Ph D	ECOLOGY
CHINTALA	MARNITA	MS	ECOLOGY AND EVOLUTION
DELUCA	LYNN	BS	ECONOMICS
GREENBERG	JEFFREY	MS	ELECTRICAL ENGINEERING
BRANDT-WILLIAMS	SHERRY	Ph D	ENVIRONMENTAL ENGINEERING
CAI	TINGTING	Ph D	ENVIRONMENTAL ENGINEERING
CAMPBELL	DANIEL	Ph D	ENVIRONMENTAL ENGINEERING

CANTWELL	MARK	MS	ENVIRONMENTAL SCIENCE
GARDNER	GEORGE	BS	FISHERIES
OSTERMAN	FRANK	BS	GENERAL STUDIES
GALLOWAY	WALTER	MS	GEOCHEMISTRY
KEITH	DARRYL	MS	GEOLOGICAL OCEANOGRAPHY
LAPAN	RICHARD	BS	GEOLOGY
NICHOLSON	MATTHEW	Ph D	LANDSCAPE ECOLOGY
MOORE	WILLIAM	MS	MARINE AFFAIRS
GUTJAHR-GOBELL	RUTH	BS	MARINE BIOLOGY
RUBINSTEIN	NORMAN	MS	MARINE BIOLOGY
BERGEN	BARBARA	Ph D	MARINE CHEMISTRY
LAKE	JAMES	Ph D	MARINE SCIENCE
WIGAND	CATHLEEN	Ph D	MARINE SCIENCE
CARDIN	JOHN	BS	MICROBIOLOGY
CHAMPLIN	DENISE	BS	NATURAL RESOURCE DEVELOPMENT
BENYI	SANDRA	MS	OCEANOGRAPHY
GARBER	JONATHAN	Ph D	OCEANOGRAPHY
KIDDON	JOHN	Ph D	OCEANOGRAPHY
WALKER	HENRY	Ph D.	OCEANOGRAPHY
LIVOLSI	JOSEPH	MS	ORGANIC GEOCHEMISTRY
DETTMANN	EDWARD	Ph D	PHYSICS
RYBA	STEPHAN	BS	RESOURCE DEVELOPMENT
JOHNSON	ROXANNE	MS	STATISTICS
ROSSNER	LAWRENCE	Ph D	THEORETICAL ASTROPHYSICS
HAEBLER	ROMONA	Ph D	VETERINARY PATHOLOGY
TAPLIN	BRYAN	MS	WATER RESOURCES
REGO	STEVEN	BS	WILDLIFE BIOLOGY
HOROWITZ	DORANNE	BS	ZOOLOGY
MILLS	DOUGLAS	BS	ZOOLOGY
PELLETIER	MARGUERITE	MS	ZOOLOGY
PEREZ	KENNETH	Ph D	ZOOLOGY
SERBST	JONATHAN	BS	ZOOLOGY
WINWARD	LAURA	BS	ZOOLOGY
AHLGREN	RUSSELL	ND	
DISTEFANO	LINDA	ND	
JACOX	CARRIE	ND	
JOHNSON	MARY	AA	
STEARNS	LUCY	ND	

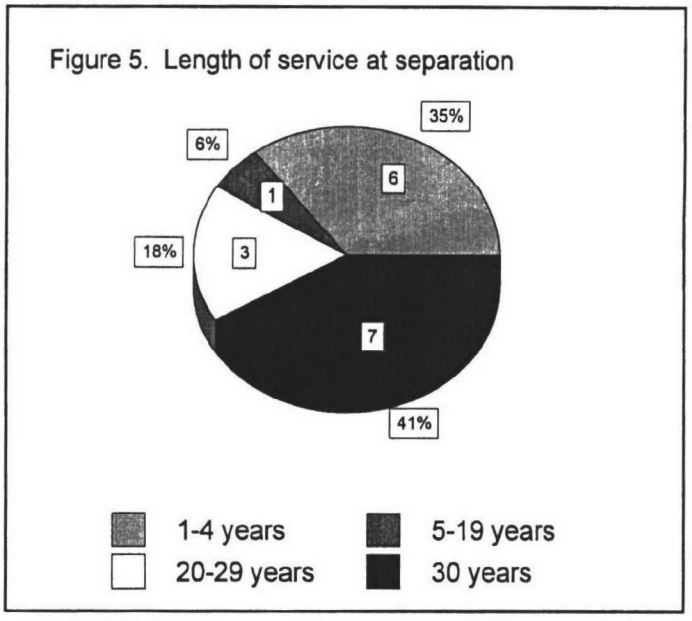
2. Employee accessions and separations history

Figure 4 illustrates the relative stability of the AED workforce over the past five years. Recent small gains in staffing offset prior separations. Figure 5 shows average length of service at separation. Over half (59%) of separations involved staff with over 20 years of service pursuing retirement. Six separations (35%) occurred after only 1-4 years of service. Only 1 employee separated after 5 years with less than 20 years of service.



3. Career development

Opportunities for career development are especially important in a relatively stable workforce. AED emphasizes targeted training opportunities and outside work experiences allowing employees to grow in their experiences and capabilities. AED has excelled in providing training and work experience opportunities for its staff for many years. In 2002, two AED employees were competitively selected to participate in NHEERL's newly reconstituted "Long Term Training Program." This program addresses the need for scientific career development to meet changing Agency needs.



4. On-site contractors, interns, co-operators, pre- and postdoc associates

In addition to the 82 federal employees who make up the core of AED's scientific and administrative workforce, an additional 59 non-federal personnel work in the laboratory (Table 3). These individuals support important functions including administrative and secretarial services, building maintenance, library services, security, and glassware preparation. Non-federal staff also include student interns, trainees, undergraduate students, pre-doctoral students, postdoctoral fellows, and visiting scientists conducting research in the facility under various formal agreements.

Table 2. AED's on-site non-federal staff.

Employer Name	Count
BOB HOLTZ SERVICES INC.	9
COMPUTER SCIENCES CORPORATION	16
ENVIRONMENTAL CAREERS ORGANIZATION	2
SENIOR SERVICES OF AMERICA INC	14
OPTIMUS CORPORATION	3
SAI CONSULTING COMPANY	3
SECURITY CONSULTANTS GROUP	9
T&T JANITORIAL SERVICES	3
	59

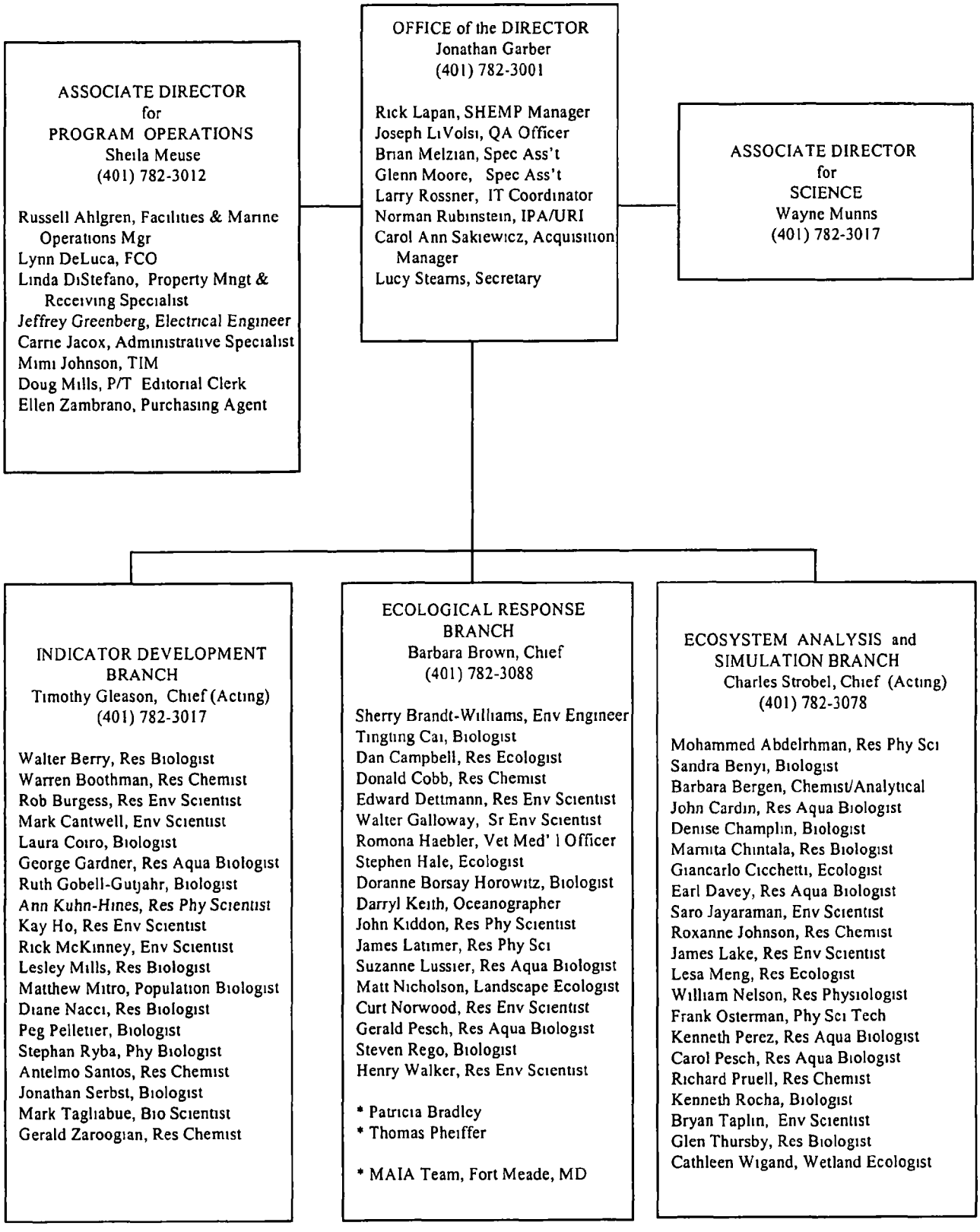
II. Organizational Structure

AED has implemented an organizational structure designed to support attainment of our mission and goals (Figure 6) The Division Director has total responsibility and authority for all aspects of Division operations. The Division Director also functions as an interface with NHEERL senior management, and reports directly to NHEERL's Associate Director for Ecology Supporting the Division Director are the Associate Director for Science and the Associate Director for Program Operations.

First-line research and scientific staff supervision occurs at the level of the Branch. In addition to responsibility for direct supervision and career development of branch staff, our Branch Chiefs support the Division Director in performance of administrative functions. The Branch Chiefs are responsible for the allocation of resources within the respective Branches, including personnel, supplies and equipment, and travel dollars.

To continue to provide optimal organizational infrastructure support for the mission, the organization is evolving to meet current and future needs. To this end, a reorganization plan was submitted through NHEERL to Office of Research and Development (ORD) in July 2002. Approval for implementation has been granted recently, and plans are to begin implementation this fall.

Figure 6 Organizational Chart



III. Other Resources and Infrastructure

Effective allocation of other resources and sound infrastructure is critical to enabling the professional staff to work efficiently and effectively toward and achieve the mission and program objectives. Financial and personnel resources, facility, marine operations and field support, research library resources, Information Technology (IT) and conferencing room capabilities are addressed in this section

1 Financial and Personnel Resources: 1997- 2002

Table 3 provides a summary of the sources of funds (in $K) and numbers of full-time employee equivalents (FTE) for federal employees for fiscal years 1997 to 2002. Table 4 shows FY 2002 allocations by category of expenditure

Table 3. AED Financial and personnel resources (in $K) FY1997-2002.

FISCAL YEAR	BASE R&D (Extramural)	BASE S&E/"E" (Intramural)	Total Base	All Other Sources (Non-Base)	Total $K	FTEE
1997	3,867 30	8,619 80	12,487 10	376 50	12,863 60	82 4
1998	2,613 40	8,631.70	11,245.10	0	11,245.10	81 8
1999	2,010 50	7,892.30	9,902 80	14.20	9,917 00	81 2
2000	1,991 10	9,175 40	11,166 50	31 5	11,198 00	80 7
2001	2,262 60	10,109 40	12,372 00	0	12,372 00	80 7
2002	3,135 80	10,740 30	13,876 10	0	13,876 10	79 7

Table 4. Breakdown of categories of AED expenditures ($K) for FY2002:

Category of Expenditure	Amount ($K)
Salaries	6,722 9
Travel	153 9
Lab Operations	2,598 8
*Facility Support	1,390 9
ADP Operations Ctr	782 6
**Other Contracts	100 1
SEE Coop Agreement	150.0
State Monitoring Coops	1,390.8
***Other Coop Agreements	586.1
Totals	13,876 1

*Includes O&M (1,057 4) Security (169 8), Janitorial (154 0), Pest Control (7) and solid waste (9 0)
**Includes Dishroom (46 7), Sample Analysis (20 8), Peer Review (30 0), and Loon Workshop (2 6)
*** Includes NNEMS (22 0), EOC (160 0), ECO (74 2), SMILE (41 9), and Population Modeling (288 0)

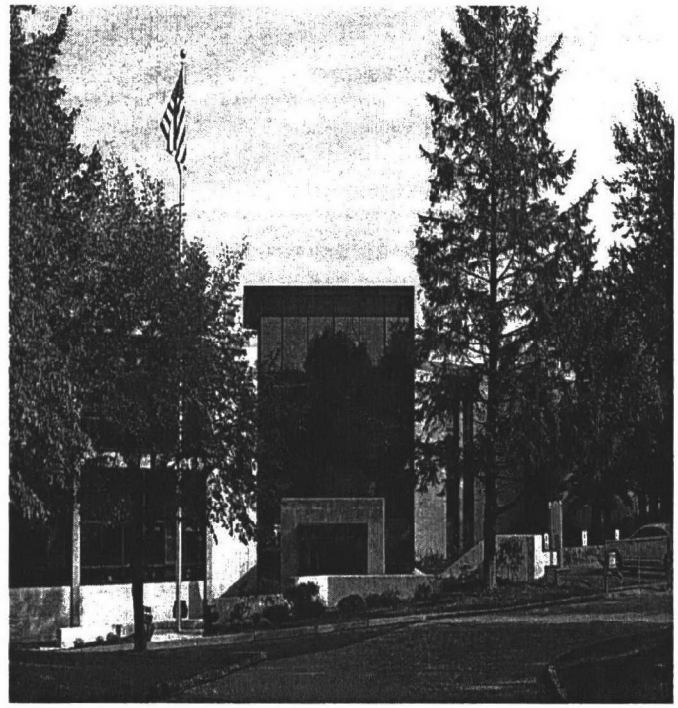
2. Research Support and Facilities: Buildings, Grounds, Facilities and Marine Support

a. Location

AED is located approximately 30 miles south of Providence, Rhode Island, on an 11-acre site overlooking the West Passage of Narragansett Bay. The surrounding area is predominantly rural or residential, with services provided at village-sized commercial centers. The 165-acre Bay Campus is adjacent to AED and houses the University of Rhode Island's Graduate School of Oceanography, the Coastal Resources Center, and the Rhode Island Nuclear Science Center. Also adjacent to AED is the NOAA National Marine Fisheries Service Narragansett Laboratory. The main campus of the University of Rhode Island is 7 miles west of the site. This location is optimal due to access to high quality sea water for experiments and for deployment of marine operations for the Atlantic coastline.

b. Buildings

Front Entrance Main Building



AED's buildings provide 78,600 square feet for research and support activities. The AED campus includes a number of unique or special facilities, such as our wet lab, organic and inorganic analytical chemistry labs, IM/GIS/Training Center, organism culture facilities, and microcosms.

The Main Office and Laboratory are comprised of approximately 58,000 square feet in three buildings:

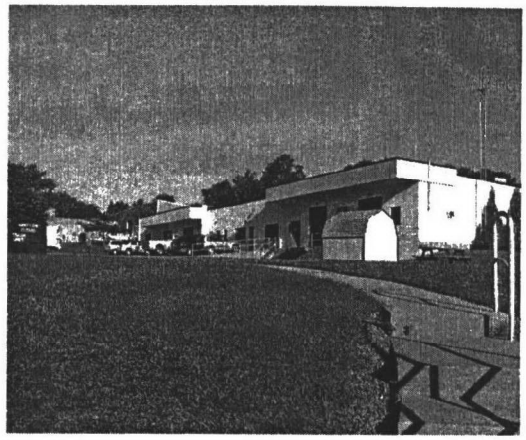
Building 1, is a two-story concreted frame structure providing office space of administrative support functions, computer facilities (GIS lab) and contractor offices.

Building 2 is a three-story structure for wet lab activities and laboratory systems equipment (such as air pressure pumps for the wet lab.)

Building 3 is a three-story high bay, concrete frame structure providing space for chemistry laboratories, a salt water aquarium, wet lab functions and support for wet lab research, sample preparation areas, constant temperature and humidity chambers, flow through seawater, test chambers, office support and storage rooms.

Additional services buildings include:

Support Services Building



- Support Services Building (9,900 ft^2) for receiving, storage, machine and woodworking shops, diving locker facilities, and on-site contractor administration.

- Hazardous Materials Building (1,656 ft^2) provides isolated and segregated storage for bulk chemicals, compressed gases, and hazardous wastes.

- High Hazard Laboratory and Pollution Abatement Building (690 ft^2) houses a containment laboratory for handling and conducting experiments with highly toxic or contaminated materials (upper floor) and the Laboratory's wastewater pre-treatment facility (lower floor).

- Field Operations Building and Boat Maintenance Facility (3,600 ft^2) houses maintenance space for boats and other field equipment. A state of the art vessel storage and maintenance facility was constructed and accepted in 2001. Vessels are stored and maintained in a climate controlled environment, overhead lifts and lighting allow for the outfitting of vessels in a secure, protected environment.

- A small frame cottage provide about 4,000 ft^2 of office space is currently occupied by the U.S. Fish and Wildlife Service under a two-year MOU.

3. Unique and World Class Research Capabilities

a. Wet laboratory

Wet laboratory facilities are especially noteworthy, and occupy approximately 12,500 square feet. Each day approximately 500,000 gallons of sea water flow through the pipes, tanks, wet tables, and aquaria in the wet lab areas. Sea water can be delivered in any combination of raw, filtered (down to 5 microns), heated, or chilled states. Vacuum processing allows suppression of dissolved oxygen levels, and salinity concentration may be tempered with the addition of de-ionized water.

b. Facilities Team and Marine Operations research support activities

In addition to ensuring facility support, the AED Facility and Marine Operations Program provides support to the fleet and equipment used in field activities. An inventory of the available

boats and related equipment (along with specifications) is maintained and available to the science staff to assist in current and future research planning.

The AED Facilities Team provides 24 hour/7 days a week response to science initiatives to include response to alarms generated affecting laboratory functions (monitored by Digital Direct Control (DDC) system), delivery of spare parts or alternate vessels and vehicles to research location, communication support, state-of-the-art mobile Differential Global Positioning Systems (DGPS) compatible with GIS technology (all vessels over 17' have DGPS and global mapping devices and RADAR as noted in Table 6). Professional Captain services are available at researchers' request.

c. Information Center

The Information Center is divided into four main service areas. These service areas include a training room capable of accommodating up to 12 students at six shared PC workstations with: state-of-the-art ceiling mounted projection equipment; a GIS laboratory providing specialized hardware and software to the ADP staff for the entry, analysis, and display of spatially-oriented data, a locked machine room with state-of-the-art security features, including environmental, power, and other physical controls to centrally house the Divisions data servers, other associated LAN equipment, and data archives, and an I-O room for easy access by the user community to commonly needed peripherals such as printers, drives and a digitizer.

d. Research Library

The research library provides scientific, technical, and administrative library services to support Division research and management. Library holdings include: approximately 2700 volumes; technical books; abstracts and databases on disk, CD-ROM, and on-line; theses; journals; selected Codes of Federal Regulations; EPA Research Reports; AED publications collection; and environmental legislation.

e. Conferencing facilities

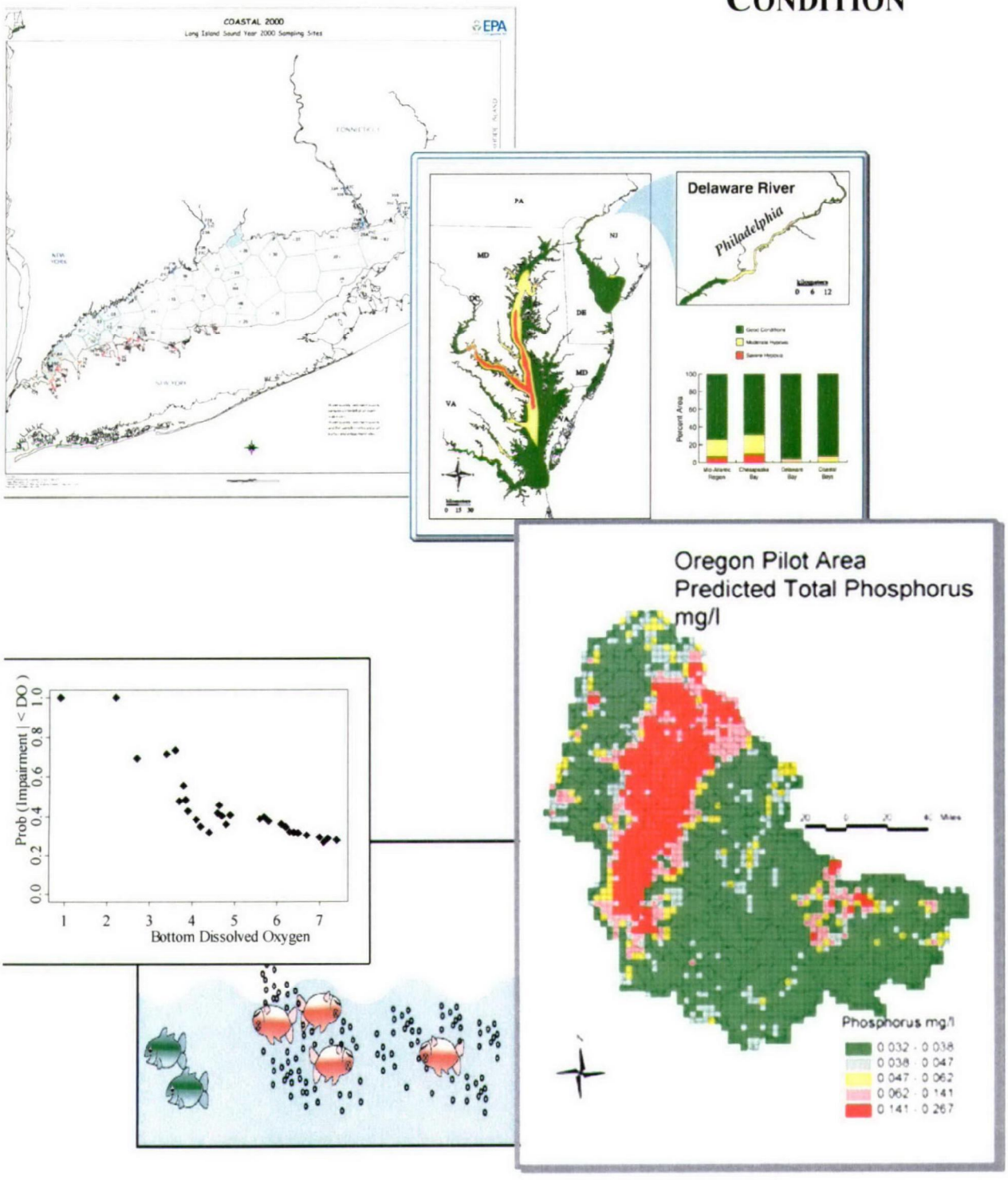
There are two main conference rooms within the main building, in addition to numerous conferencing areas distributed within the work areas suitable for team meetings and small conferences. Conferencing capabilities include video-teleconferencing in addition to the more commonly used teleconferencing.

f. Laboratory Modernization Project

EPA is currently reviewing a five year "road map" for incremental, yearly modernization plans for the Chemistry and Wet Lab functions. We will explore two scenarios to achieve the EPA goal to modernize these Laboratories within the $1,000,000 funding constraint anticipated each fiscal year for the duration of the project. Consideration will be given to mechanical, electrical and plumbing systems (infrastructure) with an eye towards sustainable design parameters. Laboratory fit-outs (case work, fume hoods, finishes both natural and artificial lighting, etc.) with be included

in the upgrades. The project includes a practical emphasis on "Green" design such as recyclable and recycled materials, low impact development construction sequencing and the like. Physical reconfiguration of the laboratory spaces will be in basic accordance with functional space requirements outlined by "Labs of the 21st Century" working groups comprised of end-users.

MONITORING, ASSESSMENT AND DIAGNOSTIC RESEARCH TO CHARACTERIZE ENVIRONMENTAL CONDITION



Monitoring, Assessment and Diagnostic Research to Characterize Environmental Condition Overview

Agency Problem

The mission of the U.S. Environmental Protection Agency (EPA) is to protect human health and to safeguard the natural environment – air, water, and land – upon which life depends. However, during the past decade, concerns have been raised about the Agency's ability to assess and compare risks to ecosystems adequately, to protect and restore them, and to track progress in terms of ecological outcomes. One of the most recent evaluations focusing on this problem in implementing the Clean Water Act (GAO 2000) stated:

> "...[EPA's] National Water Quality Inventory does not accurately portray water quality conditions nationwide. A major reason is that states collectively assess only a small percentage of waters in the United States. ... It would be cost-prohibitive to physically monitor all of the waters in the country, and, therefore, almost all states monitor a subset of their waters. However, most monitoring is not done in a way that allows for statistically valid assessments of water quality conditions in unmonitored waters. In addition, the Inventory is not reliable because wide variation exists in (1) the way that individual states select their monitoring sites, (2) the kinds of tests they perform on their waters and how the results of these tests are interpreted, and (3) the methods they use to determine the causes and sources of pollution in waters that do not meet water quality standards.
>
> As a result, the information in the Inventory cannot be meaningfully compared across states. EPA uses information from the Inventory as a basis for a number of important decisions and activities, such as deciding how to allocate federal funds for Clean Water Act programs to states and measuring and communicating EPA's and states' progress in implementing the act. However, the dearth of the waters actually monitored, combined with the wide variation among states' monitoring and assessment approaches, make the national statistics unreliable and subject to misinterpretation and, therefore, of limited usefulness for these purposes. While these limitations may call into question some of EPA's decisions that rely on these data, there is little doubt among experts that the remaining problems are considerable and that solutions will entail significant expenditures. What is uncertain, however, is the precise extent of water quality problems, where and what the most severe problems are, and the location of high-quality waters that need to be protected."

In response to the concerns expressed over the last decade, ORD has set the goal to provide the scientific understanding to measure, model, maintain and restore the integrity and sustainability of highly valued ecosystems as part of our core research program (GPRA 8). To do this, ORD has organized its research to answer four scientific questions:

- What is the current ecosystem condition, what are trends in this condition, and what stressors appear to have been responsible for harm or deterioration?

- How do biological, chemical and physical processes affect the condition of ecosystems, and how can we most accurately diagnose problems facing ecosystems and forecast future effects?

- What are the relative risks posed to ecosystems by stressors, alone and in combination, now and in the future?

- How can we most effectively reduce risks to protect ecosystems and to restore them once they have become degraded?

The first two questions are the basis for much of NHEERL's research to characterize ecological condition, with an emphasis on. 1) providing tools to monitor ecosystem condition in a manner that reflects the scale of the problem, the causes of harm, and the success or failure of restoration and mitigation efforts; and 2) developing models and methods that help diagnose the causes of degradation to ecosystems and forecast future condition. The third and fourth questions are the focus for much of our ecological effects research and will be addressed in more detail in subsequent sections of this briefing book.

ORD/NHEERL/AED Research Approach

ORD realized that substantial amounts of both time and money were being spent to collect data on ecosystem condition that were neither complete, nor necessarily relevant to understand current conditions. Fundamental research needed to be conducted to improve the science associated with ecological monitoring and therefore, in 1990, ORD created the Environmental Monitoring and Assessment Program (EMAP) to lead its research efforts to develop better monitoring designs and indicators to allow scientifically defensible statements to be made about the ecological condition of the Nation's natural resources. Early in EMAP's history, it became apparent that EMAP alone could not develop designs and indicators for all the Nation's resources, and that a subset of these would have to be chosen. EMAP selected aquatic ecosystems for development because they integrate the atmospheric, landscape, and upstream water inputs, and because EPA has clear statutory mandates related to clean water.

EMAP has made significant progress in developing methods to characterize ecological condition and USEPA's Office of Water is strongly encouraging incorporation of these methods into state monitoring programs (USEPA 2002) It has become apparent in recent years that establishing an understanding of overall condition is necessary, but not sufficient to ensure the protection of aquatic ecosystems. Once overall condition is established, the specific waters which have problems, and the particulars of the causes of those problems, must be identified to allow development of appropriate restoration strategies. For example, in implementing the Clean Water Act, a list of the specific impaired waters must be generated biannually (the "303(d) list").

In addition, once the systems most likely to have problems have been located, confirmation of the problem and diagnosis of the specific cause(s) of that impairment are necessary to develop the most appropriate, cost effective means to restore the ecosystem to its desired state. This is the basis of the Clean Water Act requirement to develop Total Maximum Daily Loads (TMDLs) for impaired waterbodies. The need to identify specific impaired waters and the cause of the impairment has therefore been the basis of much of the piecemeal and costly site-specific monitoring which has characterized aquatic monitoring in the United States over the last 30 years.

To meet the needs described above, ORD's Ecological Research Multi-Year Plan (MYP) outlines several Long-Term Goals (LTGs), including that.

- A national monitoring framework is available for estuaries and streams that can be used from the local to the national level for statistical assessments of the condition and change,

- Methods to effectively monitor trends in environmental condition with known confidence are available to EPA, the States, and Tribes,

- The states and tribes use a common monitoring design and appropriate ecological indicators: to allow a scientifically-valid determination of the status and trends of their aquatic resources; to improve the cost-effectiveness of their environmental programs and policies; and to allow their findings to be aggregated into regional and national determinations to support Clean Water Act 305(b) and GPRA requirements, and

- Tools are provided to assess and diagnose impairment in aquatic systems and the sources of associated stressors

To help address ORD's goals of developing tools to monitor for condition and diagnose cause in a manner which can be implemented in a cost-effective manner by appropriate management agencies, the EMAP Strategy (USEPA 2001) outlines an approach to build the scientific basis, and the local, state and tribal capacity, to monitor for status and trends in the condition of the Nation's aquatic ecosystems. Our approach is based on developing statistically-based sampling designs that are spatially extensive and allow aggregation of monitored data from the local level to the national level. Within this, key scientific issues relating to ecological indicators, ecosystem classification, and reference conditions are being addressed to develop a comprehensive aquatic ecosystem monitoring approach for the nation. EMAP's approach has been to develop the tools and methods to address these issues in particular ecosystem types (or "resources"), test and hone the methods in prototype geographic regions, then transfer the technology nationally to the entities which have responsibility for implementing the monitoring programs. Methods development, demonstration, and technology transfer are well underway for estuaries and wadeable streams. Large rivers is the next priority.

EMAP is also initiating research to determine how to predict the location of the Nation's impaired waters and their cause of impairment in a cost effective manner through development of screening models which incorporate probability-based survey data and landcover/landscape

information to allow identification of the likely locations of impaired waters. Key scientific issues include identification of classifying variables of watershed or ecosystem susceptibility to impairment to allow pre-stratification for sampling and aid in data analysis; identification of landscape characteristics which correlate with metrics of impairment to allow development of empirical relationships that link stressors, effects and characteristic patterns of source and causality; and synthesis of these relationships into statistical models to predict those non-monitored areas which have the highest probability of ecological alteration or impairment.

NHEERL has developed a framework for its ecological effects research on aquatic stressors (GPRA Goal 2, described later in this briefing book). A key component of that work focuses on development of tools to populate a diagnostic framework for resource managers to interpret cause-and-effect relationships of stressors on aquatic systems. Key scientific issues include development of: 1) conceptual ecosystem models based on appropriate mechanisms of action that can be used to improve the accuracy of impairment decisions, and classification frameworks that explain variation in the response of individuals, populations, communities and ecosystems at regional, watershed, water body and habitat scales, 2) single-stressor diagnostic methods and models to determine the primary source of biological impairment of aquatic ecosystems; 3) methods and models to allocate causality among multiple stressors and to diagnose interactions among them; and 4) forecasting methods and models to evaluate the ecological benefits of source reductions, investigate stressor interactions, and assess the gains and losses realized by various alternatives for restoration and remediation. Issue 1 obviously overlaps with similar work in the EMAP development of screening models. The EMAP screening models can be considered a first-stage screening diagnosis, to be followed by a more rigorous, confirmatory diagnosis based on the mechanistic models and protocols to be developed to support specific Office of Water stressors of concern.

Extensive work is needed to address this scale of problems; research effort has therefore been distributed over a number of NHEERL and other ORD laboratory divisions. The basic components in EMAP include: research on monitoring designs, led by WED; landscape modeling techniques, led by NERL's Environmental Sciences Division; information management, led by AED; and a number of geographic initiatives. The Mid-Atlantic Integrated Assessment is led by AED; Western EMAP by WED; the National Coastal Assessment by GED; and a new start, the Central Basin Initiative, is led by MED. Although each of these research areas has a lead division, support from all divisions is critical in each area. NHEERL's diagnostic research is similarly performed by all divisions, with each division having the lead for a particular, regionally-focused case study. These are described in more detail in the diagnostics section of this briefing book.

Organization of Research

To support the approach described above, AED's current research to support characterization and diagnosis of condition is structured in three parts:

- Assessing condition of estuaries and streams (Goal 8)
- Identifying areas of ecological impairment (Goal 8)
- Diagnosing causes of ecological impairment (Goal 2)

Assessing Condition of Estuaries and Streams

As described above, the first step in integrated monitoring and assessment is to describe the condition of the resource at the appropriate scale. ORD's EMAP program has identified the priority scientific needs as: development of design techniques for probabilistic sampling of aquatic resources, identification and development of appropriate measures and indicators of ecosystem condition which can be monitored routinely, and demonstration and transfer of these designs and methods to the agencies responsible for environmental resource management. AED research and development has supported development of EMAP since its inception. AED had the lead for the first project which demonstrated that probabilistic sampling and integrated monitoring of the physical, chemical and biological properties of an ecosystem could be used to assess the condition of estuaries at regional scales (Paul et al.1999). AED was also the lead in the next step of demonstrating that not only could these methods be used, but that multiple agencies could effectively integrate their existing monitoring programs through these methods to assess both regional condition as well as the condition of individual embayments without additional funding (USEPA 1998, in press). AED is now the lead for the Northeastern Component of the National Coastal Assessment, which is building the capacity of state and tribal water quality agencies to incorporate these methods into their base monitoring programs to address their multiple information needs, while at the same time acquiring the data for the first baseline assessment of one class of our Nation's aquatic resources.

A parallel effort has been underway in wadeable streams ecosystems concurrent with the efforts in estuarine ecosystems. AED has been working with the states and NHEERL's Western Ecology Division to develop probabilistic monitoring designs for the wadeable streams for 12 of the 13 northeastern states. AED has also been working with the individual states and EPA Regions to demonstrate the utility of these methods to meet the multiple information needs of the states' base monitoring programs. The ultimate aim is to assist the states in combining the results of both the streams and estuaries monitoring into an overall assessment of the state of their environment.

Identifying Areas of Ecological Impairment

A critical gap remains in our ability to move from overall assessment of ecosystem condition to taking specific management action to restore or maintain the integrity of a particular ecosystem – it is necessary to first identify specific management units that are impaired and diagnose the cause of such impairment Although surveying techniques are now being used that can adequately describe overall system condition, it is often overlooked that data from such surveys contain important information on the actual location being sampled. Furthermore, because surveys to assess overall condition are designed to quantify the variability in the resource being surveyed, sample points usually capture a wide range of conditions present for other resources within the ecosystem. Thus, it is reasonable to expect that if predictable relationships exist

between the resource in question and other more completely measured resources, these relationships can be modeled and used to predict condition of the resource in areas where it is not sampled. AED has begun to evaluate ecosystem characteristics, such as patterns of land cover, for their use in predicting aquatic impairment (Paul et al. 2002). As part of this research, a broad spectrum of ecosystem characteristics that are known from remote sensing, field observation and modeling are being assessed. In addition, the available statistical tools to draw relationships between data are being compared. If reliable models can be developed to identify unsampled resources that are ecologically impaired, then monitoring efforts can be prioritized toward sampling those areas that have a high likelihood of being impaired. Moreover, such models could suggest potential causes of impairment, thus providing important evidence for diagnosis and ultimate mitigation of ecological impairment

Diagnosing Causes of Ecological Impairment

AED's diagnostic research in support of the Office of Water (Goal 2) focuses on the need to diagnose causes of biological impairment within an integrated framework linking watersheds with receiving water bodies to support the Total Maximum Daily Load (TMDL) process. The starting point for diagnostic process is the need to respond to suspected or reported biological impairment, non-attainment of aquatic life use, and other indications of adverse effects (e.g., toxicity, benthic community damage). Initial assessments may also record evidence of multiple potential causes of impairment and conflicting lines of evidence that might complicate a diagnosis. Thus, the goal of the diagnostic process is to both define the primary causes of impairment as well as allocate observed effects among multiple potential stressors, and assess potential interactive effects among stressors.

To narrow the number of possible stressors of concern, diagnostic models and methods are being developed based on the Toxicity Identification Evaluation (TIE) procedures (Norberg-King et al. 1991, Burgess et al. 1996, Ho et al. in prep.). In TIE, toxic stressors are first considered in broad classes, and as the evaluation proceeds, the focus moves to specific toxicants. In this way, large numbers of insignificant toxicants are excluded from further consideration. For example, sediment toxicity may be first classified as being caused by organic contaminants, then narrowed to pesticides, and finally identified as being due to DDT. Analogously, in a multi-stressor diagnostic process, broad classes of stressors (i.e., nutrients, clean sediments, altered habitat, toxic chemicals) would be narrowed to identify the specific stressor or combination of stressors causing the impairment.

To develop these diagnostic methods and models, three specific areas of research and development are being pursued. First is the development of conceptual models based on appropriate mechanisms of action that can be used to provide a framework for understanding how stressors affect ecosystems on an individual and combined basis. Further, these models will improve the accuracy of impairment decision-making by environmental managers in the Regions, States and Tribes. Second, classification schemes are being developed to explain variation in the responses of individuals, populations, communities and ecosystems at regional, watershed, water body and habitat scales. Most importantly, valid classification schemes will provide Regional, State and Tribal environmental managers methods for collapsing the over

40,000 TMDLs into more manageable numbers by aggregating into similar units or water body classes. Finally, a series of case studies are being performed in which diagnostic methods will be developed and the conceptual models and classification schemes applied. The case studies will also provide the best opportunity to integrate our diagnostic methods with stressors-response relationships for nutrients, toxic chemicals and other stressors as developed by other components of our Aquatic Stressors research (described later in this briefing book).

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(References cited in bold signify AED research products)

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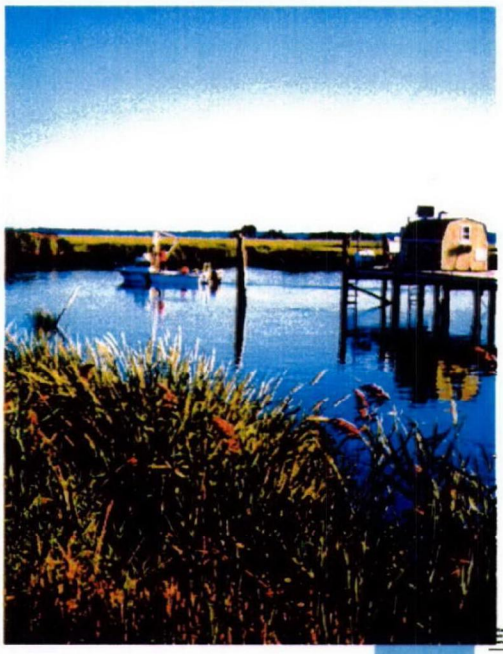
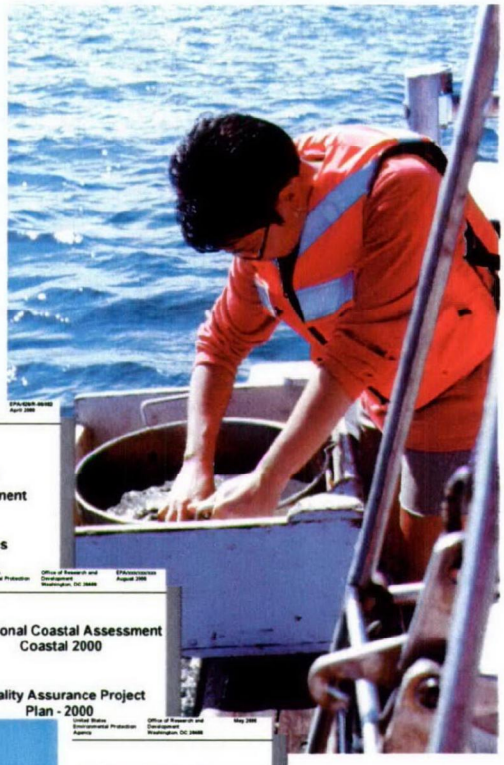
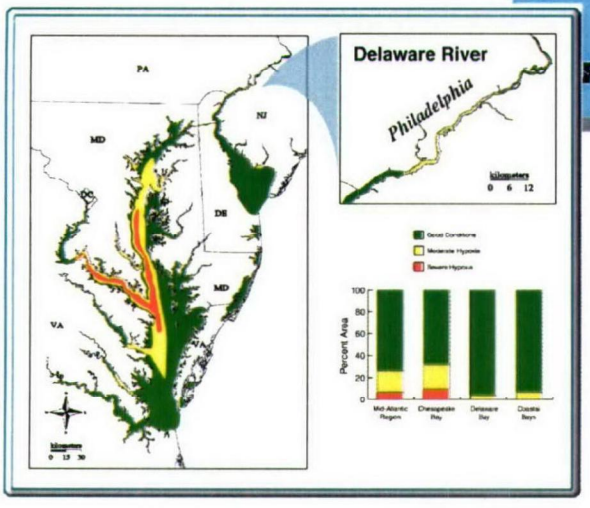
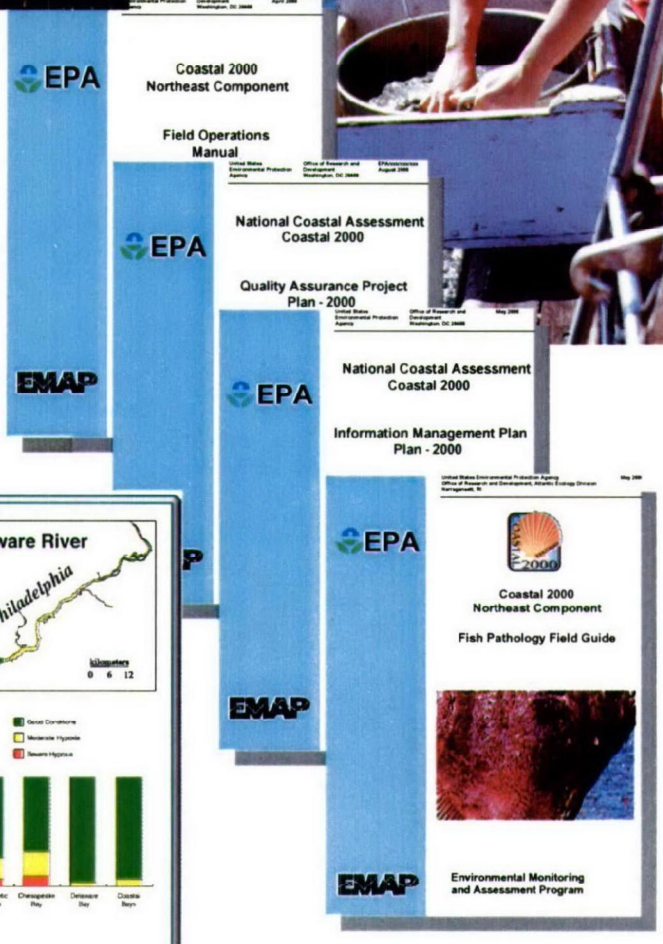
ASSESSING THE CONDITION OF ESTUARIES AND STREAMS (GPRA GOAL 8)









Assessing the Condition of Estuaries and Streams (GPRA Goal 8)

Agency Problem

The Clean Water Act (CWA) Section 305(b) directs States to assess the overall quality of the waters in the States, determine whether that quality is changing over time, identify problem areas and management actions necessary to resolve those problems, and evaluate the effectiveness of CWA programs. The Agency needs the ability to assess and track risks to ecosystems In particular, to successfully meet CWA requirements, States and Tribes need tools to monitor, maintain, and restore their resources However, less than half of all waters are currently assessed (USEPA 1998a). The monitoring that is done is not coordinated among states. Each state uses their own methods and their own sampling designs. Therefore, the data from different states cannot be compared and regional and national assessments of condition are not well supported scientifically.

Objectives of Research

Within the context of the EMAP Strategy (USEPA 2001a) and to support ORD's Multi-Year Plan for Ecosystem Research (Goal 8) Long-Term Goals (see Monitoring, Assessment and Diagnostic Research to Characterize Environmental Condition Overview), the primary goal of AED's condition research is to build the scientific basis, and the local, state, and tribal capacity, to monitor for the status and trends in the condition of the Nation's aquatic ecosystems, initially focusing on estuaries and streams. The foundation of the EMAP approach to monitoring condition is a statistical (or probability) sampling framework that provides the basis for estimating resource extent and condition, for characterizing trends, and for representing spatial pattern, all with a known level of confidence. Within this monitoring framework, condition is measured by sampling ecological indicators that reflect the ecosystems' biological, chemical and physical attributes. EMAP primarily uses biological indicators as they integrate all the different stressors acting on a system EMAP typically conducts this research in specific geographic areas to reduce the scientific uncertainties associated with the design and indicators as well as to engage and transfer the technology to the entities, such as States and Tribes, who will hopefully incorporate this approach into their base programs (EPA Environmental Indicators Initiative 2001). All four ecology divisions of NHEERL have EMAP implementation responsibilities and work closely together to ensure that our activities support and complement the overall objectives.

The focus of AED's condition research over the next 5 years is to:

- Test and demonstrate this approach nationally in diverse areas to ensure applicability and establish the statistical variability of the measured parameters.
- Determine the ability of the EMAP indicators and design to detect changes and trends in the condition of stream and estuarine ecosystems.
- Develop new and better indicators of condition, if needed.

- Demonstrate the efficacy of the EMAP approach to state, tribal and local agencies, and build their capacity to develop and analyze information from statistical monitoring designs.
- Improve information storage and transfer to optimize the available information from the EMAP monitoring approach

Approach and Recent Accomplishments

AED researchers have designed and implemented monitoring programs to report on the ecological condition of several regions in the past decade. The nature and expectations of the activities has evolved over time in conjunction with the evolution of EMAP itself. Schimmel et al. (1994) and Strobel et al. (1995) produced statistical summaries of annual results obtained in the EMAP-Estuaries Virginian Province surveys conducted by AED in 1990-93. The lessons of the four-year Virginian Province study were summarized by Paul et al. (1999), and we additionally evaluated associations between ecological condition as indicated by biologically-based indicators (e.g , a multi-metric benthic index) and other physical and chemical measures.

Mid-Atlantic Integrated Assessment (MAIA)

In 1994, the National Science and Technology Council's Committee on the Environmental and Natural Resources (CENR) reviewed the state of environmental monitoring during the preceding two and a half decades in the United States. While noting advances in the development of monitoring tools and methods, the Committee concluded that federal, state and local agencies still collected data that were fragmentary, often incompatible and lacking coverage on a national scale. They recommended that federal agencies coordinate monitoring efforts, conduct assessments on ecosystems rather than on regions, and provide information that is applicable on various spatial scales (CENR 1996). In response to the CENR report, the Mid-Atlantic Integrated Assessment (MAIA) was selected as a prototype demonstration, focusing attention at a regional scale to test the concepts. The Mid-Atlantic region was selected as the site of the study because it contained a variety of ecological systems (lakes, streams, forests, agricultural areas, wetlands and estuaries) and exhibited a wide range of environmental problems.

AED personnel played a major role in the design and implementation of the estuarine component of the MAIA program (MAIA-Estuaries). During the summers of 1997 and 1998, a consortium of federal and state agencies conducted an assessment of conditions in Delaware Estuary, Chesapeake Bay, the coastal bays of Virginia and Maryland, and the Albemarle-Pamlico Estuarine System. The objectives of this program were to: (1) characterize the ecological condition of the Mid-Atlantic estuaries using a common set of measurements, (2) focus research on small estuaries to help design more efficient monitoring approaches for these critical systems, and (3) demonstrate that effective partnerships can be established among Federal and State agencies for resource management purposes. In preparation for the study, AED researchers synthesized information previously published in scientific reports and databases (USEPA 1998b), highlighting data gaps evident in the previous work (e.g., the lack of consistent measurements of eutrophication-related indicators in all systems). Successful elements of the

EMAP program were incorporated in the MAIA-Estuaries study, including reliance on a probabilistic sampling design, use of a common set of indicators and analytical methods, and emphasis on biological indicators. New elements of the MAIA-Estuaries program included the participation of more than a dozen environmental agencies active in the region, and incorporation of existing sampling programs where possible without sacrificing the probabilistic nature of the EMAP design. In particular, the MAIA-Estuaries study included intensive sampling of small estuaries selected by regional managers to focus attention on conditions at the local scale. In addition to the core indicators measured by EMAP, the MAIA-Estuaries program placed additional emphasis on water quality indicators to better evaluate the incidence and possible causes of a key management concern, estuarine eutrophication, in the region.

Evolution was also evident in the analysis and reporting activities of the MAIA-Estuaries program. The earlier EMAP studies concluded with statistical summaries and assessments prepared exclusively with EMAP data (Schimmel et al. 1994, Strobel et al. 1995, Paul et al 1999), and emphasized comparison of conditions in broad categories, for instance, in tributaries and in large and small estuaries. In contrast, *Condition of the Mid-Atlantic Estuaries* incorporated other sources of data (Paul et al. 2000), and related analysis and reporting to various scales of integration, ranging from specific estuaries and tributaries, to large estuarine systems, to the entire Mid-Atlantic region (Paul et al. 2000, Strobel et al. 2000, Kiddon et al. in prep). A peer-reviewed MAIA-Estuaries summary report (USEPA in prep), which analyzed the 1997 and 1998 MAIA-Estuaries data, was prepared with extensive participation of all MAIA partners, and was written for the general public and environmental scientists as well as for environmental managers. This broad inclusion resulted in the incorporation of several novel reporting features, such as a report card comparing conditions in neighboring estuaries. An important contribution of this report is a presentation of changes that occurred in the region between the 1990-93 EMAP-Estuaries and 1997-98 MAIA-Estuaries studies, thus demonstrating for the first time the advantage of the estimates of condition and uncertainty allowed by the probabilistic sampling designs employed during both sampling programs. Methods developed for *The Condition of the Mid-Atlantic Estuaries* were used in the development of the *National Coastal Condition Report* (USEPA 2001b); this report incorporated the data and information generated by AED for the EMAP Virginian Province. The *National Coastal Condition Report* used available information to develop a national "report card" using existing data largely from EMAP, and the National Oceanographic and Atmospheric Administration's Status and Trends program.

National Coastal Assessment

The US EPA's National Coastal Assessment (NCA) is a current EMAP geographic initiative. This five year program (2000-2005), coordinated by NHEERL's Gulf Ecology Division (GED), focuses on surveying the condition of the Nation's coastal resources (estuaries and offshore waters) through an integrated, comprehensive coastal monitoring program among the coastal states to assess coastal ecological condition The approach for NCA focuses on a strategic partnership with all 24 U.S. coastal states Using a compatible, probabilistic design and a common set of survey indicators, each state is surveying and assessing the condition of their coastal resources independently. These data can then be used to develop statements of condition at multiple scales.

AED researchers are currently directing the planning, sampling, and reporting activities in the NCA of estuaries in northeastern states (Virginia to Maine). During the five year program period, the intention is to demonstrate the utility of probability based monitoring to support state needs and priorities, and to build capacity and transfer the needed technology to each of the states to implement a probability based design component in their own state programs. To support transfer of this technology, AED researchers administer approximately $1 million annually in cooperative agreements with the nine Northeastern states, as well as provide annual week-long training to each state's field crew, on-site quality assurance visits to crews during sampling events, visits to laboratories responsible for NCA-related analyses and as-needed technical consultation with state field or laboratory personnel. To facilitate and standardize these processes, AED personnel have developed or substantially contributed to a number of guidance documents, including the *NCA Quality Assurance Plan* (USEPA 2001c), *NCA Field Operations Manual* (USEPA 2001d), and the *Coastal 2000 Northeast Component Fish Pathology Field Guide* (USEPA 2000).

The data from the first two years of NCA will be aggregated by AED to assess conditions at the state, EPA Regional and biogeographical levels in the Northeast, and incorporated by GED into the 2003 assessment of condition at the National level. Successful completion of the NCA will result in the first comprehensive national environmental assessment of our Nation's coastal resources using consistent methods, and a baseline from which to measure future change. Ongoing AED work to support the NCA is described more fully in the remaining needs section below.

Tables 1-4 summarize the evolution and advancements to the basic design, indicators, reporting and technology transfer methodologies of EMAP which have resulted from the studies to date.

EMAP Information Management

AED is responsible for managing the data and information from the national EMAP program, including the surface waters, estuaries, and landscapes data generated through the efforts of NHEERL's Western and Gulf Ecology Divisions and NERL's Environmental Services Division, respectively. The approach developed by AED is described in the *EMAP Information Management Plan* (Hale et al. 1999). The major components of this approach are the national EMAP Data Directory, Data Catalog, EMAP Bibliography data and metadata files, and coastal database, which includes the national coastal species database and an online coastal data mapping application. The EMAP Web site (www.epa.gov/emap) is a well recognized source for quality data on environmental condition, as evidenced by its inclusion by the Internet Scout Report for Science & Engineering in their "best of the Web" report. AED is also working to ensure long-term management of the data by supporting EPA's Office of Water (OW) in their redesign of the STORET system to allow the EMAP data to be archived, and by exporting data directory information to EPA's Environmental Information Management System (EIMS).

Table 1
Progression of Sampling Designs

Program	Survey design	Incorporation of existing program sites
EMAP-Virginian Province 1990-93	**sampling classes (strata) based on physical extent** **separate design for each class** *large systems - tesselated, centerpoint chosen* *small systems - list frame, random start for 1st year, all systems over 4 yrs* *tidal - rib & spine*	**none possible**
MAIA-Estuaries 1997-1998	**RTS (random tesselated stratified) for each strata** *large - tesselated, random point w/in cell* *small - list frame* **equal weights within each strata**	**incorporate other sites for entire strata**
National Coastal Assessment 2000-2004	**RTS with variable weights for each strata** **sites restricted to estuarine resource**	**criteria for possible use of existing sites** **strata may contain mix of existing and survey sites**

Table 2
Progression of Indicators

Program	Type of Indicators
EMAP-Virginian Province 1990-93	**best available, mostly standard methods, nothing on eutrophication**
MAIA-Estuaries 1997-1998	**best available, mostly standard methods, with additional indicators for eutrophication**
National Coastal Assessment 2000-2004	**incorporate in state monitoring programs, new research indicators**

Table 3
Progression of Analysis and Reporting

Program	Type of Assessments
EMAP-Virginian Province 1990-93	ORD Statistical Summaries and Assessments with EMAP data
MAIA-Estuaries 1997-1998	Partnered assessments incorporating other data (e.g., State of the Estuaries Report)
National Coastal Assessment 2000-2004	Assessments jointly with state partners to varying level of detail as needed (one-pagers, four-pagers, Web-based reporting)

Table 4
Progression of Infrastructure Investment and Technology Transfer

Program	Type of Partnering
EMAP-Virginian Province 1990-93	Crews by ORD contracts/Cooperative Agreements
MAIA-Estuaries 1997-1998	ORD , federal, state, academic crews
National Coastal Assessment 2000-2004	Crews of state personnel, supplemented by ORD

The data gathered and state capacity built by this research will be directly incorporated to complete the following goals and products for Goal 8:

Annual Performance Goal (APG) - The condition of estuarine coastal ecosystems is determined for the US by 2006

Annual Performance Measure (APM) - Report on the condition of coastal ecosystems in the US by 2003

APM - Report on the trends in condition of coastal ecosystems in the US by 2006

APG - National probabilistic stream and estuarine monitoring frameworks are developed by 2007

APM - Transfer monitoring design technology for states and tribes to use in monitoring stream and estuarine condition by 2007

Impacts of Research

AED has significantly contributed to major improvements in environmental monitoring, resulting in:

1. A scientifically defensible, cohesive approach for state-based statistical monitoring designs for streams and estuaries; aggregation of state data to the national level; and provision of scientifically defensible measures of changes in ecosystem condition in support of the Government Performance and Results Act (GPRA).

2. Acceptance by EPA OW of probability-based monitoring as appropriate for state reporting on the status of state water resources (305(b)), as reflected in the Consolidated Assessment and Listing Methodology (CALM) guidance and OW's integrated listing and assessment guidance for 2001.

3. National monitoring of a water resource (estuaries) with a common set of indicators and compatible probability-based designs, which will result in 2003 in the first comprehensive national environmental assessment of our Nation's coastal resources and a baseline from which to measure future change.

Remaining Needs

To support attainment of the LTG and Annual Performance Goals laid out in the Goal 8 Ecological Research Multi-Year Plan, future AED efforts on condition will center on:

1 Completion of the NCA to establish trends in the environmental state of US coastal waters.

We are three years into the five year NCA program. The monitoring data collected by the states in the first two years will be used to prepare the 2003 national assessment of all US estuaries. The data collected in the remaining years will be used to develop the 2006 trends report comparing condition between the two time periods, and will be used as well to help us assess the strengths and improvements needed to the probability sampling design to detect trends

2. Testing potential new indicators and designs for coastal assessment

Some of the Northeastern states participating in NCA are evaluating additional indicators as part of their effort. Connecticut is interested in a more ecologically-based management of Long Island Sound (LIS) and NCA monitoring is viewed as an important component in their strategy to achieve this. Nutrient loading and eutrophication are large problems in LIS. Connecticut currently relies on dissolved oxygen (DO) levels as a response indicator for eutrophication, although a phytoplankton/zooplankton based index may be more sensitive and responsive. In the summer of 2002, Connecticut is including monthly samples at their NCA stations for plankton identification and enumeration. Pigment samples are also being taken for HPLC analysis. These measures, taken together, are intended to identify sensitive measures of plankton response to nutrient enrichment in Long Island Sound waters. Because better water column condition

indicators for eutrophication are needed to assess coastal environmental condition, what is learned in Long Island Sound is likely to have broad application nationally This work represents a collaboration between Connecticut and AED's research in both condition research and Aquatic Stressors Nutrients research.

Some of the Northeastern states participating in NCA are evaluating the potential of hybrid monitoring designs to control both spatial and temporal components of variation in estuarine conditions in Long Island Sound and Narragansett Bay. Rhode Island is testing a design which, in addition to being able to characterize Narragansett Bay in relation to regional and national coastal conditions, will support identification of the location and timing of low dissolved oxygen events. The hybrid monitoring includes

- sampling during the late summer index period based on probabilistic designs
- continuous sampling using moored instruments at fixed sites in the bay
- sampling on periodic transects of the bay by NOAA-NMFS
- periodic, event-driven sampling by the state and other partners at locations and times when low DO events are anticipated

3. Surveying the condition of the Northeast streams resources.

The strategy for the Northeast streams survey is much the same as that for the NCA, and focuses on building strategic partnerships with the states to develop and use compatible, probabilistic designs and a common set of survey indicators, assisting each state to conduct the survey and assess the condition of their streams independently, and aggregating these estimates to assess conditions at the state, EPA Regional, biogeographical, and National levels.

AED researchers are currently working with EPA Region I to implement the New England Wadeable Streams (NEWS) survey as a component of a Regional EMAP (REMAP) program. A probabilistic monitoring design, developed by AED in collaboration with NHEERL's Western Ecology Division, and a core set of metrics are being demonstrated by a team from the New England Interstate Water Pollution Control Commission (NEIWPCC) and EPA Region I during 2001 to 2003. In 2002 and 2003, four of the New England states (Connecticut, Vermont, New Hampshire and Maine) are conducting similar monitoring efforts based on EMAP developed designs within their borders. Rhode Island's wadeable streams were monitored in similar fashion in the summer of 2000.

Similarly, AED scientists have worked for the past six years with EPA Region III to implement stream surveys in the Mid-Atlantic States. To date, REMAP projects have been completed in Delaware and Maryland (both of which have incorporated EMAP designs and methods into their base state monitoring programs), are currently ongoing in West Virginia (which will also be using the streams data to develop their state biological criteria), and will be initiated in Virginia in 2003 to help the state assess the effects of toxics in their streams.

4 Developing methods to allow joint reporting and analysis of environmental data and information to optimize assessment.

A focus of this effort will be to develop the methods and institutional commitments for Web-based reporting of environmental data derived from the states' efforts. These may include active links between the National State of the Environment Report, the National Coastal Condition Report, regional coastal conditions reports, and state level reports on strategies, state level conditions, and action plans.

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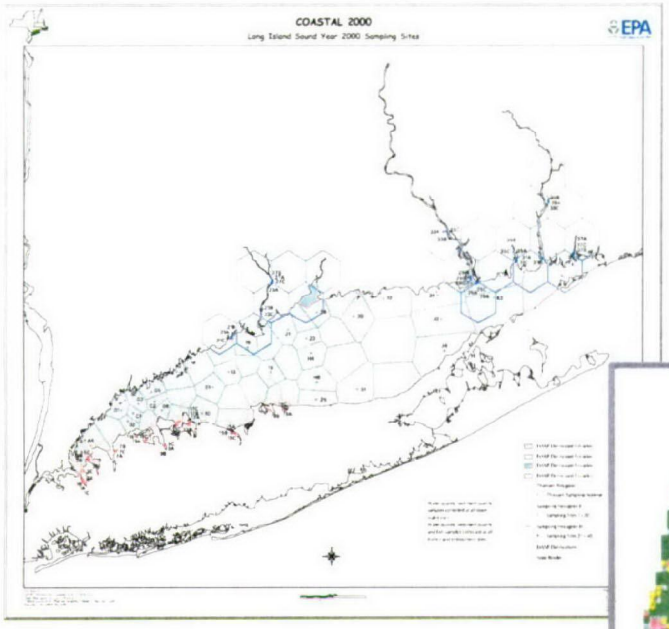
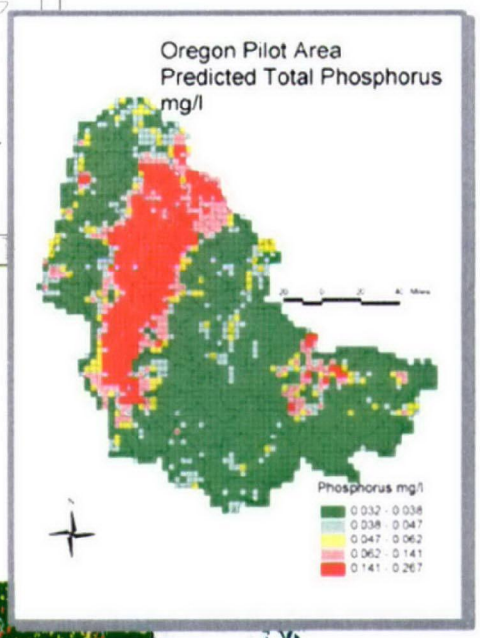
IDENTIFYING ECOLOGICAL IMPAIRMENT (GPRA GOAL 8)





Identifying Ecological Impairment (GPRA Goal 8)

Agency Problem

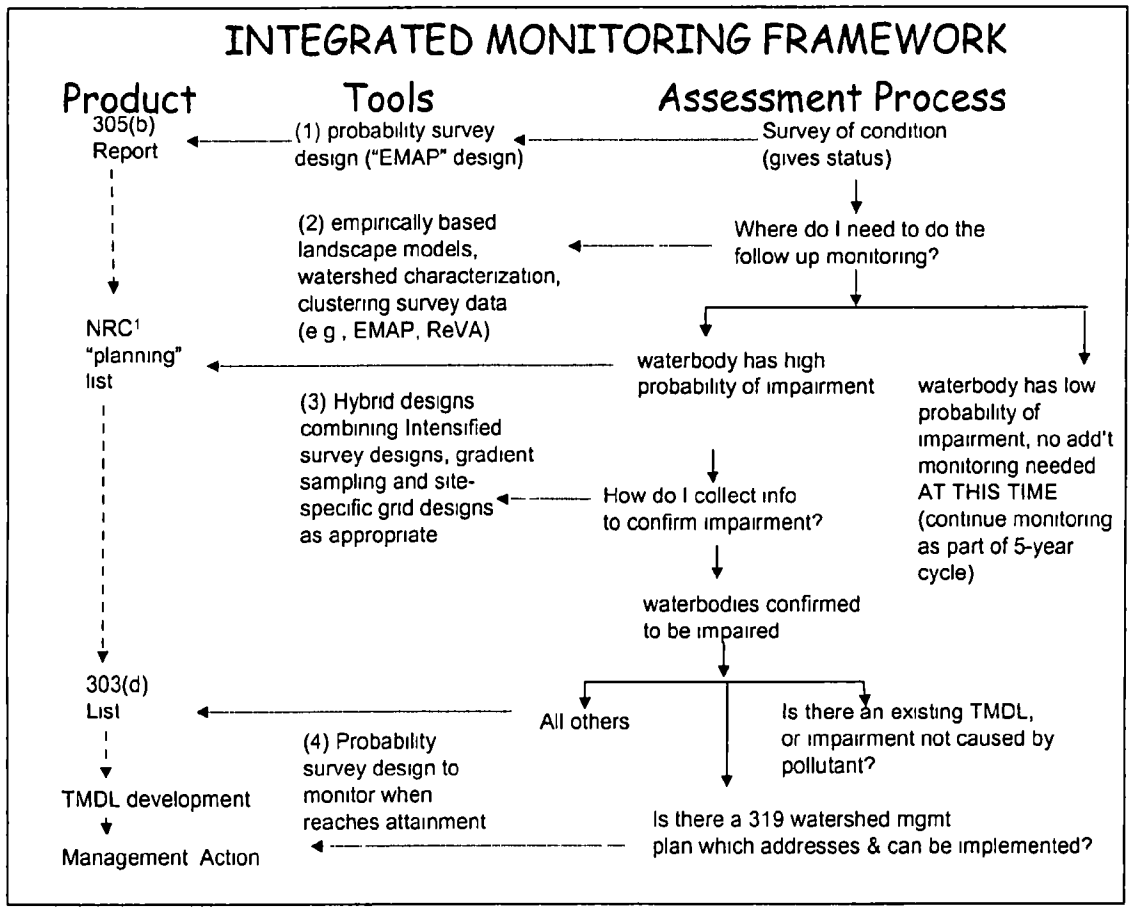
The objective of the Clean Water Act (CWA) is to "restore and maintain the physical, chemical, and biological integrity of the Nation's waters". To achieve this objective, Section 303(c) of the Act mandates that states adopt Water Quality Standards that include designated uses for waters, as well as narrative and numeric criteria to protect those uses. When a state determines that waters do not meet these standards or criteria, they are considered impaired. Under section 303(d) of the CWA, states must develop lists of all impaired waterbodies and prioritize these waters for establishment of TMDLs designed to restore degraded areas

Earlier sections of this Briefing Book provide an overview of the objectives, rationale and approach being used by the AED to help improve the Nation's aquatic resource monitoring and assessment activities. This research is contributing to an improved framework for integrated monitoring and assessment in support of CWA requirements As part of this work, environmental indicators and probabilistic sampling (survey) designs are being developed and implemented to characterize the overall condition of aquatic resources in a state (e.g , percent of surveyed waters with evidence of impairment) for reporting under section 305(b) of the CWA Missing from surveys intended for 305(b) reporting is an explicit determination of the actual waterbodies impaired to allow for listing under section 303(d) Often overlooked is the fact that data used for 305(b) reporting not only can be used for estimating overall condition of aquatic resources, but also are real information on the actual sites sampled. These data can and should be used in the 303(d) listing process. However, by the nature of survey designs, these data do not completely census the entire aquatic resource. In their assessment of the 303(d) process, the National Research Council (2001) recommended the use of predictive models when data are limited. Given limited financial resources and limited data, models are needed that help predict aquatic resource impairment in support of the 303(d) process, thus providing States with an explicit rationale for targeting their follow up investigations of aquatic resources in focused manner.

Objectives of Research

Figure 1 describes a process that can be used to address the assessment and reporting requirements of the CWA (Brown et al. in prep). This staged approach starts with an accurate, though broad-scale, overall assessment of the quality of all waters, then refines that assessment through screening models to target follow-up confirmatory monitoring in areas which have a high probability of impairment.

Figure 1. Tools to help States meet the requirements of the Clean Water Act.



The condition research described earlier provides the tools and data to support section 305(b) of CWA reporting (Tool #1, Figure 1). AED's research to identify ecological impairment is intended to develop assessment tools to improve our understanding of the quantitative relationships among watershed characteristics associated with impairment, known stressors, and aquatic resource condition. Building upon such associations, the probability of impairment in streams and coastal waters across an entire state or region should be predictable. The tools developed to make such predictions will support the States in meeting the listing requirements of 303(d) (Tool #2, Figure 1). These tools will link 305(b) reports on condition to 303(d) listing of impairment, and ultimately to the establishment of TMDLs. The research described in the next section of this Briefing Book ("Diagnosing Causes of Ecological Impairment") will develop tools needed to identify the causes of impairment to support development of those TMDLs (Tool #3, Figure 1). All of this research supports implementation of the recent Consolidated Assessment and Listing Methodology (CALM) provided by the EPA Office of Water (U S. Environmental Protection Agency 2002a).

This research contributes directly to completion of the Long-Term Goal (LTG) of ORD's Multi-Year Plan for Ecosystem Research (Goal 8).

> The states and tribes use a common monitoring design and appropriate ecological indicators: to allow a scientifically-valid determination of the status and trends of their aquatic resources; to improve the cost-effectiveness of their environmental programs and policies; and to allow their findings to be aggregated into regional and national determinations to support Clean Water Act 305(b) and GPRA requirements

and indirectly to attainment of the LTG of the Multi-Year Plan for Water Quality (Goal 2):

> Tools are provided to assess and diagnose impairment in aquatic systems and the sources of associated stressors

Our primary objective is to develop statistical models for predicting the condition of aquatic resources by merging probabilistic survey data with broadly available geographic data to estimate regional stressor patterns. Specifically, we are addressing the following questions:

1) What watershed characteristics are associated with variations in aquatic condition?

2) What are methodologies for discerning relationships between watershed characteristics and aquatic condition?

3) Can the probability of impairment in aquatic resources be accurately predicted with watershed characteristics?

Approach and Recent Accomplishments

To simplify modeling efforts, we have focused initial analysis and model development to one region of the coastal United States, the Virginian Biogeographic Province (Cape Cod, MA to Cape Henry, VA). The Virginian Province was chosen because coastal areas within the Province have been the subject of extensive EPA monitoring efforts (i.e., Virginian Biogeographic Province 1990-1993, Paul et al. 1999; Mid-Atlantic Integrated Assessment 1997-1998, U.S EPA 2000a; National Coastal Assessment 2000-present, U S EPA 2000b). In addition, this area has been at the center of a larger interagency effort in environmental data collection and analysis, including the Mid-Atlantic Integrated Assessment Thus, a wealth of information is available concerning environmental condition and stressor distributions. While initial modeling tool development has focused in the Mid-Atlantic, some applications will be tested in other areas of the US to ensure broad applicability of the methods

Initial analysis in this study is focusing on estuarine and coastal conditions within the Virginian Province. Similar methods to identify probability of aquatic ecosystem impairment in wadable streams in the region are being developed in research efforts led by NHEERL's Western Ecology

Division and NERL's Landscape Ecology Branch. In later stages of ORD research, methodologies developed in different aquatic ecosystems will be compared for their ability to predict impairment, to aid in determining causes of impairment, and to provide more efficient sampling and reporting in support of CWA requirements. The Virginian Province is likely to be the first region in the US where this level of cross system integration on condition of aquatic ecosystems will be attempted.

The most recent guidance on water quality monitoring and assessment (U.S. EPA 2001) recommends that States develop integrated water quality monitoring and assessment reports that satisfy CWA requirements for both 305(b) reports and 303(d) lists. According to this guidance, these reports should delineate water quality assessment units (AUs). These AUs are the defined boundaries of waterbodies within the state and should be the unit for 303(d) listing. As the ultimate goal of this project is to provide tools to aid States in integrating water quality assessments, State-determined AUs (when available) and their associated watershed are the basic units of analysis in this research

Thus, the challenge is one of using information from regional scale probabilistic surveys of aquatic ecosystem condition, in conjunction with other information describing watersheds, to predict which AUs are impaired Together with NHEERL's Western Ecology Division and the Landscape Ecology Branch of NERL, the following critical path of research will be used to address this challenge·

- Develop appropriate definitions for aquatic impairment.
- Identify key watershed attributes potentially associated with impairment.
- Quantify relationships between watershed attributes and aquatic impairment and use these relationships to predict impairment.

Defining Impairment

Preferably, State water quality standards would define impairment for the purposes of this study However, water quality standards vary between States and no single measure of impairment exists for our study area Impairment should be determined by those physical, chemical, and biological characteristics that measure a waterbody's ability to support its intended use (U.S EPA 2002a) Some indicators of waterbody impairment, such as nutrient over-enrichment, may be quantitatively linked to watershed characteristics. Others, such as biological measures of community structure, may only have indirect links to the watershed characteristics through anthropogenic stressors Clearly, the definition used for impairment will impact our ability to predict aquatic condition In our initial research we are assessing predictive models using various measures of waterbody impairment. This may ultimately lead to a definition of impairment that combines multiple lines of evidence (e.g., biological and chemical) into a single estimate of impairment (U.S EPA 2002b).

Data from the EMAP-Virginian Province (Paul et al. 1999) and MAIA-Estuaries (U.S. EPA 2000a) monitoring programs are being used to determine estuarine condition EMAP collected environmental data in the Virginian Province during the summers of 1990 to 1993. Samples

were collected of sediments, water column and biological communities using a probabilistic survey design that provided an unbiased estimate of the ecological condition of the estuaries Sediment samples were collected at 425 stations in 148 estuaries. The MAIA-Estuaries program collected sediment, water and biological community data in Mid-Atlantic estuaries during the summers of 1997-1998. The estuarine systems included Delaware Bay, Chesapeake Bay, Maryland and Virginia coastal bays and the Albemarle-Pamlico Estuarine System (APES). Samples were collected using a probability-based sampling design. Sediment samples were collected at 399 stations in 67 estuaries.

The Virginia Province and MAIA-Estuaries programs used comparable sampling and analysis methods to characterize sediments. Measured or calculated indicators that can be used in assessing estuarine condition include sediment grain size, total organic carbon, index of benthic community condition (calculated as described in Paul et al. 1999), sediment toxicity, dissolved oxygen and sediment contamination for heavy metals and organic toxicants expressed using toxicity benchmarks developed by Long et al. (1995). All of these data are being used to evaluate multiple measures of impairment.

Characterizing Watersheds

Watersheds can be characterized in multiple ways. A primary goal of this research is to assess various measures of watershed condition for their use in predicting aquatic impairment. Because the tools we are developing will ultimately be used by States, and are intended as initial screening methods not requiring extensive additional data collection, one qualification of any data we assess must be that they are widely available and spatially ubiquitous. While national data sets are available for land use or hydrology, other potentially useful data are sparsely collected. Therefore, in addition to geographic data, we are exploring the use of predictive models (e.g., atmospheric deposition models) for filling information gaps.

Human use of land impacts waterbodies in innumerable ways. The type of landuse present in a watershed influences groundwater recharge, flooding, sedimentation, and the extent and severity of point and nonpoint source pollution. Indeed, many researchers have documented links between landuse patterns and excess nutrients (Wahl et al. 1997), metals (Paul et al. 2002), and pesticides (Munn and Gruber 1997), amongst others. Based on a search of the literature we are assessing the use of several landscape metrics. National Land Cover Data is being used to measure the percent composition of each watershed in a set of land cover classes. Most researchers examining relationships between water quality and the surrounding watershed have focused on landscape metrics associated with composition (e.g , % of an area in agriculture). It is reasonable to assume that the spatial arrangement (pattern) of elements within a watershed also affects water quality. For example, Comeleo et al. (1996) found that the area of developed land located within 10km of an estuarine site affected sediment condition far greater than developed land further away in the watershed. Therefore, we are also investigating how the arrangement of patches within a watershed impacts water and sediment quality. In addition to standard measures of landscape structure such as contagion and interspersion (Riitters et al 1995), we are also exploring the use of Neutral Landscape models (O'Neill et al. 1996) in predicting aquatic impairment.

In addition to land cover, we are gathering other data to characterize watersheds including: soils from the State Soil Geographic Database, human population density from the Census TIGER database, livestock presence and abundance from U S Department of Agriculture's Annual Census of Agriculture, topography from Digital Elevation Models, and point sources of pollution from the National Pollutant Discharge Elimination System. Finally, the efficacy of information derived from models on hydrology, climate variability, atmospheric deposition of pollutants and others is being examined.

Quantifying Relationships

In research originally conducted in the mid 1990s, researchers at AED used a combination of multivariate linear regression and principle component analysis to investigate relationships between landscape composition and concentrations of metals in estuarine sediments to help understand and quantify the causes of observed estuarine condition (Comeleo et al. 1996) As this work has progressed we have refined our characterization of the landscape (Paul et al 2002), and used other statistical approaches that provide a more direct estimation of impairment probability (Hale et al. in prep) Having recognized that different statistical approaches provide different insights into relationships, we are currently testing five modeling techniques for predicting aquatic condition Statistical tools that are being evaluated include multivariate linear regression, multivariate logistic regression, classification and regression tree analysis, quantile regression and Bayesian Analysis This multi-pronged approach will provide a comparison of the different techniques available for predicting condition.

The available data has been parsed into two groups, one for model development and one for model validation. Each statistical approach is being assessed by measuring prediction performance (e.g., Kappa statistic) and confidence associated with predictions. Additionally, statistical tools will be evaluated for suitability in use by States.

Although this research has just begun, it builds on previous research conducted at AED relating landscape characteristics to estuarine condition (Comeleo et al. 1996, Paul et al 2002, Hale et al. in prep.). To date a literature review has been conducted and pertinent spatial data have been gathered. Statistical approaches to predicting impairment have been identified and when necessary appropriate software has been procured. In addition, there are multiple opportunities for synergy between this work and the Aquatic Stressors Diagnostics research described in the next section of this Briefing Book. For example, the research described here will be based primarily on statistical models of association, while the Diagnostics research will explore mechanistic evaluation of causality Although the primary product of our research will be a method for prediction of estuarine impairment for unsampled waters, the tools used in prediction can also be used to estimate the relative contribution of explanatory variables to the statistical diagnosis of impairment. In this way, the statistical models developed here could be used as evidence in the diagnostic decision support system described in the following section.

Impacts of Research

If accurate and accessible methods can be developed for predicting aquatic impairment, these tools can be transferred to States to help in the 303(d) reporting and TMDL processes. Not only could the statistical models developed here help prioritize sampling efforts to confirm impairment, they also could shed light on the potential causes of impairment. Finally, if strong associations between aquatic impairment and watershed characteristics exist, this could lead to hypotheses and further research regarding the mechanisms for such associations. This would also support the Diagnostics research in specific waterbodies described later in this Briefing Book.

Remaining Needs

The following steps remain to complete this effort:

Step 1 Develop appropriate definitions for aquatic impairment

We are continuing a search of the literature including scientific research and the current State 303(d) listing procedures to develop appropriate definitions of aquatic impairment. Measures of impairment are being scrutinized based on availability of data to confirm impairment and will be assessed further using newly developed statistical approaches for evaluation of ecological indicators (Murtaugh 1996). This will be a continuing effort, although most work should be complete within the next fiscal year.

Step 2 Identify key watershed attributes potentially associated with impairment

This effort is attempting to identifying measures of watershed condition that potentially could be used in model development. Criteria for assess suitability of watershed characteristics in this application will include whether links to watershed function (and therefore aquatic condition) have been hypothesized or demonstrated in the literature, and if the characteristics can be measured or modeled for all watersheds in the study. In addition to standard measures of landscape composition, we are evaluating which landscape patterns, such as contagion and interspersion of impervious and pervious surfaces (i e , potential contaminant sources and sinks), affect watershed processes pertinent to impairment across the watershed. In some cases, data are unavailable or limited. For these cases we are exploring the use of models to estimate watershed characteristics. These include existing mathematical models for ecological processes and geostatistical approaches for interpolating point estimates of data. Essential to this task is that all data must exist at a scale that is appropriate for the goals of our research. Most of the available geographic data for the Virginia Province has been gathered and are currently being processed. This will be an ongoing effort, although most watershed characteristics should be identified and appropriate geographic analysis complete within the next fiscal year.

Step 3 Quantify relationships between watershed attributes and aquatic impairment and use these relationships to predict impairment

As described above, we are developing statistical models that predict estuarine impairment within the Virginian Biogeographic Province. As part of the task, we are using several statistical approaches for modeling and prediction. A comparison of the statistical methods for prediction should be complete in the second year of the project. Once appropriate statistical tools and watershed characteristics have been tested within the Virginian Province, methods developed there will be extended to other regions of the country and potentially at different scales. It is reasonable to assume that some watershed characteristics not identified within the Virginian Province effort may be critical elsewhere and therefore the models developed may not be broadly applicable; however, it is expected that the overall methodology for model development should remain the same.

The research described here is part of a larger effort by ORD to predict aquatic impairment from probabilistic surveys designed to address section 305(b) of the CWA. A final step in AED's research will be to integrate our efforts with those of several other ORD Divisions that focus on a variety of aquatic systems to develop a methodology that will assist States in identifying impairment for all aquatic ecosystems

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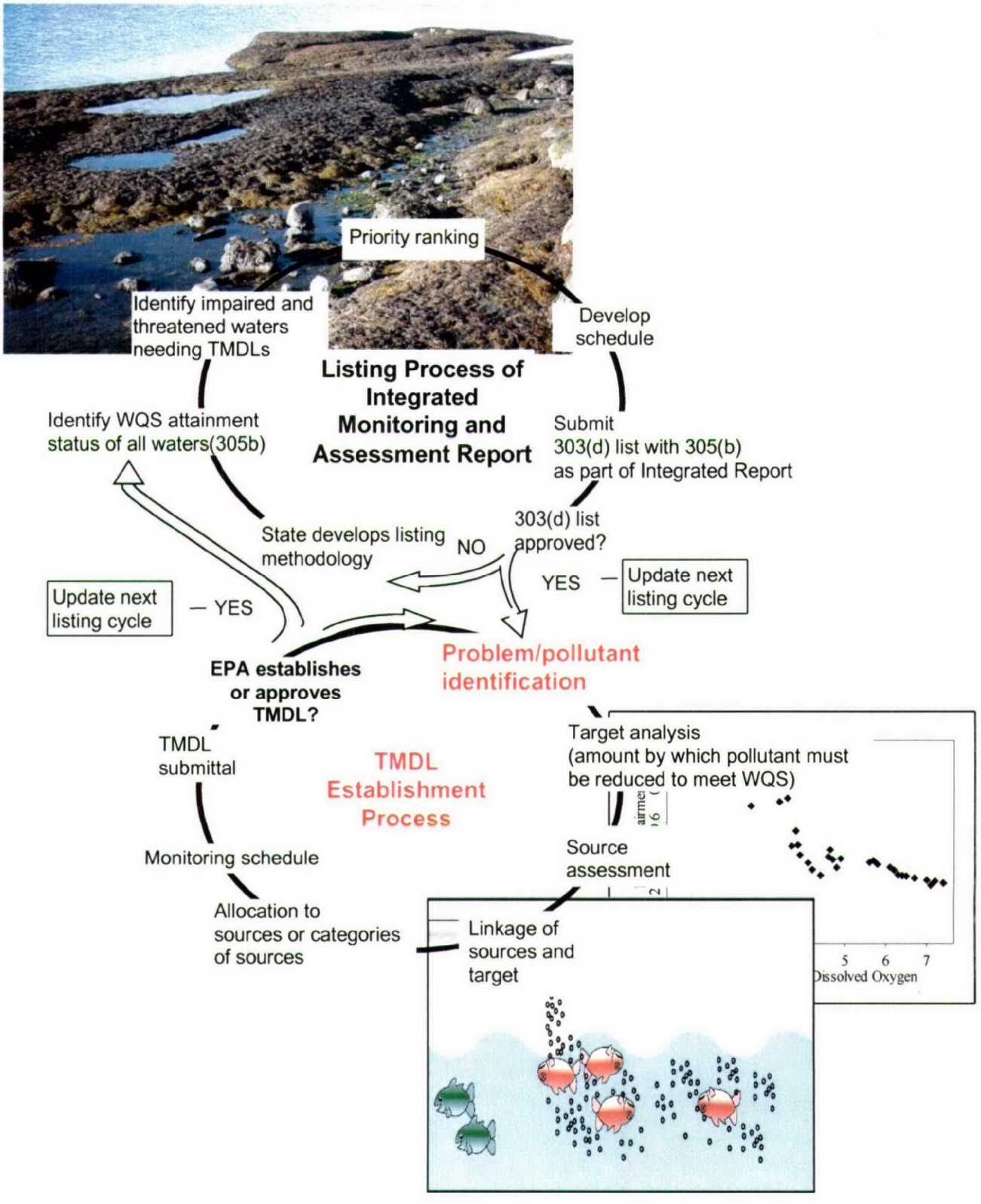
Diagnosing Causes of Ecological Impairment (GPRA Goal 2)



Diagnosing Causes of Ecological Impairment (GPRA Goal 2)

Agency Problem

Under the Clean Water Act, States must list surface waters as impaired or threatened on 305(b) reports and 303(d) listings based on one or more of three types of criteria biological criteria (narrative or numeric), chemical criteria, or physical attributes (e.g., habitat quality assessments). When impairment is determined based on biological criteria (26% of impairment decisions), States are also faced with the problem of diagnosing the cause of impairment before plans can be made to reduce the loading of pollutants through the total maximum daily loads (TMDL) process (40 CFR Ch.1, Part 130; US EPA 1991; http://www.epa.gov/owow/tmdl/).

The nation-wide scope of this diagnostic task is enormous; approximately 21,000 water bodies have been designated as impaired (44% of stream or river miles, 49% of lakes, reservoirs, and ponds, 98% of Great Lakes shoreline waters, and 42% of estuaries (EPA 2000a)) The U.S. EPA Clean Water Action Plan (1998) states that to improve overall efficiency of the TMDL process and to coordinate remediation activities, diagnosis of the causes of impairment is needed. A National Academy of Sciences (2001) review of TMDL procedures concluded that the Agency should promote development of methods and models that can more effectively link environmental stressors to biological responses (e.g., indications of impairment) Finally, the General Accounting Office (2002) states that there are large variations in State approaches and a lack of sufficient (and consistent) scientifically-rigorous EPA guidance to aid in TMDL development. Consequently, a clear need for diagnostic tools, methods and models exists.

Objectives of Research

To meet the needs described above, ORD's Multi-Year Plan for Water Quality outlines a Long-Term Goal (LTG) to "Provide the tools to assess and diagnose impairment in aquatic systems and the sources of the associated stressors." The Aquatic Stressors Framework (described later in this Briefing Book) describes NHEERL's multidivisional diagnostics research to support attainment of this goal, with special emphasis on the need to diagnose causes of biological impairment within an integrated framework linking watersheds with receiving water bodies to support the TMDL process.

Four primary objectives support attainment of this LTG:

1) Provide a framework for interpreting cause-and-effect relationships including:

- development of conceptual ecosystem models based on appropriate mechanisms of action that can be used to form the framework for diagnostic methods, tools and models, and ultimately, a user-friendly decision support system for the States

- development of classification schemes that explain variation in the response of individuals, populations, communities, and ecosystems at the habitat, water body, watershed and regional scales and may be used to reduce the overall number of impaired water bodies to a manageable number by grouping similar systems

2) Develop single-stressor diagnostic methods and models to determine the primary cause of biological impairment of aquatic ecosystems

3) Develop methods and models to allocate causality among multiple stressors and/or to diagnose interactions among them.

4) Develop methods and models capable of forecasting to evaluate the ecological benefits of source reductions, to investigate stressor interactions, and to assess the gains and losses realized by various alternatives for restoration and remediation

An ancillary objective is to provide to the Regions, States and Tribes tools with different levels of accuracy and sophistication dependent upon the cost-benefit ratios of a given resource decision. Tools for diagnosing both single-stressor impacts and multiple stressor interactions are being piloted using regional case studies. These pilots will then be incorporated as example applications into decision-support systems. Ultimately, the decision-support systems will be linked to tools and models developed by ORD's National Risk Management Research Laboratory (NRMRL; responsible for restoration research), forecasting not only future impacts based on no action, but also the results of alternative remediation scenarios.

Approach and Recent Accomplishments

NHEERL's Aquatic Stressor Diagnostics research is based on a critical path with four steps to accomplish its objective of development of methods and models to aid the States and Tribes for identifying causes of impairment in water bodies. The relationship of the steps in the critical path to each other and to the research of ORD's other laboratories (National Exposure Research Laboratory (NERL) and NRMRL) is defined Figure 1. The steps in the critical path of research are as follows:

Step 1. Develop a conceptual model and classification framework

This step includes development of conceptual models illustrating stressor-response relationships for single and multiple stressors and development of appropriate classification frameworks at the habitat, water body, watershed, and regional scales Development of hierarchical classification frameworks involves determination of which types of habitats, water bodies, watersheds, and regions are expected to behave similarly in response to a given level of stressor(s) or loading(s). Thus, classification helps establish regional, watershed, or habitat-specific criteria and the range across which model extrapolations (including empirical stressor-

response relationships) are appropriate. At this stage, the nature of significant interactions among stressors is also being defined based on the expected modes of action.

Step 2 Development of single-stressor methods and models

Methods and models for diagnosis of the predominant cause of impairment from single stressors are needed. Significant input is required at this step from other Aquatic Stressors research areas (described in later sections of this briefing book) including nutrients, suspended and bedded sediments, habitat alteration and toxic chemicals. We are exploring characteristics of environmental factors that influence stressor-response relationships that may be exploited as diagnostically valuable. For example, measurement of acid volatile sulfides (AVS) may allow us to catagorize habitats as susceptible to metal toxicity because AVS is a major environmental factor that controls metal bioavailability

Step 3 Development of multiple-stressor methods and models

Methods and models for single stressors are combined and refined to diagnose multiple sources of impairment The latter stage includes the development of tools both to allocate cause among multiple additive stressors and to diagnose significant interactive effects among stressors Ultimately these tools will be incorporated into a decision-support system.

Step 4· Develop forecasting approaches

This step builds upon the development of multi-stressor methods and models (Step 3) that include forecasting techniques to project the response of aquatic ecosystems to load reductions or watershed restoration activities into the future. Forecasting methods are particularly important in protecting large, complex, unique resources (e.g., Great Lakes, Gulf of Mexico, Chesapeake Bay) for which costs of restoration are large, interactions are involved, and lag times between an event and the eventual system response must be taken into consideration. Development of forecasting techniques also allows NHEERL to be proactive in defining potential shifts in the causes of impairment, and to anticipate future threats to the environment. Activities in this area are coordinated with NRMRL, ORD's Laboratory for restoration research.

To complete the four steps describing this critical path of research, three explicit research projects are being conducted by AED: (1) establish a conceptual framework to guide implementation of diagnostics methods and models, (2) develop classification schemes across habitat, water body, watershed and regional scales to provide a means for grouping similarly impaired systems, and (3) perform case studies to develop and test methods and models for both single and multiple stressor scenarios, assess the likelihood of multiple stressor interactions, and establish the structure for a decision-support system. These projects are coordinated with NHEERL's other ecology divisions to support the objectives of Aquatic Stressors Diagnostic research.

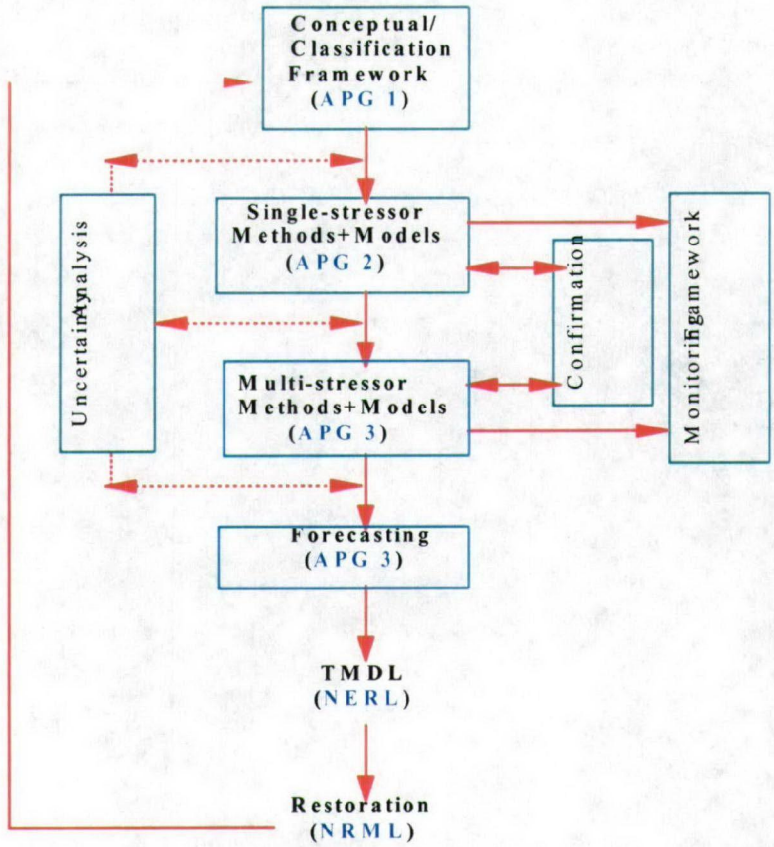


Figure 1. Flow diagram of critical path for diagnostics research.

Project 1. Conceptual Model Development and Information Management Framework

The goal of this project is to support the problem formulation stage of a diagnostic assessment. The main objective is to develop conceptual models describing the factors that control stressor-response relationships with respect to diagnosis within ecosystems, including potential interactions among multiple stressors across all scales relevant to setting a protective TMDL. These conceptual models provide the basis for creating a national database on toxic and non-toxic aquatic stressor-response relationships and for improving information management systems in support of 303(d) assessment activities.

Conceptual model development focuses on the effects of habitat alteration, nutrients, suspended and bedded sediments, and toxic chemicals on appropriate endpoints (i.e., individuals, populations, communities, ecosystems) across spatial scales (habitats, water body, watershed, region) relevant to setting a protective TMDL. This research is being performed in coordination with NHEERL's Mid-Continent and Gulf Ecology Divisions. Priorities for refining conceptual models for single and multiple stressors at the habitat scale are being

established by examining the relative frequency of stressor X or stressor combination X_1,X_2 with habitat type Y combinations in the Office of Water 303(d) listing database (USEPA 2001, http //www epa gov/owow/tmdl/trcksys html). A determination of impairment may be controlled by different factors as the scale of impact gets larger Therefore, conceptual models examine the cross-scale interactions (habitat <=> water body <=> watershed <=>region) that must be understood to determine the appropriate scale at which a protective TMDL must be established In addition, interactions among predominant stressors are included as appropriate, based on expected mechanisms of action Conceptual models are being developed through a series of cross-divisional workshops and in consultation with EPA Offices and Regions.

To date, narrative conceptual models have been developed for four stressors We are working towards establishing relationships that affect the behavior of these four stressors in different systems This work has interfaced with the classification effort and resulted in models which encompass both stressors and traditional classification schemes.

Project 2 Classification Framework

Integrated hierarchical classification schemes are being developed at the scale of habitats, water bodies, watersheds, and regions to identify systems that are expected to respond similarly to aquatic stressors. For example, estuaries with longer retention times are more susceptible to the effects of nutrient loading (Palter and Dettman 1999). The relative impact of suspended and bedded sediments via sedimentation and physical habitat alteration versus turbidity also depend on retention time. The effect of toxic chemicals can also be expected to vary systematically depending on physico-chemical characteristics of water bodies and sediments such as organic carbon, AVS, suspended solids and hardness (Hamelink et al. 1994, Bergman and Dorward-King 1997).

The central question that must be answered to determine if a classification system will be useful for diagnosis is, "does grouping of systems by class simplify the problem of determining the cause of the observed ecological effects which are equated with an impaired condition of a water body?" We are answering this question by developing classification systems that are keyed to, or inclusive of, the different levels of a nested spatial hierarchy that proceeds as follows: habitat, water body, watershed, and region. Some classification schemes already exist for systems at each of these levels of organization (e.g., Cowardin et al. 1979, Omernik 1987, McKee et al. 1992, Brinson 1993, Maxwell et al. 1995, Frissell et al. 1986, Rosgen 1996, Detenbeck et al. 2000) To be useful in diagnoses, classification systems must be based on differences in the spectrum of forcing functions that result in differences in the behavior of systems among classes (e.g., fluvial versus lagoonal geomorphology of a water body). The key to the viability of a classification system at any of these hierarchical levels is that the classes identified behave differently under the influence of the stressor of concern. Classes are being identified based on existing or new classification systems, and screening of the stressor-response data at all four levels of organization will determine if research should proceed further on a specific stressor/class combination

Classification research is working towards the following goals

- Identification of key factors (forcing functions) controlling sensitivity of response to different classes of toxic and non-toxic (non-point source) stressors
- Identification of key factors determining sensitivity of response across multiple stressors to facilitate development of a comprehensive classification scheme rather than multiple schemes.
- Development of national and regional classification frameworks.
- Coordination of opportunities for testing classification strategies in a systematic fashion.

Existing classification frameworks and necessary elements of an integrated classification strategy are being reviewed by a cross-NHEERL work group with representation from other ORD Laboratories and Centers, other Federal agencies, EPA Program Offices, and non-governmental organizations as appropriate. Each scheme is being assessed for its utility in meeting diagnostic needs, and we are determining whether portions of different schemes can be merged together to develop a useful classification scheme for all possible watershed stressors. We are also developing strategies to test classification frameworks through regional case studies (Project 3). These case studies are based on multiple-scale classification schemes, with coordination across NHEERL to bring together appropriate areas of expertise In particular, stressor-response relationships will be compared among regional/watershed/water body/habitat classes.

Project 3. Diagnostic Tool Development and Application through Regional Case Studies

Case studies are useful for developing and testing conceptual models, classification systems, diagnostic tools and models, and stressor-response relationships. Furthermore, case studies focused on specific places or issues of interest to the Agency provide an excellent mechanism to address high priority environmental problems, including the development of TMDLs. Diagnostic case studies provide a mechanism for developing, testing, and applying methods and models for distinguishing among single aquatic stressors and allocating cause among multiple stressors. The case studies are designed to incorporate the habitat, water body, watershed, and regional spatial scales as well as the appropriate organismal, population, community, and ecosystem levels of biological organization. Specific objectives of each case study are to:

- Develop and validate diagnostic tools for single and multiple stressors.
- Illustrate the application of diagnostic methods, tools and models for single and multiple stressors (including forecasting models).
- Provide input to regional decision-support systems.
- Demonstrate how assessment results can be extrapolated across habitats, water bodies, watersheds and regions.

- Illustrate how stressor-response relationships vary among different classes of systems in a predictable fashion.
- Develop forecasting models.

With these objectives in mind, Aquatic Stressors Diagnostic research case studies have been selected based on the following critical attributes.

- Sites have been selected from those already designated as impaired or threatened based on the 305(b) or 303(d) reporting process, representing a range of degree of impairment, a range of stressor combinations, multiple stressors with interaction potential, and common stressor-resource class combinations

- Sites have been selected to represent specific habitat-water body-watershed-regional classes, such that results can be extrapolated using a regional or nationwide classification system.

- Coastal systems have been selected to include both watershed(s) and receiving waters

Three of NHEERL's ecology divisions (AED, MED and GED) are conducting regionally-focused case studies with methods and information management coordinated across case studies. Initial AED research focuses on Narragansett Bay and potentially a neighboring coastal system in Massachusetts. In this case study, we are applying a diagnostics approach based on the Toxicity Identification Evaluation (TIE) process developed by NHEERL (Norberg-King et al. 2001, Burgess et al. 1996, 2000, Burgess 2000, Ho et al. 1997, 2002) The approach utilizes a screening step and then three phases: 1) Characterization, 2) Identification and 3) Confirmation. In general, the approach begins by considering all possible stressors, then through careful consideration of diagnostic evidence (including what stressors are present in the impaired system), narrows down the search to likely causal stressors. In the Characterization step, evidence of a stressor source, a stressor and an effect must be present In the Identification phase, evidence linking the source to the stressor and the stressor to the effect is developed. Finally, in the confirmation phase, evidence is sought to confirm the correctness of the diagnosis. The approach includes guidance as to the patterns of evidence expected at each phase and steps to take when certain patterns emerge. For example, after the characterization phase, there may be evidence of a stressor and an effect, but no source. Guidance recommends looking outside of the boundaries of the original site (cross-boundary flow) to identify possible sources A structured walk-through of this approach is underway using existing data from New Bedford Harbor (MA), and we have contributed this thinking in development of the Stressor Identification Evaluation (SIE) guidance (USEPA, 2000b).

The relationship of the diagnostic Annual Performance Goals (APGs) to each other and to the research of other ORD laboratories (NERL, NRMRL) is defined in the critical path diagram of diagnostic research (Figure 1) Three APGs are associated with Aquatic Stressors Diagnostics

research. Three NHEERL Divisions (AED, MED and GED) and contributing towards these goals

APG 1 (FY03) Provide the scientific foundation and information management scheme for the 303(d) listing process including a classification framework for surface waters, watersheds, and regions to guide problem formulation.

APM 1A (FY02) Conceptual framework for both single and multiple stressors including a consideration of cross-scale issues.

APM 1B (FY03) Classification frameworks for geographic regions and at the watershed, water body and habitat scale

APG 2 (FY04) Provide first generation of diagnostics methods to distinguish among major classes of single aquatic stressors and/or suggest causal mechanisms that contribute to impairment of marine and freshwater systems.

APM 2A (FY03) Guidance on whole sediment TIE procedures.

APM 2B (FY04) Guidance on and user-friendly interfaces for derivation of diagnostic indicators for individual stressors.

APG 3 (FY07) Provide EPA Regions and States decision support systems that enable diagnostic assessments for listing impairments via 303(d) and for inferring cause of listed impairments across multiple scales for freshwater and coastal systems.

APM 3A (FY02) Case studies of multivariate approaches to community data analysis to apportion cause among stressors.

APM 3B (FY04) Simulation of key stressor interactions with generic ecosystem models using sensitivity analysis to define the range of stressors and stressor combinations under which non-additive interactive effects will occur.

APM 3C (FY07) Decision-support system(s), including forecasting of future cause-effect relationships.

Impacts of Research

Conceptual models provide frameworks for developing stressor-response relationships and an information framework for organizing geospatial and toxicity data tailored to diagnostic applications (e.g., methods and models) Development of the geospatial database support

system is being coordinated with OW's Office of Science and Technology and their BASINS modeling support system will serve as the integrative system. This provides State, Regional and Tribal authorities with critical and essential tools, currently unavailable, for starting the diagnosis process on an impairment problem. Ultimately, these information management tools can be incorporated into decision-support systems

A classification framework provides Regional, State, and Tribal regulatory authorities a tool to collapse the over 40,000 TMDLs into a more manageable number of similar units or water body classes Defining water body classes allows creation of a TMDL template for remediating impairments which could then be applied to all of the water bodies within the class with minor adjustments. Classification frameworks also help to regionalize criteria development and define thresholds for impairment. This improves the applicability of criteria to specific sites or classes of sites and lower the error rate in identifying impaired or threatened aquatic ecosystems In particular, a watershed classification scheme within a regional framework helps to integrate and coordinate the 303(d) listing process at the watershed scale

Case studies support diagnostic tool development and will produce the single stressor, multiple stressor, and forecasting methods and models necessary to determine the causes of adverse effects on intact water bodies. These case studies provide the basis for verifying the efficacy of these diagnostic tools. Further, regional case studies provide the basis for development of the guidance listed above, and allow diagnostic tools to be demonstrated to stakeholders in sites where TMDLs need to be developed. These studies enable OW to understand how multiple stressors, such as nutrients and toxic chemical loadings, affect important habitats separately and in combination for several types of coastal ecosystems across the United States. We are developing generic methods and models for specific stressor-ecosystem combinations so they can be applied in other regions that contain similar stressor-ecosystem class combinations. Classification schemes allow us to regionalize results and recommendations for TMDLs and watershed restoration activities The scientific approach used here is also generic and could be applied to develop similar relationships for the ecosystems and stressors that predominate in any region

Remaining Needs

Aquatic Stressors Diagnostic research is in the early stages of a five year program. Key informational gaps have been identified relating to nutrient effects in marine systems, and the adverse impacts of clean suspended and bedded sediments on coastal wetlands and estuaries Because these are significant stressors, attainment of Diagnostics research objectives will require substantial input from the stressor-response research being conducted by the other components of our Aquatic Stressors program (described later in this Briefing Book). Significant collaboration with other federal programs (e.g., NOAA, Chesapeake Bay Program) and academic institutions also will be required

In addition, the lack of information about effects on biological communities in many combinations of resource class and stressor will need to be addressed, as this is the level of organization at which the States are assessing biological impairment in current monitoring programs. We are assessing the freshwater approach for measuring condition, used by several States, to increase our knowledge of effects at the community level. Diagnostic methods development will be coordinated with EMAP condition assessments of watersheds and development of appropriate exposure metrics to improve monitoring designs, as well as with NERL to develop improved loading models for TMDLs that include components predicting biological responses. In addition, classification frameworks and other tools developed here will be coordinated with research on prioritization of watershed restoration activities, prediction of recovery paths, and assessment of the success of remediation actions currently under way within NRMRL NRMRL scientists have been and continued to be appraised of the progress of our research. Expertise available at AED is being supplemented with expertise in watershed classification and assessment through collaboration with other research groups (e.g., MED, GED, USGS NAWQA, and Nature Conservancy programs).

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WILDLIFE RESEARCH STRATEGY

The Wildlife Research Strategy

Agency Problem

The mission of the U.S Environmental Protection Agency (EPA) is to protect human health and to safeguard the natural environment – air, water and land – upon which life depends. During the past decade, concerns have been raised about EPA's ability to adequately assess and compare risks to ecosystems, to protect and restore them and to track progress in terms of ecological outcomes. Advanced ecological risk assessment knowledge bases and methods, particularly with respect to the effects of anthropogenic stressors on populations of aquatic life and wildlife, is a need for multiple Program Offices and Regional programs as reflected below. Although immediate needs focus primarily upon the potential adverse effects of chemical contaminants, the importance of effects associated with multiple types of stressors (e.g., chemical and habitat) is also recognized

The Office of Pesticides Programs (OPP) within the EPA Office of Pollution Prevention and Toxic Substances (OPPTS) has responsibility for the pesticides registration process under the Federal Insecticide, Fungicide and Rotenticide Act (FIFRA). During the 1990s, OPP began working to improve the implementation of the pesticides registration process by more explicitly estimating the ecological risks (the probability and magnitude of adverse effects) of pesticides in the environment. The Ecological Committee on FIFRA Risk Assessment Methods (ECOFRAM) was established in 1997 to seek input from experts throughout government, industry, academia, and non-governmental organizations on an improved risk assessment methodology. The ultimate goal as stated by OPP management was to develop and validate risk assessment tools and processes that address increasing levels of biological organization (e.g., individuals, populations, communities, ecosystems), accounting for direct and indirect effects that pesticides may have. This goal has not yet been reached.

In addition to criteria for protection of aquatic organisms directly from toxic chemicals in water and sediments, the Office of Water requires criteria that protect aquatic-dependent populations of wildlife. Prototypical methodologies to assess risks of bioaccumulative chemicals to wildlife were developed in 1995 through the Great Lakes Water Quality Initiative (USEPA 1995). Wildlife criteria methodology, as well as numeric criteria for four specific pollutants (DDT, 2,3,7,8-TCDD, PCB, and mercury), were developed collaboratively by federal and state scientists and risk assessors However, a draft Memorandum of Agreement between the Office of Water, U.S. Fish and Wildlife Service (FWS), and National Marine Fisheries Service (Federal Register, January 7, 1999) calls for development of improved approaches for wildlife criteria derivation, and requires EPA to explicitly address protection of threatened and endangered species in implementation of the Clean Water Act. The draft Jeopardy Opinion for the California Toxics Rules also requires the Office of Water to derive new wildlife criteria (specifically for mercury and selenium)

The 1990 Clean Air Act Amendments require the Office of Air to consider possible effects on wildlife from airborne deposition of hazardous substances. Adverse effects from airborne deposition of mercury is of special interest In the Agency's Mercury Report to Congress (USEPA 1997), the approaches used in the Great Lakes Water Quality Initiative (USEPA 1995) were adapted to assess risks to piscivorous birds and mammals Limitations in current techniques and databases were noted. Of particular concern were the paucity of controlled experiments on sensitive avian species and lifestages assessing the effects of mercury exposure to wildlife and the relatively limited data available to support population level assessments. The Office of Air is in the process of developing approaches to assess the significance of effects from other hazardous air pollutants on wildlife and related ecosystem components

Finally, the Office of Solid Waste and Emergency Response (OSWER - Superfund) program is attempting to establish consistency in wildlife risk assessment approaches for organic compounds and metals, with an emphasis on terrestrial ecosystems In the absence of a cohesive approach to wildlife risk assessment, risk assessors render decisions impacting wildlife based on variable assumptions regarding exposure and effects. Currently, an OSWER-sponsored multi-stakeholder workgroup is attempting to develop scientifically sound screening levels for chemicals in soils that would be protective of mammalian and avian wildlife populations. The mammalian and avian benchmarks will be based on a hazard quotient method derived from toxicity data for higher vertebrates and a generic food chain model. In addition to generating discrete benchmark values, the workgroup is considering using methods to estimate the likelihood of wildlife effects based upon probabilistic distributions of toxicity and exposure data for some chemicals.

ORD/NHEERL/AED Research Approach

The Agency-wide problems described above have been translated into research goals through the ORD multi-year planning process. The ORD Multi-Year Plans have identified the following Long Term Goals (LTGs) for ecological effects research:

Problem Driven Research:

GPRA Goal 2 (Support for Office of Water)

Provide the approaches and methods to develop and apply criteria to support designated uses.

GPRA Goal 4 (Support for Office of Pollution Prevention and Toxic Substances)

To create the scientific foundation for probabilistic risk assessment methods to protect natural populations of birds, fish and other wildlife.

Core Research·

GPRA Goal 8

> Managers and researchers understand links between human activities, natural changes, and ecological stressors and between multiple stressors and valued resources at the appropriate level of ecological organization (e.g , species, populations, communities).

NHEERL's ecological effects research is designed to contribute to the attainment of the LTGs that support both the "problem driven" Program Office needs and the Core research program that develops techniques and tools that are generally applicable across the Agency Programs. Underlying each of the above LTGs is the need for improved techniques to develop stressor response relations and extrapolate effects across species, levels of biological organization, and landscapes.

There are two primary components to the NHEERL ecological effects research program. the Wildlife Research Strategy and the Aquatic Stressors Framework. The Wildlife Research Strategy describes a conceptual model for integrating NHEERL's ecological effects research focusing on risks to populations of wildlife and aquatic populations. This strategy is described below. The Aquatic Stressors Framework describes research to understand the relations between key stressors of concern for EPA's Office of Water and ecological responses of fish, shellfish, and aquatic-dependent wildlife and will be described later in this document.

The NHEERL Wildlife Research Strategy (WLS; NHEERL 2000) provides a conceptual model for integrating wildlife toxicology, population biology, and landscape ecology to address the critical research needs identified by the ORD multi-year planning process. The focus of the research strategy is effects on wildlife, in particular birds, amphibians and mammals. Historically, ORD's ecological research has dealt predominately with aquatic biota and, to a lesser degree, terrestrial vegetation, as the basis for defining water and air quality criteria authorized under the Clean Water and Clean Air Acts. The present focus on wildlife is designed to build on approaches previously developed for aquatic biota. Tests of new models and hypotheses will incorporate both wildlife and aquatic biota to ensure that the approaches developed are robust across taxa and ecosystem types.

The assessment endpoint entity in this research is the population, that is, the abundance (numbers, biomass) and long-term viability of a given species within a defined geographic area. We recognized that other assessment endpoint entities (e.g., at the individual or community level) may be appropriate for some wildlife risk assessments. NHEERL research focuses on population-level effects, however, because they represent ecologically and legislatively important endpoints of concern as expressed, for example, in the Great Lakes Water Quality Initiative (USEPA 1995) and the Endangered Species Act. While mortality or injury of individuals (e g., malformations) may cause concern, a more important question ecologically is

whether these individual losses affect population growth and viability. Community-level effects, such as declines in species diversity or disruption of food webs, are important endpoints as well, but are far less tangible from both scientific and management perspectives Furthermore, information on population-level responses represents an important stepping stone to improved understanding of community-level responses

EPA regulatory authorities deal most directly with limiting release of chemical stressors into the environment. Wildlife populations also are impacted, however, by many other stressors resulting directly or indirectly from human activities (e.g., habitat loss and alterations, introduced species, harvesting pressures) The sensitivity of a population to a given contaminant, as well as the ecological significance of a contaminant effect, are influenced by these other stressors. Thus, an important aspect of this research strategy is to develop approaches for assessing risks of contaminants within this broader context. This strategy deals explicitly with the combined effects of contaminants and habitat alteration on wildlife populations Other types of stressors (e g., introduced species, direct human disturbance) could also be readily incorporated into the framework and models, but are not the subject of focused attention in the near term.

It is well recognized that neither stressors nor wildlife populations are distributed uniformly within the environment. The interplay between spatial and temporal heterogeneity in wildlife population structure, and in spatial and temporal patterns of stressors can be an important factor controlling the severity of effects on wildlife populations (e g., Kareiva 1990; Turner et al. 1995; Hanski 1998). Thus, an important feature of the NHEERL research approach is development of models that deal explicitly with the spatial distribution of population and stressors over time. These models are being designed for application to real landscapes, by interfacing with geographical information systems (GIS).

It is impractical for NHEERL to undertake an extensive empirical testing program for all species, contaminants, and habitats, and therefore an extrapolation approach to fill gaps in existing knowledge is being developed. Consequently, the research strategy reflects an integration of strategic laboratory and field-based studies with mechanistic modeling. Additionally, because of the scope of these research needs, emphasis is being placed on fostering partnerships with external partners to collaborate on these research problems. To that end, we are actively developing partnerships where appropriate with academic institutions, other federal and state organizations and non-government organizations. Examples of these critical partnerships will be described more fully in subsequent sections.

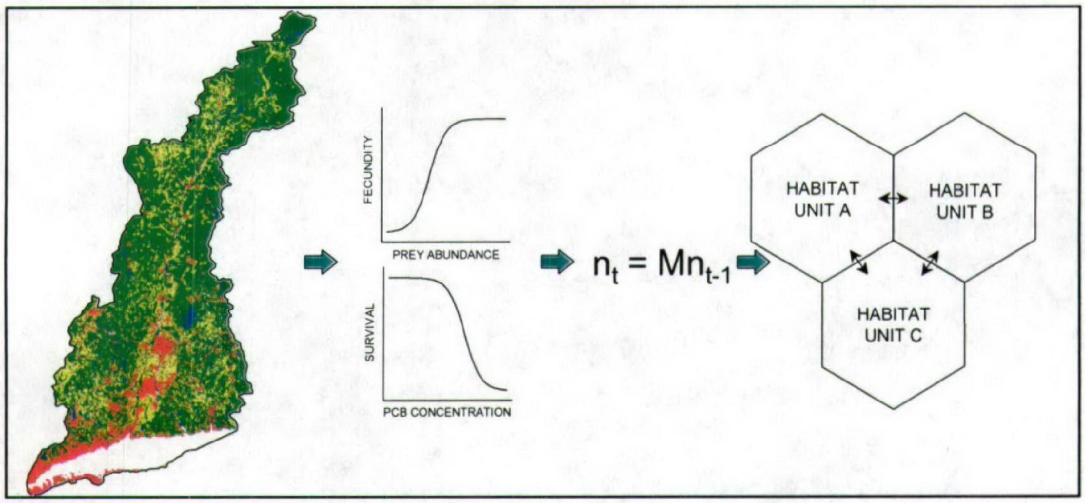

Figure 1. Conceptual approach to wildlife risk assessment.

Figure 1 illustrates our conceptual approach for wildlife risk assessment. The first step of this process involves spatial and temporal characterization of stressors, and in particular contaminant exposure and habitat suitability that may adversely impact the assessment population. Much of this information, especially data on contaminant exposures, is being derived from appropriate monitoring and assessment studies and exposure studies (e.g., EMAP, ORD's National Exposure Research Laboratory exposure modeling efforts, OPP's Environmental Fate and Effects Division (EFED)). The second step uses stressor-response relationships to translate stressor information into effects on reproduction and survival, the two key demographic rates that determine population growth. NHEERL research supporting this step includes development and quantification of the appropriate exposure-response and habitat-response relationships at the individual level. The demographic rates from this second step in turn drive population models in the third step, which generate outputs describing population growth rate or other appropriate population-level endpoints (e.g., extinction probabilities). Finally, these population measures are inserted back into the landscape in the last step to determine habitat-specific population sources and sinks using spatially explicit modeling platforms. Analysis of the cumulative population dynamics across the landscape would provide estimates of wildlife risks from chemical exposure, habitat changes, introduced species, and other forms of disturbance in the landscape.

Organization of Program

The conceptual framework outlined above provides the structure for organization of NHEERL's Wildlife research and defines the three major research objectives of NHEERL's program:

1. Develop mechanistically-based approaches for extrapolating toxicological data across wildlife species, media, and individual-level response endpoints.

2. Develop approaches for predicting population-level responses to stressors. Identify the responses at the individual level that have the greatest influence on population-level responses for a wide range of life-history types.

3. Develop approaches for evaluating relative risks from chemical and non-chemical stressors on spatially structured wildlife populations across large areas or regions.

Objectives 1-3 correspond to the last three steps, respectively, in the conceptual framework presented in Figure 1. Objective 1 deals with development of individual-level exposure-response relationships. We are not developing these relationships by substantially new mammalian and avian toxicity testing, in part because such work can be achieved by collaborating with existing facilities better suited for such efforts (e g., USGS Patuxent Research Center) Rather, NHEERL research emphasizes approaches for extrapolating toxicity data to a broader array of species, environmental media, and response endpoints (in particular, the endpoints required as input to population response models). NHEERL's Mid-Continent Ecology Division (MED) has taken the lead for this research objective.

Objective 2 addresses extrapolation from individual level responses up to the population level. The development and application of population response models is the primary approach and organizing structure for this objective. Modeling efforts are being supplemented with targeted field and laboratory studies designed to evaluate model outputs, key assumptions and model parameters, as well as potential population-level compensatory mechanisms. Analyses also are being conducted to identify responses at the individual level that have the greatest influence on population-level responses, to help prioritize future research under Objective 1. AED is NHEERL's lead division for this objective.

Objective 3 introduces issues associated with the spatial and temporal heterogeneity of populations and stressors, and extends the analyses under Objectives 1 and 2 to applications in real landscapes Because different stressors tend to be distributed differently in the landscape, it is under Objective 3 that we can most completely address the interactive effects of contaminants and habitat alteration on wildlife populations. Models and analyses under Objective 3 are designed both to assess risks from multiple stressors and to evaluate the relative effectiveness of alternative management strategies. NHEERL's Western Ecology Division (WED) is leading research to achieve this objective.

The following two sections in this briefing book describe AED's ecological effects research that support development of scientifically sound wildlife risk assessment methods. Specifically, this work is:

1. **Population Modeling to Support Ecological Risk Assessment (GPRA Goals 4 and 8).** AED's population modeling research - developing approaches for predicting population-level responses to stressors, evaluating efficacy of modeling approaches and

potential compensatory mechanisms The research described in this section supports development of core methods for wildlife risk assessment, as well as OPP's need for refined risk assessment methods focusing on populations

2 **Wildlife Risk Assessment – Loon/Hg Demonstration Project (GPRA Goal 2).** Rather than focusing on one aspect of the conceptual model above, this demonstration project is attempting to integrate research efforts across the 4 steps of the conceptual model to develop tools to assess the relative risks of habitat alteration and chemical exposure (Hg) for common loon, a high trophic level piscivorous bird. This work directly addresses OW's need for a method to establish wildlife criteria.

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POPULATION MODELING

Population Modeling to Support Ecological Risk Assessment (GPRA Goals 4 and 8)

Agency Problem

The mission of the U.S. Environmental Protection Agency (EPA) is to protect human health and safeguard the natural environment upon which life depends. Whereas human health protection is focused primarily on individual humans and their health, ecological protection requires consideration of diverse aquatic and wildlife populations to preserve the biological integrity of ecosystems. This mandate requires scientifically sound, generalized approaches to evaluate and predict population status and trends. It also requires an understanding of how anthropogenic stressors affect populations, and the management strategies to restore those that are adversely affected. Research to advance ecological risk assessment knowledge bases and methods, particularly with respect to the effects of anthropogenic stressors on populations of aquatic life and wildlife, is critical to strengthening the Agency's ability to assess ecological risks and weigh risk management options in an objective and scientifically defensible manner.

These broad Agency needs are reflected in the specific problems faced by individual Program Offices. For instance, the Office of Water (OW) requires criteria protective of populations of aquatic species and aquatic-dependent wildlife. The Office of Solid Waste and Emergency Response (OSWER) is beginning to recognize the need to establish consistency in wildlife risk assessment approaches employed in remedial investigations of hazardous waste sites. Further, the Office of Pesticides Programs (OPP) within EPA's Office of Pollution Prevention and Toxic Substances (OPPTS) is leading the way in expanding ecological risk assessments to provide probabilistic expressions of risk to fish and wildlife populations. OPP has responsibility for the pesticide registration process under the Federal Insecticide, Fungicide and Rotenticide Act (FIFRA). During the 1990s, OPP began working to refine implementation of the registration process by more explicitly estimating the ecological risks of pesticides in the environment. To support this refinement, the Ecological Committee on FIFRA Risk Assessment Methods (ECOFRAM) was established in 1997 to provide input on appropriate risk assessment methodologies from experts throughout government, industry, academia and non-governmental organizations. ECOFRAM's recommendations helped OPP to identify a challenging goal to develop and test risk assessment tools and approaches, supporting a tiered risk assessment process, that address increasing levels of biological organization (e.g., individuals, populations, communities, ecosystems). Additionally, the resulting methodology would account for both direct and indirect ecological effects that pesticides might have in real pesticide applications and landscapes. Although OPP has made progress in this direction, this goal has not yet been met.

NHEERL's research addresses the growing recognition across EPA of the need to assess effects of anthropogenic stressors on populations of aquatic life and wildlife. The NHEERL Wildlife Research Strategy (NHEERL 2000), described earlier in this Briefing Book, conveys a conceptual model for assessing risks to wildlife (including populations of aquatic species), and an approach for integrating NHEERL ecological effects research that can address this need. The

goal of the Wildlife Research Strategy is to develop scientifically valid approaches for assessing risks to wildlife populations from multiple stressors that can be used to solve multiple Agency problems

Objectives of Research

AED's Population Modeling research is developing the tools and specific models to support attainment of Long Term Goals (LTGs) in two of ORD's Multi-Year Plans (MYPs): the draft MYP for Safe Communities in support of OPPTS in GPRA Goal 4, and the Goal 8 MYP for Ecosystem Research. Our efforts in this area are addressing specific problems faced by OPPTS, and are developing a comprehensive basis for responding to a wide range of ecological risk assessment issues as part of our core program

The Safe Communities MYP LTG "*to create the scientific foundation for probabilistic risk assessment methods to protect natural populations of birds, fish and other wildlife*" is the focus for much of NHEERL's and AED's problem-driven ecological research in support of OPPTS. Using the concepts developed in the Wildlife Research Strategy, NHEERL's Ecology Divisions are developing the tools that will allow OPP to assess pesticide risks to non-target populations of aquatic species and wildlife. In close consultation with OPP's Environmental Fate and Effects Division (EFED), NHEERL has developed a demonstration project to build and test the appropriate tools for a refined risk assessment methodology. The demonstration focuses on the potential adverse effects of typical agricultural pesticide application practices on non-target bird populations Building on EFED's probabilistic exposure assessment methodology, our research focuses on development and application of both spatially-independent and spatially-explicit population models, and involves contrasting landuse and pesticide-use scenarios. AED has the lead for developing spatially-independent bird population models as part of this demonstration. AED is also supporting refinement of EFED's aquatic risk assessment methodology through development and demonstration of spatially-independent population models for key invertebrate and fish species. The objective of these two efforts is to provide the modeling tools and information that will advance EFED's ability to assess the risks of pesticides to populations of naturally occurring, non-target species.

AED is contributing to the attainment of Ecosystem Research (Goal 8) MYP LTG that "*managers and researchers understand links between human activities, natural changes, and ecological stressors and between multiple stressors and valued resources at the appropriate level of ecological organization (e.g , species, populations, communities)*" by developing approaches for modeling populations, evaluating model performance and examining potential population-level compensatory mechanisms that confound model efficacy. Additionally, catalogues of models for particular species and classes of life histories are being developed to provide the information needed to solve a variety of ecological risk assessment problems in the future. The overall objective of this research is build a capability for population risk assessment that will address a number of Agency problems.

Approaches and Recent Accomplishments

AED's Population Modeling research is described below relative to three main areas of activity: development of refined risk assessment methods for pesticides in support of OPP EFED (Goal 4), development of core population risk assessment capabilities (Goal 8), and technical support for population risk assessment (Goal 8).

Population Models for Refined Risk Assessment of Pesticides

Acting on the recommendations of ECOFRAM, EFED has begun development of refined risk assessment methods for terrestrial and aquatic non-target species. To date, their efforts have focused primarily on developing fairly rigorous probabilistic estimates (using Monte Carlo simulation techniques) of agricultural pesticide exposure to birds through a number of terrestrial exposure pathways, and to a lessor extent on aquatic invertebrates and fish through aquatic pathways. In both cases (terrestrial and aquatic), biological effects have been simulated as mortality of individuals, the prediction of which is based on estimated distributions of species' (and life stages') sensitivities to a model pesticide and individual variation therein. The outputs of these simulations, and therefore the estimates of risk themselves, are couched in terms of individual mortality. AED's Population Modeling research is developing the species-specific models that will permit these mortality outputs, in conjunction with predictions of effects on reproduction, to be used to predict the population consequences of these exposure scenarios.

Several approaches for modeling populations have been developed by the population biology community, including bioenergetics models (e.g., Hewett 1989), individual-based models (e.g., DeAngelis and Gross 1992) and matrix population models (e.g., Caswell 2001). To meet the objectives of our pesticide risk assessment research, a modeling approach is needed that: 1) integrates individual-level (i e., survivorship and fecundity) stressor-response data to project population-level responses; 2) is compatible with the simulation approach developed by EFED, 3) is compatible with a spatially-explicit modeling framework to allow evaluation of different scenarios of landuse and pesticide use; 4) provides a basis for estimating effects on species with different life history strategies, and 5) is relatively easy for risk assessors and risk managers to use in terms of application and interpretation. We have chosen to focus on developing matrix population models to meet EFED's needs because they provide the best overall match with these criteria. Matrix models utilize basic demographic data, including age- or stage-specific survival and reproduction, as input. This information has been published for many species, thus reducing the need to conduct extensive studies to collect baseline data. Matrix models also provide a great deal of flexibility because they can be developed with a range of complexity from very general to highly detailed, making them appropriate for multiple levels of a tiered risk assessment approach. For example, simple density-independent matrix models using literature-derived demographic data can be used for screening-level risk assessments, while more complex models incorporating stochastic processes and density-dependence can be developed for detailed, site-specific risk assessments Finally, the demographic information required as input to matrix models is compatible with the data typically generated by toxicity tests (mortality and reproduction) that are required as part of the pesticide registration process.

Over the past decade, AED's Population Modeling research has developed a number of matrix models for aquatic invertebrate and fish species appropriate to OPP's refined risk assessment goal. Many of these were developed in earlier support of OW's objective to enhance the technical basis for derivation of aquatic life criteria (Munns et al. 1995). More recently, we developed and evaluated (see Mitro 2001) the efficacy of matrix models for predicting population responses to chemical exposure under controlled laboratory conditions. In this research, AED used exposure-response data generated from standard mysid shrimp toxicity tests as input to a model constructed to capture the temporal nature of data collection in the tests (i.e., daily measures of deaths and reproduction), and evaluated model predictions of long-term population dynamics in a subsequent multi-generational study (> 3 generations) involving the ubiquitous contaminant *p*-nonylphenol (Kuhn et al. 2000, 2001). This evaluation demonstrated that the matrix model was able to predict within a few micrograms per liter the concentration at which significant population-level effects would begin to occur (16 µg/L predicted by model versus 19 µg/L measured in multi-generational assay). AED's Population Modeling effort has also developed models for other aquatic invertebrate species used in toxicity testing (e.g., Gleason et al. 2000, Kuhn et al. 2002), and has used matrix models to understand population-level effects of natural fish populations in the field (e.g., Munns et al. 1997).

In support of EFED's terrestrial risk assessment refinements, AED developed matrix models for four bird species (selected in consultation with EFED) common to agricultural settings: Vesper Sparrow, Horned Lark, Mourning Dove and Meadowlark. Using demographic information available in the literature, this effort demonstrated parameterization of stochastic matrix models, how species' population responses could vary with life history, and how the models in turn could be used to identify data deficiencies that, if corrected, would improve the quality of population risk assessments. For example, elasticity analyses and simulated perturbations to model parameters illustrated that changes in adult survival effected greater (Mourning Dove) or about equal (Vesper Sparrow, Horned Lark, and Meadowlark) changes in population growth rate as compared to proportional changes in reproductive output and juvenile survival. Therefore, high quality data describing pesticide effects on survival are as important as data for reproduction in EFED's terrestrial risk assessment. This knowledge assists OPP in identifying the nature and quality of information required of registration applicants as part of the pesticide data packages they submit.

AED is also working with NHEERL's Western (WED) and Mid-Continent (MED) Ecology Divisions to support development of spatially-explicit models to meet EFED's need to evaluate realistic landuse scenarios of pesticide application. This effort utilizes PATCH, a cellular automaton spatial model developed by WED (Schumaker 1998) and realistic landuse data to simulate agricultural mosaics in landscapes typical of the Central US. The models for birds described above will used to represent typical species utilizing these landscapes to estimate pesticide risks to non-target avian species. Ultimately, PATCH and the associated population models for birds will be linked explicitly to EFED's probabilistic modeling framework to produce the next generation of refined risk assessment tools for pesticide registration.

Development of Core Population Risk Assessment Capability

At the heart of NHEERL's Wildlife Research Strategy is the objective to develop approaches for predicting population responses to multiple environmental stressors and to identify the responses at the individual level that have the greatest influence on population responses for a wide range of life-history types. AED's Population Modeling research is addressing this objective by evaluating modeling approaches in a variety of risk assessment applications, identifying individual and population compensatory mechanisms that might limit the usefulness of modeling approaches. We are also evaluating how characteristics of species' life histories influence the effects of exposure to stressors. Together with our efforts to facilitate availability of life history data for wildlife species, the products of this research will support development of core population risk assessment capability for addressing multiple Agency needs.

AED used laboratory and field-based studies to develop and evaluate a population model for an estuarine fish species living in a highly contaminated environment and identified a compensatory mechanism indicating the need for model refinement. Matrix population modeling was used to estimate effects of dioxin-like compounds (DLCs) to populations of the mummichog, *Fundulus heteroclitus*, resident at the New Bedford Harbor, MA Superfund site (Munns et al. 1997). Population effects were modeled using demographic data obtained in short-term laboratory studies as input. Model projections suggested relatively high risks to mummichog populations subject to high DLC exposure, such those living near the highest sediment concentrations of DLC in the Harbor. However, mummichogs appeared to be thriving in those areas, indicating inadequacies in model construction or parameterization. Through an elegant series of laboratory experimentation and field evaluations summarized in Nacci et al. (2002), adaptation of the aryl hydrocarbon (Ah) receptor system (mechanistically linked to DLC effects) was suggested to decrease CLC sensitivity of New Bedford Harbor mummichogs. This research highlights the need to consider evolutionary and other compensatory mechanisms in developing approaches for population risk assessment.

Ecological risk assessments often proceed in a tiered fashion (as reflected in OPP's pesticide risk assessment approach described earlier), starting with screening activities and proceeding through to more definitive (realistic and site-specific) tiers if required. NHEERL's Wildlife Research Strategy identifies the need for a range of methods and tools to support assessments at different tiers in the assessment process. In addition to developing fairly sophisticated stochastic modeling approaches, AED's Population Modeling research is exploring methods that can be used to screen population response that are based on species' life history patterns Specifically, we are developing an ordination scheme based on demographic elasticity analyses that groups species according to the life history characteristics that have the greatest influence on population growth rate, and therefore on population response to stressor. This approach builds from earlier work by Heppell et al. (2000) and others. Our approach in this research has been to conduct elasticity analyses of most species-specific models developed to date. Once a sufficiently-large catalogue of species-specific models has been developed, we will use appropriate multivariate statistical techniques to ordinate life history types. With understanding of a stressor's mechanism of effect with respect to demographic parameters, this scheme should permit screening-level predictions of the effects of that stressor on population response. We expect to

develop an initial ordination scheme within the next three years.

A core capability for population risk assessment requires easy access to life history and population trends data. AED has recently formed a cooperative research partnership with the Cornell Laboratory for Ornithology (CLO), the lead organization for Partners in Flight which serves as an umbrella organization for the Audubon Society and other private and public conservation and environmental protection organizations. Entitled "Avian Risk Assessment for Multiple Anthropogenic Stressors Through Citizen Science Monitoring of Bird Populations," this collaboration will facilitate access to bird population monitoring data sets generated through "citizen scientist" activities and managed by CLO. These data can be used to develop population models and realistic risk assessment scenarios, to evaluate the efficacy of population risk assessments, and to identify emerging risk problems relative to bird populations in the Western Hemisphere. The cooperative partnership also affords a mechanism for joint research to link spatially-explicit bird abundance and environmental quality data to support development of new methodologies for wildlife risk assessment.

Technical Support for Population Risk Assessment

Many environmental managers and ecological risk assessors lack practical knowledge of the concepts, approaches and methods for assessing the effects of environmental stressors on populations. Questions often asked concern how to extrapolate effects on individuals to the responses of populations, what to measure to characterize effects on populations, how to make such measurements for field-based populations, and how to interpret measured population responses. Such questions were recently asked of ORD's Ecological Risk Assessment Support Center (ERASC) by EPA Regional risk assessors and managers associated with Superfund and Resource Conservation and Recovery Act (RCRA) site-specific investigations of hazardous waste sites. AED responded to this request by developing a state-of-the-science white paper for site-specific population risk assessment (Munns and Mitro 2002). The ERASC report provides information that supports performance and interpretation of population-level risk assessments conducted during the Superfund remedial investigation/feasibility study process. Focusing on the evaluation of effects on populations (as opposed to issues of exposure assessment), the white paper describes population-level endpoints, development and application of population models to link effects on individuals to populations, and methods for measuring population responses in the field. This product may become the basis of guidance to Superfund and RCRA for population risk assessment.

A limiting factor in the development of population models for many wildlife species is the paucity of published demographic information. This necessitates collecting or discovering information, and using modeling techniques to derive best estimates for population parameters. AED recently used these approaches in partnership with a local conservation organization, the Barrington (RI) Land Conservation Trust to complete a comprehensive analysis of a long-term mark-recapture data set for a diamondback terrapin population in Narragansett Bay, RI. The data set comprised 12 years of mark-recapture data for breeding females. Analyses of these data yielded estimates of abundance, apparent survival rate, capture probability, seniority (the probability that an animal in the population at time t was in the population at time t-1),

recruitment, and population growth rate, and showed how these parameters changed over time. A matrix population model was developed using these estimates and additional demographic information from the literature. Apparent survival rates were high (about 95%) and recruitment of breeding females was low and decreasing. Elasticity analyses indicated population growth rate to be highly sensitive to proportional changes in survival versus reproduction. We used the model to evaluate the management strategy of capping nests to improve reproductive success. Model results indicated that this strategy could increase population growth, but that the magnitude of increase was positively related to pre-reproductive survival, thereby negating nest capping as a remedy for declining populations or ones with poor juvenile survival. This work demonstrated the development of a population model for conservation purposes, highlighting: 1) model development using a long-term data set, 2) evaluation of management options using the population model; and 3) as illustrated throughout this Briefing Book, AED's partnership strategy that integrates our analytical capability with talents of collaborators to solve environmental problems.

AED is also supporting a Society of Toxicology and Chemistry (SETAC) "Pellston" workshop to advance the science of population risk assessment. Entitled "Population-Level Ecological Risk Assessment," this workshop will ask international experts in population modeling and risk assessment from North America, Europe, and Asia to address four key issues:

- Establishing ecological protection goals for populations
- Empirical approaches for population-level assessment
- Modeling approaches for population-level assessment
- Risk management decision-making for protecting populations

In addition, the workshop will establish a framework for population-level ecological risk assessment that integrates the workshop recommendations concerning all four of these issues. Scheduled for summer of 2003, this workshop builds from an earlier Pellston workshop entitled "Ecological Variability: Separating Natural form Anthropogenic Causes of Ecosystem Impairment" (Baird and Burton 2001), which in part addressed extrapolation of organismal-level effects to population response (Maltby et al. 2001). AED is represented on the Steering Committee of the Population workshop and will chair one of its working groups.

Finally, AED has also provided training in population modeling to Office of Water personnel on detail to AED. When population models are delivered to Program Offices, it is anticipated that considerable technical support will be provided concerning the development and interpretation of model results.

AED's progress towards attainment of LTGs supporting Goals 4 and 8 are measured by annual performance goals (APG) and annual performance measures (APM). Our Population Modeling research supports the following APGs and APMs addressed by NHEERL's Wildlife research Strategy:

GPRA Goal 4
APG 05 - ORD will develop improved methods and models to evaluate the impact of environmental stressors on human health and ecological endpoints for use in guidelines, risk assessments, and risk management strategies by 2002.

> APM 150 - A report to demonstrate approaches in FIFRA ecological risk assessment methods by projecting the consequences of probabilistic risk estimates to bird populations in various agricultural scenarios by 2002. (completed)

APG 19 - Develop improved tools and models to assess and predict human health and ecological risk from exposure to commercial chemicals and microorganisms by 2003.

> APM - Literature based verification and performance evaluation of demographic modeling approaches by 2003

GPRA Goal 8
APG - Deliver to Program Offices and Regional Offices data and models for understanding national distribution of habitat and natural populations for spatially explicit ecological risk assessments by 2005.

> APM - Knowledge base of regional and national distributions and population trends for North American bird species by 2005.

APG - Deliver to the Program Offices and Regional Offices life-history and other biological data for estimating the effects of natural variation and habitat disturbance on the variability of natural populations by 2007

> APM - Demographic classifications for screening-level assessments by 2005.

APG - Deliver to Program Offices and Regional Offices an updated GIS with databases and models for conducting spatially-explicit ecological risk assessments by 2008.

> APM - Evaluation of the efficacy of population modeling approaches to assess risk from multiple stressors from demonstration projects by 2007.

Impacts of Research

Through our efforts in the agricultural pesticides demonstration, AED's Population Modeling research is supporting development of OPP's refined risk assessment methodology for pesticide registration We are developing methods to link EFED's probabilistic exposure model outputs to population models for bird species, and in doing so are helping to define the nature and quality of data required by OPP in registration data packages. Similar support is being provided for aquatic risk assessment methods development. We are also supporting development of methods for

evaluating realistic scenarios of landuse and pesticide use by providing population modeling input to the spatial model developed by WED. This support is helping OPP to respond to the recommendations of ECOFRAM and meet its ambitious goal of refined risk assessment for pesticide registration This is an important first step towards achieving the Safe Communities MYP LTG

Our Population Modeling research is also contributing to establishment of a core methodology for wildlife risk assessment that can be used to address multiple Agency needs. Development of a catalogue of species-specific models, evaluation of model efficacy, identification of compensatory mechanisms that can affect population responses to environmental stressors (and therefore our ability to predict them), and development of tools for application at various levels in a tiered risk assessment approach address many of the critical elements of need identified in NHEERL's Wildlife Research Strategy. Facilitating access to high quality wildlife demographic and population trends data will support specific application of the core methodology to address a number of population risk assessment problems the Agency faces. The population modeling expertise we have developed over the past several years will continue to a source of advice and technical support while this core methodology is being developed by ORD and NHEERL.

Remaining Needs

NHEERL's Wildlife Research Strategy outlines the objectives and future direction of research in support of population risk assessment, including coordinated population biology and toxicology research to improve predictions of population dynamics in spatially-explicit landscapes, and research to advance techniques for assessing the relative risk of chemical and non-chemical stressors on wildlife and other populations. AED's Population Modeling research will contribute to these objectives through:

1. Continued support for OPP in development of refined risk assessment methods for pesticide registration. A technical challenge to be overcome in the near term is interfacing EFED's probabilistic exposure procedures with population models to create a seamless risk assessment modeling package. AED is exploring options for linking program codes or outputs to facilitate a solution to this challenge.

2. Continued exploration of both spatially-independent and spatially-explicit population modeling approaches suitable for various risk assessment applications. Our past research has focused primarily on matrix modeling formulations We will need to develop a capability for other modeling approaches (e.g , individual-based models) to evaluate which models are best used to address specific combinations of species life history, exposure scenario, and risk problem. Additionally, our support of spatial model development and application has been primarily limited to the PATCH cellular automaton approach As described for the Loon/Hg Demonstration later in this Briefing Book, this approach may not be best suited for certain wildlife risk assessment problems. This suggests the need to explore alternative approaches for spatial modeling.

3. Integration of habitat-response relationships with chemical-response relations through population models. As described for NHEERL's Aquatic Stressors research later in the Briefing Book, habitat alteration is recognized as an important stressor for populations of fish, shellfish and aquatic-dependent wildlife. NHEERL's Wildlife Research Strategy acknowledges that our core population risk assessment methodology needs to incorporate methods for evaluating the relative and absolute risks of multiple stressors in the landscape. A key scientific challenge to accomplishing this objective relates to the modeling approaches used to integrate the effects of multiple stressors. AED's Population Modeling research will address this challenge by evaluating different mathematical (perhaps based on mechanisms of effect) and simulation approaches to integration.

The goals of the NHEERL's Wildlife Research program are ambitious and success in some areas will depend on our ability to develop external partnerships to leverage expertise from other Federal and State government scientists and managers, academic institutions, and non-government organizations.

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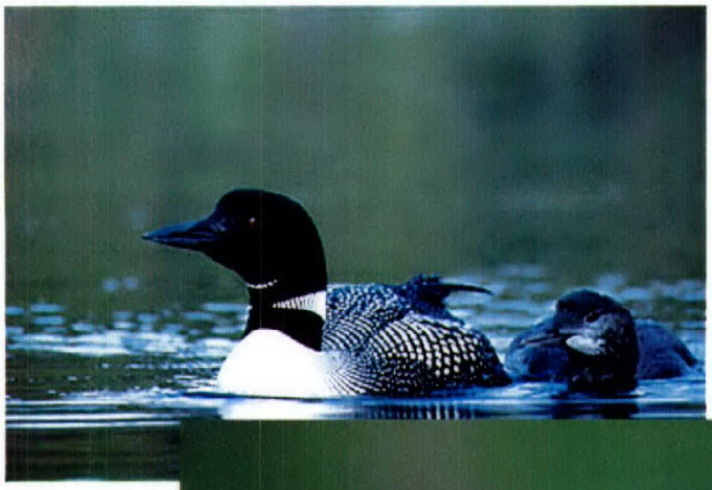
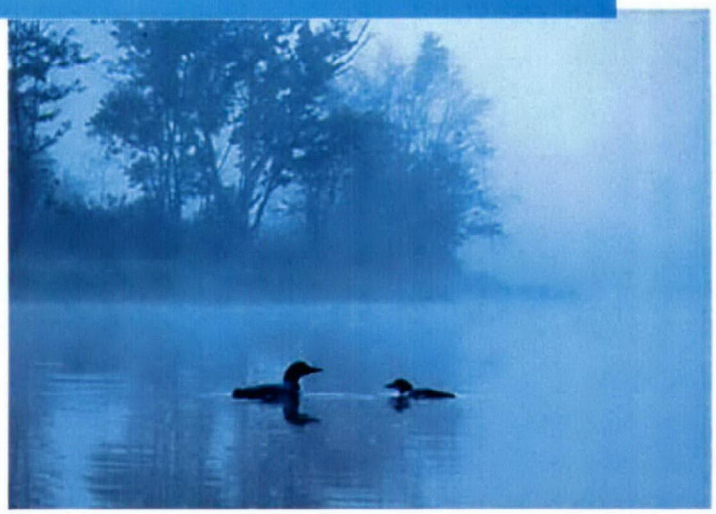


LOON/HG DEMONSTRATION



WILDLIFE RISK ASSESSMENT – LOON/HG DEMONSTRATION PROJECT (GPRA Goal 2)

Agency Problem

The Clean Water Act (CWA) provides the legislative mandate under which the Office of Water (OW) is charged with restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters. To fulfill this mandate, EPA has established under Government Performance and Results Act (GPRA) Goal 2, sub-objective 2.2 3, requirements for developing ecological criteria that protect use designations for the Nation's aquatic resources. NHEERL developed its Aquatic Stressors research (described later in this briefing book) to provide scientific support for OW to address this need with respect to criteria development for aquatic species and aquatic-dependent wildlife (US EPA 2002). Much of this research focuses on specific categories of aquatic stressors that have been recognized for their potential and actual impacts on aquatic ecosystems (e.g., US EPA 1998, NOAA 1999, US EPA 2000a). Two of these high priority stressors are toxic chemicals and critical habitat alteration.

Historically, minimizing the risks of chemical contaminants to aquatic and aquatic-dependent wildlife populations has been an important goal for EPA, and OW, with support from ORD, developed Water Quality Criteria (WQC) to be protective of adverse effects to aquatic organisms (e.g , US EPA 1991, 1994, 1995). These chemical-specific criteria have had an enormous impact on the Agency's ability to manage toxic chemical inputs to aquatic systems. However, the procedures used to develop WQC are based on simplifying assumptions and a relatively narrow framework that limit their use in fully assessing the risks of a wide range of toxic chemicals to both aquatic life and aquatic-dependent wildlife (US EPA 2002). In recognition of some of these limitations, OW, again with the support of ORD, developed prototypical methodologies to assess risks of persistent, bioaccumulative and toxic (PBT) chemicals to wildlife through the Great Lakes Water Quality Initiative (US EPA 1995). These efforts advanced specific aspects of wildlife risk assessment considerably, and this approach was adapted to assess risks to piscivorous birds and mammals in the Agency's Mercury Report to Congress (US EPA 1997). However, mercury (Hg) contamination remains a high priority issue for OW, other EPA Program Offices, Regions, and States and Tribes because of widespread atmospheric deposition and concerns of accumulation through aquatic food webs of the extremely toxic methylmercury (CH_3Hg). In addition, the draft Jeopardy Opinion for the California Toxics Rules also requires the Office of Water to derive new wildlife criteria, specifically for Hg and selenium.

Whereas environmental protection of the Nation's waters over the last several decades has focused on the effects of single chemical contaminants, the mandates of the Clean Water Act dictate the need to address stressors other than chemicals, and employ approaches that reflect greater environmental complexity. To meet this goal, EPA has recognized the need to enhance understanding of the ecological effects of habitat alteration, and how co-occurring anthropogenic stressors and natural factors may affect habitat quality (US EPA 2002). Of specific concern to OW is that alteration of critical habitats threatens the persistence of populations of aquatic

species and aquatic-dependent wildlife. In addition, EPA is being asked increasingly to participate in interagency species protection and conservation efforts where the importance of habitat issues have been long been recognized. For example, a draft Memorandum of Agreement between OW, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service (Federal Register, January 7, 1999) calls for development of improved approaches for wildlife criteria derivation and requires EPA to address explicitly protection of threatened and endangered species in implementation of the Clean Water Act. In fact, 'habitat-based' approaches, e.g., habitat suitability models typically used for wildlife conservation purposes, provide a framework for assessing effects of multiple, co-occurring environmental factors. However, the utility and accuracy of this approach in an environmental protection context requires further evaluation.

Thus, there are defined needs for research to provide methods, models, and data to address concerns related to toxic chemicals and habitat alteration in the context of wildlife risk assessment and criteria development This need has resulted in the development of NHEERL's Wildlife Research Strategy (NHEERL 2000a). Key research needs, identified through EPA Science Advisory Board consultations and other EPA peer-reviews, that are addressed in the Strategy include improved capabilities for cross-species extrapolation, prediction of population dynamics in spatially-explicit habitats, assessment of the relative risk of chemical and non-chemical stressors and definition of appropriate spatial scales for wildlife risk assessments. The advancement of science in these areas requires approaches that integrate theory and practice from scientific disciplines ranging from chemistry, toxicology, pathology, population biology and spatial ecology.

The ecological research described in this section reflects application of NHEERL's wildlife risk assessment research approaches within the framework of NHEERL's Aquatic Stressors research program to support the wildlife criteria development needs of OW. Specifically, methods and approaches are being developed to assess the effects of Hg and habitat alteration on populations of aquatic-dependent wildlife. Because Hg bioaccumulates in the aquatic food web, this project focuses on the risks of CH_3Hg to a top level predator, the common loon (*Gavia immer*). Although there is evidence of reduced productivity in some piscivorous birds and widespread reports of Hg in wildlife tissues at concentrations exceeding levels associated with adverse effects in controlled studies, it is unclear what impact Hg has on the viability of populations of piscivorous wildlife (US EPA 1997). In addition to the effects of Hg, other effects of broad-ranging industrial pollution (i.e., acidification), point source contamination and land-use changes have altered biotic and abiotic characteristics of habitats that support loons and other wildlife species. Thus, this project was developed to address the need to improve characterization of the effects of this toxic chemicals and altered critical habitat to wildlife populations, but also to identify the effects of interactions among stressors, and quantify the relative risks among potential stressors to populations of wildlife species at various spatial scales. Focus on the common loon to develop and demonstrate wildlife risk assessment methods necessitates collaborations with local and national avian conservation organizations that have invaluable expertise and an abundance of information on this charismatic, wild bird.

Objectives of the Research

This project has been developed as a demonstration and evaluation of the utility of the research approaches described in NHEERL's Wildlife Research Strategy and Aquatic Stressors Framework to support attainment of ORD's Water Quality Multi-Year Plan long term goal to "provide the approaches and methods to develop and apply criteria to support designated uses." This specific project was identified as the demonstration because it involved minimal data collection activities and addressed a problem of immediate concern (risks of Hg) to the Agency. The overall objective of this demonstration project is to develop the tools and approaches for assessing the risks of multiple stressors to populations of piscivorous wildlife, leading to the development of risk-based criteria. The research attempts to make advances in key research areas through demonstration and evaluation of the tools necessary to conduct an assessment of the risks of PBTs (i.e., Hg) and habitat alteration to populations of piscivorous birds in northeastern U.S. and Canada. In the process of developing the approach and tools for conducting the risk assessment, we will also develop a framework for establishing wildlife criteria using piscivorous birds and Hg as the example. Another component of this project involves assessment of the interactive effects of landscape-level habitat alteration and Hg on loons. Therefore, research issues regarding habitat alteration, including evaluating the spatial configuration of loon habitat and Hg impacts in the landscape mosaic, and the issue of scaling up from local to regional impact assessments will constitute a significant component of this project. Three specific major research objectives are

- Development of a mechanistically-based approach for extrapolating Hg toxicological data across wildlife species.

- Development of approaches for predicting population-level responses of common loons and other avian species, to stressors including Hg exposure and habitat alteration, and identification of responses at the individual level that have the greatest influence on population-level responses.

- Development of approaches for evaluating the absolute and relative risks from Hg exposure, habitat alteration, and other environmental factors on (spatially structured) common loon populations of northeastern US and Canada at varying scales ranging up to watershed and biogeographic region.

Approaches and Recent Accomplishments

The Loon/Hg Demonstration Project is being conducted as six interdependent research activities, which collectively represent the critical path of research needed to meet the objectives above Research conducted within each activity is designed to contribute towards the advancement of ecological risk assessment in both general and specific ways. However, this project is also designed to demonstrate a risk assessment methodology which connects information from each activity through important feedback loops. The level of refinement needed in the models and

data acquired is a function of the degree of uncertainty acceptable for setting criteria. Therefore, the application of tools will explicitly consider the availability and quality of data for various tiers (screening to definitive) of risk assessment.

The first activity involves acquisition and organization of data that provides the basis for predicting effects of Hg and habitat alteration on aquatic-dependent piscivorous wildlife species. Data on the spatial and temporal distribution of environmental characteristics, including natural and anthropogenic factors associated with potential loon habitat, are being acquired and organized using a geographic information system. These data are obtained through national programs such as ORD's Environmental Monitoring and Assessment Program (EMAP), as well as regional and state-sponsored environmental monitoring programs Spatially-explicit data on the abundance and distribution of loons is being acquired from government environmental agencies and through collaborations with avian conservation groups. To facilitate this, AED sponsored two workshops over the past two years An initial expert symposium in 2000 was attended by internationally-recognized experts who provided state-of-the-science information on various aspects of loon biology and Hg effects. Six invited speakers, including representatives from academia, private industry, and US, State and Canadian governments, provided focused presentations on subjects that ranged from molecular- to landscape-scale effects of environmental Hg contamination. The following year, AED convened a multi-divisional workshop focused on development of a data management system for the assembly and analysis of existing data. This system is modeled after the highly successful EMAP data management approach developed and maintained at AED. In addition to NHEERL scientists, participants (about 40) included representatives from USGS, the Canadian Wildlife Service, New York and New England state departments of environmental protection, management, and conservation, Tufts University School of Veterinary Medicine, and private loon conservation groups from New England and New York. This workshop highlighted some of the risk assessment tools under development at AED and demonstrated their application to the Loon/Hg project and other conservation issues. In addition, the workshop provided an opportunity to begin addressing issues related to data sharing amongst the various organizations represented. The outcome of this workshop was the development of collaborations and agreements for data sharing that have enhanced project development. These two workshops also supported the other remaining five activities of the Loon/Hg Demonstration.

Also supporting this activity is the development of a cooperative research agreement between AED and the Cornell Laboratory of Ornithology (CLO), the lead organization for Partners in Flight, which serves as an umbrella organization for the Audubon Society and other private and public conservation and environmental protection organizations. Entitled "Avian Risk Assessment for Multiple Anthropogenic Stressors Through Citizen Science Monitoring of Bird Populations," this collaboration will provide a mechanism for NHEERL and CLO scientists to compare and contrast current risk assessment methodologies, and develop new methodologies that take advantage of avian monitoring data sets, generated through "citizen scientist" activities, and currently managed by CLO. Generally, cooperative research projects with academic and other scientific institutions which complement the objectives of the EPA ensure that the Agency supports the highest quality peer-reviewed environmental science. More specifically, Cornell's leadership role at the center of the science of bird conservation in North America will provide the

best opportunity for NHEERL to extend support into new areas of research related to aquatic-dependent and terrestrial bird species for the principle purpose of the general advancement of wildlife risk assessment.

The second research activity is designed to improve current understanding of relationships between aquatic Hg, environmental factors and Hg bioaccumulation in species at higher trophic levels. Currently focusing on top-level aquatic and aquatic-dependent predators, it supports future development of predictive relationships between environmental and tissue Hg concentrations for common loons and other piscivorous birds. Such relationships will provide a mechanism to link changes in atmospheric Hg deposition to predictions of ecological effects. Within this activity, data are being gathered and used to develop predictive relationships for Hg concentrations in several species of freshwater fish and some of their predators (e g., mink, snapping turtles, and some birds). These relationships are based on measurements of Hg concentrations and stable isotopic data in tissues, and site-specific environmental information, including water chemistry, land use, and selected physical factors. Currently, this research is being conducted in several freshwater lakes in southern New England.

In the third activity, CH_3Hg dose-response relationships are being developed for important demographic endpoints, including stage-specific survival and fecundity rates, for common loon. Relationships are being developed empirically from field data and generated in laboratory tests based on representative exposure scenarios. Where data are available, these relationships are developed based on responses of caged and wild loons. Additional dose-response information is being extrapolated from controlled exposures of a surrogate test species, the American kestrel (*Falco sparverius*), conducted through a cooperative agreement with the USGS Patuxent Wildlife Center. A primary goal of this effort is to develop a physiologically-based toxicokinetic (PBTK) model for CH_3Hg in kestrels that can be used to extrapolate effects information from kestrels to other avian species, including loons, on the basis of CH_3Hg concentrations in selected tissues. This research is being conducted primarily by NHEERL's Mid-Continent Ecology Division (MED).

The fourth activity also focuses on CH_3Hg effects on individual birds. Specifically, pathological analysis is being conducted using tissues from the Patuxent caged kestrel studies. Analysis of pathological endpoints of Hg intoxication from these controlled studies are being used to diagnose Hg intoxication in wild birds, and serves as a basis for predicting Hg sensitivity in diverse avian species. In addition, avian pathology records of the Tufts University School of Veterinary Medicine are being organized and analyzed to evaluate the relative role of Hg and spatio-temporal trends in the morbidity and mortality of loons and other avian species.

In the fifth activity, population models are being developed using empirical data on loons indigenous to different geographic areas and subject to varying levels of Hg exposure. Population models predictive of Hg effects on wild loons have been developed using Hg stressor-response relationships for demographically important endpoints (developed in the third activity of this project). In addition to population modeling, this activity includes application and development of molecular genetic techniques to define and assess the condition of loon populations within the assessment area This work is occurring through a collaboration between

AED and the Molecular Ecology Research Branch within ORD's National Exposure Research Laboratory's (NERL) Ecological Exposure Research Division. This collaboration has resulted in the development of molecular genetic markers for common loons (and other avian species) and has provided a training opportunity for an AED NRC postdoctoral fellow.

The sixth and final activity involves integration of information in a spatial context. Specifically, loon-specific habitat suitability models are being developed that provide an approach to assess the relative importance of natural and anthropogenic features in defining and predicting loon distribution and abundance, using information accessible through the first activity of this project. In addition, spatially-explicit population modeling approaches are being applied to describe and predict population dynamics across heterogeneous landscapes where variable stressor levels and habitat quality influence the distribution of populations. Ultimately, these models will be applied at differing spatial scales as an approach to characterize the relative risk of stressor effects as a function of spatial scale of assessment. Our intention is to use data and information obtained in New England and southeastern Canada in the developmental stages of this research. Ultimately, evaluation of the methods and approaches will be made by applying them to loon populations in the north central portion of the US (i.e., the Great Lakes).

Impacts of Research

The final planning phase for this project has just recently concluded, and initial research activities have been underway for approximately one year. Preliminary habitat suitability relationships and population models have been developed that provide the bases for guiding much for the research in activities of the project. A prototype data management system is being populated to support specific development and assessment needs. Substantial data also have been collected that address Hg concentrations in top-level consumers in lakes from southern New England.

While the full benefits of this research have yet to be realized, this project is designed ultimately to provide the Agency, States, and other environmental protection and conservation organizations with scientifically defensible methods to enhance ecological risk assessment and wildlife criteria derivations. These methods, identified in the Aquatic Stressors Implementation Plan as critical steps to achieve this ultimate goal, will improve characterization of risks to individuals (including those from species of special concern), extrapolation of population level effects from individual-level data, and evaluation of risks to wildlife populations at various spatial scales of stressors, including toxic chemicals, in the context of other stressors. Several specific products developed within this project are described as annual performance goals (APGs) and measures (APMs), and provide specific support to GPRA Goal 2.2.3, Long Term Goal 1 (Table 1).

In addition to supporting OW needs directly, the research conducted within this project will help to address the science-based problems of other Program Offices with respect to ecological risk assessment. Specifically, this research will improve the ability of managers and researchers to

Table 1. AED research products for the Loon/Hg Demonstration Project in support of GPRA GOAL 2.2.3 Long Term Goal 1.

ANNUAL PERFORMANCE GOALS (APGs) AND MEASURES (APMs)		YEAR
APG - Provide models for linking habitat alteration stressors and mercury to the regional problems of Northeast Loons.		2003
APM	Habitat suitability indices to support population models for projecting relative risks of multiple stressors including toxic chemicals and habitat alteration to *common loons*	2003
APG - Provide methods for developing water quality criteria based on characterization of population-level risks of toxic chemicals to aquatic life and aquatic-dependent wildlife		2005
APM	Population models that project the relative risks of multiple stressors (toxics, habitat alterations) to piscivorous birds	2004
APG - Provide methods for extrapolating chemical toxicity data across exposure conditions and across endpoints, lifestages, and species which can support assessment of risks to aquatic life and aquatic-dependent wildlife for chemicals with limited data		2006
APG - Provide approaches for evaluating the relative and cumulative risks from toxic chemicals, with respect to risks from nonchemical stressors, on populations of aquatic life and aquatic-dependent wildlife at various spatial scales.		2008
APM	Approaches for addressing spatial scale issues in assessing risks of multiple stressors to wildlife populations in spatially-diverse landscapes	2006

understand links between human activities, natural changes, and ecological stressors, and between multiple stressors and valued resources at the appropriate level of ecological organization (a long term goal for Diagnosis and Forecasting in GPRA Goal 8). For example, through our cooperative research with the Cornell Laboratory of Ornithology, we are beginning development of a knowledge base of regional and national distributions and population trends for North American bird species (a Goal 8 APM for 2005), that will support delivery to Program Offices and Regional Offices of data and models for understanding the national distribution of habitat and natural populations for spatially explicit ecological risk assessments. In addition, through our evaluation of the efficacy of population modeling approaches to assess risk from multiple stressors (a Goal 8 APM for 2007), we will provide tools for environmental managers in

Program and Regional Offices to diagnose present conditions that support decision making.

Remaining Needs

This is an ambitious project and given its early stage of implementation, many technical challenges remain. Notable among these are:

- Institution of data management, quality assurance and quality control procedures to facilitate development of accessible databases directly supporting the Loon/Hg demonstration and describing status and trends for avian species through the cooperative agreement with the Cornell Laboratory of Ornithology. Strategic partnerships with other government and non-government organizations will support this need, as well as provide access to essential data. Close coordination with EMAP data management activities is also required.

- Development of appropriate stressor-response relationships relating Hg exposure to biological effects, and habitat suitability as it affects key demographic rates. Methods also are needed to combine stressor-response relationships involving different stressors in biologically realistic ways.

- Refinement of GIS-based spatial modeling methods taking loon life history and ecology into account. We currently have cellular automaton models (Schumaker 1998) that divide landscapes into cells through which individual organisms move, but this approach may not describe loon (and other) life history adequately. Other modeling approaches may need to be explored in this regard.

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(References cited in bold signify AED research products)

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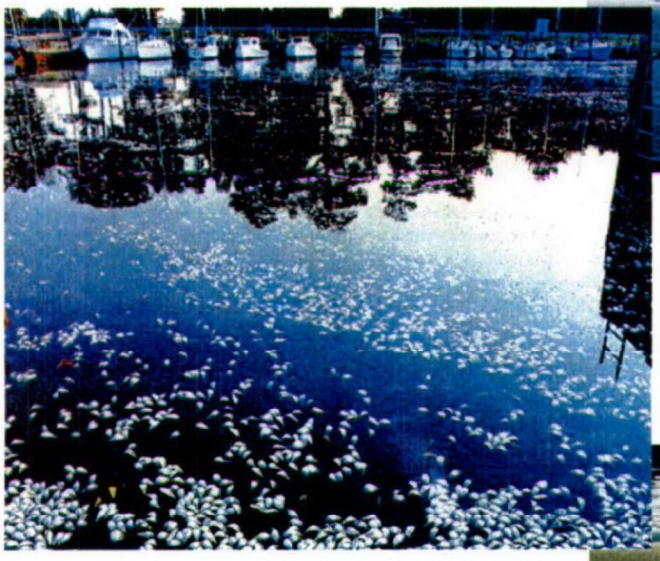
FRAMEWORK FOR ASSESSING EFFECTS OF AQUATIC STRESSORS



Framework for Assessing Effects of Aquatic Stressors

Agency Problem

EPA's Office of Water (OW) has primary regulatory responsibility for protecting the ecological integrity of the Nation's aquatic resources and ecosystems. Three elements provide the regulatory context for this responsibility First, the Clean Water Act (CWA) provides the legislative mandate to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Second, the Administration's Clean Water Action Plan (CWAP; U S EPA 1998a) establishes key actions focused on watershed, wetland, and stream corridor protection and restoration; nutrient assessment and criteria development; and development of a contaminated sediment strategy. Finally, to fulfill this mandate, EPA has established under GPRA Goal 2, requirements for developing ecological criteria that protect use designations for the Nation's aquatic resources. To accomplish its mission, OW requires the knowledge bases and methods to assess the ecological risks of aquatic stressors. The immediate need is to develop and improve ecological criteria and diagnostic capabilities for managers to help them meet the designated uses of water bodies, and to develop options for protection and remediation efforts.

The common management goal for all aquatic ecosystems is to maintain ecological integrity by protecting these systems against degradation of habitat, loss of ecosystem functions and services, and reduced biodiversity To this end, environmental managers must be able to: 1) assess the condition of an aquatic resource and determine its degree of impairment, 2) diagnose the causes of impairment if observed, 3) forecast the effects of changes in stressor levels, and 4) develop and implement remediation and maintenance strategies. To accomplish these, managers must be able to characterize aquatic systems, knowing the appropriate reference conditions against which to compare their assessments, have the diagnostic tools necessary to ascertain causes, and understand specific aquatic systems well enough to forecast the effectiveness of potential remediation efforts. The information, methods, and tools needed by the Agency, States, and Tribes to conduct these activities are incompletely developed with respect to many of the Nation's aquatic resources.

ORD/NHEERL/AED Research Approach

In response to these needs, ORD's Multi-Year Plan for Water Quality has established two long term goals (LTG): 1) "Provide the approaches and methods to develop and apply criteria to support designated uses," and 2) "Provide the tools to assess and diagnose impairment in aquatic systems and the sources of the associated stressors " NHEERL has organized its aquatic stressors research within an interdivisional framework to support attainment of these goals. Working closely with the OW and the Regions, NHEERL developed the multidivisional Aquatic Stressors Framework and Implementation Plan for Effects Research (NHEERL 2002). The purpose of this framework is to focus NHEERL's stressor-effects research on the specific research needs for criteria development and diagnostic capability, and to provide an effective mechanism for interdivisional collaboration.

Consistent with recent scientific consensus of their potential to cause adverse ecological effects on aquatic ecosystems (NRC 1993, Naiman et al. 1995, Vitousek et al. 1997, U.S. EPA 1998b, 2000a, NOAA 1999), NHEERL's Aquatic Stressors research focuses on the effects of the habitat alteration, nutrients, suspended and bedded sediments, and toxic chemicals These stressors are cited most often in failures of aquatic resources to meet their designated uses, and States and Tribes commonly report these stressors in their 303(d) lists of impaired waters under the Clean Water Act However, the methods used to assign causation are inconsistent at best. Therefore, Aquatic Stressors research will also develop diagnostic tools for a decision support system for environmental managers.

Effective management and protection of aquatic resources requires multiple science-based elements. NHEERL's Aquatic Stressors research process for developing these elements, and the products of that research, are shown in Figure 1. Although this process presents a generally linear research sequence, some research elements are being conducted simultaneously.

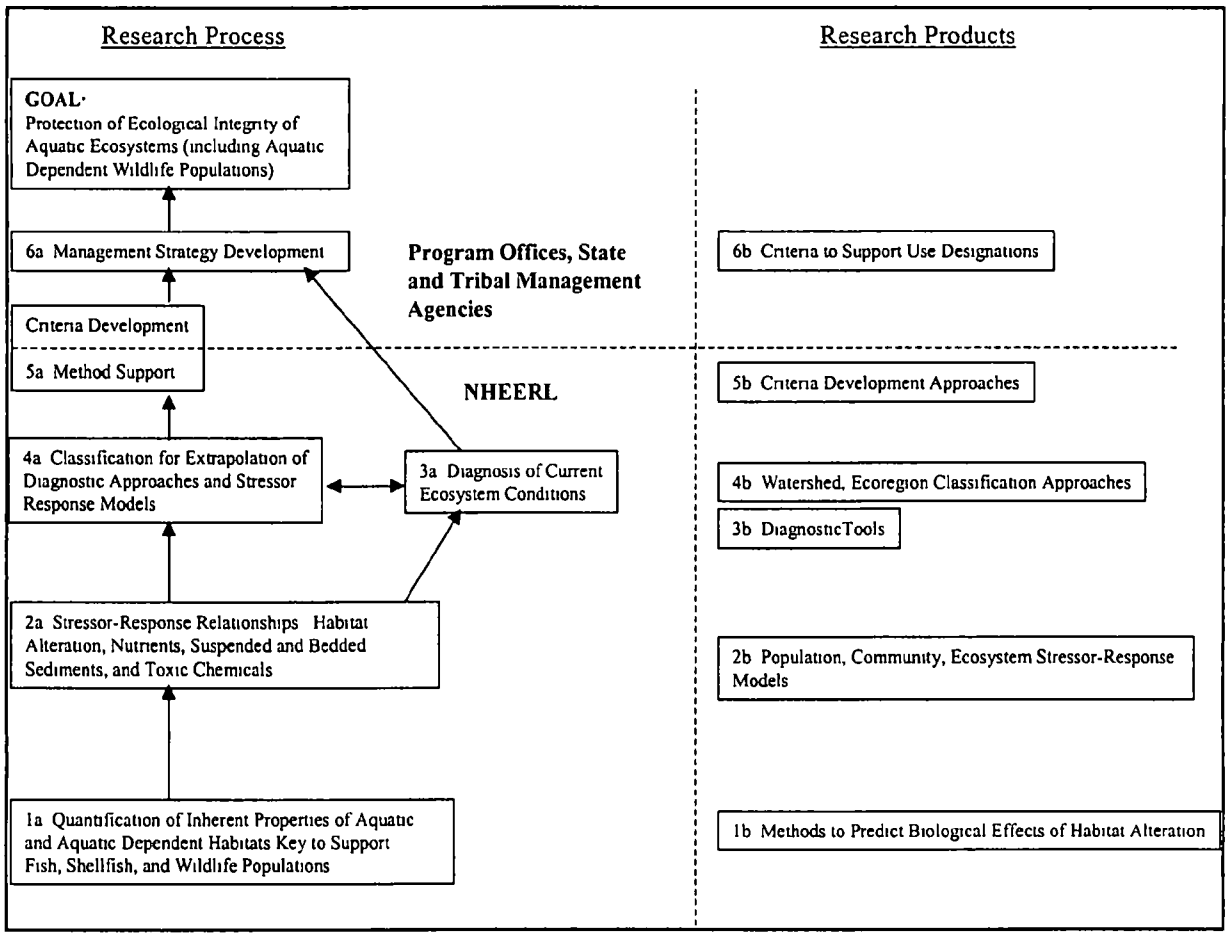


Figure 1. Research process and products for the Aquatic Stressors Framework

Protection of the ecological integrity of aquatic ecosystems must begin with a quantification of the inherent properties of habitats that are critical to the life-support of important fish, shellfish and aquatic-dependent wildlife populations (Figure 1: box 1a). The importance of habitat quality and quantity for maintaining species is indisputable, but quantifying exactly how species depend on habitats is multi-faceted and complex. Aquatic Stressors research addressing this issue focuses on habitat types (submerged aquatic vegetation, wetlands, habitat mosiacs) of priority to OW to assess their life-support functions and provide quantitative methods to link biological effects with alteration of these functions

Knowledge of the life-support properties of priority aquatic habitats are key to developing stressor-response relationships not only for habitat alteration, but also for other aquatic stressors (Figure 1· box 2a). These relationships provide the fundamental information required to define response patterns or thresholds needed to establish aquatic life and aquatic-dependent wildlife criteria. Determining stressor-response relationships also helps to define the symptoms of impairment and their diagnosis NHEERL's Aquatic Stressors research is developing stressor-response models (Figure 1: box 2b) for each of the four priority stressors (habitat alteration, nutrients, suspended and bedded sediment, and toxic chemicals). Although initial research focuses on development of stressor-response relationships for individual stressors, such models will eventually reflect multiple stressor interactions. Much of AED's Aquatic Stressors research is currently focusing on development of stressor-response relationships for habitat alteration and nutrients.

As stressor-response relationships are being determined, research is also being directed towards developing diagnostic approaches (Figure 1 box 3a), which will provide tools (Figure 1· box 3b) for building a decision support system, supporting ORD Water Quality Multi-Year Plan LTG 2 Resource managers then can use the system to diagnose the causes of impairment, and to predict the results of corrective actions that might be needed. AED's role in diagnostic research is described earlier in this Briefing Book, and builds from our development of Toxicity Identity Evaluation methods (TIE, Burgess et al. 2000, Pelletier et al. 2001, Ho et al. 1997).

Stressor-response relationships can be specific to different classes of ecological systems. Thus, research is also focused on developing ecosystem classification approaches (Figure 1: boxes 4a,b) that support extrapolation of diagnostic approaches and stressor-response models across systems. Classification is valuable for two primary reasons: 1) grouping ecosystems according to similar criteria, and 2) spatially classifying ecosystems that are connected via stressor actions. Since little is known about scale relative to ecosystem classification, our effects research also results in guidance about the most appropriate scale for various ecosystem classification approaches, up to and including the watershed scale. AED's Aquatic Stressors research is focused at the habitat, shoreline (mosaic) and landscape scales.

Research identified in boxes 1a-4a will result in methods and approaches for deriving criteria (Figure 1· boxes 5a,b) for protecting aquatic ecosystems. Establishing specific criteria and the management strategies for their use are the responsibility of OW. In combination, the elements of Aquatic Stressors research will improve the tools available to managers for meeting aquatic designated uses (Figure 1: boxes 6a,b).

Organization of Program

NHEERL's Aquatic Stressors research into five research areas.

- Stressor-Response Relationships for Habitat Alteration
- Stressor-Response Relationships for Nutrients
- Stressor-Response Relationships for Suspended and Bedded Sediments
- Stressor-Response Relationships for Toxic Chemicals
- Diagnostics Research

Based on consideration of their programmatic history and resident expertise, lead responsibility for these areas has been distributed amongst NHEERL's four ecology divisions (Gulf Ecology Division - GED, Mid-Continent Ecology Division - MED, Western Ecology Division - WED, and AED). AED is the lead division for Suspended and Bedded Sediments research, but is contributing substantially to the other four research areas.

Many human activities exert their influence on biota via effects on habitat, and habitat alteration is arguably the most important cause of declines in ecological resources in North America (U.S EPA 1990). Although the Agency has not traditionally focused its regulatory, policy and research efforts on habitat alteration as a stressor, a number of factors converge to justify a new EPA emphasis on habitat issues. These include the mandate of the CWA "to restore and maintain the physical, chemical, and biological integrity of the Nation's waters" and that habitat alteration is a commonly-cited cause for failure of aquatic systems to meet designated uses. The goal of NHEERL's Aquatic Stressors Habitat Alteration research (WED lead) is to provide the scientific basis for assessing the role of essential habitat in maintaining healthy populations of fish, shellfish, aquatic-dependent wildlife, and the ecosystems upon which they depend A key scientific challenge is the development of habitat-alteration-population response relationships for the species and habitats of priority concern, capable of quantifying effects of both incremental and catastrophic habitat alteration. These relationships must reflect both individual habitat components and interactions among them AED's research in this area is organized into three major components: coastal vegetated habitat, shoreline scale, and landscape scale. The first two, described in detail later in this Briefing Book, build on foundations laid in previous wetlands and fish habitat research (e.g., Wigand and Thursby 2000, Wigand et al. 2001, Meng et al. 2001). Landscape Scale research (predominantly the Loon/Hg Demonstration Project, which also supports Aquatic Stressors Toxic Chemical research and is described earlier in this book), is essentially a new area of endeavor for AED.

Human activities have dramatically changed the amounts, distribution, and movement of major nutrients in the landscape, and have increased nutrient loading to receiving waters. Some of these changes affect use of the Nation's aquatic resources, and pose risks to human health and the environment (NRC 2000) The principal goal of Aquatic Stressors Nutrient research (GED lead) is to provide the scientific basis and load-response relationships required to develop numeric criteria protective of aquatic life. This research is focused on coastal receiving waters as opposed to inland waters and wetlands AED is supporting this goal by assessing the responses of

dissolved oxygen (DO), submerged aquatic vegetation (SAV) and food web changes to nutrient loading using an empirical approach (other portions of NHEERL's program are taking modeling approaches to establish loading-response relationships). This approach requires quantification of loading rates to coastal systems, in addition to measurement of system response relative to the three primary endpoints both spatially and temporally, and builds on our contributions to the existing guidance for saltwater DO criteria (U.S. EPA 2000b) and nutrient criteria (U.S. EPA 2002). AED's research to overcome these challenges is described in the following section of this Briefing Book.

Sediment loading to aquatic systems is often cited as a cause for failure of aquatic systems to meet designated uses, and OW has identified criteria for suspended and bedded sediments as one of its highest priorities The primary goal of Aquatic Stressors Suspended and Bedded Sediment research (AED lead) is to provide and demonstrate the approach for establishing sediment criteria that support aquatic life use in streams and rivers, lakes and reservoirs, wetlands, and estuaries. The methods and models developed to obtain this goal will link directly to exposure assessment and management models (e g , TMDLs) for use in regulatory actions, and should provide a practical solution for States and Tribes in monitoring and assessing suspended and bedded sediment problems. A first step in the critical path of research to meet this goal is a state-of-the-science review of the direct effects of sediment on aquatic biota, and direct effects on the physical habitat which result in indirect effects on biota. AED is completing this review this year. Because the expertise needed to develop mechanistically-based stressor-response relationships is limited within NHEERL, we anticipated that any future work in this area will be conducted primarily through analysis of existing stream condition data collected through ORD's Environmental Monitoring and Assessment Program (EMAP).

NHEERL has a long history of supporting development of the technical basis for toxic chemical criteria for waters and sediment (e g., Boothman et al 2001), and procedures for deriving aquatic life water quality criteria have existed for many years. However, these procedures are based on simplifying assumptions and a relatively narrow framework that limit their use in fully assessing the risk of a range of toxic chemicals to both aquatic life and aquatic-dependent wildlife. A key uncertainty in the use of current criteria arises from the use of organismal-level toxicity (primarily mortality) to establish concentrations protective of populations and communities Aquatic Stressors Toxic Chemicals research (MED lead) is addressing this and other uncertainties associated with criteria development for broad classes of inorganic and bioaccumulative organic chemicals. The goal of this research is to develop scientifically-defensible methods for describing risks of toxic chemicals to aquatic and aquatic-dependent populations and communities. AED's research to support attainment of this goal consists primarily of the Loon/Hg Demonstration Project. This effort is demonstrating population-level, risk-based methods for wildlife criteria development using the common loon (*Gavia immer*) as a model assessment endpoint, and mercury and habitat alteration as stressors (described earlier in this Briefing Book). We are also contributing to conceptualization of approaches to develop risk-based criteria for classes of inorganic and organic contaminants. This research builds from AED's substantial history and expertise in developing the technical basis for water quality criteria and sediment quality guidelines. Much of this expertise now contributes to supporting the science-based needs of EPA's Office of Solid Waste and Emergency Response (OSWER) for

managing contaminated sediments. Our contaminated sediments effects research currently is directed toward attainment of ORD's Contaminated Sites MYP LTG of providing "scientific tools, methods, models, data, guidance, and technical support to more accurately, rapidly, and cost-effectively characterize the extent of site contamination, estimate risks to human health and the environment, and evaluate residual (post-cleanup) risks" to achieve GPRA Goal 5, as described later in this Briefing Book.

When States list waters as biologically impaired, they're faced with the problem of diagnosing the cause(s) of that impairment before plans can be made to reduce loadings of pollutants through the TMDL process. A key scientific need in diagnosing impairment is a decision support system that allows interpretation of cause-and-effect relationships and allocation of causality among likely stressors. The goals of Aquatic Stressors Diagnostic research (MED lead) include development of a framework for interpreting cause-and-effect, diagnostic methods and models for single and multiple stressors to allocate causality, and methods and models capable of forecasting causality to support evaluation of the ecological benefits of various alternatives for source reduction and restoration. AED's research to support attainment of these goals builds from our development of TIE methods for chemical stressors in water and sediments (e.g., Burgess 2000, Burgess et al. 1997, 2000, Ho et al 1997, 2002, Pelletier et al. 2001), and uses a case study approach to development diagnostic methods for estuaries. This research is described earlier in this Briefing Book in the context of supporting OW, State, and Tribe needs with respect to meeting the monitoring, listing and TMDL requirements of the Clean Water Act.

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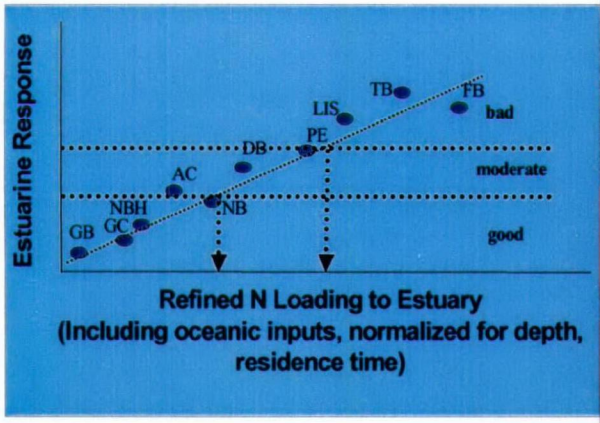
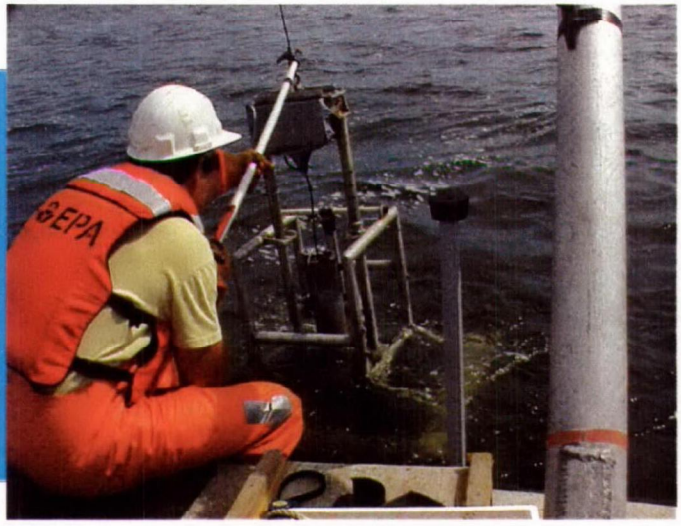
STRESSOR-RESPONSE RELATIONSHIPS FOR NUTRIENTS





Stressor-Response Relationships for Nutrients (GPRA Goal 2)

Agency Problem

There is growing evidence that human activities have dramatically changed the amounts, distribution, and movement of major nutrient elements (nitrogen-N and phosphorus-P) in the landscape and have increased nutrient loading to receiving waters. Some of these changes affect use of the Nation's aquatic resources, and pose risks to human health and the environment (NRC 2000). EPA is in the process of developing guidelines that States and Tribes will use to set nutrient criteria for our Nation's waters. For waters failing to meet water quality standards, States and Tribes are required to develop Total Maximum Daily Loads (TMDLs) to eliminate the causes of non-attainment. At present we cannot extrapolate knowledge of nutrient load-response relationships from systems for which we have adequate data to predict adverse effects on specific systems with more limited data. Sound methods and information on nutrient load-response relationships are required to develop numeric nutrient criteria protective of aquatic life to manage nutrient risks for such systems.

A primary goal of NHEERL's Aquatic Stressors research (NHEERL 2002) is to develop and improve ecological criteria and diagnostic capabilities for managers, to help them meet designated uses, and to develop options for protection and remediation efforts As part of this effort, AED along with the Gulf, Western, and Mid-Continent Ecology Divisions, are implementing an integrated research plan whose goal is to develop stressor-response models for nutrients in marine and Great Lakes coastal waters useful to the Office of Water, the Regional Offices, and the States and Tribes in establishing numeric nitrogen criteria that protect aquatic life in estuarine and coastal waters. This research will advance and augment the current scientific basis for the developing water quality criteria as outlined in the technical guidance manual for estuaries (U.S. EPA 2002).

Objectives of Research

A long-term goal (LTG) of ORD's Multi-Year Plan for Water Quality is to provide the approaches and methods to develop and apply criteria to support designated uses. Aquatic Stressors Nutrient research supports this goal by quantifying relationships between nitrogen loading and ecological responses for estuarine and coastal waters (NHEERL 2002). Increased algal biomass (or carbon supply as defined by Nixon (1995)) is the principal causative agent for the three key effects in aquatic systems: (1) low dissolved oxygen (DO) or hypoxia leading to fish kills or loss of shellfish and degradation of benthic habitats, (2) shifts in basic food webs (including changes in algal community composition and the presence of harmful algal blooms) leading to loss of commercially important fisheries and overall aquatic biodiversity; and (3) loss of natural submerged aquatic vegetation (SAV) habitat, important to fish and other biota and due to changes in water clarity, epiphytic growth, or smothering by invasive algae. These effects (or endpoints) are the primary focus of Aquatic Stressors Nutrient research.

AED's contribution to development of stressor-response relationships for nutrients focuses primarily with coastal receiving waters and the development of nitrogen load-response relationships for dissolved oxygen, submerged aquatic vegetation, and food web (community composition) changes using an empirical approach. Our specific objectives are to:

- Provide the science to support consistent dissolved oxygen criteria for prevention of hypoxia impacts in all coastal regions of the US.
- Provide a first generation protocol to classify eutrophication models for nutrient load allocation in coastal systems.
- Provide the scientific foundation for development and application of quantitative measures of food web attributes that are sensitive to ecological changes associated with nutrient enrichment.
- Provide the scientific foundation for establishing site-specific nutrient threshold criteria to protect estuarine SAV.

Approaches and Recent Accomplishments

NHEERL's Aquatic Stressors Nutrient research follows a critical path of activities to meet the objectives above:

Step 1. Mine and assess existing information.
Step 2. Develop conceptual models
Step 3. Develop classification schemes.
Step 4. Develop standard methods and procedures.
Step 5. Develop nutrient loading-ecological response models

AED is utilizing a comparative systems empirical approach as outlined in an appendix of EPA's Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters (U.S. EPA 2002, Cicchetti et al. 2000, Latimer et al. 2000). This approach has been used successfully to derive water quality standards and total maximum loads for some embayments of Buzzards Bay (Costa et al. 1999). Three kinds of information are needed to develop loading-response relationships using this approach: 1) loading estimates, 2) classification factors, and 3) response measures.

Step 1. Mine and assess existing information

Three main tasks are needed to complete this portion of the critical path:

- Obtain data sets, models, pertinent reports and articles

- Set up a central bibliographic database at AED with cross-divisional access
- Maintain database (AED)

To date, AED has developed a bibliographic database that is accessible to ORD scientists working on Aquatic Stressors Nutrient research. Presently, this database is populated with over 2,300 records Information will be added to the database in an ongoing manner throughout the life of the nutrients effort.

Step 2 Develop conceptual models

Conceptual models describing important aspects of ecosystem response, relative to the three key endpoints to excess nutrients, are currently under development. These describe the ecological relationships between nutrient input to the aquatic system, and changes in key system processes as they influence each endpoint. To date, the conceptual model for response of DO has been developed in final form

Step 3 Develop classification schemes

Development of nitrogen loading-response relationships requires consideration of the factors that govern estuary response to nitrogen loading. Classification factors may be used to separate estuaries into more-or-less discrete categories that correspond to the sensitivity of estuary response to nitrogen loading In other cases, a variable that influences the sensitivity of estuarine response to nitrogen loading may be used to scale (or normalize) nitrogen loading. For instance, the volume and freshwater residence time of the estuary are often used to normalize the loading rate of nitrogen when analyzing the relationship between the loading rate and ecological response (e g , Dettmann 2001). This form of analysis makes use of the continuous nature of volume and residence time, and does not divide the estuaries into categories; rather, systems are ordinated along axes of residence time. Some parameters are inherently discrete (e.g., physiographic setting and primary production base) and therefore lend themselves only to classification; others are continuous (e.g., volume, residence time, depth) and may be used for normalization. Continuous parameters may be used in either way, depending on the application.

Classification and normalization procedures for estuaries and coastal waters are currently being developed for the specific endpoints important to Aquatic Stressor Nutrients research. Although several estuary classification schemes already exist in the literature, most have been developed for purposes other than evaluating response to nutrient loading and do not lend readily themselves to this purpose. An NHEERL workshop was conducted in 2001 to frame the classification scheme research. It is probable that separate methods of classification or normalization will be required for each of the three ecological endpoints. For instance, it is likely that some parameters, such as residence time and estuary volume are important for all response categories. On the other hand, degree of benthic filter feeding can be an important control on phytoplankton abundance, but is not for seagrasses. Stratification of the water column is probably more important in controlling oxygen depletion than some other responses. Efforts to develop classification and normalization procedures include application and extension of a

model developed at AED (Dettmann 2001), investigation of nitrogen-chlorophyll relationships, and conducting a state-of-science review of estuary classification. Anticipating that water residence time will play an important role in any method to classify estuaries and to normalize loading rates in developing loading-response relationships, we are using simulation models and statistical models that relate water residence time to estuary morphological parameters

Step 4 Develop standard methods and procedures

Loading Estimates

Estimates of nitrogen loads from watershed, atmospheric, and point source inputs are needed to establish empirical multi-scale nitrogen loading-response relationships for East Coast estuaries and coastal water bodies. Point source inputs from municipal and industrial discharge sites can be estimated from existing nitrogen concentration and flow data generated as part of the National Pollutant Discharge Elimination System (NPDES) Permitting Program. Atmospheric nitrogen inputs are being estimated from studies on regional atmospheric deposition. Exchange-water inputs are being estimated using published data on nitrogen concentrations in the water column combined with physical transport estimates based on flushing analyses. Watershed (non-point) sources of nitrogen are estimated by the use of nitrogen loading models which, in their various forms, incorporate land-use characteristics and human population density estimates. Currently, we are using the Waquoit Bay Land Margin Ecosystems Research (WBLMER) project nitrogen loading model (Valiela and Bowen 2002) to calculate nitrogen loads from land-use characteristics. This model estimates inputs by land use types (natural vegetation, agricultural land, turf, residential land and impervious surfaces) within the watershed. The model then estimates and corrects for losses in the various compartments (vegetation and soils, vadose zone, aquifer) in the watershed ecosystem as nitrogen is transported to the estuary.

In addition, we are using stable nitrogen isotopes to assess the relative source strengths of the various nitrogen sources to each embayment. Because the nitrogen isotope ratio increases in a fairly predictable fashion as it passes through the food chain (Fry 1988), anthropogenic nitrogen inputs can influence the isotopic composition of organisms in an ecosystem. Stable nitrogen isotope measurements can thus be used to trace nitrogen from diffuse, land-based sources to coastal marshes (McClelland and Valiela 1998). Therefore, the nitrogen isotope ratio, or signature, of a biotic component or components of an ecosystem is being used to characterize the relative magnitude of point and non-point derived nitrogen inputs to that system (McKinney et al. 2001, 2002).

System Responses to Nitrogen

DO assessment endpoint – Dissolved oxygen is somewhat unique relative to the other response endpoints in that the Office of Water requires specific numeric criteria based on DO concentration in addition to loading-DO response models for establishing nutrient criteria. Thus, AED's research on the dissolved oxygen endpoint has two primary components: (1) development of the technical basis for saltwater DO water quality criteria for aquatic life, and (2) development of nitrogen load-hypoxia relationships for coastal waters. AED developed an approach (U.S EPA 2000) and the data (Coiro et al 2000, Miller et al. 2002) necessary for establishing site-specific DO criteria that utilizes both standard toxicity endpoints (mortality, individual growth)

and a population-level endpoint (recruitment) This approach, for which AED scientists received a Bronze Medal from OW, was demonstrated for the northeast and mid-Atlantic regions of the US. The approach applies both to persistent and cyclic hypoxia. The demonstration yielded saltwater criteria of 4.8 mg/L to protect against unacceptable effects on growth of aquatic animals, 2.3 mg/L to protect against unacceptable effects on juvenile and adult survival, and larval recruitment to a population. Currently, AED is conducting species sensitivity studies using west coast species. This information will be used in conjunction with results of testing underway at NHEERL's Gulf Ecology Division (GED) to determine the applicability of these criteria Nation-wide Support also has been provided to the Office of Water's Chesapeake Bay Program in Bay-specific application of the approach.

While it is most desirable to develop modeled relationships between nitrogen loading to coastal systems and measures of hypoxia intensity and duration, in practice, the logistical and resource demands required for accurate models are relatively high. AED is currently testing the feasibility of using surrogate measures for hypoxia intensity and duration. Depth of the redox potential discontinuity (RPD, as measured using sediment profile imaging (SPI)) and redox-sensitive metals are being measured over a three month period (the time period encompassing the lowest expected DO levels) along with continuous DO measurements at four stations of differing expected hypoxia intensity and duration Laboratory experiments, using AED's controlled DO dosing system, are being used to interpret RPDs measured in the field. The kinetics and timing of the formation and destruction of the RPD are being determined for environmentally relevant DO conditions and for various types of sediment (e.g., biotic and abiotic). If successful, this series of experiments will allow managers to use benthic profile data to assess whether a system has exceeded water quality criteria for saltwater dissolved oxygen (U.S. EPA 2000).

An alternative to the use of RPD depth as an indicator of DO levels in bottom waters is the measurement of so-called "redox-sensitive" metals such as uranium, vanadium, rhenium, and molybdenum (U, V, Re, and Mo) in sediments. These metals are highly enriched in reducing sediments due to their very low crustal abundance, conservative behavior in oxic seawater and their greatly decreased solubility in lower oxidation states (Morford and Emerson, 1999). As a result, differential patterns of enrichment may be used to discern both the spatial extent and duration of anoxic bottom water conditions (Adelson, 2001). Laboratory experiments, using AED's controlled DO dosing system, will determine the short-term kinetics of enrichment and oxidative remobilization of the metals to examine potential complications in interpreting field sediment records. Completion of this year's field and laboratory effort will determine whether the SPI data and redox-sensitive metals are reasonable surrogates for hypoxia intensity and duration in bottom waters of shallow well flushed systems.

Food web assessment endpoint – Phytoplankton are at the base of many marine food webs. Assessments of phytoplankton biomass as a function of nutrient input can be used as an indicator of food web effects. Yet, changes in phytoplankton biomass as a primary symptom of nitrogen pollution can be difficult to determine because they are quite variable in space and time A large area must be sampled, and measurements must be taken regularly over a prolonged time period. Remote sensing via aircraft allows broad spatial coverage as well as the ability to sample through time, since all systems can be covered relatively synoptically. Satlantic, Inc. (Halifax, N.S) has

developed the MicroSAS remote sensing system, a complete spectral analysis package that consists of three digital sensor heads to measure solar and sea surface radiance and solar irradiance in the visible portion of the electromagnetic spectrum (300-700 nm) with data logging software. Using conversion software, these data can be transformed into measurements of light reflectance from the sea surface from which estimates of chlorophyll concentration can be derived from algorithms developed to examine selected bandwidths. By combining the spectral data with locational (i.e., GPS) data, the spatial distribution of chlorophyll can be mapped onto system chart overlays (Keith et al. 2002). AED is using this approach to quantify phytoplankton biomass in coves, bays, and rivers from Connecticut through Massachusetts with substantial spatial and temporal resolution. These data can also be used to estimate productivity for entire systems over several years. The spectral system is being flown from an aircraft at an altitude of 152 m (500 ft) with a maximum spatial resolution of eight meters. AED is validating algorithm-derived estimates using *in situ* fluorometric determination of chlorophyll *a*, together with HPLC phytopigments analysis for phytoplankton taxonomy, and spectrophotometric determination of colored dissolved organic matter (CDOM) to measure light absorption by this material. Moreover, existing data on chlorophyll *a* and nitrogen in estuaries are being used to develop relationships to augment the relationships derived from the field effort.

SAV assessment endpoint - abundance of seagrass – Some of the damaging effects of eutrophication occur through destruction of seagrass beds. Nitrogen overenrichment leads to a variety of system changes that tend to favor growth of phytoplankton and macroalgae over SAV, leading to the destruction of productive seagrass meadows. A seagrass indicator is being developed by AED as the area actually covered by seagrass compared to the area that is potentially useable by seagrasses (i.e , area of coverage/area of colonizable habitat). The area of actual seagrass coverage is taken from digital imagery captured during airplane flyovers. Towed video transects are being run to validate this approach. Potential habitat depths are estimated using historical data from the study region and from a SAV restoration model output (Thayer et al. 1997).

Step 5. Develop nutrient loading-ecological response models

Once the necessary methods and information have been developed using the approaches above, load-response models will be developed by AED for:

- Nitrogen loading-dissolved oxygen levels (direct DO or surrogate indicators)
- Nitrogen loading-phytoplankton abundance (remotely-sensed chl-*a* concentration)
- Nitrogen loading-diatom/dinoflagellate community abundance (remotely-sensed phytopigment concentration)
- Nitrogen loading-SAV (extent/potential colonizable habitat extent)

Part of this work is based on application and extension of a model previously developed at AED that relates the loading rate of total nitrogen to concentrations, export and retention of total

nitrogen in estuaries (Dettmann 2001). This model quantifies the relationship between estuarine response and estuary volume, residence time, and a first-order rate coefficient for long-term nitrogen removal from the water column. Although this model was derived for total nitrogen (TN), it has also been found to provide good estimates of dissolved inorganic nitrogen (DIN) in a broad range of estuaries, and may be useful in investigation of maximum annual macroalgal biomass in estuaries A preliminary study of Long Island Sound, Boston Harbor/Massachusetts Bay and Chesapeake Bay identified a linear relationship between annual (or longer-term) average concentrations of DIN and TN. This largely explains why the model works for DIN as well as TN. This model has proven useful in providing a quantitative basis for some of our work on estuary classification, and we are continuing to investigate methods to extend this model to predict quantities other than total nitrogen.

We are also investigating the relationship between nitrogen concentrations and planktonic chlorophyll concentrations in estuaries. Recent work at AED has shown strong relationships between average seasonal, annual and longer-term concentrations of TN and chlorophyll in Long Island Sound This work shows that the long-term average slope of the chlorophyll:TN relationship in Long Island Sound is similar to that found in freshwater lakes by Sakamoto (1966), but that it is smaller for years beginning with warm wintertime water temperatures than for years with colder winter water temperatures.

The following are AED's contribution to NHEERL's Annual Performance Goals (APGs) and Measures (APMs) that support attainment of the LTG:

Assessment Endpoint. Hypoxia
APG 1 (FY03) Provide the science to support consistent dissolved oxygen criteria for prevention of hypoxia impacts in all coastal regions of the US.

> **APM 1** (FY02) Minimum DO requirements of important marine organisms (fish and crustaceans) from the Nation's coastal waters (Atlantic, Pacific, and Gulf of Mexico).
> - South Atlantic (Cape Hatteras to Florida Keys) (**AED**, FY01)
> - Pacific Coast (**AED**, WED; FY02)

APG 2 (FY04) Provide first generation protocols to classify eutrophication models for nutrient load allocation in coastal systems.

> **APM 2** (FY03) Propose classification scheme for predicting sensitivity of coastal receiving waters to effects of nutrients on DO (MED, GED, **AED**).

Assessment Endpoint: Foodweb
APG 4 (FY07) Provide scientific foundation for development and application of quantitative measures of food web attributes that are sensitive to ecological changes associated with nutrient enrichment.

> **APM 4G** (FY06) Report on classification scheme for grouping coastal or lake receiving waters based on sensitivity to food web alterations (GED, WED, **AED**, MED).

Assessment Endpoint: SAV

APG 3 (FY07) Provide the scientific foundation for establishing site-specific nutrient threshold criteria to protect estuarine SAV.

APM 3D (FY04) Development of empirical load-response models for *Zostera marina* in NE US (**AED**)

APM 3E (FY05) Development of load-response models for estuaries of Pacific Northwest and Gulf Coast, and validation of stress-response model for *Zostera marina* in NE US (WED, GED, **AED**)

APM 3F (FY05) Propose classification scheme for predicting sensitivity of coastal receiving waters to the effects of nutrients on SAV (WED, GED, **AED**)

APM 3G (FY06) Report on the empirical and numeric models for SAV (WED, GED, **AED**)

APM 3H (FY06) Report on a classification scheme for grouping coastal receiving waters based on sensitivity to nutrients.(WED, GED, **AED**)

Impacts of Research

NHEERL's Aquatic Stressors Nutrient research is in the early stages of its approximate 6-year program. Although maintenance of the bibliographic database described earlier is intended to be an ongoing activity throughout the program, AED has made substantial progress towards completing this step of the critical path of research. This database provides the most recent and important citations related to the eutrophication issue. We have also completed major laboratory-based components of research needed to support DO criteria derivation, but substantial field effort remains with respect to developing a nutrient loading-response relationship for this assessment endpoint. AED's Nutrient research has begun to develop the information necessary for development of classification schemes, and nutrient loading-response relationships for the SAV and food web assessments, and will complete these efforts over the next five years.

AED has been instrumental in engaging the Office of Water and Region 1 in the development and use of empirically derived stressor-response models. The division has received funding from the Office of Water and Region 1 to initiate an airplane-based remote sensing program for the development of nutrient loading-chlorophyll-*a* and SAV abundance response models for southern New England. AED researchers also participate on several Office of Water and Regional Advisory Committees aimed at the development and implementation of water quality criteria and standards for nutrients. Once completed, AED's Nutrient research will provide empirically-derived stressor-response relationships that, when combined with the results of the modeling approaches being undertaken by other NHEERL divisions in this program, will provide

the basis for deriving nutrient criteria by OW and the States for protection of important aquatic resources. Accomplishing this objective is an important step towards meeting the LTG of ORD's Water Quality Multi-Year Plan.

Remaining Needs

Over the next six years (2002-2008), Aquatic Stressors Nutrient research, integrated across biogeographic areas associated with NHEERL's ecology divisions, will provide increasingly sophisticated tools to help resources managers develop numeric nutrient standards and target nutrient loads for coastal and estuarine waters. We anticipate that development of schemes suitable for classifying the wide variety of coastal waters around the country will present a significant scientific challenge to our overall progress in completing the critical path of research We will approach this problem initially by applying three classification factors: biogeography, residence time, and water clarity. Alternative factors will be sought if insufficient reductions of response variability are observed. Additionally, we will need to assess the advantages and disadvantages of the empirical methods being employed by AED and the numerical modeling approach being used by GED. Because NHEERL Nutrients research is focusing on a common set of assessment endpoints regardless of approach taken, we should be able to compare these methods in terms of accuracy of prediction and control of variation in loading-response relationships. Ultimately, we expect both approaches to provide information useful to the Office of Water, the States and Tribes in their derivation of nutrient criteria and standards.

Further development of this research will require continuing interaction between the Office of Research and Development's (ORD) Laboratories and Centers, as well as with EPA's Program Offices and Regions, to ensure that the approaches developed are compatible with their needs. In addition, it will be essential to integrate the research with future grant initiatives (including EPA's Science to Achieve Results, STAR, program) to ensure that ORD-sponsored research complements in-house programs.

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Stressor-response Relationships for Habitat Alteration

Stressor-Response Relationships for Habitat Alteration (GPRA Goal 2)

Agency Problem

Many anthropogenic activities exert their influence on fish, shellfish, and waterfowl via effects on habitat. In fact, habitat alteration is arguably the most important cause of declines in ecological resources in North America. Thriving populations of fish, shellfish, and waterfowl are valued by the public, not only for commercial, recreational, and aesthetic reasons, but also as tangible and visible surrogates for the overall condition of the environment. Habitats essential to the well being of these species are rapidly being affected by many human activities. For example, by the 1980s, about one-half of all wetlands in the conterminous 48 United States were lost to filling in or draining for human activities such as land development and agriculture (Mitsch and Gosselink 2000), and the current rate of wetland loss in the US is about 40,000 acres per year (US Ocean Policy Commission 2002). Habitat alterations have been identified as a major cause of endangerment for species within the United States. For example, the US has the most diverse temperate freshwater fish fauna in the world, but 35-40% of its 790 fish species are imperiled because of poor land use practices, wetland alteration, introductions of exotic species and other habitat altering factors (Warren and Burr 1994, Stein and Flack 1997). In addition, more than 50% of US marine fisheries (exclusive of Alaska pollock) exploit species that are dependent on estuaries at some life stage, and many estuarine fisheries are in decline due to combined effects of over fishing, habitat alteration and pollution (Houde and Rutherford 1993)

Assessing the ecological consequences of habitat alteration has been called one of the most challenging scientific problems and environmental policy issues confronting society in recent years (National Research Council 1997, Rapport et al. 1998). The importance of habitat quality and quantity for maintaining species is indisputable, but quantifying exactly how species depend on habitats is multi-faceted and complex Habitat provides a wide array of species life-support functions, ranging from providing shelter, substrate, and appropriate physiological conditions, to mediating natural disturbances and anthropogenic stressors, to maintaining food webs by hosting primary and secondary production. Consequently, alteration of habitat can degrade diversity, food-web structure, ecosystem function, and populations of valued fish, shellfish and waterfowl via complex effect pathways. Mobile and migratory species can use multiple habitats to meet developmental requirements or sustain local populations, and "habitat" for them may refer to a combination of quantity, quality, extent and arrangement of different habitat types at a variety of spatial scales. Many stressors interact in aquatic systems in ways that alter the normal spatial distribution or mosaic of habitat patches, with important implications for ecosystem function and fish, shellfish and waterfowl populations. More generally, successful preservation of biological diversity and ecosystem structure and function requires protection of multiple habitats within a landscape framework and not merely individual habitats in isolation For many important aquatic habitats, there is little quantitative information on the relationship of habitat alteration to dependent biota, in particular how changes in habitat quality influence the well being of fish, shellfish and aquatic-dependent wildlife populations. Finally, broad biogeographic gradients affect the responses of ecosystems and biota to habitat alteration. For all these reasons,

quantifying the life support functions of specific habitats and habitat complexes in sufficient detail to predict the biological effects of both incremental and catastrophic habitat alteration is a significant challenge.

EPA's Office of Water (OW) has primary regulatory responsibility for protecting the ecological integrity of the Nation's aquatic resources and ecosystems. Although the Agency has not traditionally focused its regulatory, policy and research efforts on habitat alteration as a stressor, a number of factors converge to justify a new EPA emphasis on habitat issues. These include the mandate of the Clean Water Act (CWA) "to restore and maintain the physical, chemical, and biological integrity of the Nation's waters" and that habitat alteration is a commonly-cited cause for failure of aquatic systems to meet designated uses. Additionally, EPA is being asked increasingly to participate in interagency species protection and conservation efforts where the importance of habitat issues have been long been recognized. For example, a draft Memorandum of Agreement between OW, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service (Federal Register, January 7, 1999) calls for development of improved approaches for wildlife criteria derivation and requires the Agency to address explicitly protection of threatened and endangered species in implementation of the CWA. In response to its need to develop ecological criteria to assess the role of essential habitat in maintaining healthy populations of fish, shellfish and aquatic-dependent wildlife, NHEERL's Aquatic Stressor Habitat Alteration research will provide approaches and methods to assess critical habitats and their ability to sustain fish, shellfish and wildlife.

Objectives of Research

ORD's Multi-Year Plan (MYP) for Water Quality has established as a Long-Term Goal (LTG): "Provide the approaches and methods to develop and apply criteria to support designated uses." The purpose of NHEERL's Aquatic Stressors Habitat Alteration research is to focus stressor-effects research on developing approaches, methods and information for developing criteria support of this LTG. The specific goal of Habitat Alteration research is to provide the scientific basis for assessing the role of essential habitat in maintaining healthy populations of fish, shellfish, aquatic-dependent wildlife, and the ecosystems upon which they depend. A key scientific challenge is the development of habitat-alteration-population response relationships for the species and habitats of priority concern, capable of quantifying effects of both incremental and catastrophic habitat alteration. AED's efforts focus on New England coastal zones including wetlands, tributaries, near shore and estuarine areas to describe relationships between habitat alteration and biota (i.e., populations of fish, shellfish and aquatic-dependent wildlife) at appropriate spatial scales and with sufficient detail and resolution to quantify the effects of habitat alteration.

Approach and Recent Accomplishments

The approach taken for NHEERL and AED's habitat research has four primary steps as

identified in Figure 1. The first step in this critical path is a literature and data review to identify the target species representing the key assessment endpoints, the habitats upon which they depend, and published data on habitat alteration-biota response relationships. A key factor influencing this was the inclusion of specific habitat types of concern to OW. These include freshwater and estuarine wetlands, stream corridors, and marine coastal zones. Additionally OW identified a specific interest in vegetated aquatic habitats since it is not only a key habitat for many wetland, estuarine, and coastal species, but also a key mediator of stressor effects on aquatic biota and a primary response variable for anthropogenic stressors such as nutrient and sediment loading. Additionally, focal species (economically or ecologically important) were identified and their key habitat needs determined. As a result, AED has developed a listing of the high priority species and habitat types that includes fish (winter flounder, striped bass, bluefish), shellfish (quahogs and bay scallop), and wintering waterfowl (e g., harlequin ducks, buffleheads, and mallards) in vegetated aquatic habitat and estuarine systems in general.

Development of habitat alteration-response for these species and habitat types will be the near term focus for AED's research (Step 2 of the critical path). This research will focus on development of stressor-response relationships at three scales: vegetated habitat, shoreline, and landscape (AED's Habitat Alteration research at this last scale is described in the Wildlife Risk Assessment - Loon/Hg Demonstration section of this Briefing Book). One result of the vegetated habitat and shoreline scale research will be a number of habitat alteration-response relationships (shown conceptually in Figure 2) that can be used to guide habitat protection and restoration decisions (Steps 3 and 4 in the critical path) by OW and the States. Additional anticipated products include rapid assessment methods for evaluating the integrity of coastal wetlands and their ability to sustain fish, shellfish and waterfowl.

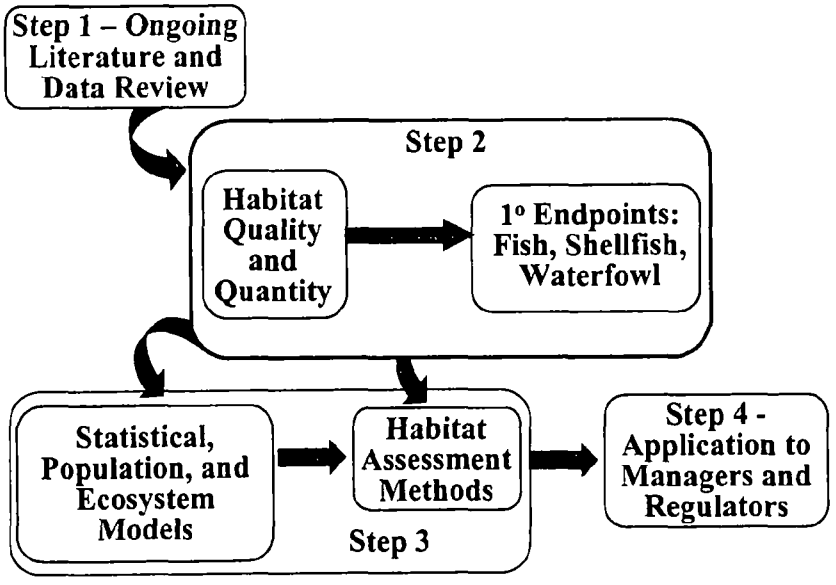

Figure 1. Critical path of research.

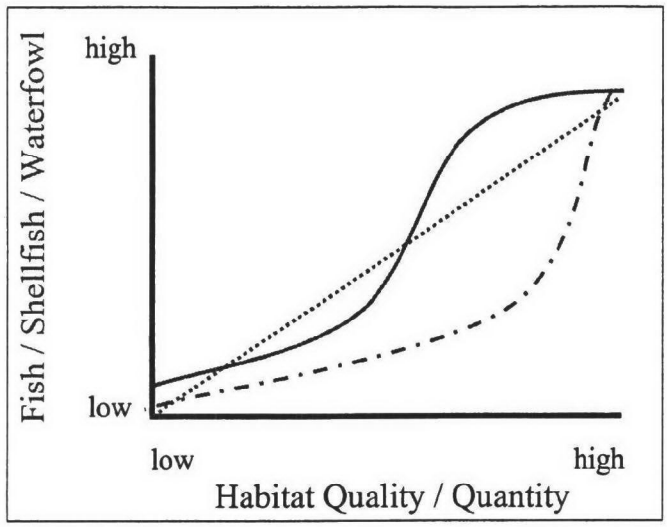

Figure 2. Stressor-response approach.

Vegetated Habitat Scale Research

For a number of years, research at AED has focused on developing methods and tools for evaluating the condition and quality of New England wetlands (Wigand and Thursby 2000, Wigand et al. 2001). This previous habitat-scale research provides the groundwork for the development of indicators of habitat quality for use in the establishment of stressor-response relationships between habitat alteration and populations of some fish, shellfish, and waterfowl (Figure 2). AED is using a reference-based assessment approach adapted from both the Hydrogeomorphic Approach of Bioassessment (Brinson 1993) and the Index of Biotic Integrity Approach (Karr 1991, Karr and Chu 1999). We recognize the need to evaluate similar habitats in the context of their natural geomorphology, elevation, and hydrology before examining the structure and function of the habitats and the effect of habitat alteration on biotic

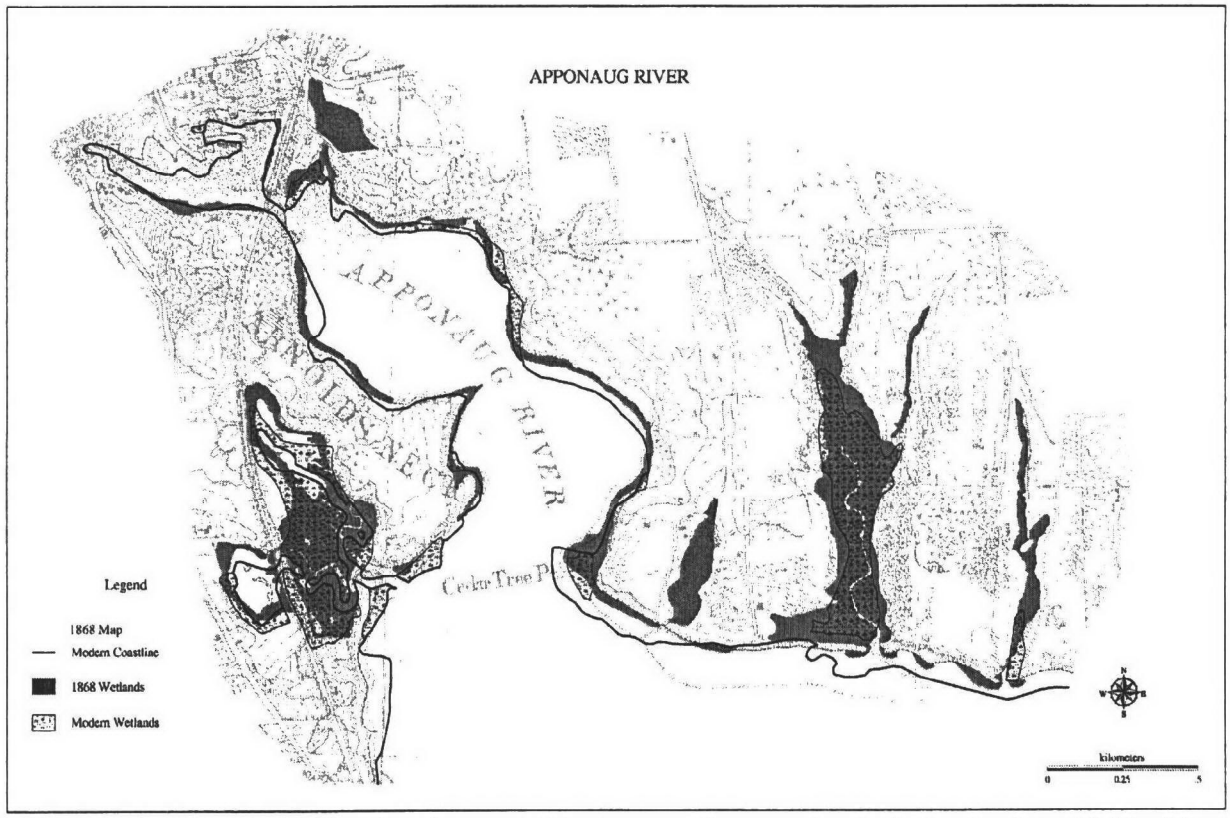

Figure 3. Comparison of a historic map of Apponaug Cove wetlands dating back to 1868 with present-day wetlands.

assemblages (Wigand et al. 2002). Therefore, habitats being examined are first pre-classified into similar habitat types (e.g., fringe salt marshes; seagrass beds; mudflats) with similar hydrogeomorphology. In addition, connectivity of habitats in the watershed along with areal extent is being examined using geographic information system (GIS) approaches and ground-truthing. For example, the habitat quantity and quality of the adjacent riparian zone and discharge streams into coastal salt marshes are under study in our current coastal salt marsh assessment (Lussier et al. 2002a, b).

Efforts to evaluate changes in habitat quantity include an examination of historic maps dating back 200 years, historic photographs, and town records as well as present-day overflights to determine extent of coastal habitats (e.g., salt marshes and seagrass beds). To quantify extent of wetlands over time, area of wetlands on old maps (1800s) will be compared to those on contemporary maps using GIS technology (Figure 3). These GIS techniques have been successfully developed and demonstrated in previous AED research on the ecological history of the New Bedford Harbor watershed (Pesch and Garber 2001, Voyer et al. 2000). Measurements of historic and present-day extent of aquatic habitats will be linked with measurements of the habitat biota.

Assessing wintering sea ducks at the habitat-scale includes a combination of measures including census of resident populations, field study of animal behavior (i.e., activity budgets), and diet assessment at a number of expected low and high impact sites. Census activities began in winter 2001 and are being used to quantify the number of animals per site. We are using direct observation of the waterfowl from land using binoculars and spotting scopes and, if resources permit, census activities may be augmented by aerial observations and simultaneous observance at multiple sites (Stott and Olson 1972, 1973, Robertson et al. 1998). Numbers of birds will be related to the habitat area and quality to determine patterns of habitat utilization.

To relate quality of a vegetated habitat area to shellfish endpoints, surveys of bivalves are being conducted at marsh sites at least once during the sampling season, and will be made both on the marsh and off the edge adjacent to the marsh. Marsh quantity and quality are being assessed, and counts and size measurements of individual bivalves will be used to estimate the population of bivalves along the marsh edge. In addition to adult clams, mussels and oysters, samples of surface sediments are being collected to count and measure spat that have settled, and an estimate of their potential contribution to the settled population will be determined. Other aquatic habitats (e.g., seagrass beds, mudflats) supporting bivalves, particularly quahogs and bay scallops, will also be sampled and animal population measurements will be related to the quantity and quality of the habitat.

Our research efforts are also focusing on the ability of coastal habitats to provide critical life support functions, that is suitable food, shelter, and clean water to fish, shellfish, and waterfowl. The food value of New England fringe salt marshes are being examined by taking invertebrate cores and sampling the resident forage species on the marsh surface of reference and impacted marshes. Nekton are being sampled with 2 x 3 m bottomless lift nets. There are also two pit traps inside each net. The nekton research will provide information on both juvenile fish use of

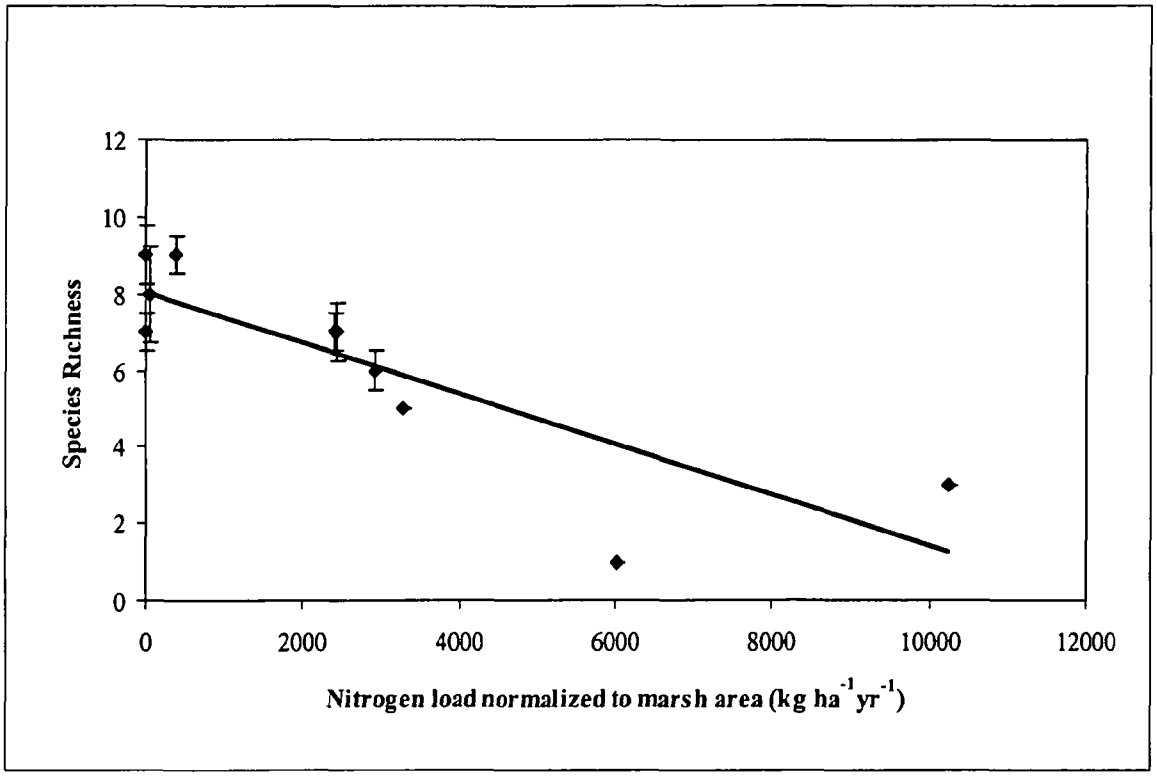

Figure 4. Marsh plant species richness and estimated nitrogen loads

the marshes by societally important species (e.g , winter flounder, striped bass) as well as availability of forage species. Other approaches to examine quality of the food for fish, shell fish, and waterfowl include various phytoplankton and benthic surveys as well as video transects of habitats

Plant structure is linked to habitat quality because of the refuge service of the habitat, and AED is currently measuring plant species richness, density, biomass and extent of invasive species using survey approaches (i.e , marsh transects and underwater camera transects of intertidal and subtidal habitats) AED past wetland research showed a significant inverse relationship between marsh plant species richness and estimated nitrogen loads from the watershed (Figure 4). Water quality of the habitat is being described by measurement of nutrient and dissolved oxygen concentrations. We expect that a multi-metric indicator will be necessary to describe habitat quality, and building on our past and present wetlands research, we are developing one for New England coastal salt marshes.

Successful rapid assessment methods for evaluating habitat quality of inland wetlands in a number of US states have already been developed, and we are adapting these methods for coastal habitat assessments. Along with a more intensive habitat assessment (e.g., measurements of prey items, plant structure, and water quality), the rapid assessment methods will be conducted at various coastal habitat types. An iterative approach to modify the rapid assessment methods will be employed until they satisfactorily describe the condition of each separate set of habitats to

support populations of fish, shellfish, and wildlife. This work will support completion of Step 3 of the critical path (Figure 1).

Shoreline scale

To help predict consequences of alteration (i.e., loss and degradation) of multiple habitats at the estuarine scale, we are developing a habitat alteration-population response model for winter flounder in western Narragansett Bay. This research directly contributes to Step 2 of the critical path, developing stressor-response relationships. This research was started in spring of 2002 using a random probabilistic design. The habitat alteration-population response model will be based on empirical relationships between habitat quality (the spatial arrangement and abundance of multiple habitat types on an estuarine shoreline) and animal density. Prior extensive research at AED examining winter flounder and its relationship to habitat quality will provide the foundation for the development of the current stressor-response research (Meng and Powell 1999, Meng et al. 2000, 2001, 2002). For the current investigation, all nearshore habitat types (unvegetated intertidal, macroalgae, shellfish reef, shallow unvegetated subtidal, seagrass, deeper subtidal, etc.) are being sampled using an instrument platform consisting of an integrated underwater videocamera, beam trawl, GPS, and water quality monitor. This instrument platform is towed in random transects from the intertidal through the 7 m depth stratum at high tide. High-resolution aerial image data will also be acquired from each sampling location at low tide to characterize aquatic habitats, salt marshes, and shoreline development at larger scales. Using these approaches, we will link juvenile winter flounder densities to habitat characteristics and shoreline development at scales ranging from a few square meters to 10,000 square meters. We will also explore links between winter flounder nurseries and high-value adult flounder populations using chemical signature methods (i e., stable isotopic ratios and trace metals) based on the initial (central) otolith deposits in adult fish, which were laid down during the period of juvenile near-shore dependency. Our goals are to establish empirical links between habitat quality and winter flounder populations at several scales, and to develop transferable methods for characterizing altered habitats and quantifying population responses that can be applied to other species, habitat types, and locations (this research will support Steps 2 and 3 in the critical path).

The research described for vegetated habitat and shoreline scales supports ORD's MYP for Water Quality and the following Annual Performance Goals (APGs) and Annual Performance Measures (APMs) identified in the Aquatic Stressors Framework.

APG (FY02) Provide suites of relevant fish, shellfish, and wildlife species endpoints suitable for setting habitat protection priorities for coastal regions, along with preliminary reviews of methods, modeling approaches, and available data for relating habitat alteration to changes in those species.

> APM (FY02) Listings of the high-priority species of fish, shellfish, and aquatic-dependent wildlife for study in the northeast coastal region, and listings of the habitats that are critical to each.

APG (FY06) Provide demonstration stressor-response relationships and/or models linking loss and alteration of habitat to selected biotic endpoints.

> APM (FY04) Report characterizing the relationship between alteration of vegetated habitats and nekton use of those habitats.
>
> APM (FY04) Report characterizing the relationships between multiple habitat types and economically valuable fish at the scale of an estuarine shoreline.
>
> APM (FY06) Report characterizing relationships between abundance, quality, and arrangement of various habitat types and selected biotic assessment endpoints in coastal ecosystems (WED has the lead for this but AED will be a significant contributor).

APG (FY08) Provide suites of habitat alteration-biological response relationships and generalization/extrapolation schemes suitable for developing broad-scale habitat criteria for streams and coastal systems, and provide approaches for evaluating combined effects of habitat alteration and other stressors.

> APM (FY08) Synthesized quantitative species-habitat relationships suitable for developing regional habitat-based biocriteria for shorelines, lakes, and estuaries. (WED and AED share the lead on this)

Impacts of Research

Through our cooperative efforts with MA Coastal Zone management and EPA Region 1 we have developed rapid assessment methods for evaluating the condition of coastal salt marshes of New England, and we will use these methods to serve as a model for development of rapid assessment methods for other coastal habitats in support of OW. We are progressing along the identified critical path towards our goal to provide the scientific basis for assessing the role of essential habitat in maintaining healthy populations of fish, shellfish, aquatic-dependent wildlife, and the ecosystems upon which they depend. We have completed the literature review and identified the species and habitat types for our research and have initiated the fieldwork to develop empirical relationships between habitat quality and quantity in multiple habitats (salt marshes, seagrass beds, macroalgal beds, and mud/soft bottom) with fish, shellfish, and/or waterfowl. These empirical relationships will provide the basis for stressor-response models to link habitat alteration to key fish, shellfish, and wildlife endpoints. We have developed partnerships with Federal and State agencies and these cooperative efforts are resulting in data collection to develop stressor-response relationships and models. Results of the habitat alteration research will provide approaches and methods to develop ecological criteria to assess critical habitats and their ability to sustain fish, shellfish, and wildlife.

Remaining Needs

We have outlined an ambitious research agenda to develop stressor response relationships for the effects of habitat alteration on populations of fish, shellfish, and aquatic dependent wildlife. This research is at a relatively early stage of development and as such several of the steps along the critical path (Figure 1) remain to be completed. We anticipate that as we progress along the critical path that a key technical challenge will be in integrating the models and approaches developed at AED with those from the other NHEERL Divisions. Interdivisional workgroups, NHEERL-wide meetings and workshops help to ensure adequate communication of methods and results and integration of approaches. Continuing communication and cooperation with OW will ensure that our research efforts to focusing on the effect of habitat alteration on fish, shellfish and wildlife will address the long-term goal to provide the approaches and methods to develop and apply criteria to support designated uses.

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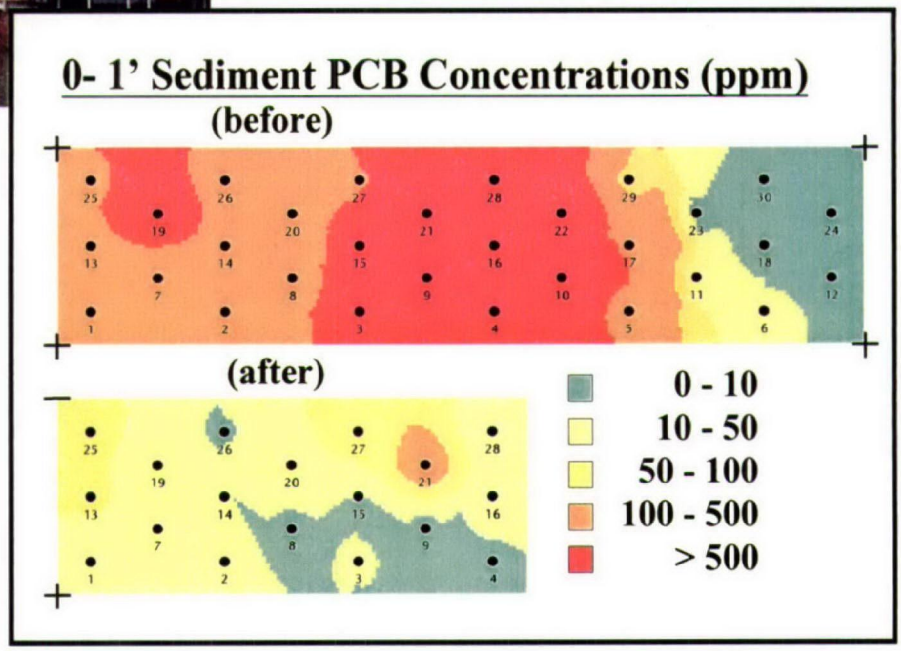
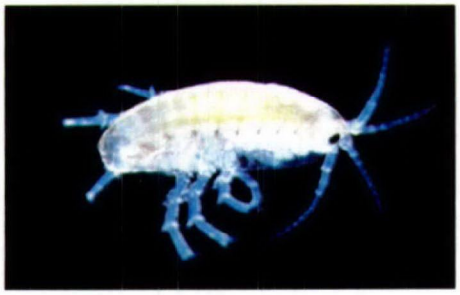
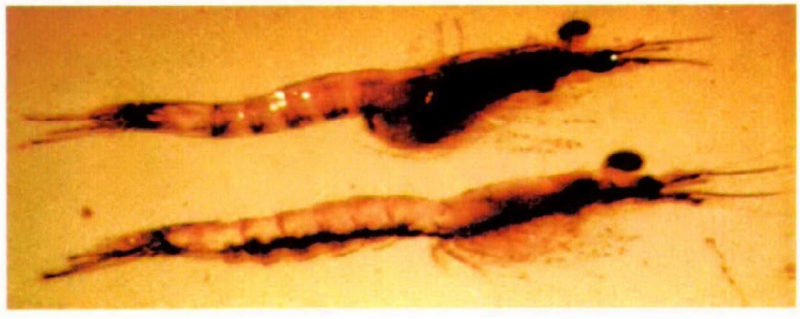
EFFECTS OF CONTAMINATED SEDIMENT







Effects of Contaminated Sediment (GPRA Goals 2 and 5)

Agency Problem

EPA's mission is to protect human health and to safeguard the natural environment – air, water, and land – upon which life depends Sediments are an integral component of aquatic ecosystems providing a habitat for many aquatic organisms Many sediment-dwelling organisms at the base of the food chain are eaten by organisms at higher trophic levels. Chemicals released to surface waters from industrial and municipal discharges, atmospheric deposition, and polluted runoff from urban and agricultural areas can accumulate in sediment to environmentally harmful levels Humans, aquatic organisms, and wildlife are at risk through direct exposure to pollutants or through consumption of contaminated fish and wildlife Exposure to these contaminants is linked to cancer, birth defects, neurological defects, immune dysfunction, and liver and kidney ailments Contaminated sediments may also cause economic impacts to corporations and taxpayers, at both the local and regional level (U S EPA in prep a)

In 1997, the National Sediment Quality Survey (U.S EPA 1997) identified potential sediment contamination in all regions and states Currently, there are over 2,800 fish consumption advisories in the US and these are often traced to sediment contamination. In addition, there are 340 Superfund sites that have at least a partial sediment component. For these reasons, EPA has had to respond to an increasing amount of congressional interest and mandates regarding contaminated sediment This includes addressing the recommendations made in the National Research Council (NRC) report entitled *A Risk Management Strategy for PCB-Contaminated Sediments* (NRC 2001). One of the report's recommendations was that EPA increase research to reduce the uncertainty surrounding contaminated sediment issues, not only the ecological effects of contaminated sediment itself but also the effects of available remedial technologies (e g , dredging, natural attenuation).

Objectives of Research

In 2001, U.S. EPA's Science Policy Council (SPC) initiated the development of the Contaminated Sediments Science Plan (CSSP) (U S EPA in prep b). The CSSP was coordinated across EPA program and Regional Offices because contamination of sediments is a multi-faceted, cross-Agency issue The CSSP identified key scientific questions that ORD and NHEERL research should address·

a **Sediment Site Characterization:** What physical, chemical and biological methods best characterize sediments and assess sediment quality?

b. **Exposure Assessment:** What are the primary exposure pathways to humans and wildlife from contaminants in sediments and how can we reduce uncertainty in quantifying and modeling the degree of exposure?

c **Health Effects and Risk Assessment:** What are the risks associated with

exposure to contaminants in sediments through direct and indirect pathways?

d **Ecological Effects and Risk Assessment:** What are the risks associated with exposure to contaminants in sediments to wildlife species and aquatic communities?

e. **Sediment Remediation:** What sediment remedial technology or combination of technologies is available to effectively remediate sites?

f. **Baseline and Post-Remediation Monitoring:** What types of monitoring are needed to ensure that the implemented remedy meets remedial performance goals and does not cause unacceptable short-term effects?

g **Information Management and Exchange Activities:** How do we improve information management and exchange activities on contaminated sediments across the Agency?

ORD has developed the Goal 5 Contaminated Sites Multi-Year Plan to address these and other contaminated sediment issues with the Long Term Goal (LTG) of providing "scientific tools, methods, models, data, guidance, and technical support to more accurately, rapidly, and cost-effectively characterize the extent of site contamination, estimate risks to human health and the environment, and evaluate residual (post-cleanup) risks". Additionally, ORD in collaboration with the Office of Solid Waste and Emergency Response's (OSWER) Office of Emergency and Remedial Response (OERR, Superfund), the Office of Water (OW), and the Regions have instituted a number of Focus Groups to address the important technical issues in contaminated sediments outlined in the CSSP The Focus Group topics are:

- bioaccumulation and fate and transport modeling
- biological, chemical and physical monitoring approaches
- risk management
- community involvement
- ecological significance
- dermal contact

The Focus Groups will review the state of science needed to address contaminated sediment problems, recommend research approaches and annual performance goals and measures to help solve those problems, and facilitate communication of research results. ORD's Multi-Year Plan and Focus Group activities will help ORD meet its commitments to the CSSP.

Approaches and Recent Accomplishments

AED has had an active contaminated sediment research program for more than 20 years The majority of this work was conducted to support OW in attainment of Goal 2 – Water Quality (e.g , Equilibrium Partitioning Sediment Benchmark development: Burgess and Ryba 1998, Burgess and McKinney 1999, Burgess et al 2000, 2001, Boothman et al 2001, Cantwell and Burgess 2001, Berry et al 1999, O'Connor and Paul 2000, U.S. EPA 2002a-g), and as technical assistance at sediment sites (e g, support to Army Corps of Engineers (ACOE) and Region 1 at

the New Bedford Harbor Superfund site· Nelson et al 1996, Ho et al 1997, Bergen et al 1998) In FY 2002, NHEERL transferred 10 positions from Goal 2 to support OERR's Superfund-related contaminated sediment research needs in Goal 5 The purpose of this redirection of resources was to increase research which provides the scientific basis for the regulation and remediation of contaminated sediment, specifically those sediments at Superfund sites. Five of those positions are located at AED, with the remainder being assigned to NHEERL's Mid-Continent Division (MED) in Duluth, MN The objective of NHEERL's and AED's future contaminated sediment research will be to support attainment of the LTG of the Contaminated Sites Multi-Year Plan in response to the science needs of OERR. Within the next six months, NHEERL staff will develop a multi-year implementation plan (MYIP) which will describe the specific research which will be undertaken at AED and MED to reach this goal.

During this initial period of transition of research effort from Goal 2 to Goal 5, AED is focusing on three main areas of activity· 1) timely completion of the Contaminated Sediment research products originally initiated in Goal 2; 2) responding to OERR's stated highest priority " . to continue to provide site-specific technical support", and 3) research planning to support development of the NHEERL Goal 5 MYIP. The following are summaries of AED's current problem-solving research, site-specific technical support, and program support activities related to contaminated sediment in the first two areas above.

Equilibrium Partitioning Sediment Benchmarks (ESBs)

Regulatory programs in OERR and OW require methods to evaluate, at least in a screening mode, the potential toxicity of sediments Many of the numerical sediment guidelines developed to date rely on empirical relationships between sediment chemistry and biological effects. However, the use of such guidelines is limited in situations where it is important to predict the biological effect of a particular chemical or class of chemicals In earlier research supporting OW in Goal 2, a scientifically defensible approach was developed by AED, MED and NHEERL's Western Ecology Division (WED) to derive sediment concentrations protective of benthic organisms using equilibrium partitioning as the technical basis (e.g., Berry et al. 1999, U.S. EPA 2002a-g). These Equilibrium Partitioning Sediment Benchmarks (ESBs) are based on laboratory sediment effects data and geochemical models of bioavailability As the culmination of this research, descriptions are being produced of the ESB methodology and its application for cationic metals, two pesticides, and PAHs. The description for cationic metals will include an appendix describing research to support benchmark development for chromium, performed in part in assistance to the Shipyard Creek Superfund site in Region 4 ESB methods for site-specific applications are also available, together with screening values for 67 other contaminants. The ESB approach provides a variable level of protection to suit resource management needs, as long as sufficient effects data are available. Site-specific application can be made by adjusting the level of protection for specific receptors and, if necessary, accounting for unusual chemical partitioning at a site. The seven ESB documents (U.S. EPA, 2002 a-g) will be completed under Goal 5 by the end of 2003. Completion of these products represents the conclusion of AED's sediment benchmark research

Toxicity Identification and Evaluation

NHEERL and AED have developed methods to diagnose the likely causes of sediment toxicity when such impairment is observed (Burgess et al. 2000, Ho et al. 1997, 2002). Toxicity Identification and Evaluation (TIE) procedures use chemical manipulations to partition toxicity among classes of chemicals, such as metals, organic compounds and ammonia (Ho et al. 2002). In TIE, chemical stressors are first considered in broad classes, and as the evaluation proceeds, the focus moves to specific toxicants. In this way, large numbers of insignificant toxicants are excluded from further consideration. For example, sediment toxicity may be first classified as being caused by organic contaminants, then narrowed to pesticides, and finally identified as being due to DDT. Based on TIE data, site remediation efforts can be designed to target contaminants determined to be causing toxic effects (Ho et al. 1997). As with the ESB research described above, AED's TIE research is moving towards final completion with development of a guidance document scheduled for completion in the upcoming year As a joint product with GED, this guidance describes TIE procedures for marine and freshwater sediments, and directly supports attainment of the Goal 2 LTG for diagnostic methods (see "Diagnosing Ecological Impairment" earlier in this Briefing Book)

National Sediment Inventory

On a biennial basis, OW is required to report to Congress on the condition of the sediments in US waters. The National Sediment Inventory (NSI) is a project which provides information used to help set national policy on contaminated sediments AED scientists have served on the Technical Advisory Board for the NSI since its inception, providing technical assistance and advice on contaminated sediment issues.

New Bedford Harbor Superfund Site

In support of OSWER and EPA Regions, AED has provided technical support to a large number of Superfund remedial investigations around the Nation over the past several decades (e g., Nacci et al. 2000, Johnston et al 2001, 2002). In particular, we are providing substantial assistance to Region 1 at New Bedford Harbor (MA), one of the Nation's largest marine Superfund sites, and one with extreme PCB sediment contamination. We participated in the initial sediment toxicity testing at this site in the mid-1980's. During a pilot dredging feasibility study in 1987, AED designed and implemented a real-time monitoring program, including developing site-specific decision criteria used by the Region to manage offsite release of PCBs during dredging operations (Bergen et al 1998). Over the last 15 years, AED scientists, in conjunction with EPA Region 1 and the U.S. Army Corps of Engineers, have designed monitoring programs to assess the effects of a variety of remedial and other sediment-related activities (e g , Hot Spot remediation, pre-design dredge field testing). We have also designed, and currently participate in, the long-term monitoring program that will be used to assess the overall effectiveness of all remedial activities (Nelson et al. 1996) This design is based on the probabilistic survey methodology developed by ORD's Environmental Monitoring and Assessment Program (EMAP, described in earlier sections of this Briefing Book) In addition to these technical assistance activities, several site-specific biological, chemical, and physical research activities have been

conducted by AED at New Bedford Harbor (e g , Munns et al. 1997, Nacci et al 1998, 2002a-b, Black et al. 1998a-b) These efforts have produced information that was incorporated into the Superfund decision-making process for the site, as well as directly addressing specific research objectives in Goals 4 and 8 Currently, AED staff are members of the New Bedford Harbor oversight committee which provides technical advice to the site Remedial Project Managers (RPMs), and are supporting plan development for the full-scale upper Harbor remediation.

Contaminated Aquatic Sediment Remedial Guidance Workgroup

The multi-agency Contaminated Aquatic Sediment Remedial Guidance Workgroup (CASRGW) was formed in 1998 to assist OERR in developing national guidance for selecting amongst remedial options at Superfund sites. Together with representatives of OERR, ORD's Office of Science Policy, EPA's Regions, NOAA, ACOE, the US Fish and Wildlife Service, and site RPMs, AED is developing guidance that describes four of the most commonly selected remedial options (dredging, capping, monitored natural process and no action), together with the advantages and disadvantages of each, and consideration for selecting amongst them on a site-specific basis. This guidance currently is in Agency-level review, and is scheduled for completion by the end of 2002.

Contaminated Sediments Technical Advisory Group

OSWER Directive 9285.6-08, *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (February 12, 2002), established the Contaminated Sediments Technical Advisory Group (CSTAG) to "monitor the progress of and provide advice regarding a small number of large, complex, or controversial contaminated sediment Superfund sites " CSTAG has three main purposes· 1) to help RPMs of a select number of large, complex, or controversial sediment sites investigate and manage their sites in accordance with OSWER's 11 Risk Management Principles, 2) to encourage national consistency in the management of sediment sites by providing a forum for exchange of technical and policy information; and 3) to provide a mechanism for monitoring and evaluating the progress at a number of the largest and most complex sites. CSTAG membership consists of one representative from each EPA Region, two from ORD, one from OW, and two from OERR. AED's Barbara Bergen currently is one of ORD's representatives on CSTAG The group has reviewed two sites to date: the Kalamazoo River (MI) and the Ashland (Northern States Power) Lakefront (WI). A review of the Housatonic River (MA) site is scheduled for October 2002.

AED's current Contaminated Sediment Effects research supports attainment of the LTG of ORD's MYP for Contaminated Sites with the following products. We expect that NHEERL multi-year implementation planning will identify additional future products that reflect application of AED's expertise to priority OERR science needs.

> Annual Performance Goal (APG) - In FY05, provide improved methods, tools, and guidance on contaminated sediment ecological issues

Annual Performance Measure (APM) - In FY04, provide an approach for long-term ecological monitoring to assess the effectiveness of contaminated sediment remediation at the New Bedford Harbor, MA, Superfund site

Impacts of Research

The NHEERL research program for Contaminated Sediment Effects in support of the Contaminated Sites MYP is in its planning stage However, completion of the research described above will contribute to the science needs of both OERR and OW. Completion of the ESB documents represents closure to the critical path of research providing screening-level risk assessment tools for cationic metals, pesticides, and PAHs The significance of this research was recognized by OW in awarding its Science Achievement Award for Water Quality to scientists from AED and MED. Additionally, the diagnostic approach described by TIE guidance will support determination of the causes of toxicity when such impairment is observed. Both can be used as effective decision-support tools for managing the risks of contaminated sediment.

AED's support of national guidance development helps bring consistency to the Superfund process A lack of national consistency in EPA's approach to sediment is one reason Potentially Responsible Parties (PRPs) often cite in arguments to limit their liability at contaminated sediment sites. The CASRGW document will be used nationally to assist RPMs in comparing and selecting remedial options at Superfund sites This guidance is the first step in the critical path to achieve ORD's MYP long-term goal for risk management ". .selecting, implementing and verifying remediation options for contaminated sites" (U S. EPA 2001).

Another criticism used by PRPs in arguments to reduce or eliminate liability is that monitoring during sediment remediation, as well as documentation of the effectiveness of the selected remedy, are inadequate or even nonexistent at sediment sites. In addition to supporting development of effective monitoring designs and providing site-specific data, AED is assisted OERR staff in developing a monitoring "fact sheet". When complete, this and other topically-oriented fact sheets will be given to all RPMs nationally to ensure that scientifically sound proper monitoring approaches, including collection of appropriate baseline samples, are employed at all Superfund sediment sites This support provides the foundation for addressing ORD's MYP Long-Term Goal, specifically with respect to site characterization and monitoring components (U.S. EPA 2001)

Remaining Needs

Reflecting the recent transition of our contaminated sediments research from Goal 2 to Goal 5, the next step in our planning process will be the completion of the NHEERL MYIP. AED and MED staff will develop this plan over the next 6 months and continue an on-going dialogue with OERR to enhance our understanding of the nature and format of products that will most directly support the ORD Contaminated Sites LTG. It is likely that NHEERL's future Contaminated

Sediment Effects research will include studies on the uptake of contaminants from sediment and their effects once they reach biotic compartments, in addition to research to evaluate the ecological effectiveness of various remedial options

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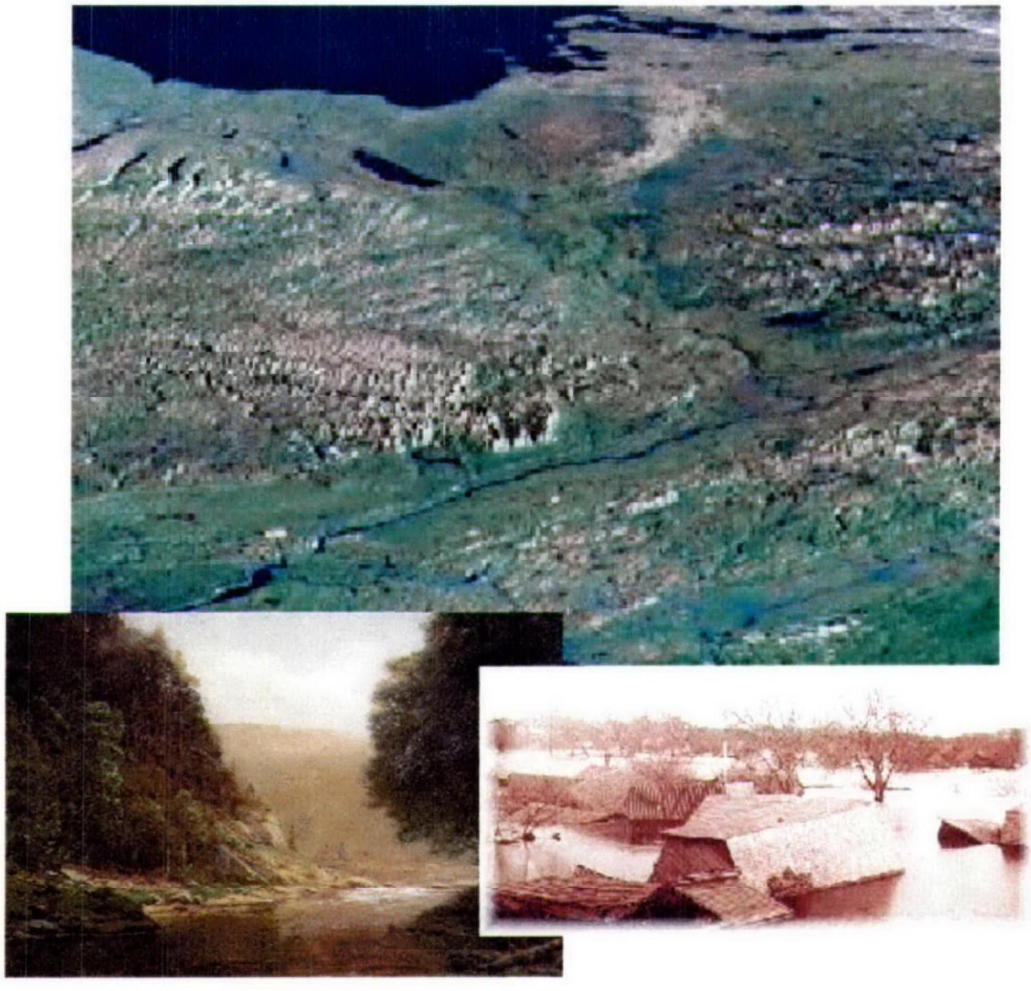
INTEGRATIVE RESEARCH – INTEGRATING ECOLOGY, HUMAN HEALTH AND SOCIOECONOMICS (GPRA GOAL 8)



Integrative Research
Integrating Ecology, Human Health and Socioeconomics (GPRA Goal 8)

Agency Problem

Environmental and public health policy continues to evolve in response to new and complex social, economic and environmental drivers. Globalization and centralization of commerce, evolving patterns of land use (e g., urbanization, deforestation), and technological advances in such areas as manufacturing and development of genetically modified foods have created new and complex classes of stressors and risks (e.g., climate change, emergent and opportunist disease, sprawl, genomic change). The Agency's current media-specific and unidisciplinary focus is ill equipped to address these risks as they pertain to protection and sustainability of human health and the environment

At the heart of this issue is the fact that human living standards are inextricably linked through the economy to the integrity of the natural resources from which they are derived. Reconciliation of society's developmental goals with the planet's environmental limits over the long term is the foundation of the idea of sustainable development (NRC 1999). Currently, the efforts to link human health, ecological condition and socioeconomics are disjointed, and without integrating mechanism. The complex trade-offs needed to shape sustainable living standards will require a much greater ability to predict the consequences of public policy with respect to both socioeconomic and environmental conditions.

To address this challenge, EPA requires an understanding of the causal linkages between policy decisions and their consequences with respect to economic productivity and environmental quality, and the methods and tools to evaluate policy options for their consequences The science needed to support this understanding includes determining the impacts of human activity patterns on human well-being as mediated through the environment, as well as identifying the information and tools needed to support decisions directed towards human and environmental well-being.

ORD/NHEERL/AED Research Approach and Recent Accomplishments

An organizational goal of ORD and NHEERL is to anticipate future environmental issues that will affect the Agency's ability to accomplish its human health and environmental protection mission – a portion of our research should be forward-looking to prepare the Agency to meet emerging problems with science-based solutions. As part of our core research effort, we have undertaken two principal activities to begin addressing the integration needs outlined above. The first is a collaborative effort involving ORD, the WHO International Programme on Chemical Safety (IPCS), the European Commission (EC), and the Organization for Economic Cooperation and Development (OECD) to foster integration of assessment approaches used to evaluate human health and ecological risks. The second is a joint research project involving NHEERL, and

ORD's National Risk Management Research Laboratory (NRMRL) and National Center for Environmental Assessment (NCEA) that initially focuses on testing and demonstrating integrated environmental-socioeconomic approaches in the Mid-Atlantic Highlands region of the US in partnership with the Canaan Valley Institute (CVI). This latter effort also indirectly supports a Long Term Goal of ORD's Water Quality Multi-Year Plan that "Federal, State and local managers are provided the tools to restore and protect aquatic systems and to forecast the ecological, economic, and human health outcomes of alternative solutions." As intermediate goals and products in this effort, ORD will:

> Annual Performance Goal (APG) - Demonstrate proof of concept integrated assessments for allocation of restoration resources within context of relevant socioeconomic factors, infrastructure, and ecological integrity by 2006
>
> > Annual Performance Measure (APM) Report on integrated application of regional planning for economic development, infrastructure development and replacement, and strategic restoration and pollution prevention investments in 2006.

Integrating Ecological and Human Health Risk Assessment

Recognizing the need to enhance the effectiveness and efficiency of risk assessments globally, ORD, IPCS, EC and OECD formed a collaborative partnership to foster integration of assessment approaches used to evaluate human health and ecological risks (Munns et al. in press a). AED played a key leadership role in all phases of this collaboration. The primary objectives of this effort include: 1) ensuring better understanding of the benefits of integration, 2) identifying the obstacles that might be encountered in the integration process; and 3) engaging key agencies, organizations, and scientific societies to promote discussion of integration. Through a series of international meetings and working sessions (e g., Munns and MacPhail 2002), a framework and supporting documentation were developed that describe an approach for integration based on existing models for health and ecological risk assessment (Suter et al. in press) Four case studies were constructed to illustrate how integrated risk assessments might be conducted for chemical (persistent organic pollutants, Ross and Birnbaum in press; butyltins and phenyltins, Sekizawa et al. in press; organophosphorous pesticides, Vermeire et al. in press) and nonchemical stressors (ultraviolet radiation, Hansen et al. in press). The concepts and approaches developed in this effort were evaluated in an international workshop involving approximately 40 environmental managers, risk assessors, and environmental scientists from European, Asian, and North and South American countries Participants were asked to identify the benefits of and obstacles to integration, the research needed to facilitate its implementation, and the mechanisms and actions that facilitate practical application of integrated risk assessment (Munns et al. in press b). As a final component to this research, planning is underway to conduct an actual integrated risk assessment focusing on a risk problem with high visibility to the international environmental community AED's role in conducting that risk assessment will be determined by the risk problem and our technical expertise

Integrating Ecology and Socioeconomics - the CVI Project

Two questions are central to our research to integrate ecology and socioeconomics:

- What methods support the linkage of ecological and economic attributes?
- How can these linkages be evaluated dynamically to permit alternative futures to be evaluated in addition to current condition?

To begin answering these questions, ORD developed a partnership in 2001 with the Canaan Valley Institute, a not-for-profit, non-advocacy organization committed to enhancing the ability of the Mid-Atlantic Highland's residents to improve their quality of life. CVI works to help communities build on their assets and implement locally-determined solutions to problems that threaten their economic and environmental resources. Reflecting this mission, CVI is interested not only in issues at the local scale, but also how the cumulative effects of these issues affect ecoregions, subregions, and the entire Mid-Atlantic Highlands, as well as how decisions made at the Highlands scale affect local issues. Developing tools through this partnership will help ensure a direct connection to decision makers and stakeholders at multiple levels.

The "CVI Project" is focused on two primary objectives:

- Developing a multi-scale, multi-issue process that integrates economic and ecological information to support decision making
- Illustrating how the process captures the cascading and ascending linkages from a local watershed scale to the entire Highlands region

We initially are evaluating energy systems theory and economic valuation as providing the concepts and approaches to link environmental and socioeconomic condition. AED's research focuses on emergy analysis and its methods (Odum 1996, described below) to achieve project objectives. NRMRL and NCEA are testing various methods of economic valuation to the same end. Ultimately, the two approaches will be compared for their relative strengths, weaknesses and possible synthesis. To support the primary objectives, AED's research is organized into three related components:

- Developing and comparing emergy inventories across multiple states to identify differences in outcomes of policy implementation and economic investment
- Developing and evaluating spatially-explicit models of emergy flows at multiple spatial scales
- Comparing findings from emergy and economic valuation to evaluate their potential roles in supporting decision making

Component 1 - Large scale emergy analysis of states and regions – The objective of this component is to provide scientific evidence documenting the relationships between economic productivity, environmental resources and equity of exchanges for states and regions in the United States to support the development of sound public policies. In addition, these macroscopic assessments will provide ecological-economic indices that are needed as inputs to carry out environmental assessments at smaller scales.

Environmental accounting of macroeconomic relationships for states and regions will be carried out through emergy auditing (Odum 1996). Emergy provides a complete accounting mechanism for evaluating the environment because the work of the environment, economy and society are made comparable by expressing each in equivalent units, solar equivalent joules (sej). Emergy measures the real value in an economic or environmental product or service because it tabulates the energy of all kinds (expressed in equivalent units) that was required both directly and indirectly in making the product or service. Emergy can be thought of as an "energy memory" because it quantifies the energy used in the past to make a product or service and as such it requires a new unit of quantification, the emjoule, connoting past energy use. Extensive data documenting the annual flows of energy and materials for the states and the nation are available from US government and other sources. For the most part, these data are of known quality and serve as the basis for performing an emergy audit. In an emergy audit an annual "income" statement is created for the state, region, or nation under analysis by documenting all major inflows, exports, production, and consumption using a standard energy systems model as the starting point, and modifying it as needed based on the particular circumstances of the system under evaluation. These raw data are converted to energy by using standard physical formulae, and the energy flows converted to emergy by multiplying by the appropriate transformity Transformity is the ratio of emergy input to the unit energy output for any specific entity. Many transformities have been tabulated, but when one has not and is needed, it can be determined by performing an emergy analysis of the production process for that entity. Once emergy values for system flows and storages are determined, useful indices can be formed that provide information on the relative degree of self-sufficiency, development intensity, resource import and export, and human well-being that exist in the state when compared to the values of the same indices for other states. Emergy analysis can address difficult questions for managers, such as 1) "What degree of economic development is sustainable for a state or region?", 2) "Is there an equitable exchange of real wealth between the state and other states or between the state and the nation?", and (3) "What is the cost of environmental degradation in the state relative to economic gains?"

An emergy audit of the state of West Virginia has been completed in draft form. This analysis examines inputs to and outputs from the state economy at the level of a macroeconomic analysis. West Virginia's indices are being interpreted within the context of existing emergy analyses of six other states (e.g., Campbell 1998) and the nation as a whole. Analyses of additional states in the Northeast-Midwest region of the US are planned and will be used for comparison purposes. These analyses are expected to be completed in the next two to three years.

Component 2 - Spatial modeling and emergy analysis of landscapes – The objective of this research component is to produce models based on energy transformations as the underlying causal factor to predict and interpret the spatial organization of environment, economy and

society on the landscape. A change in the spatial organization of the landscape is often the most noticeable result of an environmental policy choice, and is often of greatest interest to managers and the residents of an area. The models being developed will allow evaluation of the effects of policy alternatives on the environment, economy and society of systems with arbitrarily defined spatial boundaries. Multiple scales of spatial aggregation can then be analyzed to make spatially-explicit predictions by simulating the underlying energy based model. This format is often the most meaningful to stakeholders and for developing policy at all scales of governance from local watershed groups to the state as a whole.

Energy systems theory (Odum 1994) is being used as an integrating approach for modeling the key interrelationships of environmental, economic and social factors on the landscape. The vehicle for modeling spatial patterns is the construction of a "unit model" which explicitly represents the kinetics and energetics of the network of interactions among the environmental, economic and social factors that constitute the structural and functional organization of an individual spatial unit. This research builds from a simpler approach used to quantify water, nutrient and emergy movement at a watershed scale (Brandt-Williams 1999, Brandt-Williams and Shirley 2001, Brandt-Williams 2002). These earlier simulations used energy and material models to complete standard difference equations balancing flows in and out of each spatial unit, with use or retention within each cell dependent upon the unique characteristics of that cell. Similar cellular energy and emergy models have been developed and tested for a large repertoire of natural and socioeconomic interactions (Odum 1994, 2001, Brandt-Williams 1999, Tilley 1999, Odum and Odum 2000)

The boundaries of a spatial unit can be defined arbitrarily, but for our purposes watershed and political boundaries are most useful. The unit model is replicated over the entire area of the system under analysis, and one spatial unit is linked to another using expressions for the transport of energy materials, or information that is based on the underlying process and infrastructure Change on the landscape is driven by the energy sources that enter each unit and the rules controlling the transfer between units The internal dynamics of the unit model itself determine the patterns that result. Emergy is being simulated concomitantly with the flows of energy, material and information so that integrative emergy indices can be easily calculated over the landscape and used as comprehensive evaluation criteria to judge the relative costs and benefits of policy alternatives for the system over several scales of spatial aggregation

A conceptual model for unit spatial evaluations has been developed and a mathematically explicit unit model should be complete in early 2003. Preliminary data required to run simulations have been identified, and assessment of their availability and applicability will be complete for West Virginia by the end of 2002. Development of deterministic models using spatial energy and emergy data will begin immediately following data assessment. A version of this model will also be used as the foundation for CVI's simulated watershed initiative, which is attempting to develop a user-friendly, scenario-building tool for stakeholders to evaluate possible futures for their watershed.

Component 3 - Comparison of emergy analysis and economic methods for determining value – The objective of this component is to evaluate and compare the costs and benefits of alternative management choices using different assessment methods. One problem that decision makers face in determining the best management policies for the environment is that the conclusions drawn from different assessment methods can produce conflicting information about the consequences of management alternatives. This research is comparing economic assessments using market and nonmarket valuations with value as determined by comprehensive emergy analysis

Economic value, whether market or nonmarket, is based on the willingness of people to pay for something. Thus, value is determined by the receiver of the good or service, and is therefore a subjective measure. The emergy value of a product or service is determined by accounting for all the energy (in equivalent units) required for the existence of the product or service, and thus is donor-based and objective in nature The emergy of a product or service is a measure of the real wealth in it. Real wealth is what a product or service can do when used within the system determining its design. For example, a gallon of gas will move a car only so many miles regardless of the price of that gallon The real value of the gallon of gas is in what it can do when used for its designated purpose Assuming people have perfect knowledge of the real value of environmental and economic products and services, their subjective assessments of value would be expected to correspond with the assessments of value based on emergy.

AED's approach to understanding the relationship between value as determined by these two methodologies is to evaluate environmental management alternatives proposed to solve a particular problem in West Virginia using both economic and energetic evaluations. Our initial focus has been on the issue of flooding as an organizing principle to evaluate the relationships among multiple environmental and socioeconomic components. Flooding is a major problem identified by stakeholders throughout the Highlands, thereby satisfying the "multi-scale" criterion of the first objective of the CVI Project. Working with local experts within CVI, we've begun developing conceptual models (or "systems diagrams") reflecting the key components of the environmental-socioeconomic systems realized at several spatial scales, starting at a localized sub-watershed level and moving to the level of the entire Highlands region. This process has identified changes in the controlling relationships among system components as the scale of evaluation changes (e.g., the importance of mountain-top mining as an economic activity influencing environmental condition), as well as changes in the perceived importance of various environmental and socioeconomic stressors. Once completed, the systems diagrams will be made mathematically explicit using information about the rates of the various processes linking system components. Outputs from analyses of these models will then be compared with similar analyses using economic valuation methods being developed concurrently by ORD's NRMRL and NCEA.

AED is also participating in the development of an international Society of Toxicology and Chemistry (SETAC) Pellston workshop ("Valuation of Ecological Resources: Integration of Ecological Risk Assessment and Socio-Economics to Support Environmental Decisions") to help address issues of valuation as they affect decision making. Scheduled for summer of 2003, the overall goal of this workshop is to integrate the respective theories, tools, and procedures of

ecological risk assessment and economics to support sound environmental decisions. Some of the concepts upon which the Valuation workshop builds were developed in an NHEERL and AED-sponsored predecessor Pellston workshop entitled "Interconnections Between Human Health and Ecological Integrity" (DiGuilio and Benson 2002, Miranda et al 2002). The Valuation workshop will support the objective of this component of our CVI Project.

Impacts of Research

With communication of the approach for integrated risk assessment (international peer review and workshop; Munns et al. in press b), organizations responsible for evaluating risks of chemical stressors have begun to embrace many of the concepts and approaches described in Suter et al (in press). For example, the Netherland's National Institute of Public Health and the Environment (RIVM) recently developed a probabilistic risk assessment of dibutylphthalate (Vermeire et al. 2001, Jager et al. 2001). Although jurisdictional requirements prevented performance of a completely integrated risk assessment, the assessment used data sets and methods common to both human health and ecology to evaluate risks More broadly, international organizations such as the European Chemical Industry Council (CEFIC) have begun to address some of the specific integrated risk assessment research needs identified by our collaborative effort. Along these lines, NHEERL is currently evaluating future contributions we can make integrating human health and ecological risk research.

In 2001, Congress directed EPA to develop a Highlands Action Program to implement collaborative monitoring, research, management and restoration activities needed in the Mid-Atlantic Highlands region CVI was specifically mentioned by Congress as playing an important role in development of this program based on its mission and accomplishments CVI is preparing a Highlands Action Program report (Canaan Valley Institute in prep.) in response to this need, and has identified several key management questions concerning environmental and socioeconomic conditions and trends in the Highlands. Working closely with the authors of this report, ORD's CVI Project will provide the tools, information, and analyses needed to answer those questions with a known degree of scientific confidence. Although our CVI Project effort only began in earnest in 2001, it has already produced a tool (the West Virginia emergy analysis) in draft form to answer some of these questions at a State level. Completion of similar analyses for other States in the Highlands will permit a more complete assessment of environmental-socioeconomic status for the entire region. Further, successful development and application of the spatially-explicit unit model will support dynamic simulation of various management and policy alternatives to help support selection of appropriate actions to meet management goals in the Highlands. Once fully developed and demonstrated, these tools can be used throughout the country to improve management decisions

Remaining Needs

A final step remains with respect to meeting the objectives of our integrated risk assessment research: completion of a truly integrated risk assessment. As mentioned, discussions are currently underway to identify a risk problem with high visibility to the international environmental community. A planning session of project collaborators is scheduled to coincide with the upcoming annual meeting of SETAC that will define the specific objectives of this assessment, and begin to develop candidate risk problems A strategy for conducting the assessment will also be developed, as will a strategy for communicating the activity and its results. Although AED will play a key role in this remaining step, our participation in conducting integrated risk assessment activities will be determined by the risk problem and our technical expertise.

Reflecting the maturity of ORD's CVI Project, substantial research remains to be conducted before the goals of this effort can be met There are a number of technical challenges that must be overcome to complete emergy analyses and produce an integrated, spatially-explicit simulation model of the environment, economy and society. Most importantly is incompatibility in the methods of collection and in the resolution of data sources for socioeconomic versus environmental information. Creative solutions will need to be found to overcome this obstacle

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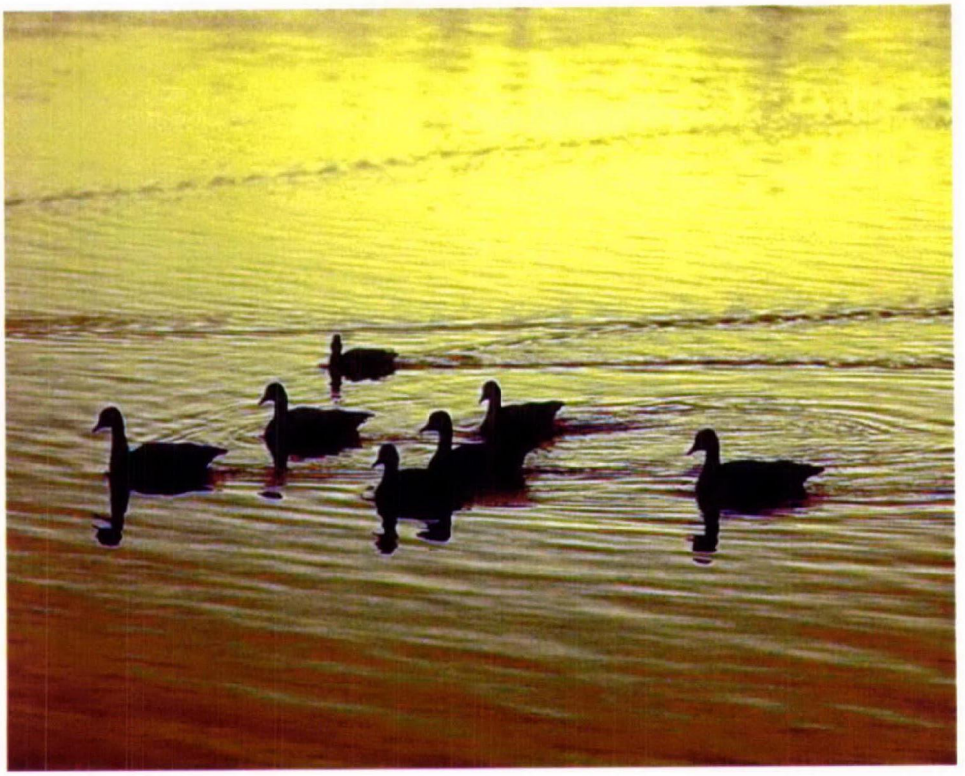
LEADERSHIP AND ADVICE



Atlantic Ecology Division
Scientific Leadership and Advice

Evidence of scientific leadership by Atlantic Ecology Division staff can be shown in several ways Similarly, the extent to which advice and assistance are sought from our staff can be demonstrated using various kinds of evidence. We have chosen to highlight our scientific leadership and the degree to which our advice is sought by others by identifying awards received by Division staff (Table 1), participation by staff in various committees, panels and advisory boards (Table 2), participation in program, organizational and proposal reviews (Table 3), academic appointments (Table 4), leadership roles in professional societies (Table 5), technical presentations at professional meetings (Table 6), and recent (2001-2001) support and advice provided to Regional Offices (Table 7).

The information in these tables (except Table 7) covers the 5-year period since AED's previous Peer Review in 1997.

Table 1. Awards Received by Division Staff

EPA Awards

EPA Silver Medal for scientific contributions in leadership in developing the science and tools for monitoring and assessing the status and trends of the condition of our environment

EPA Bronze Medal for demonstrating exceptional skill, creativity and attention to partner and stakeholder involvement in completing an assessment of the current environmental condition of the Mid-Atlantic estuaries

EPA Bronze Medal for Exceptional/Outstanding ORD Technical Assistance to the Regions or Program Offices as part of the ORD Ecological Survey Design Team

EPA Bronze Medal for significant contributions toward maintaining and improving the science and technology base for environmental and natural resource issues through production of the Region III (Mid-Atlantic) State of the Estuaries Report

EPA Bronze Medal for significant achievement in the rapid response to *Pfiesteria* outbreaks, resulting in the protection of human health-threatening conditions and effective coordination of an immediate response by the Federal government

EPA Bronze Medal for creativity, scientific excellence, and endurance in creating the nation's first comprehensive assessment of the ecological condition of a very important natural resource (EMAP Estuaries Team)

EPA Bronze Medal for dedicated service to EPA and the public by completing an extensive study of Hawaii sugar mill discharges, thereby contributing to continuing compliance with existing effluent guidelines and preventing potentially severe environmental impacts

EPA Bronze Medal for outstanding leadership and initiative in the development and application of a marine sediment testing program for the San Francisco Bay

EPA Bronze Metal for outstanding accomplishments in developing an innovative water quality criteria for dissolved oxygen in saltwater to protect aquatic life in the Mid-Atlantic region

EPA Bronze Medal for the development of techniques to assess the risks of metals in sediments using interstitial water metal concentrations and ratios of metals in sediments to acid volatile sulfide concentrations in sediments

EPA Bronze Medal for Coastal 2000 implementation

EPA Bronze Medal as a member of the ORD Organization Development Team

EPA Bronze Medal for Commendable Service for the initiation and execution of the first integrated and comprehensive survey of coastal condition throughout the Western United States

EPA Bronze Medal for the National Assessment Team for production of the first U S National Assessment Report "Climate Change Impacts on the United States"

EPA Bronze Medal for Commendable Service for the development of a technically-rigorous basis upon which to assess the environmental risk of metals in sediment using AVS SEM and interstitial water metal concentrations

EPA Bronze Medal for Marine Toxicity Identification Evaluation (TIE) Guidance Document Phase I

EPA Science Achievement Award for Water Quality for National Sediment Quality Assessment Research

EPA Community-Based Environmental Protection Award, 1996

EPA Fellowship Award

Exceptional/Outstanding ORD Technical Assistance to the Regions or Program Offices for Exceptional achievements in promoting EMAP monitoring design concepts and principles within States, Regions and Tribes

EPA 2002 ORD Statesmanship Award given in Recognition of Outstanding Efforts of Providing the Scientific and Technical Needs of the Program Offices, Regions ans States as a member of the National Coastal Assessment - North East Coordination Team

EPA Region 1 Office Award for Superior Accomplishment Award

EPA New England Region 1 Employee of the Month for October as a member of the RI Team/Urban Environmental Initiative

Lee M Thomas Excellence in Management Award

EPA Scientific and Technical Achievement Awards
(Awards for significant publications having impact on Agency needs)
1997 - Level III (1), Honorable Mention (2)
1998 - Level III (2), Honorable Mention (3)
1999 - Level III (2)

Scientific Society Awards

American Chemical Society Division of Environmental Chemistry Award of Excellence

American Chemical Society Division of Environmental Chemistry Outstanding Graduate Student Award

Estuarine Research Federation Appreciation Award for Exceptional Contribution to ERF'97

American Fisheries Society Special Achievement Award

American Fisheries Society Outstanding Member Award

American Fisheries Society 1998 Skinner Memorial Award

National Society for Histotechnology Annual Conference, Outstanding Poster Presentation Award in the Veterinary, Industry, and Research Fields

Best of Session Award- 4th International Conference on Remote Sensing for Marine and Coastal Environments

Honorable Mention, American Fisheries Society/Sea Grant Outstanding Student Paper Award, American Fisheries Society 128th Annual Meeting

Other Awards

RI Governor's Commendation for participation in Rhode Island Oil Spill Assessment

U S Fish and Wildlife Service Special Recognition Award for "Recovery Plan for Native Fishes of the San Francisco Bay Estuary"

National Science Foundation MEDI Fellowship

Women's Studies Student Association Women at the University of Florida Award

Certificate of Recognition from U S. Department of Commerce for serving as original member of Working Group on Unusual Marine Mammal Mortalities

Unit Citation from DOC/NOAA Under Secretary for Oceans and Atmosphere for contribution to the US Antarctic Marine Living Resources Program

Letters of Recognition from Anne Arundel County Maryland for Leadership in Addressing Radium Problems in Drinking Water

National Technical Association Top 10 Minority Women in the United States

Table 2. Participation in Committees, Panels and Advisory Boards

International

Environment Canada Technical Subcommittee on Development of Guidelines
Environment Canada Method Development & Application Section Science Advisory Group
World Health Organization International Programme on Chemical Safety (WHO IPCS)/Organization for Economic Cooperation and Development (OECD)/U.S. EPA Steering Group for Approaches to Integrated Risk Assessment

National Multi-Agency

Contaminated Aquatic Sediment Remedial Guidance Workgroup (CASRGW)
New Bedford Harbor Technical Advisory Panel
California/Federal Coalition to Restore San Francisco Bay (CAL/FED)
Everglades Restoration Initiative, USACE-Southern Golden Gates Estates Restoration Interagency Planning Committee
NMFS/EPA/USCG/US Navy/COE Northeast Implementation Team for Recovery of the North Atlantic Right Whale
NMFS Working Group on Unusual Marine Mammal Mortality Events
National Park Service, National Capital Region Science Advisory Committee
Mid-Atlantic Federal Partners for the Environment (MAFPE)
EPA/NOAA/USGS Clean Water Action Plan for Coastal Research and Monitoring Workgroup
U.S. EPA/U.S. Army Corps of Engineers (ACOE)/National Oceanic and Atmospheric Administration (NOAA) Bioaccumulation Guidance Work Group

EPA

EPA Risk Assessment Forum, Eco-Risk Oversight Group
Contaminated Sediments Technical Advisory Group (CSTAG)
OERR/ORD/OW Contaminated Sediment Focus Groups
Chesapeake Bay Program Dissolved Oxygen Work Group
ORD Ecological Survey Design Team
Region 1 Technical Advisory Group for Nutrient Criteria in Estuaries and Coastal Waters
EMAP Information Management Working Group
EMAP Indicators Working Group
Region 2 Steering Committee - Case Studies on National Estuary Program's Use of Environmental Indicators and Measurements
ReVA Steering Committee
ORD-Region III Mid-Atlantic Integrated Assessment Steering Committee
Mid-Atlantic Integrated Assessment Integrated Assessment Group
Mid-Atlantic Integrated Assessment Estuaries Assessment Group
Mid-Atlantic Integrated Assessment Forest Assessment Group

Mid-Atlantic Integrated Assessment Surface Waters Assessment Group
Mid-Atlantic Integrated Assessment Ground Water Assessment Group
Mid-Atlantic Integrated Assessment Landscape Ecology Group
Consolidated Assessment and Listing Methodology (CALM) Workgroup
Sediment Effects Research Group
Toxicity Identification Evaluation (TIE) Workgroup
Select Expert Review Team, Scientific Basis for Development of Dissolved Oxygen Criteria for Chesapeake Bay
OW/ORD Stressor Identification Evaluation (SIE) Work Group

State and Local

Save the Bay (RI) Scientific Council and Advisory Board
New Jersey Sea Grant Science Advisory Council
Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) Water Quality Monitoring Program National Assessment Workgroup
RI DOH Fish Advisory Group

Non-Governmental

National Association of Marine Laboratories (NAML)
University of Chicago External Advisory Board for Integrating Statistics and Environmental Science
American Water Works Association Standard Methods Committee
Center for Urban Environmental Research and Education Urban Roundtable
Pennsylvania Consortium for Interdisciplinary Environmental Policy (PCIEP)
National Center for Graduate Education for Minorities
Harvard School of Public Health Superfund Basic Research Program

Table 3. Participation in Program, Organizational and Proposal Reviews

Program and Organizational Reviews

NOAA/EPA/NASA Coastal Intensive Site Network (CISNet) Research Program (NCER)
EPA Region 2/CENAN Framework for Evaluating Dredged Material for Proposed Placement at the HARS
Scientific Basis for Development of Dissolved Oxygen Criteria for Chesapeake Bay, Select Expert Review Team
USGS Biological Resources Division Interagency Peer Review Panel
Scientific and Technical Advisory Committee (STAC) of the Maryland Coastal Bays Program, Environmental Goals for Aquatic Habitat
The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET)
USGS Woods Hole Research Program Review

Proposal Reviews

The Netherlands National Institute for Coastal and Marine Management
Environment Canada
NOAA Coastal Ocean Program, ECOHAB (Ecology and Oceanography of Harmful Algal Blooms)
ERF - Dissertation Symposium for the Advancement of Coastal, Estuarine and Great Lakes Science applications
National Science Foundation
NOAA Graduate Fellowships for Narragansett Estuarine Research Reserve
Hudson River Foundation
Natural Environmental Research Council
NOAA National Undersea Research Center
Maryland Department of Natural Resources
Massachusetts Bays Program
South Carolina Sea Grant Consortium
WHOI Sea Grant
Virginia Sea Grant
University of New Hampshire Sea Grant
Water Environment Research Foundation
Long Island Sound Research Fund
Harvard School of Public Health
California/Federal Coalition to Restore San Francisco Bay (CAL/FED)

Table 4. Academic Appointments

Sherry Brandt-Williams – Florida Gulf Coast University, College of Arts and Science
Daniel Campbell – University of Rhode Island, Graduate School of Oceanography
Daniel Campbell – Bigelow Laboratory for the Ocean Sciences
George Gardner – University of Puerto Rico, Marine Sciences
Timothy Gleason – University of Rhode Island, Department of Fisheries and Veterinary Sciences
Kay Ho – University of Rhode Island, Graduate School of Oceanography
Wayne Munns – University of Rhode Island, Biomedical Sciences
Matthew Nicholson – University of Rhode Island, Natural Resources
Kenneth Perez – University of Rhode Island, Natural Resources Science
Gerald Pesch – University of Rhode Island, Graduate School of Oceanography
Glen Thursby – University of Rhode Island, Biological Sciences
Cathleen Wigand – Bard College, Graduate School of Environmental Studies

Table 5. Leadership Roles in Professional Societies and Organizations

American Fisheries Society, Program Committee
American Fisheries Society - Early Life History Subdivision, Sally Richardson Committee
American Fisheries Society - Southern New England Chapter, Program Committee Chair
American Society for Testing and Materials, E47 Workgroup Co-chair
National Shellfisheries Association, Student Endowment and Awards Committee
National Society for Histotechnology, Veterinary, Industrial, and Research Committee, Webmaster
Northeast Algal Society, Treasurer
Northeastern Association of Marine and Great Lakes Laboratories, President-Elect
Regional Association for Research on the Gulf of Maine, Chair
Regional Association for Research on the Gulf of Maine, Vice Chair
Regional Association for Research on the Gulf of Maine, Board Member
Rhode Island Society for Histotechnology, Board Member
Society for Environmental Toxicology and Chemistry, Board of Directors
Society for Environmental Toxicology and Chemistry, Standing Committee for Short Courses Chair
Society for Environmental Toxicology and Chemistry, Meetings Committee Chair
Society for Environmental Toxicology and Chemistry, Annual Meeting Program Chair
Society for Environmental Toxicology and Chemistry, Annual Meeting Program Committee
Society for Environmental Toxicology and Chemistry, Editorial Board (2 staff)
Society for Environmental Toxicology and Chemistry, Ecological Risk Assessment Advisory Group Workgroup on Assessing Risks to Populations
Society for Environmental Toxicology and Chemistry - North Atlantic Chapter, President
Society for Environmental Toxicology and Chemistry - North Atlantic Chapter, Board Member (5 staff)
Society for Environmental Toxicology and Chemistry - North Atlantic Chapter, Short Course

Committee Chair
Society for Environmental Toxicology and Chemistry - North Atlantic Chapter, Nominations Committee Chair
Society for Environmental Toxicology and Chemistry - North Atlantic Chapter, 1999 Meeting Chair
Society for Environmental Toxicology and Chemistry - North Atlantic Chapter, Webmaster

Table 6. Technical Presentations at Professional Meetings

International

Meeting	*Location*	*Year*	#
Association of Applied Biologists Conference on Challenges of Applied Population Biology	London, England	1999	2
European Environmental Mutagen Society	Vilnius, Lithuania	1999	2
European Environmental Mutagen Society 29th Annual Meeting	Copenhagen, Denmark	1999	2
2nd Biennial International Workshop on Advances in Energy Studies - Exploring Supplies, Constraints and Strategies	Porto Venere, Italy	2000	2
Human Health and Environmental Effects of Agent Orange/Dioxins	Hanoi, Viet Nam	2002	1
30th Annual Society Invertebrate Pathology	Banff, Canada	1997	1
Aquatic Toxicity Workshop	Winnepeg, Canada	2001	1
Argentum V (Silver Conference)	Hamilton, Canada	2001	1
UNEP/WHO/IPCS EC International Workshop on Integrated Risk Assessment	Orta, Italy	2001	1
American Society of Limnology and Oceanography	Victoria, Canada	2002	1
ASTM 10th Symposium on Environmental Toxicology and Risk Assessment Science Policy and Standardization-Implications for Environmental Decisions	Ontario, Canada	2000	1
Canadian Association of Geographers	Montreal, Canada	2001	1
Chapman Conference on the North Atlantic Oscillation	Galicia, Spain	2000	1
Coastal Stewardship Lessons Learned and the Paths Ahead	St John, Canada	2000	1
European Environmental Mutagen Society	Salzburg, Austria	1998	1
Society of Environmental Toxicology and Chemistry European Meeting	Leipzig, Germany	1999	1
Wildlife Toxicology Program Science Meeting	Ottawa, Canada	2001	1

National/Regional/Local

Meeting	*Location*	*Year*	#
19th Annual ESRI International User Conference	San Diego, CA	1999	1
4th International Conference on Remote Sensing for Marine and Coastal Environments	Orlando, FL	1997	1
International Association of Landscape Ecology	Tempe, AZ	2001	1
International Business Community Conference-Ecological Risk Assessment Tools for an Emerging Discipline	Boston, MA	1997	1
International Nitrogen Conference	Potomac, MD	2001	2
International Society for Systems Science	Atlanta, GA	1998	2
International Symposium on Global Patterns of Nutrient Over-Enrichment in Coastal Waters	Washington, DC	2000	1
International Symposium on Society and Resource Management	Indiana University, ID	2002	1
1st Annual Emergy Analysis Research Conference	Gainesville, FL	1999	2
1st Biennial NOAA/NMFS Conference on the Biology of Tautog and Cunner	Mystic, CT	1999	3
224th National Meeting of the American Chemical Society	Boston, MA	2002	1
25th Annual Benthic Ecology Symposium	Portland, ME	1997	2
25th Annual Eastern Fish Health Workshop	Plymouth, MA	2000	2
25th Annual Meeting of the New England Association of Environmental Biologists	Norwich, CT	2001	1
26th Northeast Endocrinology Conference	Narragansett, RI	1999	1
2nd Biennial Emergy Evaluation and Research Conference	Gainesville, FL	2001	2
3rd Annual EMAP Research Symposium	Albany, NY	1997	5
3rd International Conference on Arsenic Exposure and Health Effects	San Diego, CA	1998	1
3rd Marine and Estuarine Shallow Water Conference	Atlantic City, NJ	1996	1
41st Annual Meeting of the Society of Toxicology	Nashville, TN	2002	1
9th Symposium on Environmental Toxicology and Risk Assessment Recent Achievements in Environmental Fate and Transport	Seattle, WA	1999	1

Meeting	*Location*	*Year*	#
ACE/EPA Dredged Material Assessment Seminar	Baltimore, MD	2001	2
ACS Environmental Chemistry Division Symposium Emphasis on EPA and EPA Supported Research	Washington, DC	2000	3
AFS Southern New England Chapter Meeting	Narragansett, RI	2000	1
American Association of Geographers Annual Meeting	Honolulu, HA	1999	2
American Chemical Society Annual Meeting	Boston, MA	1998	1
American Chemical Society Annual Meeting	Orlando, FL	2002	2
American Chemical Society Annual National Meeting	Anaheim, CA	1999	2
American Chemical Society Conference	San Francisco, CA	1997	1
American Fisheries Society Annual Meeting	Monterey, CA	1997	1
American Fisheries Society Annual Meeting	Hartford, CT	1998	1
American Geophysical Union 1999 Meeting, Hydrology Section	Boston, MA	1999	1
American Geophysical Union 2000 Ocean Sciences Conference	San Antonio, TX	2000	1
American Society of Limnology and Oceanography	Albuquerque, NM	2001	3
American Society of Limnology and Oceanography/Ecological Society of America Conference on the Land-Water Interface Science for a Sustainable Biosphere	St Louis, MO	1998	2
American Waterbird Society Annual Meeting	Plymouth, MA	2000	5
Annual Meeting of the Society of Risk Analysis	Atlanta, GA	1999	3
ASLO/AGU Ocean Sciences Meeting 2002	Honolulu, HA	2002	1
Association of American Cancer Society	New Orleans, LA	1998	2
ASTM	St Louis, MO	1997	1
Chesapeake Bay Program Meeting	Baltimore, MD	2001	1
Chesapeake Bay Program Monitoring Subcommittee Meeting	Forte Meade, MD	2000	1
Coastal Zone 2001	Cleveland, OH	2001	1
Conference on Linkages Between Biodiversity, Ecosystem Health and Human Health	Washington, DC	2002	1
Contaminated Aquatic Sediment Remediation Guidance Workshop	Potomac, MD	1998	4
Dredged Materials Managers Meeting	San Francisco, CA	2002	1
Eastern Fish Health Workshop	Leestown, WV	2001	1
Ecological Society of America Annual Meeting	Albuquerque, NM	1997	1
Ecological Society of America Annual Meeting	Spokane, WA	1999	1
Ecological Society of America Annual Meeting	Snowbird, Utah	2000	3
Electrical Power Research Institute	Palo Alto, CA	1998	1
EMAP Coastal Symposium on Coastal Monitoring	Pensacola, FL	2001	5
EMAP Symposium 2002	Kansas City, MO	2002	2
EMAP Symposium on Western Ecological Systems	San Francisco, CA	1999	1
EPA Superfund Meeting on Managing Ecological Risk at Contaminated Sediment Sites	Chicago, IL	2002	2
Estuarine Research Federation	Providence, RI	1997	13
Estuarine Research Federation 16th Biennial Conference	St Petersburg, FL	2001	14
Estuarine Research Federation '99	New Orleans, LA	1999	14
Federal Interagency Workshop on Urban Sprawl	Harpers Ferry, WV	2000	1
Flatfish Biology Conference	Mystic, CT	2000	1
Gordon Conference on Environmental Endocrine Disruptors	Plymouth, NH	1998	1
Great Lakes National Program Conference	Chicago, IL	1998	2
Larval Fish Conference	Gulf Shores, AL	2000	1
Long Island Sound Research Conference	New Haven, CT	1996	1
Mid-Atlantic Integrated Assessment Working Conference	Baltimore, MD	1998	6
MIT Conference on Options for Dredged Material Disposal Management	Cambridge, MA	2000	2
National Conference on Marine Bioinvasions	Boston, MA	1999	2
National Research Council Conference-Data for Science and Society	Washington, DC	2000	1
National Shellfisheries Association Conference	Seattle, WA	2000	1
National Society of Histotechnology Conference	Providence, RI	1999	2
National Water Quality Monitoring Council Annual Meeting	Madison, WI	2002	1
National Watershed Coalition Annual Meeting	Austin, TX	1999	2
New England Association of Environmental Biologists	Cromwell, CT	1997	1
New England Association of Environmental Biologists	Newport, RI	2002	3

Meeting	*Location*	*Year*	#
New England Estuarine Research Society Regional Meeting	New London, CT	1998	1
New England Estuarine Research Society Regional Meeting	Block Island, RI	2000	9
New England Estuarine Research Society Regional Meeting	Salem, MA	2001	1
New England Estuarine Research Society Regional Meeting	Block Island, RI	1996	1
New England Estuarine Research Society Regional Meeting	Wells, ME	1997	1
New England Pharmacologist Meeting	Newport, RI	2001	1
New England Regional Assessment Meeting	Durham, NH	2001	1
New England Waters Sharing Successes Building the Future Conference	Kingston RI	1997	1
Fourth NHEERL Symposium on Research Advances In Risk Assessment Extraploation in Human Health and Ecological Risk Assessment	Cary, NC	1998	2
Fifth NHEERL Symposium on Research Advances in Risk Assessment Indicators in Health and Environmental Risk Assessment	RTP, NC	2000	7
NIST/NOAA/EPA Quality Assurance Meeting	Charleston, SC	1998	1
North American Benthological Society Annual Meeting	Pittsburg, PA	2002	1
North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry	Portland, ME	1997	5
North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry	Saratoga Springs, NY	1998	2
North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry	Boston, MA	1999	1
North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry	Newport, RI	2000	5
North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry	Plymouth, MA	2001	3
North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry	Portland, ME	2002	3
Northeast ARC Users Group-16th Annual Conference	Worcester, MA	2001	1
Northeast Fish and Wildlife Conference	Portland, ME	2002	2
PITCON	Atlanta, GA	1997	1
Preserving Place-Growing Smart Conference	Kingston, RI	1997	1
RI Natural History Survey 2002 Conference	Warwick, RI	2002	1
RI Natural History Survey 1998 Conference	Kingston, RI	1998	1
RI Natural History Survey 1999 Conference	Providence, RI	1999	1
Right Whale Consortium Annual Meeting	Boston, MA	2000	1
SETAC Ecovulnerability Syposium	Seattle, WA	1998	2
Society For Human Ecology Conference	Bar Harbor, ME	1997	1
Society of Environmental Toxicology and Chemistry, 17th Annual Meeting	Washington, DC	1996	16
Society of Environmental Toxicology and Chemistry, 18th Annual Meeting	San Francisco, CA	1997	19
Society of Environmental Toxicology and Chemistry, 19th Annual Meeting	Charlotte, NC	1998	11
Society of Environmental Toxicology and Chemistry, 20th Annual Meeting	Philadelphia, PA	1999	11
Society of Environmental Toxicology and Chemistry, 21st Annual Meeting	Nashville, TN	2000	8
Society of Environmental Toxicology and Chemistry, 22nd Annual Meeting	Baltimore, MD	2001	16
Society of Environmental Toxicology and Chemistry, 23rd Annual Meeting	Salt Lake City, UT	2002	8
Society of Molecular Biology/Evolution and American Genetics Association	New Haven, CT	2000	1
Society of Toxicology Annual Meeting	Cincinnati, OH	1997	1
Society of Toxicology Annual Meeting	Seattle, WA	1998	1
Society of Toxicology Annual Meeting	New Orleans, LA	1999	1
Society of Toxicology Annual Meeting	Philadelphia, PA	2000	2
Society of Toxicology Annual Meeting	San Francisco, CA	2001	1
Society Of Wetland Scientists Meeting	Bozeman, MT	1997	1
Society of Wetland Scientists New England Chapter 2nd Annual Conference	Worcester, MA	2002	4
Southern New England Chapter of the American Fisheries Society	Old Lyme, CT	2000	3
Southern New England Chapter of the American Fisheries Society	Bristol, RI	2002	1
Southern New England Chapter of the American Fisheries Society	Woods Hole, MA	1997	2
Striped Bass Working Symposium	Baltimore, MD	2000	1
National Water Quality Monitoring Council's National Monitoring Conference 2000 Monitoring for the Millennium	Austin, TX	2000	1
American Geophysical Society Meeting	Boston, MA	1999	1
Northeast Algal Symposium	Durham, NH	2002	1
US EPA 20th National Annual Conference on Managing Environmental Systems	St Louis, MO	2001	1
US EPA National Environmental Monitoring Conference	Boston, MA	2000	1
Watersheds 2002	Fort Lauderdale, FL	2002	1

Table 7. Recent (2001-2002) Support and Advice Provided to Regional Offices

EPA Region	Support Function
1	Provided Hydrolab equipment and technical guidance via an RLA to the Wood Pawcatuck Watershed Association based on a request from Region 1.
1	Provided technical reviews of several Providence River dredging proposals.
1	Reviewed Quality Assurance Project Plans for a modeling study of 89 Massachusetts estuaries and for a flushing study of Acushnet River Estuary, RI.
1	Technical review of modeling portions in a proposal to EPA-Long Island Office, New York Sea Grant, and Connecticut Sea Grant: Multifactorial analysis of time-dependent variables contributing to hypoxia in Western Long Island Sound.
1	Technical review of proposal for Quonsett Point, RI dredging.
1	Assisted in the Long Island Sound "Site Designation Study".We are quantifying macrophage aggregate area in spleen of winter flounder (as a marker of PAH pollution and disease), and reviewed the physical oceanography Quality Assurance Project Plan for this project.
2	Project officer for a research grant to investigate the cause of American lobster mortality in Long Island Sound.
2	Examining lobsters from Long Island Sound for histopathological changes. Technical expertise for the Long Island Sound Lobster Mortality Project.
1	Reviewed Charles River water quality monitoring proposal.
1	Advisory support and technical assistance for monitoring activities at multiple superfund sites in the northeast. Includes deployment of mussels, and subsequent chemical analysis of those mussels, in and around New Bedford Harbor.
1	Provide an historical assessment of New Bedford Harbor
1	Assist Regional personnel in the synthesis and interpretation of sediment profile image data from Mount Hope Bay, RI.
4, 6	Participated in EMAP workshops - Technical transfer of probability-based environmental monitoring design and data management systems.
1 - 10	REMAP - Transfer of information management tools and techniques.
1, 2, 3	National Coastal Assessment - Transfer of information management tools and techniques.

EPA Region	Support Function
1, 2, 3	Support of Regional 305 (b) efforts through National Coastal Assessment monitoring designs and interactions with individual states.
1, 2, 3	Currently working with Regional personnel in designing "state of the environment" reports based on data collected through the National Coastal Assessment
1	One staff member is located in the Region 1 office and serves as a technical advisor for training staff on technical issues, setting up workshops and responding to technical requests.
1	Support Region 1 in developing probability-based monitoring designs for streams, lakes, and ponds.
1	Currently working with Region 1 in development of a coastal wetland monitoring program
2	Project officer on several Region 2 REMAP projects. Also reviewed proposals for these projects and coordinated data analysis.
2	Project officer on Region 2 estuarine biocriteria RARE project.
1	Develop proposal for Regional Methods Initiative - Develop bioassessment methods for tidal-fresh streams.
1	Reviewed a proposal for eutrophication-related research on Long Island Sound.
1	Providing support to Region 1 concerning evaluating loading of nutrients to estuaries, and modeling the effects of that loading, in the context of the National Estuary Program.
1	Supported model-based TMDL study in the Seekonk and Providence Rivers.
1	Reviewed Implementation Manual for Nutrient Criteria in Lakes.
1	Served on Region 1 Technical Advisory Group for Development of Nutrient Criteria in Estuaries.
1	Participated in the development of a contaminant monitoring program for Rhode Island fish.
1	Provided technical information related to the development of protocols for evaluating dredged material and provided technical information related to the measurement of lipids in tissues being tested as part of dredged material assessments.
1	Measured contaminant levels in sediment samples from the Barrington River.

EPA Region	Support Function
1	Provided technical information related to dioxin contamination of the Woonasquatucket River, RI.
3, 10	ORD representative for a regional methods project on the development of standard protocols for the measurement of PCBs and PBDEs.
1	Provided information on standard reference materials for the measurement of dibenzodioxins.
1	Collected and provided data and literature information on contaminant levels in winter flounder.
1	Transmitted protocols on the measurement of lipids in marine tissue samples.
2, 3, 4	Supported development of monitoring approaches and indicators of wetlands in 2 pilot watersheds (Juniata and Nanticoke).
2, 3, 4	Expansion of Bird Community Index to Coastal Plain & Piedmont; Use of BBS data - Transfer of state-of-science integrative indicator of ecosystem condition through existing long-term monitoring program
2, 3, 4	Supported development of volunteer monitoring program for amphibians (NAAMP) and development of stream-side salamander monitoring techniques.
3	Mid-Atlantic Integrated Assessment - Transfer of information management tools and techniques.
3	Initiated MAIA/STAR pilot - purpose is to transfer of state-of-science knowledge and products from STAR grant program to support Program mission.
3	An Ecological Assessment of the United States Mid-Atlantic Region (Landscape Atlas) - transfer of state-of-science knowledge of landscape ecology to support Program mission.
3	Condition of the Mid-Atlantic Estuaries Report - transfer results of Mid-Atlantic Estuaries Assessment to Region and States.
3	From the Mountains to the Sea: The State of Maryland's Freshwater Streams - transfer results of Maryland Stream Assessment to Region and States.
3	Birds Indicate Ecological Condition of the Mid-Atlantic highlands - transfer of state-of-science landscape-level biological indicator to support program mission.
3	Mid-Atlantic Highlands Streams Assessment - transfer results of Mid-Atlantic Highlands Streams Assessment to Region and States

EPA Region	Support Function
3	Maryland Agriculture and Your Watershed - transfer of state-of-the-science statistical methods to support Program mission.
3	How Will Climate Change Affect the Mid-Atlantic Region? - transfer key messages from the Mid-Atlantic Regional Assessment of Global Climate Change to Region and States.
3	What is the State of the Environment in the mid-Atlantic Region? - transfer key messages from five years of MAIA assessments to Region and States.
2, 3, 4	Watershed Partnership to Stabilize Stream Banks in the Spring Creek Watershed, Central, Pennsylvania - transfer watershed-group's approach to stream restoration to Regions, States and local governments.
2, 3, 4	Pesticide Use Reduction with Geographic Information Systems, Ruggles Golf Course, Aberdeen Proving Ground, Maryland - transfer of application of GIS approach to Regions, States and local governments.
2, 3, 4	Web-based Inventory of Ecological Restoration Projects in the Mid-Atlantic Region - transfer information on restoration projects in the Mid-Atlantic region to Region, States, and local governments.
2, 3, 4	A Guide to Land Cover/Land Use in the Mid-Atlantic Region - transfer information on research and application of land cover/land use information, including standards.
2, 3, 4	Update of State BioAssessment Programs in the Mid-Atlantic Region.
5	Interpretation of historical AVS and metals data, and chemical analysis, reporting and interpretation of AVS/SEM concentrations in Tuscarawus River sediment samples collected by the PPG Barberton Ohio facility.
4	Reporting and interpretation of results from chemical analysis and toxicity testing of sediments from Shipyard Creek in the Macalloy corporation Superfund site (Charleston, SC).
1	Established conduit for technical transfer of latest information on endocrine disrupting chemicals to Region 1 scientists.
9	Participated in meeting to identify issues/needs of Region 9 that NHEERL could assist with.
1	Assisting Region 1 TMDL Coordinator in the development of diagnostic tools.
1	Project Officer for RARE project to develop a rapid method for measuring pathogens in seawater samples.
9	Reviewed site-specific Copper Water Quality Criteria for San Francisco Bay.

AED Staff Biosketches

MOHAMED ABDELRHMAN
Research Physical Scientist
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B.S., (Honors), Civil Engineering, Cairo University, Giza, Egypt, 1971
M.S., Civil Engineering, Cairo University, Giza, Egypt, 1977
Ph.D., Civil Engineering, Ohio State University, Columbus, OH, 1985

Employment:

1995-present	Research Physical Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Senior Environmental Engineer, Science Applications International Corporation (SAIC), Narragansett, RI
1990-1993	Senior Technical Staff Programmer/analyst/modeler, Computer Sciences Corporation, Narragansett, RI
1989-1990	Associate Research Scientist, Kuwait Institute for Scientific Research, Kuwait.
1988-1989	Senior Technical Staff Programmer/analyst/modeler, Computer Sciences Corporation, Narragansett, RI
1987-1988	Postdoctoral Research, University of Florida, Gainesville, FL
1986-1987	Postdoctoral Fellow, Memorial University of Newfoundland, St. John's, Newfoundland, Canada
1985-1986	Postdoctoral Research, The Ohio State University, Columbus, OH
1980-1985	Graduate Research Associate, The Ohio State University, Columbus, OH
1977-1980	Assistant Lecturer, Cairo University, Giza, Egypt
1971-1977	Graduate Teaching Associate, Cairo University, Giza, Egypt

Research Expertise and Skills Relative to Agency Needs:

Mohamed is a civil engineer with expertise in computational fluid dynamics and transport phenomena of contaminants in surface waters; mathematical and numerical modeling; hydraulics and water resources; coastal engineering and sediment transport; and data analysis and pattern recognition.

Professional Societies:

Member Professional Engineering Society, State of Rhode Island
Member The American Geophysical Union
Member The Egyptian Professional Engineering Society

Selected Recent Publications:

Abdelrhman, M.A. (submitted) Effects of eelgrass (*Zostera marina*) canopies on flow and transport. Marine Ecology Progress Series.

Abdelrhman, M.A. 2002. Modeling how a hurricane barrier in New Bedford Harbor, Massachusetts, affects the hydrodynamics and residence times. Estuaries 25(2):177-196.

Abdelrhman, M.A. 2001. Mapping bathymetry and bottom type in a shallow estuary. Poster. EMAP Symposium 2001, Pensacola, FL.

Abdelrhman, M.A., E. Davey, and K. Rocha. 1999. Hydrodynamic data from the Slocums River estuary, Massachusetts, during the period 26 October to 5 November 1998, with bathymetric surveys during summer of 1999. Data Report, Contribution Number NHEERL-NAR-2116, U.S. EPA, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, RI. 101 pp.

Abdelrhman, M.A., B.J. Bergen, and W.G. Nelson. 1998. Modeling of PCB concentrations in water and biota *Mytilus edulis* in New Bedford Harbor, Massachusetts. Estuaries 21(3): 435-448.

Abdelrhman, M.A. and E.G. Dettmann. 1997. Two-dimensional modeling of current circulation and contaminant transport in surface waters. Chapter 12 in Next Generation Environmental Models: Computational Methods, Ed. George Delic, in Society of Industry and Applied Mathematics, pp.117-123.

SANDRA J. BENYI
Research Biologist
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B.S., Marine Science, Southampton College, Long Island University, N.Y., 1983
M.S., Oceanography, Graduate School of Oceanography, University of Rhode Island, R.I., 1992

Employment:

1995 - present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1995	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI
1984-1988	Graduate Research Assistant, University of Rhode Island
1982	Aquaculture Intern, Aquatic Systems Inc., San Diego, Calif.

Research Expertise and Skills Relative to Agency Needs:
Sandra is a biological oceanographer with experience in analyzing large environmental data sets and evaluating shellfish and marsh habitat.

Selected Appointments/Honors/Major Awards:
Member National Shellfisheries Association
U.S. EPA Bronze Medal for Chronic Effect of Cadmium In Sediments On Colonization By Benthic Marine Organisms

Selected Recent Publications:

Schimmel, S.C., S.J. Benyi, and C.J. Strobel. 1999. Assessment of the ecological condition of Long Island Sound, 1990-1993. Environmental Monitoring and Assessment: 56:27-49.

Strobel, C.J., H.W. Buffum, S.J. Benyi, and J.F. Paul. 1999. Environmental monitoring and assessment program: current status of Virginia Province (U.S.) estuaries. Environmental Monitoring and Assessment 56: 1-25.

Hansen, D.J., J.D. Mahony, W.J. Berry, S.J. Benyi, J.M. Corbin, S.D. Pratt, D.M. DiToro, and M.B. Abel. 1996. Chronic effect of cadmium in sediments on colonization by benthic marine organisms: An evaluation of the role of interstitial cadmium and acid-volatile sulfide in biological availability. Environmental Toxicology & Chemistry 15(12): 2126-2137.

Nelson, W.G., B.J. Bergen, S.J. Benyi, G.E. Morrison, R.A. Voyer, C.J. Strobel, S.A. Rego, G.B. Thursby, and C.E. Pesch. 1996. New Bedford Harbor long-term monitoring assessment report: Baseline sampling. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, RI. EPA/600/R-96/097.

Munns, W.R. Jr, C. Mueller, B.A. Rogers, S. Benyi, S. Anderson, T. Gleason, W.G. Nelson, and R. K. Johnston. 1994. Risk assessment pilot study - phase III. Naval Construction Battalion Center, Davisville, RI. U.S. Environmental Protection Agency.

Strobel, C.J., H.W. Buffum, S.J. Benyi, E.A. Petrocelli, D.R. Reifsteck, and D.J. Keith. 1994. Statistical Summary: EMAP-Estuaries Virginian Province -1990 to 1993.

Benyi, S.J. 1993. Contaminated sediment effects on calcium hemolymph and calcium concretions in selected species of marine mollusks. M.S. Thesis. University of Rhode Island, Graduate School of Oceanography.

Gardner G.R., P.P. Yevich, J. Hurst, P. Thayer, S. Benyi, J. Harshbarger, and R.J. Pruell.1991. Germinomas and teratoid siphon anomalies in soft-shelled clams, *Mya arenaria*, environmentally exposed to herbicides. J. Environ. Health Perspectives 9: 43-51.

BARBARA J. BERGEN
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B.A., Biology, Southampton College, Southampton, NY, 1982
B.S., Marine Chemistry, Southampton College, Southampton, NY, 1982
M.S., Marine Chemistry, University of Rhode Island, Kingston, RI, 1991
Ph.D., Oceanography, University of Rhode Island, Kingston, RI, 1999

Employment:

1995-present	Research Chemist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1995	Chemist/Work Assignment Manager, Science Applications International Corporation (SAIC), Narragansett, RI
1986-1988	Chemist/Bookeeper, Spatco Ltd, Narragansett, RI
1984-1986	Chemist, Analytical Testing Services, Pawtucket, RI
1982-1984	Graduate Student, Graduate School of Oceanography, Narragansett, RI
1981-1982	Research Assistant, Skidaway Institute of Oceanography, Savannah, GA

Research Expertise and Skills Relative to Agency Needs:

Barbara is a marine chemist with expertise in applying quantitative methods to assess the effects and fate/transport of chemicals in the marine environment, developing monitoring plans for contaminated sediment remediation, and evaluating the impact of nutrient enrichment on coastal areas.

Selected Appointments/Honors/Major Awards:

Representative to U.S. EPA's Contaminated Sediment Technical Advisory Group, 2002
U.S. EPA STAA award Honorable Mention, 2001
U.S. EPA Special Accomplishment Recognition Award, Participation in the Contaminated Aquatic Sediment Remedial Guidance Workgroup - 2000
Member, Estuarine Research Federation - 1997- present
Division of Environmental Chemistry of the American Chemical Society: Award of Excellence, Graduate Student Paper Award for "Remediation at a Marine Superfund Site: Surficial Sediment PCB Congener Concentration, Composition, and Redistribution"- 1998
Division of Environmental Chemistry of the American Chemical Society: Outstanding Graduate Student Award - 1997
CBEP Champion Award, U.S. EPA, For significant contributions to community-based approaches to environmental protection - 1996

Selected Recent Publications:

Bergen, B.J., W.G. Nelson, J.G. Quinn, and S. Jayaraman. 2001. Relationships among total lipid, lipid classes, and polychlorinated biphenyl concentrations in two indigenous populations of ribbed mussels (*Geukensia demissa*) over an annual cycle. Environmental Toxicology and Chemistry 20(3): 575-581.

Bergen, B.J., J.G. Quinn, and C.C. Parrish. 2000. Quality assurance study of marine lipid classes using Chromorod/Iatroscan TLC-FID. Environmental Toxicology and Chemistry 19: 2189-2197.

Bergen, B.J., K. Rahn, and W.G. Nelson. 1998. Remediation at a marine superfund site: Surficial sediment PCB congener concentration, composition and redistribution. Environmental Science and Technology 32: 3496-3501.

Bergen, B.J., W.G. Nelson, and R.J. Pruell. 1996. Comparison of nonplanar and coplanar PCB congener partitioning in seawater and bioaccumulation in blue mussels (*Mytilus edulis*). Environmental Toxicology and Chemistry 15 (9): 1517-1523.

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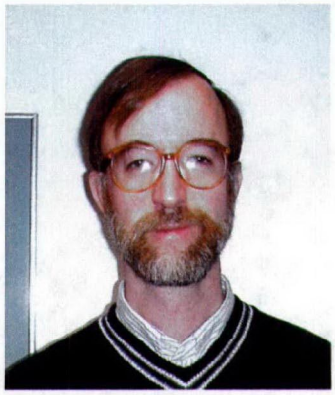

A.B., Biology, Vassar College, Poughkeepsie, NY, 1976
Ph.D., Biological Oceanography, University of Rhode Island, Kingston, RI, 1987

Employment:

1995-present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1989-1995	Senior Biologist, Science Applications International Corporation (SAIC), Narragansett, RI
1987-1988	Research Associate, University of Rhode Island, Kingston, RI
1984-1987	Biologist/Semior Biologist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Walter is a Research Biologist with the United States Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division in Narragansett, Rhode Island. Walter holds a Ph.D. in Biological Oceanography from the University of Rhode Island. His research has focused primarily on the bioavailability of metals in sediments. He has also worked on the development of Equilibrium Partitioning Derived Sediment Guidelines (ESGs), and been involved in a number of navigational dredging projects.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry and New England Estuarine Research Society
Reviewer for Estuaries, Environmental Toxicology and Chemistry, Environmental Toxicology and Water Quality, Estuarine, Coastal and Shelf Science, Marine Ecology Progress Series, Marine Environmental Research, Water, Air, and Soil Pollution.
U.S. EPA Bronze Medal for the development of a technically-rigorous basis upon which to assess the environmental risks of metals in sediments using SEM:AVS and interstitial water metals concentrations, 1999
U.S. EPA Science and Technology Achievement Award, 1999
U.S. EPA Science Achievement Award, Water Quality, 2002

Selected Recent Publications:
Kuhn, A., W.R. Munns, Jr., J. Serbst, P. Edwards, P. Edwards, M.G. Cantwell, T. Gleason, M.C. Pelletier, and W. Berry. 2002. The chronic effects of cadmium on the amphipod, *Ampelisca abdita*. Environmental Toxicology and Chemistry 21: 865-874.
Munns, W.R., Jr., W. Berry, and T. DeWitt. 2002. Toxicity testing, risk assessment, and options for dredged material management. Marine Pollution Bulletin 44: 294-302.
Boothman W. S., D.J. Hansen, W.H. Berry, R.L. Robson, A. Helmstetter, J.M. Corbin, and S.D. Pratt. 2001. Biological response to variation of acid-volatile sulfides and metals in field-exposed spiked sediments. Environmental Toxicology and Chemistry 20: 264-272.
Berry, W.J., M. Cantwell, P. Edwards, J. Serbst, and D.J. Hansen. 1999. Predicting the toxicity of sediments spiked with silver in the laboratory. Environmental Toxicolology and Chemistry 18: 40-48.

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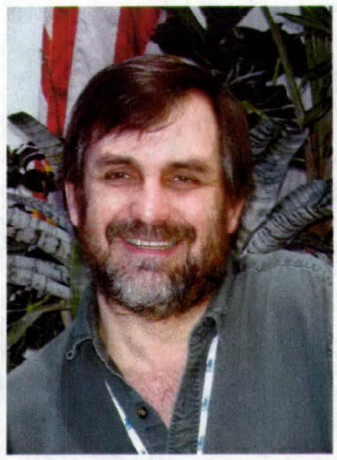

Sc.B. with Honors, Chemistry, Brown University, Providence, RI, 1973.
Ph.D., Chemistry, University of Rhode Island, Kingston, RI, 1990.

Employment:

1992-present	Research Chemist, Atlantic Ecology Division, National Health and Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1992	Chemist, National Health and Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1987-1988	Research Scientist, Texas A&M University, College Station, TX
1984-1987	Associate Chemist, Science Applications International Corporation, (SAIC), Narragansett, RI
1984	Laboratory Automation Specialist, Computer Sciences Corp. (CSC), Narragansett, RI
1981-1984	Graduate Research Assistant, University of RI, Kingston, RI
1981	SEAREX (SEa Air EXchange program) Peru research cruise.
1973-1976	Chemist, Dow Chemical Company, New England Research Lab, Wayland, Mass.

Research Expertise and Skills Relative to Agency Needs:
Warren is an environmental analytical chemist with expertise in analytical and statistical methods for assessing extent, sources and bioavailability of contaminants in marine systems, and mechanisms and environmental factors affecting geochemistry and bioavailability of metals in marine sediments and waters.

Selected Appointments/Honors/Major Awards:
Member American Chemical Society, Environmental Chemistry Division
Member Society of Environmental Toxicology and Chemistry, Board of Directors, 2001-2004
Reviewer for Environmental Toxicology and Chemistry, Comparative Biochemistry and Physiology, Archives of Environmental Contamination and Toxicology
U.S. EPA Scientific and Technological Achievement Award, Level 2, 1998
U.S. EPA Bronze Medal for the development of a technically-rigorous basis upon which to assess the environmental risk of metals in sediment using AVS:SEM and interstitial water metal concentrations. (Group award to Sediment Assessment and Criteria Workgroup), 1998

Selected Recent Publications:
Latimer, J.S., W.S. Boothman, C. Pesch, G.L. Chmura, V.Pospelova, and S.Jayaraman. Environmental stress and recovery: the geochemical record of human disturbance in New Bedford Harbor and Apponagansett Bay. Submitted to Science of the Total Environment.

Boothman W.S., D.J. Hansen, W.J. Berry, D.L. Robson, A. Helmstetter, J.M. Corbin, and S.D. Pratt. 2001. Biological response to variation of acid-volatile sulfides and metals in field-exposed spiked sediments. Environmental Toxicology and Chemistry 20: 264–272.

Lussier, S.M., W.S. Boothman, S. Poucher, D. Champlin, and A. Helmstetter. 1999. Comparison of dissolved and total metals concentrations from acute tests with saltwater organisms. Environmental Toxicology and Chemistry 18: 889-898.

Bothner, M.H., P.W. Gill, W.S. Boothman, B.B. Taylor and H.A. Karl. 1998. Chemical gradients in sediment cores from an EPA reference site off the Farallon Islands - Assessing chemical indicators of dredged material disposal in the deep sea. Marine Pollution Bulletin 36: 443-457.

M. PATRICIA BRADLEY
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B.S., Music, Towson University, Towson, MD, 1976
MBA, Golden Gate University, San Francisco, CA,1985

Employment:

1996-present	Environmental Program Manager (MAIA), Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1989-1996	Associate Director for Program Operations, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1989	Program Analyst, Office of Research and Development, U.S. EPA, Washington, DC
1987-1988	Program Analyst, Chief of Naval Operations, Washington, DC
1985-1987	Program Analysis Officer, Naval Supply Center, Norfolk, VA

Research Expertise and Skills Relative to Agency Needs:

Pat is a member of Mid-Atlantic Integrated Assessment (MAIA) Team, an ORD/Region 3 partnership to integrate scientific knowledge into the decision-making process for the Mid-Atlantic. Pat's work has focused on working with other agencies, states, local governments, citizens, and research scientists to improve the science used in assessing policy and management issues of critical importance to resource managers and environmental decision-makers. She also brings extensive expertise in administrative areas such as contract management, funds control and personnel.

Selected Appointments/Honors/Major Awards:

External Advisory Board for the Center for Integrating Statistical and Environmental Science, The University of Chicago
Science Advisory Committee, National Park Service, National Capital Region
EMAP Information Management Working Group
U.S. EPA Bronze Medal for the MAIA Integrated Assessment Team, Region III, 1999
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Region III, 1998
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Office of Research and Development , 1998
U.S. EPA Lee M. Thomas Excellence in Management Award, 1990
U.S. EPA Excellence in Management Award, Office of Research and Development, 1990

Selected Recent Publications:

Bradley, M.P. and R.B.Landy. 2000. The Mid-Atlantic integrated assessment (MAIA). Environmental Monitoring and Assessment 63: 1-13.

Bradley, M.P., B.S. Brown, S.S. Hale, F.W. Kutz, R.B. Landy, R. Shedlock, A. Morris, W.B. Galloway, J.S. Rosen, R. Pepino and B. Wiersma. 2000. Summary of the MAIA working conference. Environmental Monitoring and Assessment 63: 15-29.

Jackson, L.E. and M.P. Gant. 1998. Interactive, spatial inventory of environmental data in the Mid-Atlantic region. Environmental Monitoring and Assessment 51: 325-329.

SHERRY L. BRANDT-WILLIAMS
Landscape Systems Ecologist/Environmental Engineer
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B.S., Chemical Engineering, University of Florida, Gainesville, FL, 1984
Ph.D., Environmental Engineering Sciences, University of Florida, Gainesville, FL, 1999

Employment:

2002-present	Post-doctorate, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1999-2002	Project manager, Ecosystem Assessment, Rookery Bay NERR, Florida Department of Environmental Protection, Naples, FL
1995-1999	National Science Foundation Fellow and graduate teaching assistant, University of Florida, Gainesville, FL
1989-2002	Independent contractor: GIS and remote sensing imagery applications and modeling, computer graphics, web site development
1984-1989	Group Leader and project engineer, Paper Research and Development, Procter & Gamble, Cincinnati, OH

Research Expertise and Skills Relative to Agency Needs:
Sherry is a systems ecologist and engineer with expertise in development of temporal and spatial models as support for environmental remediation policy, quantifying the interface between environment and socioeconomics using energy and emergy, and in development and execution of terrestrial/aquatic field studies.

Selected Appointments/Honors/Major Awards:
Member, American Society of Ecological Engineers
EIT, State of Florida
"Women at the University of Florida" Award, Women's Studies Student Association, 1999-2000 U.S. Patent granted 1987
Results Achiever Award, Procter & Gamble, 1986
Benton Engineering Council Leadership Key Award, University of Florida, 1984
UF Presidential Leadership Recognition Award, University of Florida, 1984

Selected Recent Publications:
Brandt-Williams, S.L. 2002. Spatial emergy dynamics as an ecological engineering design tool. In Brown, M. (ed.), Emergy Synthesis 2: Theory and Applications of the Emergy Methodology. Gainesville, Florida, Center for Environmental Policy, in press.

Brandt-Williams, S.L. and G. Pillet. 2002. Fertilizer byproducts as agricultural emternalities: quantifying environmental services used in production of food. In Brown, M. (ed.), Emergy Synthesis 2: Theory and Applications of the Emergy Methodology. Gainesville, Florida: Center for Environmental Policy, in press.

Brandt-Williams, S. and M. Shirley. 2001. An ecological landscape characterization of the Rookery Bay National Estuarine Research Reserve and Belle Meade Watershed. Report to National Oceanic and Atmospheric Administration. Florida Department of Environmental Protection, 70 pp. and a CD.

Patten, B., B. Fath, S. Bastianoni, S. Borrett, S. Brandt-Williams, J. Choi, M. Debeljak, J. Fonseca, W. Grant, D. Karnawati, J. Marques, A. Moser, F. Müller, C. Pahl-Wostl, S. Priyanto, and R. Seppelt. 2001. Perspectives on CAHSystems—complex adaptive hierarchical systems. In Costanza, R. and S. Jorgensen (eds.), Understanding and Solving Environmental Problems in the 21st Century. New York, Elsevier, pp. 41-49.

Brandt-Williams, S. 1999. Evaluation of watershed control of two central Florida lakes: Newnans Lake and Lake Weir. Ph.D. dissertation, University of Florida, 257 pp.

BARBARA S. BROWN
Chief, Ecological Response Branch
401-782-3088
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B.S., Civil Engineering, Oklahoma State University, Stillwater, OK, 1976
M.S., Civil Engineering, Oklahoma State University, Stillwater, OK, 1983

Employment:

1995-present	Chief, Ecological Response Branch, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Regional Scientist, Office of the Regional Administrator, Region I, U.S. EPA, Boston, MA
1990-1993	Research Environmental Scientist, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1989-1990	Planning Coordinator, U.S. Army Corps of Engineers, Baltimore, MD
1985-1989	U.S. Senate Liaison/National Flood Control Program Manager, U.S. Army Corps of Engineers, Washington, DC
1977-1985	Chief, Small Projects Section/Project Manager/Civil Engineer, U.S. Army Corps of Engineers, Tulsa, OK

Research Expertise and Skills Relative to Agency Needs:
Barbara is a civil engineer with expertise in environmental monitoring and assessment, developing and applying hydrodynamic models for sediment transport, developing and applying large river basin hydrologic models, and incorporating ecological and socioeconomic considerations in environmental decision support systems.

Selected Appointments/Honors/Major Awards:
Member, American Society of Civil Engineers
Professional Engineer license: Oklahoma and Maryland
Reviewer for Environmental Monitoring and Assessment, Journal of Environmental Management
Interagency Clean Water Action Plan Workgroup for Coastal Research and Monitoring
U.S. EPA Consolidated Assessment and Listing Methodology (CALM) Workgroup
Association of State and Interstate Water Pollution Control Administrators (ASIWPCA) Water Quality Monitoring Program National Assessment Workgroup
U.S. EPA Bronze Medal for Development of the Center for Environmental Industry and Technology , Region I, 1995
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Region III, 1998
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Office of Research and Development , 1998
U.S. EPA Bronze Medal for the MAIA Integrated Assessment Team, Region III, 1999
U.S. EPA Outstanding/Exceptional ORD Technical Assistance to Regions or Program Offices, EMAP Survey Design Team, 2001

Selected Recent Publications:
Lazorchak, J.M., B.H. Hill, B.S. Brown, F.H. McCormick, V. Engle, D.J. Lattier, M.J. Bagley, M.B. Griffith, A.F. Maciorowski, and G.P. Toth. 2002. USEPA biomonitoring and bioindicator concepts needed to evaluate the biological integrity of aquatic systems. In Bioindicators/Biomonitors - Principles, Assessment, Concepts. A.M. Breure, B. Markert, and H. Zechmeister (eds)., Elsevier Science B.V., in press.

Brown, B.S.,W.R. Munns, Jr., and J.F. Paul, 2002. Integrated ecological assessment of resource condition and its application to the Mid Atlantic estuaries. Journal of Environmental Management, in press.

Bradley, M.P., B. Brown, W. Galloway, S. Hale, F.Kutz, R. Landy, R. Mangold, and R. Shedlock. 2000. Results of the MAIA conference. Environmental Monitoring and Assessment 63(1): 1-13.

USEPA. 1998. Condition of the Mid-Atlantic estuaries. United States Environmental Protection Agency, Office of Research Development, Narragansett, RI, 50 pp.

ROBERT M. BURGESS
Research Environmental Scientist
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B.S., Natural Resources Science, University of Rhode Island, Kingston, RI, 1987
M.S., Biological Oceanography, University of Rhode Island, Narragansett, RI, 1990
Ph.D., Chemical Oceanography, University of Rhode Island, Narragansett, RI, 1996

Employment:

1997-present	Research Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1997-1997	Expert Consultant, Office of Water, Office of Science and Technology, Health and Environmental Criteria Division, U.S. EPA, Washington, DC
1992-1997	Physical Scientist, Atlantic Ecology Division, National Health and Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1987-1992	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

Rob is an environmental geochemist and toxicologist with expertise in assessing the bioavailability of stressors, including organic and metal contaminants and ammonia, to marine organisms. He also has expertise in developing methods for identifying stressors in environmental media including sediments, surface waters and effluents. In general, this expertise is used to develop tools for application by environmental managers.

Selected Appointments/Honors/Major Awards:

Member American Association for Advancement of Science, American Chemical Society, American Geophysical Union and Society of Environmental Toxicology and Chemistry
Reviewer for Archives of Environmental Contamination and Toxicology, Chemosphere, Environmental Pollution, Environmental Science and Technology, Environmental Toxicology and Chemistry, Estuaries, Marine Pollution Bulletin and Organic Geochemistry
Advisory Board Member, Harvard School of Public Health, Superfund Basic Research Program
Environment Canada Technical Subcommittee on Development of Guidelines
Article Highlighted in Quintessence: Excellence in Environmental Contamination and Toxicology - 1995
U.S. EPA Bronze Metal for Toxicity Identification Evaluation (TIE) Research - 1997
U.S. EPA Science Achievement Award in Water Quality - 2002
U.S. EPA Science and Technology Achievement Awards: 1997(II), 1998 (Honorable Mentions) and 2000 (III)

Selected Recent Publications:

Burgess, R.M. 2002. Ammonia. In The Encyclopedia of Water, J.H. Lehr (ed.), John Wiley & Sons, New York, in press.
Ho, K.T., R.M. Burgess, M.C. Pelletier, J.R. Serbst, S.A. Ryba, M.G. Cantwell, A. Kuhn, and P. Raczelowski. 2002. An overview of toxicant identification in sediments and dredged materials. Marine Pollution Bulletin 44: 286-293.
Ryba, S.A. and R.M. Burgess. 2002. Effects of sample preparation on the measurement of organic carbon, hydrogen, nitrogen, sulfur and oxygen concentrations in marine sediments. Chemosphere 48: 139-147.
Burgess, R.M., S.A. Ryba, M.G. Cantwell and J.L. Gundersen. 2001. Exploratory analysis of the effects of particulate characteristics on the variation in partitioning of nonpolar organic contaminants to marine sediments. Water Research 35: 4390-4404.

DANIEL E. CAMPBELL
Systems Ecologist
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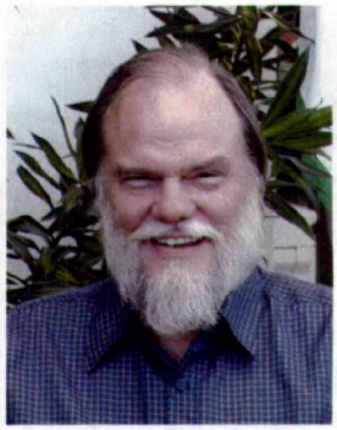

B.S., Biology, Virginia Military Institute, Lexington VA, 1970
M.S. Oceanography, Old Dominion University, Norfolk, VA, 1977
Ph.D., Env. Eng. Sciences, University of Florida, Gainesville, FL, 1984
Post-Doctoral Fellow, Zoology, University of Maine, Orono, ME, 1984-1986

Employment:

1995-present	Ecologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1990-1994	Associate Research Scientist, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI
1986-1990	Marine Resource Scientist II, Maine Department of Marine Resources, West Boothbay Harbor, ME

Research Expertise and Skills Relative to Agency Needs:
Dan is a systems ecologist with expertise in applying energy systems theory, computer simulation, and environmental accounting using emergy to (1) perform comprehensive evaluations of the environmental, economic, and social effects of environmental policies, (2) assess risks and significance of environmental change on the health and integrity of ecosystems, and (3) develop models and methods to diagnose the causes of biological impairment in our nation's aquatic ecosystems.

Selected Appointments/Honors/Major Awards:
Adjunct Professor, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI
Adjunct Research Scientist, Bigelow Laboratory for the Ocean Sciences, West Boothbay Harbor, ME
Member, Society of Environmental Toxicology and Chemistry, International Society for Ecosystem Health, Rhode Island Natural History Society, and Estuarine Research Federation
Reviewer for Population and Environment, Ecosystem Health, Chemosphere, Office of Water U.S. EPA (Biocriteria Guidance for Estuaries), Handbook of Detergents, Center for Environmental Policy, University of Florida.
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Region III, 1998
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Office of Research and Development , 1998
U.S. EPA Science and Technology Achievement Award, Honorable Mention, 1999.

Selected Recent Publications:
Campbell, Daniel E. 2002. Emergy analysis of the prehistoric global nitrogen cycle. Proceedings of the 2nd Biennial Emergy Analysis Research Conference, Center for Environmental Policy, University of Florida, Gainesville, FL, in press.
Campbell, Daniel E. 2001. An energy systems analysis of constraints on economic development. In Advances in Energy Studies, Exploring Supplies, Constraints, and Strategies, Porto Venere, Italy, May 25-27, 2000. S. Ulgiati, M.T. Brown, M., Giampetro, R. Herendeen, and K. Mayumi, (eds), Servizi Grafiei Editoriali, Padova, Italy, pp. 175-187.
Campbell, D.E. 2001. Proposal for including what is valuable to ecosystems in environmental assessments. Environmental Science and Technology 35: 2867-2873.
Campbell, D.E. 2000. Using energy systems theory to define, measure, and interpret ecological integrity and ecosystem health. Ecosystem Health 6(3): 181-204.
Campbell, D.E. 1998. Emergy analysis of human carrying capacity and regional sustainability: An example using the State of Maine. Environmental Monitoring and Assessment 51: 531-569.

MARK G. CANTWELL
Environmental Scientist
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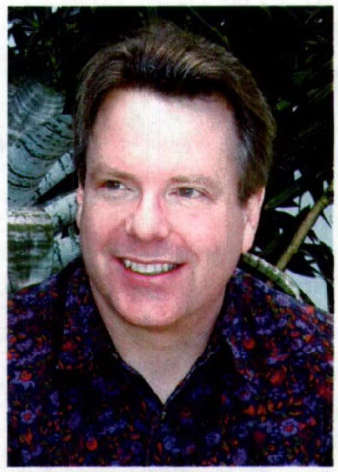

Technical Certificate, Air and Water Pollution Control Technology, SUNY, Liberty, NY, 1977
B.A., Environmental Science, SUNY, Plattsburgh, NY, 1980
M.S., Oceanography. Graduate School of Oceanography, University of Rhode Island, Kingston, RI, 2000
Ph.D. Candidate, Oceanography, Graduate School of Oceanography, University of Rhode Island, Kingston, RI, 2002

Employment:

1997-present	Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Physical Science Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Director, Technical Services Division, Koehler Instrument Co., Bohemia, N.Y.
1988-1993	Manager, Applications Engineering Department, Koehler Instrument Co., Bohemia, N.Y.
1983-1988	Chemist/Applications Engineer, Koehler Instrument Co., Bohemia, N.Y.
1980-1983	Environmental Scientist, Princeton Aqua Sciences, New Brunswick, N.J.

Research Expertise and Skills Relative to Agency Needs:
As an environmental scientist at AED, Mark has studied the distribution and biogeochemical cycling of contaminants and nutrients in marine systems. Current research is focusing on developing diagnostic methods and tools for assessing impairment in waters. Other research includes evaluating how physical and chemical disequilibria affects the bioavailability of contaminants and other stressors by measuring the ecological effects to benthic and pelagic communities.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry
Member American Chemical Society
Reviewer, Environmental Science and Technology

Selected Recent Publications:
Ho, K.T., R.M. Burgess, M.C. Pelletier, J.R. Serbst, S.A. Ryba, M.G. Cantwell, A. Kuhn, and P. Raczelowski. 2002. An overview of toxicant identification in sediments and dredged materials. Marine Pollution Bulletin. 44: 286-293.

Cantwell, M.G. and R.M. Burgess. 2001. Interactions of metals and colloidal organic carbon in interstitial waters of marine mediments: influences of salinity, pH and colloidal organic carbon concentration. Environmental Toxicology and Chemistry 20: 2420-2427.

Pelletier, M.C., K.T. Ho, M.G. Cantwell, A. Kuhn-Hines, S. Jayaraman, and R.M. Burgess. 2001. Use of *Ulva lactuca* to identify ammonia toxicity in marine and estuarine sediments. Environmental Toxicology and Chemistry 12: 2852-2859

Burgess, R. M., S.A. Ryba, M.G. Cantwell, and J.L. Gundersen. 2001. Exploratory analysis of the effects of particulate characteristics on the variation in partitioning of nonpolar organic contaminants to marine sediments. Water Research 35: 4390-4404.

Burgess, R. M., S.A. Ryba, and M.G. Cantwell. 2000. Variation of K_{oc} in surface sediment from Narragansett Bay and Long Island Sound: (1) importance of organic carbon quantity. Toxicological and Environmental Chemistry 77: 9-29.

Burgess, R.M., M.G. Cantwell, M.C. Pelletier, K.T. Ho, A. Kuhn, and H. Cook. 2000. A toxicity identification evaluation (TIE) procedure for characterizing metal toxicity in marine sediments. Environmental Toxicology and Chemistry 19: 982-991.

Pelletier, M.C., R.M. Burgess, M.G. Cantwell, J.R. Serbst, K.T. Ho, and S.A. Ryba. 2000. Importance of maternal transfer from benthic adults on occurrence of photo-enhanced toxicity in pelagic larvae. Environmental Toxicology and Chemistry 19: 2691-2698.

JOHN A. CARDIN
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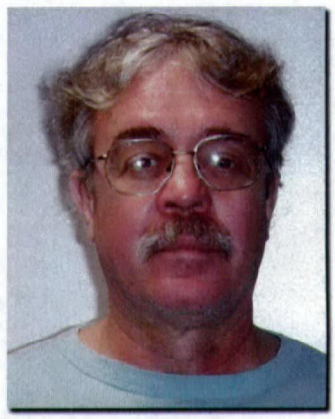

B.S., Microbiology, University of Rhode Island, Kingston, RI 1970

Employment:

1969 -present Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

John is a marine biologist with experience in developing benthic indicators of the ecological state of estuaries, conducting microcosm simulation of estuaries, and studying the structure of zooplankton communities.

Selected Appointments/Honors/Major Awards:

U.S. EPA Science and Technology Achievement Award, 2000

Selected Publications:

Davey, E.W., K.T. Perez, J.A. Cardin, R.L. Johnson, and K.J. Rocha. Application of 3D computer-aided tomography to the quantitative differentiation of marine benthic habitats. in preparation.

Johnson, R.L., K.T. Perez, E.W. Davey, J.A. Cardin, K.J. Rocha, E.H. Dettmann, and J.F. Heltshe. Discriminating the effects of anthropogenic point sources from salinity and nitrogen loading using benthic communities: a comparative estuarine approach. in preparation.

Perez, K.T, E.W. Davey, R.H. Moore, P.R. Burn, M.S. Rosol, J.A. Cardin, R.L. Johnson, and D.N. Kopans. 1999. Application of computer-aided tomography (CT) to the study of estuarine benthic communities. Ecological Applications 9(3): 1050-1058.

Perez, K.T., E.W. Davey, G.E. Morrison, J.A. Cardin, N.F. Lackie, A.E. Soper, R.J. Blasco, R.L. Johnson, and S. Marino. 1990. Science of organic matter and industrial contaminants in sewage effluents on marine ecosystems. Environmental Protection Agency internal report. February 1990.

Perez, K.T., E.W. Davey, J. Heltshe, J.A. Cardin, N.F. Lackie, R.L. Johnson, R.J. Blasco, A.E. Soper, and E. Read. 1990. Recovery of Narragansett Bay, RI: A Feasibility Study. Environmental Protection Agency internal report for Office of Marine and Estuarine Protection. March 1990.

Miller, D.C., S. Poucher, J.A. Cardin, and D. Hansen. 1990. The acute and chronic toxicity of ammonia to marine fish and a mysid. Archives of Environmental Contamination and Toxicology 19: 40-48.

DENISE M. CHAMPLIN
Biologist
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B.S., Natural Resource Development, University of Rhode Island, Kingston, RI, 1972

Employment:

1995-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1989-1995	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI
1987-1989	Biologist, University of Rhode Island, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Denise is a biologist with extensive experience in aquatic toxicology. Her current interests are in aquatic toxicology and wetland ecology.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry
U.S. EPA Science and Technology Achievement Awards, 2000 and 2001

Selected Recent Publications:

Kuhn, A. , W.R. Munns, Jr., D. Champlin, R. McKinney, M. Tagliabue, T. Gleason, and J. Serbst. 2001. Evaluation of the efficacy of extrapolation population modeling to predict the dynamics of *Americamysis bahia* populations in the laboratory. Environmental Toxicology and Chemistry 20 (1): 213-221.

Kuhn, A., W.R. Munns, Jr., S. Poucher, D. Champlin, and S. Lussier. 2000. Prediction of population-level response from mysid toxicity test data using population modeling techniques. Environmental Toxicology and Chemistry 19(9): 2364-2371.

Spehar, R.L., S. Poucher, L. T. Brooke, D.J. Hansen, D. Champlin, and D.A. Cox. 1999. Comparative toxicity of fluoranthene to freshwater and saltwater species under fluorescent and ultraviolet light. Environmental Contamination and Toxicology 37: 496-502.

Nacci, D., L. Coiro, D. Champlin, S. Jayaraman, R. McKinney, T. Gleason, W.R. Munns, Jr., J. Specker, and K. Cooper. 1999. Adaptation of wild fish populations to persistent environmental contaminants. Marine Biology 134: 9-17.

MARNITA M. CHINTALA
Research Biologist
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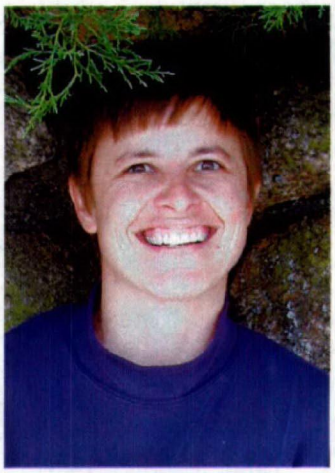

B.A., Biological Sciences, University of Delaware, Newark, DE, 1984
M.S., Marine-Estuarine-Environmental-Sciences, University of Maryland, College Park, MD, 1987
M.S., Ecology and Evolution, Rutgers University, New Brunswick, NJ, 1997

Employment:

1997-present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1994-1997	Senior Laboratory Technician, Haskin Shellfish Research Laboratory, Rutgers University, Port Norris, NJ
1993-1994	Graduate Research Assistant, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ
1992-1993	Teaching Assistant, Biology Department, Rutgers University, New Brunswick, NJ
1991-1992	Graduate Research Assistant, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ
1987-1991	Faculty Research Assistant, Horn Point Environmental Laboratory, University of Maryland System, Cambridge, MD

Research Expertise and Skills Relative to Agency Needs:
Marty is a marine ecologist with expertise in population and community ecology of invertebrates and fish, and parasitic interactions of shellfish. She has worked in a variety of habitats including marshes, estuarine coves and deeper offshore waters.

Selected Appointments/Honors/Major Awards:
U.S. EPA On-The-Spot Award, 2000
U.S. EPA S-Award, 2000
U.S. EPA On-The-Spot Award, Mentoring, 2000
U.S. EPA Quality Step Increase, 1998 and 1999
Member of Estuarine Research Federation and the New England Estuarine Research Society
Member of National Shellfisheries Association, Member of the Student Endowment and Awards Committee
Equal Employment Opportunity Chairperson, Atlantic Ecology Division
Violence in the Workplace Program Coordinator, Atlantic Ecology Division

Selected Recent Publications:
Thursby, G., M.M. Chintala, D. Stetson, C. Wigand, and D. Champlin. 2002. A rapid nondestructive method for estimating aboveground biomass of salt marsh grasses. Wetlands. in press.
Chintala, M.M., D. Bushek, and S.E. Ford. 2002. Comparison of in vitro cultured and natural *Perkinsus marinus*. I. Dosing methods and host response. Diseases of Aquatic Organisms. in press.
Ford, S.E., M.M. Chintala, and D. Bushek. 2002. Comparison of in vitro cultured and natural *Perkinsus marinus*. II. Pathogen virulence. Diseases of Aquatic Organisms. in press.
Bushek, D., S.E. Ford, and M.M. Chintala. 2002. Comparison of in vitro cultured and natural *Perkinsus marinus*. III. Fecal elimination and its role in transmission. Diseases of Aquatic Organism. in press.
Chintala, M.M. and J.P. Grassle. 2001. Recruitment frequency and growth in Atlantic surfclams, *Spisula solidissima* (Dillwyn, 1819), in inshore New Jersey waters. J. Shellfish Res. 20 (3): 1177-1186.
Wigand, C., R. Comeleo, R. McKinney, G. Thursby, M. Chintala, and M. Charpentier. 2001. Outline of a new approach to evaluate ecological integrity of salt marshes. Human and Ecological Risk Assessment: Vol. 7(5): 1541-1554.

GIANCARLO CICCHETTI
Ecologist
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B.A., Biological Science, Harvard University, Cambridge, MA, 1986
Ph.D., Biological Oceanography, School of Marine Sciences, The College of William and Mary, Williamsburg, VA, 1998

Employment:

2002-present	Ecologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1998-2002	Post-Doctoral Fellow, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1998	Monitoring Coordinator, Chesapeake Bay National Estuarine Research Reserve in Virginia, Virginia Institute of Marine Science, Gloucester Point VA
1987-1993	High School Science Teacher, Noble High School, Berwick ME
1986-1987	Aquaculturist, Sea Farms West, Carlsbad CA

Research Expertise and Skills Relative to Agency Needs:
Giancarlo is a marine ecologist with experience developing quantitative methods for field sampling of various ecosystem components including fishes, decapods, infauna, vegetation, sediment, and water quality. His primary interest is advancing empirical load-response models at larger scales. His recent work has focused on use of underwater imaging in conjunction with capture sampling to assess ecological responses to habitat alteration and nutrient pollution.

Selected Appointments/Honors/Major Awards:
U.S. EPA Quality Step Increase, 2001
Member, Estuarine Research Federation and New England Estuarine Research Society
Reviewer for Estuarine Research Federation-sponsored Dissertations Symposium for the Advancement of Coastal, Estuarine, and Great Lakes Research (2002)
Thesis Committee Member for Masters Student, The College of William and Mary, School of Marine Science, Virginia Institute of Marine Science (2000-2002)
Yearbook Dedication, Noble High School Class of 1990, Berwick, ME

Selected Recent Publications:
U.S. EPA. 2001. Aquatic stressors implementation plan for habitat alteration research, draft. Lead author for section "Shoreline, lake, and estuary scale habitat research." U.S. EPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Research Triangle Park, NC.

Cicchetti, G. and R. J. Diaz. 2000. Types of salt marsh edge and export of trophic energy from marshes to deeper habitats. In Concepts and Controversies in Tidal Marsh Ecology, M. P. Weinstein and D. A. Kreeger, eds. Kluwer Academic Publications, Dordrecht, The Netherlands.

Bartholomew, A., R. J. Diaz, and G. Cicchetti. 2000. New dimensionless indices of structural habitat complexity: Predicted and actual effects on a predator's foraging success. Marine Ecology Progress Series 206: 45-58.

Cicchetti, G. 1998. The importance of edge in creation and management of salt marshes for commercially valuable marine transient species. Minding the Coast: It's Everybody's Business, M. P. Lynch, ed. Proceedings of the 16th International Conference of the Coastal Society, Alexandria VA.

DONALD J. COBB
Physical Scientist
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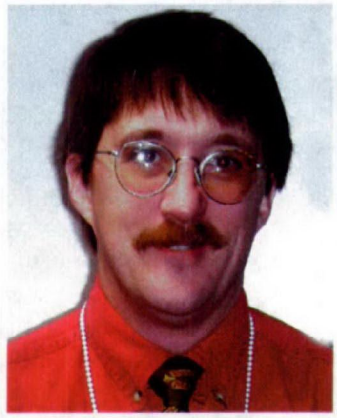

B.S., Chemistry, Southampton College of Long Island University, 1980
B.S., Marine Science, Southampton College of Long Island University, 1980

Employment:

2000-present	Physical Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-2000	Chemist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Laboratory Manager, Northeast Laboratory Services, Inc., Waterville, ME
1988-1993	Senior Chemist/Work Assignment Manager, Science Applications International Corporation (SAIC), Narragansett, RI
1986-1988	Officer, United States Navy, Newport, RI
1983-1986	Researcher, Battelle New England Marine Research Laboratory, Duxbury, MA
1980-1983	Marine Chemistry Technician, Energy Resources Company, Inc., Cambridge, MA

Research Expertise and Skills Relative to Agency Needs:

Don is a marine chemist with experience in environmental monitoring programs, including sampling design, ecological indicator development and selection, conduct of sample collection, project management, and data assessment. Additionally, he has considerable experience in the analysis of marine sediment and tissue samples for organic and metal contaminants.

Selected Appointments/Honors/Major Awards:

U.S. EPA Office of Research and Development Statesmanship Award, 2002
U.S. EPA Bronze Metal for Coastal 2000 Planning and Execution, Office of Research and Development, 2001
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Office of Research and Development, 1999

Selected Recent Publications:

Paul, J.F., J.A. Kiddon, C.J. Strobel, B.D. Melzian, J.S. Latimer, D.J. Cobb, D.E. Campbell and B.S. Brown. 2000. Condition of the Mid-Atlantic estuaries: production of a state of the environment report. Environmental Monitoring and Assessment 63: 115-129.

Paul, J.F., B.D. Melzian, B.S. Brown, C.J. Strobel, J.A. Kiddon, J.S. Latimer, D.E. Campbell and D.J. Cobb. 1999. MAIA project summary: condition of the Mid-Atlantic estuaries. 600/SR-98/147, US EPA Office of Research and Development, Washington, DC, December 1999, 6 pp.

USEPA. 1998. Condition of the Mid-Atlantic estuaries. United States Environmental Protection Agency, Office of Research Development, Narragansett, RI, 50 pp.

Paul, J.F., C.J. Strobel, B.D. Melzian, J.A. Kiddon, J.S. Latimer, D.E. Campbell and D.J. Cobb. 1998. State of the estuaries in the Mid-Atlantic region of the United States. Environmental Monitoring and Assessment 51: 269-284.

LAURA L. COIRO
Biologist
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B.A., Zoology, University of Rhode Island, Kingston, RI, 1988

Employment:

1997-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Biological Sciences Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1990-1995	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI
1989-1990	Biological Technician, Brown University-Psychology Department, Providence, RI

Research Expertise and Skills Relative to Agency Needs:

Laura is a biologist with expertise in water quality criteria development, with special emphasis on dissolved oxygen requirements of marine species. She was a primary reseacher in the development of the Salt Water Dissolved Oxygen Criteria for the Virginian Province, and is currently involved in the expansion of the Dissolved Oxygen Criteria program, the efforts of which will be used to expand the regional criteria developed for the Virginian Province to encompass the Gulf and Pacific Coasts as well.

Laura is also involved in research efforts geared at the examination of import environmental stressors including the impact of endocrine disruptors, contaminated sediments and dioxin-like compounds on the environment and aquatic wildlife. Laura was one of the primary researchers involved in the development of a novel non-destructive *in ovo* assay for the assessment of exposure and genetic adaptation to dioxin-like contaminants.

Selected Appointments/Honors/Major Awards:

U.S. EPA Special Act Award, 1997
U.S. EPA Science and Technology Achievement Awards, 1999
U.S. EPA Special Accomplishment Award, 2000
U.S. EPA Science and Technology Achievement Awards, 2000
U.S. EPA Bronze Medal for Innovation in Water Quality Criteria for the Protection of Aquatic Life: Saltwater Dissolved Oxygen, 2002

Selected Recent Publications:

Miller, D.C., S. Poucher, and L. Coiro. 2002. Determination of lethal dissolved oxygen levels for selected marine and estuarine fishes, crustaceans, and a bivalve. Marine Biology 140: 287-296.

Thursby, G., D.C. Miller, S. Poucher, L. Coiro, W. Munns, Jr., and T. Gleason. 2000. Ambient aquatic life water quality criteria for dissolved oxygen (saltwater): Cape Cod to Cape Hatteras. EPA 822-R-00-012, US EPA, Office of Water, Washington, DC

Coiro, L., S. Poucher, and D. Miller. 2002. Hypoxic effects on growth of *Palaemonetes vulgaris* larvae: using constant exposure data to estimate cyclic exposure response. Journal of Experimental Marine Biology and Ecology 247: 243-255.

Nacci, D., L. Coiro, D. Champlin, S. Jayaraman, R. McKinney, T. Gleason, W. Munns, Jr., J. Specker, and K. Cooper. 1999. Adaptations of wild populations of the estuarine rish *Fundulus heteroclitus* to persistent environmental contaminants. Marine Biology 134: 9-17.

Nacci, D., L. Coiro, A. Kuhn, D. Champlin, W. Munns, Jr., J. Specker, and K. Cooper. 1998. A nondestructive indicator of EROD activity in embryonic fish. Environmental Toxicology and Chemistry 17(12): 2481-2486.

EARL WALTER DAVEY
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B.S., Analytical Biology, University of California at Santa Barbara, 1962
M.S., Biological Oceanography, Oregon State University, 1964
Ph.D., Biological/Chemical Oceanography, Oregon State University, 1970

Employment:

1967-present	Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Earl is a research aquatic biologist with expertise in marine ecosystems, watersheds, microcosms, analytical chemistry, and computer-aided tomography.

Selected Appointments/Honors/Major Awards:
U.S. EPA Science and Technology Achievement Awards, 1992 and 2002

Selected Recent Publications:

Davey, E.W., K.T. Perez, J.A. Cardin, R.L. Johnson, and K.J. Rocha. Application of 3D computer-aided tomography to the quantitative differentiation of marine benthic habitats. in preparation.

Johnson, R.L., K.T. Perez, E.W. Davey, J.A. Cardin, and K.J. Rocha. Discriminating the effects of anthropogenic point sources from salinity and nitrogen loading using benthic communities: A comparative estuarine method. in preparation.

Perez, K.T., E.W. Davey, R.H. Moore, P.R. Burn, M.S. Rosol, J.A. Cardin, R.L. Johnson, and D.N. Kopans. 1999. Application of computer-aided tomography to the study of estuarine benthic communities. Ecol. Appl. 9(3): 1050-1058.

Davey, E.W., K.T. Perez, A.E. Soper, N.F. Lackie, G.E. Morrison, R.L. Johnson, and J.F. Heltshe. 1990. Significance of the surface microlayer to the environmental fate of di(2-ethyexyl)phthalate predicted from marine microcosms. Marine Chemistry 31: 231-269.

EDWARD H. DETTMANN
Research Environmental Scientist
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B.S., Physics, Tufts University, Medford, MA, 1962
M.S., Physics, University of Wisconsin, Madison, WI, 1964
Ph.D., Physics, University of Wisconsin, Madison, WI, 1971

Employment:

1986-present	Research Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S .EPA, Narragansett, RI
1982-1986	Chief, Ecology and Environment, Inc., Buffalo, NY
1975-1981	Scientist/Assistant Scientist, Argonne National Laboratory, Argonne, IL
1970-1975	Research and Project Associate, Institute for Environmental Sciences, University of Wisconsin, Madison, WI

Research Expertise and Skills Relative to Agency Needs:
Ed has expertise in analysis and modeling of water quality in marine and freshwater systems. The current focus of his research is eutrophication in estuaries and other coastal waters, and the physical and other factors that determine the sensitivity of these systems to nutrient loading.

Selected Memberships & Appointments:
Member, Estuarine Research Federation and New England Estuarine Research Society
Technical Oversight/Review/Advisory Committees:
Department of Interior CERCLA Type A Damage Assessment Model (1986–1989);
Siting of Massachusetts Water Resources Authority POTW Outfall (1987– 1988);
New Bedford POTW outfall (1987–1990);
Nutrient Criteria Technical Guidance Manual for Estuarine and Coastal Marine Waters (2000–2002);
NHEERL Nutrient Research/Aquatic Stressors Program (2000-present)
Region I Technical Advisory Group for Nutrient Criteria in Estuaries and Coastal Marine Waters (2000-present).

Selected Publications:
Dettmann, E.H. 2001. Effect of water residence time on annual export and denitrification of nitrogen in estuaries: a model analysis. Estuaries 24(4): 481–490.

Dettmann, E.H. 2001. Additional information on flushing in estuaries. Appendix C in nutrient criteria technical guidance manual: estuarine and marine waters. Report No. EPA-822-B-01-003, U.S. Environmental Protection Agency, Office of Water, Washington D.C.

Barrera, J., R. Cantilli, I. Davis, E. Dettmann, J. Fisher, D. Flemer, T. Gardner, G. Gibson, D. Hart, J. Latimer, S. Libby, G. Smith, C. Siciliano, and J. Word. 2001. Nutrient criteria technical guidance manual: estuarine and coastal marine waters. Guidance Manual No. EPA-822-B-01-003, U.S. Environmental Protection Agency, Office of Water, Washington DC.

Walker, H.A., J.S. Latimer, E.H. Dettmann. 2000. Assessing the effects of natural and anthropogenic stressors in the Potomac estuary: implications for long-term monitoring. Environmental Monitoring and Assessment 63: 237-251.

Dettmann, E.H., and M.A. Abdelrhman. 1997. Modeling short-term behavior of dredged material disposed in very shallow and very deep coastal waters. Proceedings of USEPA Workshop on Next Generation Environmental Models and Computational Methods (NGEMCOM), Philadelphia. Society for Industrial and Applied Mathematics, pp. 109-115.

Abdelrhman, M.A. and E.H. Dettmann. 1997. Two-dimensional modeling of current circulation and contamination transport in surface waters. Proceedings of USEPA Workshop on Next Generation Environmental Models and Computational Methods (NGEMCOM) Philadelphia. Society for Industrial and Applied Mathematics, pp. 117-123.

WALTER B. GALLOWAY
Senior Environmental Scientist
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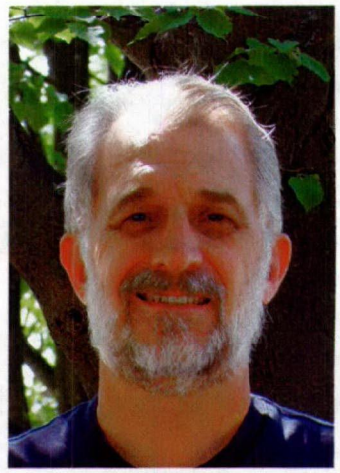

B.A., Chemistry, Oberlin College, Oberlin, OH,1969
M.S., Geochemistry, Brown University, Providence, RI, 1973

Employment:

1997-present	Senior Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1994-1997	Senior Environmental Scientist, Characterization Research Division, National Exposure Research Laboratory, ORD, U. S. EPA, Las Vegas, NV
1991-1994	Director, Office of Program Management, Environmental Monitoring Systems Laboratory, Office of Modeling, Monitoring Systems and Quality Assurance, ORD, U. S. EPA, Las Vegas, NV
1988-1991	Environmental Scientist, Environmental Monitoring Systems Laboratory, Office of Modeling, Monitoring Systems and Quality Assurance, ORD, U. S. EPA, Las Vegas, NV
1987-1988	Acting Branch Chief, Environmental Chemistry Branch, Environmental Research Laboratory, Office of Environmental Processes and Effects Research, ORD, U. S. EPA, Narragansett, RI
1974-1987	Environmental Scientist/Chemist, Environmental Research Laboratory, Office of Environmental Processes and Effects Research, ORD, U. S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

Walt has been involved in environmental research, and various forms of training, facilitation, and organization development. He has worked as a chemist, environmental scientist, facilitator, change agent, and manager. His most recent work has focused on working with local governments, citizens, and fellow research scientists to identify how to truly succeed in Community Based Environmental Protection.

Selected Appointments/Honors/Major Awards:

Member, Association for Quality and Participation
Member and Lead Facilitator, ORD Human Resources Council
U.S. EPA New England Region 1 October, 1998 Employee of the Month as a member of the EPA-New England Rhode Island State Unit and the Urban Environmental Initiative
U.S. EPA Bronze Medal for Exceptional/Outstanding ORD Technical Assistance to the Regions or Programs Offices as part of the ORD Ecological Survey Design Team, 2001
U.S. EPA Bronze Medal as a member of the ORD Organization Development Team, 2002
U.S. EPA ORD Statesmanship Award as a member of the Northeast National Coastal Assessment Team, 2002

Selected Recent Publications:

Lussier, S.M., H.A. Walker, G.G. Pesch, W.B. Galloway, R. Adler, M.A. Charpentier, R.L. Comeleo and J.L. Copeland. 2001. Strategies for protecting and restoring Rhode Island's watersheds on multiple scales. Human and Ecological Risk Assessment 7(5): 1483-1491.

Bradley, M.P., B.S. Brown, S.S. Hale, F.W. Kutz, R.B. Landy, R. Shedlock, A. Morris, W.B. Galloway, J.S. Rosen, R. Pepino and B. Wiersma. 2000. Summary of the MAIA working conference. Environmental Monitoring and Assessment 63: 15-29.

Galloway, W.B., G.G. Pesch, W.K. Smith, P.J. Morneault and W.W. Barchard. 2000. What's the C in CBEP? Proceedings of the 6th Annual National Watershed Coalition Conference "Getting the Job Done at the Ground Level (Supporting Local Decision Making), Austin, TX, May 16-19, 1999, July 2000, pp. 203-216.

Campbell, D.E., W.B. Galloway and G.G. Pesch. 1998. Appreciative inquiry: a mechanism for maximizing empower in social systems. Proceedings of the 42nd Annual Meeting of the International Society For Systems Sciences, Atlanta, GA, July 19-23 1988. J.K. Allen and J. Wilby, (eds). Paper 3107.

JONATHAN H. GARBER
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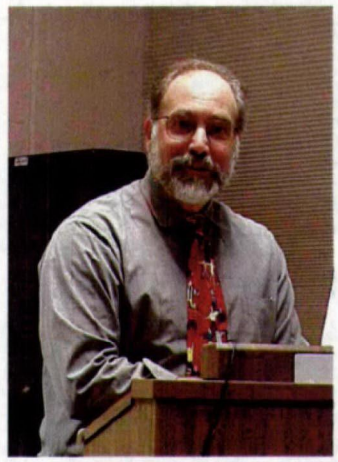

A.B., Biological Science and Science Teaching, Rutgers–The State University, New Brunswick, NJ, 1971
Ph.D., Oceanography, University of Rhode Island, Kingston, RI, 1982

Employment:

2001-present	Director, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
2000-2001	Acting Director, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1997-2000	Research Aquatic Biologist, Special Assistant to the Director, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Chief, Ecosystems Branch, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1989-1995	Chief, Ecosystems Branch, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1986-1989	Research Associate/Senior Research Associate/Associate Research Scientist, Chesapeake Biological Laboratory, University of Maryland, Solomons, MD
1982-1989	Assistant Professor, College of Oceanography, Oregon State University, Corvallis, OR
1981-1982	Postdoctoral Research Fellow, Weizmann Institute of Science, Rehovot, Israel.

Research Expertise and Skills Relative to Agency Needs:
Jonathan is a coastal marine ecologist whose expertise in nutrient dynamics and stable isotope geochemistry has been applied toward developing quantitative and historical methods to monitor and assess risks to coastal systems posed by nutrient pollution and guide the development of the Agency's strategy for nutrient pollution research.

Selected Appointments/Honors/Major Awards:
Co-Chair Technical Qualifications Board, National Health and Environmental Effects Research Laboratory
Member Estuarine Research Federation
Reviewer for Estuaries
Chairman 14th International Conference of the Estuarine Research Federation
Consultant to the Tanzania Coastal Management Partnership, Coastal Resources Center, University of Rhode Island

Selected Recent Publications:
Pesch, C.E. and J.H. Garber. 2001. Historical analysis: a valuable tool in community-based environmental protection. Marine Pollution Bulletin 42(5):339-349.

Voyer, R.A., C.E. Pesch, J.H. Garber, J.L. Copeland and R. Comeleo. 2000. New Bedford Harbor, Massachusetts: a story of urbanization and ecological connections. Environmental History 5(3):354-377.

Stahl, R.G., J. Orme-Zavelata, K. Austin, W.J. Berry, J.R. Clark, S. Cormier, W. Fisher, J.H. Garber, R. Hoke, L.E. Jackson, G.L. Kreamer, C. Muska and M.E. Sierszen. 2000. Ecological indicators in risk assessment: workshop summary. Human and Ecological Risk Assessment 6(4):671-677.

Nixon, S.W., J.W. Ammerman, P. Atkinson, W.M. Berounsky, G. Billen, W.C. Boicourt, W.R. Boynton, T.M. Church, D.M. DiToro, R. Elmgren, J.H. Garber, A.E. Giblin, R.A. Jahnke, N.J.P. Owens, M.E.Q. Pilson, and S.P. Seitzinger. 1996. The fate of nitrogen and phosphorus at the land-sea margin of the North Atlantic Ocean. Biogeochemistry 35(1): 141-180.

Boynton, W.R., J.H.Garber, R.Summers, and W.M. Kemp. 1995. Inputs, transformations, and transport of nitrogen and phosphorus in Chesapeake Bay and selected tributaries. Estuaries 18(1B): 285-314.

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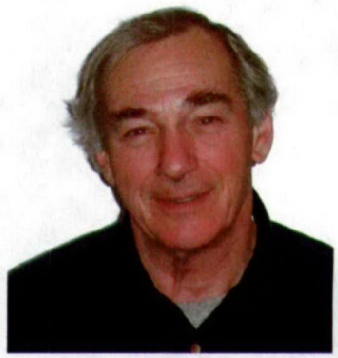

B.S., Forestry, University of Idaho, Idaho, 1962
Graduate School, Fisheries; Michigan State University,1963
Graduate School, Fisheries; Pathology Dept., University of Rhode Island, 1974

Employment:

1966-present Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

George is a research aquatic biologist with expertise in fish and shellfish histopathology; toxicologic methods development; issues of environmental and public health; ecological epidemiology

Selected Appointments/Honors/Major Awards:

Member Society for Invertebrate Pathology
Adjunct Associate Professor, University of Puerto Rico, Department of Marine Science, Mayaguez, PR
U.S. EPA Bronze Medal for 301(h) National Task Force,1982.
U.S. EPA Bronze Medal for Quincy Bay, Boston Harbor Study, 1988
U.S. EPA Science and Technology Achievement Award, 1989

Selected Recent Publications:

Johnson, K.A., G.M. Calliet, M. Stephenson, and G. Gardner. 1997. Frequency and determination of external lesions in Dover sole (*Microstomus pacifica*) and English sole (*Pleuronectes vetulus*) in Monterey Bay, CA. Southern Monterey Bay Continental Shelf Investigations: Former Fort Ord Restricted Area, US Dept of Interior, US Geological Survey, 1997, Open File Report 97-450, pp 104-113. Contribution No. AED-98-1962.

Zaroogian, G.E., G. Gardner, D.J. Borsay Horowitz, R.E. Gutjahr-Gobell, R.J. Haebler, and L.J. Mills. 2001. Effect of 17beta-estradiol, o,p'-DDT, octylphenol and p,p'-DDE on gonadal development and liver and kidney pathology in juvenile male summer flounder (*Paralichthys dentatus*). Aquatic Toxicology 54(1-2): 01-112. Contribution No. AED-99-2168.

Rhodes, L.D., G.R. Gardner, and R.J. Van Beneden. 1997. Short-term tissue distribution, depuration and possible gene expression effects of [3H]TCDD exposure in soft-shell clams (*Mya arenaria*). Environmental Toxicology and Chemistry 16(9): 1888-1894. 600/J-98/003, Contribution No. 1826.

VanBeneden, R.J., L.D. Rhodes, and G.R. Gardner. 1998. Studies of the molecular basis of gonadal tumors in the marine bivalve, *Mya arenaria*. Marine Environmental Research 46(1-5): 209-213. 600/J-98/396, Contribution No.1957.

VanBeneden, R.J., L.D. Rhodes, and G.R. Gardner. 2000. Potential alterations in gene expression associated with carcinogen exposure in *Mya arenaria*. Biomarkers 4(6): 485-491. Contribution No. 2045.

Folmar, L.C., G.R. Gardner, M.P. Schreibman, L. Magliulo-Cepriano, L.J. Mills, G.E. Zaroogian, R.E. Gutjahr-Gobell, R.J. Haebler, D.B. Horowitz, and N.D. Denslow. 2001. Vitellogenin-induced pathology in male summer flounder (*Paralichthys dentatus*). Aquatic Toxicology 51:431-441 Contribution No. AED-00-078.

Mills, L.J., R.E. Gutjahr-Gobell, R.J. Haebler, D.J. Borsay Horowitz, S. Jayaraman, R.J. Pruell, R.A. McKinney, G.R. Gardner, and G.E. Zaroogian. 2001. Effects of estrogenic (o,p'-DDT;octylphenol) and enti-androgenic (p,p'-DDE) chemicals on indicators of endocrine status in juvenile male summer flounder *(Paralichthys dentatus*). Aquatic Toxicology 52: 157-176 Contribution No. AED-99-2074.

TIMOTHY R. GLEASON
Acting Supervisory Research Biologist
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B.S., Biology, Bates College, Lewiston, ME, 1983
M.S., Fisheries, Aquaculture and Pathology, University of Rhode Island, Kingston, RI, 1988
Ph.D., Biological Sciences, University of Rhode Island, Kingston, RI, 1995

Employment:

2000-present	Supervisory Research Research Biologist (acting), Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
2001-2002	Assistant Laboratory Director, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Research Triangle Park, North Carolina (9 month temporary assignment)
1995-2000	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Tim is a biologist with expertise in developing and applying quantitative methods to support ecological risk assessment, including development and application of population models.

Selected Appointments/Honors/Major Awards:
Adjunct Assistant Professor, Department of Fisheries, Animal and Veterinary Sciences, University of Rhode Island, Kingston, RI.
Bronze Medal - U.S. EPA, Office of Water, Innovation in Water Quality Criteria for the Protection of Aquatic Life 2002
U.S. EPA Science and Technology Achievement Award 2001.
Invited speaker: Indicators in Health and Ecological Risk Assessment, NHEERL Symposium, 2000.
Invited speaker: Challenges in Applied Population Biology, Association of Applied Biologists, 1999.
Member: American Fisheries Society, Ecological Society of America, Society for Conservation Biology, AAAS
Reviewer, Environmental Toxicology and Chemistry, Journal of Experimental Marine Biology and Ecology, North American Journal of Fisheries Management, Fishery Bulletin, Marine Ecology Progress Series.

Selected Recent Publications:
Nacci, D., T. Gleason, and W.R. Munns, Jr. 2002. Evolutionary and ecological effects of multi-generational exposures to anthropogenic stressors. Human and Ecological Risk Assessment 8(1): 91-97.
Gleason, T.R., and D.E. Nacci. 2001. Risks of endocrine-disrupting compounds to wildlife: extrapolating from effects on individuals to population response. Human and Ecological Risk Assessment 7(5): 1027-1042.
Nacci, D., T.R. Gleason, R. Gutjahr-Gobell, M. Huber, and W.R. Munns, Jr. 2001. Effects of environmental stressors on wildlife populations. In Coastal and Estuarine Risk Assessment: Risk on the Edge. M.C. Newman (ed.). CRC Press/Lewis Publishers, Washington, DC, pp. 247-272.
Pechenik, J.A., T.R. Gleason, D. Daniels, and D. Champlin. 2001. Influence of larval exposure to salinity and cadmium stress on juvenile performance of two marine invertebrates (*Capitella* sp. I and *Crepidula fornicata*). Journal of Experimental Marine Biology and Ecology 264: 101-114.
Gleason, T.R., Munns, W.R., Jr., and D.E. Nacci. 2000. Projecting population-level response of purple sea urchins to lead contamination for an estuarine ecological risk assessment. Journal of Aquatic Ecosystem Stress and Recovery 7(3): 177-185.
Gleason, T.R., W.R. Munns, Jr., and D.E. Nacci. 1999. Influence of model time step on the relative sensitivity of population growth rate to survival, growth and reproduction. In Challenges in Applied Population Biology, July 8-9, 1999, Royal Holloway, University of London, produced by the Association of Applied Biologists, M.B. Thomas and T. Kedwards (eds.). Aspects in Applied Biology 53: 253-260.
Nacci, D., L. Coiro, D. Champlin, S. Jayaraman, R. McKinney, T. Gleason, W.R. Munns, Jr., J. Specker, and K. Cooper. 1999. Adaptation of wild fish populations to dioxin-like environmental contamination. Marine Biology 134: 9-17.

RUTH E. GUTJAHR-GOBELL
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B.S., Marine Biology and Chemistry, Roger Williams University, Bristol, RI, 1980

Employment:

1997-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Biological Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1986-1995	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI
1985-1986	Physical Science Technician, National Marine Fisheries Service, Narragansett, RI
1982-1985	Research Assistant, New England Aquarium, On-site grant at the U.S. EPA, Narragansett, RI
1981-1982	Research Assistant, Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA
1980-1981	Research Assistant, National Marine Fisheries Service, Woods Hole, MA

Research Expertise and Skills Relative to Agency Needs:

Ruth is a marine biologist with expertise in developing and applying quantitative methods for ecotoxicological testing with marine organisms, endocrine disrupting chemical exposure and effects on marine fish, establishing links between indicators of exposure and reproductive success in marine organisms and modeling population dynamics.

Selected Appointments/Honors/Major Awards:

Member - Society of Environmental Toxicology and Chemistry
Member - North Atlantic Chapter / Society of Environmental Toxicology and Chemistry
Reviewer - Environmental Toxicology and Chemistry
U.S. EPA Superior Accomplishment Recognition Awards, 1997, 1999, 2000 and 2001

Selected Recent Publications:

Mills, L.J., R.E. Gutjahr-Gobell, D.J. Borsay Horowitz, M Chow, N. Denslow, and G.E. Zaroogian. 2002. Relationship between reproductive success and male plasma vitellogenin levels in cunner *Tautogolabrus adspersus*. Env. Health Perspectives, in press.

Gutjahr-Gobell, R.E., M. Huber, D. Borsay Horowitz, G. Zaroogian, and L.J. Mills. 2002. A temperate reef fish *Tautogolabrus adspersus* as a potential model species for laboratory studies evaluating effects of chemical exposure. Environmental Toxicology and Chemistry 21: 380-389.

Nacci, D.E., T.R. Gleason, R. Gutjahr-Gobell, M. Huber, and W.R. Munns, Jr. 2002. Effects of chronic stress on wildlife populations: A population modeling approach and case study. In: Coastal and Estuarine Risk Assessment. M.C. Newman, M.H. Roberts, Jr., R.C. Hale (eds.). CRC Press/Lewis Publishers, Washington, DC, pp. 247-272.

Mills, L.J., R.E. Gutjahr-Gobell, D. Borsay-Horowitz, R. Haebler, R. Pruell, S. Jayaraman, R. McKinney, and G. Zaroogian. 2001. Effects of selected endocrine disrupting chemicals on GSI, HSI, plasma steroid hormone levels and vitellogenin production in juvenile summer flounder. Aquatic Tox. 52: 157-176.

Zaroogian, G., G. Gardner, D. Borsay-Horowitz, R. Haebler, R. Gutjahr-Gobell, L. Mills. 2001. Effect of 17β–estradiol *o,p*'-DDT, octylphenol and *p,p*'-DDE, on gonadal development and liver and kidney pathology in juvenile male summer flounder (*Paralichthys dentatus*). Aquatic Tox. 54: 101-112.

Gutjahr-Gobell, R.E., D.E. Black, L.J. Mills, R.J. Pruell, B.K. Taplin, and S. Jayaraman. 1999. Feeding the mummichog (*Fudndulus heteroclitus*) a diet spiked with non-ortho- and mono-ortho-substituted polychlorinated biphenyls: accumulation and effects. Environmental Toxicology and Chemistry 18: 699-707.

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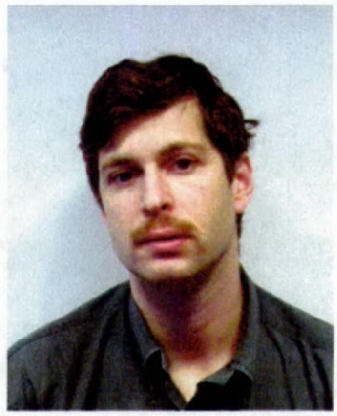

M.S., Electrical Engineering, University of Massachusetts, Dartmouth, North Dartmouth, MA, 1993
B.S., Electrical Engineering,, Southeastern Massachusetts University, North Dartmouth, MA, 1986
B.S., Computer Engineering,, Southeastern Massachusetts University, North Dartmouth, MA, 1986
B.S., Computer Science, Southeastern Massachusetts University, North Dartmouth MA, 1986

Employment:

1997-2002	Engineer, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1999	Acting Facility Manager, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Wet Lab Manager, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1995	Senior Engineer, Combat Systems Test Activity, U.S. Army, Aberdeen Proving Ground, MD

Expertise and Skills Relative to Agency Needs:
Jeffrey is a Licenced Professional Engineer, Rhode Island and Massachusetts with expertise in designing state of the art instrumentation, data acquisition, and control systems, animal holding/testing systems, power distribution systems, writing construction and performance statements of work, and monitoring contracts.

Professional Organizations/Licenses:
Member of the Aquatic Animal Life Support Operators (AALSO)
Licensed Professional Engineer, State of Rhode Island
Licensed Professional Engineer, State of Massachusetts
General Radiotelephone Operator License

ROMONA A. HAEBLER
Research Veterinary Medical Officer
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B.A., Psychology, University of Michigan, 1969
D.V.M., Doctor of Veterinary Medicine, Michigan State University, 1977
Ph.D.,Veterinary Pathology, Michigan State University, 1984

Employment:

1988- present	Research Veterinary Medical Officer Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1986-1988:	Acting Director, Marine Effects Division, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1984-1986:	Special Assistant to the Assistant Administrator, ORD, US. EPA, Washington, DC
1977-1980:	Veterinary Clinician, Zeeb Animal Hospital, Lansing, MI

Research Expertise and Skills Relative to Agency Needs:

Romona is a veterinary pathologist with skills and expertise in wildlife medicine and disease, especially concerning marine mammals and endangered species. Past work has focused on disease investigations of unusual mortality events and assessment of catastrophic marine pollution events on protected and endangered species. Current work and future interests focus on assessing anthropogenic factors driving disease emergence, especially on temporal and spatial scales.

Selected Appointments/Honors/Major Awards:

Member, Society of Marine Mammology, International Association for Aquatic Animal Medicine, American Veterinary Medical Association

Detailed to the US Fish and Wildlife Service as the Pathologist of Record for the Exxon Valdez oil spill response to wildlife. Ancorage, Alaska, 1989.

U.S. EPA Silver Medal for Response to Exxon Valdez Oil spill, 1989

Member emeritus, Unusual Marine Mammal Mortality Group(UMMMG), NMFS/ NOAA, 1990-present

Certificate of Recognition, Department of Commerce, for serving on UMMMG group to improve the quality of response to marine mammal mortality events

Member, Northeast Implementation Team the Right Whale, 1992- present

Selected Publications:

Horowitz, D.B. and R.A. Haebler. 2001. Demonstration of *apergillus sp.* in tissues of the common loon, *gavia immer*: incidence, progression, and severity. Journal of Histotechnology 24(2): 101-106.

Kuehl, D.W., and R. Haebler. 1995. Organochlorine, organobromine, metal, and selenium residues in dolphins bottlenos, *tursiops truncatus,* collected during an unusual mortality event in the Gulf of Mexico, 1990. Arch. Environ. Contam. Toxicol. 28: 494-499.

Lake, C.A., J. L. Lake, R Haebler, R. McKinney, W.S. Boothman, and S.S. Sadove. 1995.Contaminants levels in harbor seals from the northeastern United States. Arch. Environ. Contam. Toxicol. 29: 128-134.

Haebler, R. 1994. Biological effects: marine mammals and sea turtles. In J. Burger (ed.) Before and After an Oil Spill, pp. 238-252. Rutgers University Press. New Brunswick, NJ.

Kuehl, D.W., R Haebler, and C. Potter. 1994. Coplanar PCB and metal residues on dolphins, including atlantic bottlenose obtained during the 1987-1988 mass mortality. Chemosphere 28(6): 1245-1253.

Haebler, R.,and R .Moeller. 1993. Pathobiology of selected marine mammal diseases. In J.A. Couch and J.W. Fournie (eds.) Pathobiology of Marine and Estuarine Organism, CRC Press, Boca Raton, FL, pp. 217-244.

STEPHEN S. HALE
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B. A., Zoology, University of Maine, Orono, ME, 1967
M. S., Biological Oceanography, University of RI, Kingston, RI, 1974
Professional Certificate, Computer Science, University of Mass., Amherst, MA, 1985

Employment:

1995-present	Ecologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Senior Systems Analyst, Computer Sciences Corp. Narragansett, RI
1992-1993	Data Management Consultant, National Marine Fisheries Service, Narragansett, RI
1986-1992	Marine Research Associate, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI
1986	Research Programmer, Brown University, Providence, RI
1980-1985	Fishery Biologist and Biometrician, Alaska Department of Fish & Game, Anchorage, AK.

Research Expertise and Skills Relative to Agency Needs:
Benthic ecology (nutrient cycles, sediment chemistry, community dynamics, species distribution); Fish ecology (population and habitat assessment); Information management of environmental data (design, database management software, Geographic Information Systems); Ecological assessments (statistical analyses).

Selected Appointments/Honors/Major Awards:
Technical Director for Information Management, U. S. EPA's Environmental Monitoring and Assessment Program
Certified Senior Ecologist, Ecological Society of America, 2000
Certified Fisheries Scientist, American Fisheries Society, 1984
Guest Editor, Coastal and marine databases. Maritimes 43(2). 2001.
Scientific Editor, Proceedings of the First Symposium on the Mid-Atlantic Integrated Assessment Program. Environmental Monitoring and Assessment vol. 63, July, 2000.
U.S. EPA Bronze Medal for the initiation and execution of the first integrated and comprehensive survey of coastal condition throughout the Western United States, 2001.

Selected Recent Publications:
Hale S.S., M.M Hughes, C.J. Strobel, H.W. Buffum, J.L. Copeland, and J.F. Paul. 2002. Coastal ecological data from the Virginian biogeographic province, 1990–1993. Ecological Archives, in press.
McDonald, M., R. Blair, S. Hale, S. Hedtke, D. Heggem, L. Jackson, K.B. Jones, T. Olsen, S. Paulsen, J. Stoddard, K. Summers, and G. Veith. 2002. EPA's environmental monitoring and assessment program in the 21st century. Hydrologic Science and Technology, in press.
Hale, S.S., A.H. Miglarese, M.P. Bradley, T.J. Belton, L.C. Cooper, M.T. Frame, C.A. Friel, L.M. Harwell, R.E. King, W.K. Michener, D.T. Nicolson, and B.G. Peterjohn. 2002. Managing troubled data: coastal data partnerships smooth data integration. Environmental Monitoring and Assessment, in press.
Hale, S.S. 2002. Marine bottom communities of Block Island waters. In Ecology of Block Island, Rhode Island Natural History Survey, Kingston, RI, in press.
Hale, S.S. 2001. Species databases and the bioinformatics revolution. RINHewS, the Newsletter of the Rhode Island Natural History Survey 8(2): 10–11.
Hale, S.S. 2001. Coastal and marine databases. Maritimes 43(2): 1–2. Guest editor for this issue of Maritimes.
Hale, S.S. 2001. Managing data for the environmental monitoring and assessment program. Maritimes 43(2): 14–15.

Hale, S S 2001 Data are, datta is Science Editor 24 135

Hale, S S , and H W Buffum 2000 Designing environmental databases for statistical analyses Environmental Monitoring and Assessment 64 55–68

Hale, S S , L H Bahner, and J F Paul 2000 Finding common ground in managing data used for regional environmental assessments Environmental Monitoring and Assessment 63 143–157

Bradley, P , B Brown, S Hale, W Galloway, R Kutz, R Landy, R Shedlock, R Mangold, A Morris, W Galloway, J Rosen , R Pepino, and B Wiersma 2000 Summary of the MAIA Mid-Atlantic integrated assessment working conference Environmental Monitoring and Assessment 63 15–29

Hale, S S 2000 How to manage data badly (part 2) Bulletin of the Ecological Society of America 81(1) 101–103

Hale, S S 1999 How to manage data badly (part 1) Bulletin of the Ecological Society of America 80(4) 265–268

Hale, S S, J Rosen, D Scott, J F Paul, and M M Hughes 1999 EMAP information management plan 1998–2001 EPA/620/R-99/001a U S Environmental Protection Agency, ORD, NHEERL Research Triangle Park, NC, 333 pp

Hale, S S , M M Hughes, J F Paul, R S McAskill, S A Rego, D R Bender, N J Dodge, T L Richter,and J L Copeland 1998 Managing scientific data the EMAP approach Environmental Monitoring and Assessment 51 429–440

Comeleo, R L , J F Paul, P V August, J Copeland, C Baker, S S Hale, and R L Latimer 1996 Relationships between watershed stressors and sediment contamination in Chesapeake Bay estuaries Landscape Ecology 11 307–319

KAY T. HO
Environmental Research Scientist
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B.S., Environmental Toxicology, University of California, Davis, CA, 1982
M.S., Environmental Toxicology, Cornell University, Ithaca, NY, 1985
Ph.D., Chemical Oceanography, University of Rhode Island, Kingston, RI, 1992

Employment:

1992-present	Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI - Detail, Acting Indicator Development Branch Chief - Team Leader- Bioavailability - Environmental Research Scientist- Method development for marine sediment assessments.
1989-1990	Research Associate, University of Rhode Island, Narragansett, RI
1985-1986	TASIS Cyprus American School, Nicosia, Cyprus and London, England High School Teacher: Environmental Chemistry Oceanography, Biology, and Ecology

Research Expertise and Skills Relative to Agency Needs:
Kay is an marine environmental scientist with broad training in toxicology and ecology. Her expertise includes method development for assessment and identification of stressors in aquatic systems with an emphasis on benthic systems.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry
Society of Sigma Xi Inducted 1992
Reviewer for: Estuaries, Environmental Toxicology and Chemistry, Marine Environmental Research, Marine Pollution Bulletin, Environmental Toxicology, Bulletin of Environmental Contamination and Toxicology, Archives of Environmental Contamination and Toxicology, Chemosphere, Contaminant Hydrology, Journal of the Water Research Environment Federation
Editorial Board of Environmental Toxicology and Chemistry, 1999-2001
Editorial Board of Environmental Toxicology, 1997-present
Environmental Toxicology and Chemistry- Guest Editor: Session on Produced Waters 1996
National Technical Association – Top 10 Minority Women in the United States 1998
U.S. EPA Bronze Medal for Development of Marine Toxicity Identification Evaluation Methods 1998
U.S. EPA--Science and Technology Achievement Award Honorable Mention 1998 and 2001
Society of Environmental Toxicology and Chemistry:
North Atlantic Chapter-President-1995-1997.
Executive Board 1995-1998.
Hampton University, Hampton, VA Adjunct Professor. (1993-1996)
Graduate School of Oceanography, University of Rhode Island Adjunct Professor (2000-present)
Virginia Polytechnic Institute, College of Forestry and Wildlife, and Natural Resource Sciences Academic Program, Program Review Panel, 1995.
Science Advisory Group--Environment Canada-Method Development Section 1998- present.
National Center for Graduate Education for Minorities Review Panel (1994-1998); chair (1996-1998).

Selected Recent Publications:
Ho, K. T., R.M. Burgess, M. Pelletier, J.R. Sebst, S.A. Ryba, M.G. Cantwell, A. Kuhn, and P. Raczelowski. 2002. An overview of toxicant identification in sediments and dredged materials. Mar. Poll. Bull. 44:4, 286-293.
Ho, K.T., R. McKinney, A. Kuhn, M. Pelletier, and R. Burgess. 1997. Identification of acute toxicants in New Bedford Harbor sediments. Environmental Toxicology and Chemistry 16:3, 551-558.
Ho, K. T. 1997. Toxicity-based approach to environmental protection. European Water Pollution Control 7:4, 49-52.
Luoma, S. N. and K. T. Ho. 1993. Appropriate uses of marine and estuarine sediment nioassays. Handbook of Ecotoxicology:1 Peter Calow, Ed. Blackwell Scientific Publications. London, pp. 193-226.

DORANNE BORSAY HOROWITZ
Biologist
401-782-3042
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B.S., Zoology, University of Rhode Island, Kingston, RI, 1975

Employment:

1997-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Biology Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, U.S. EPA, Narragansett, RI
1986-1995	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Dodi is a biologist with expertise in marine histopathology, adapting clinical methodologies to assess the effects of toxic chemicals, stressors, and environmental condition on wildlife and marine populations and organizing these data into databases to apply quantitative methods for ecological and human health risk assessments and research.

Selected Appointments/Honors/Major Awards:
American Fisheries Society, Fish Health Section member and webmaster for Southern New England Chapter
American Society of Clinical Pathologists associate member
National Society for Histotechnology member and webmaster for Veterinary, Industry, and Research Committee, past Chair of Region I Convention/Symposium
North Atlantic Chapter of Society for Environmental Toxicology and Chemistry board member and webmaster
Rhode Island Society for Histotechnology member - past President, Vice President, Treasurer, and Board Member
Society for Invertebrate Pathology member
Southern New England Chapter of American Fisheries Society member and webmaster

Selected Recent Publications:
Gutjahr-Gobell, R.E., M. Huber, D.B. Horowitz, G.E. Zaroogian and L.J. Mills. 2002. A temperate reef fish, *tautogolabrus adspersus*, (Walbaum) as a potential model species for laboratory studies evaluating reproductive effects of chemical exposure. Environmental Toxicology and Chemistry 21(2): 380-389.

Folmar, L.C., G.R. Gardner, M.P. Schreibman, L. Magliuo-Cepriano, L.J. Mills, G.E. Zaroogian, R. Gutjahr-Gobell, R.A. Haebler, D.B. Horowitz, and N.D. Denslow. 2001. Vitellogen-induced pathology and mortality in male flounder, *paralichthys dentatus*. Aquatic Toxicology 51: 431-441.

Mills, L.J., R.E. Gutjahr-Gobell, R.J. Haebler, D.B. Horowitz, S. Jayaraman, R.J. Pruell, R.A. McKinney, G.R. Gardner and G.E. Zaroogian. 2001. Effects of estrogenic (o,p'-DDT, octylphenol) and anti-androgenic (p,p'-DDE) chemicals as indicators of endocrine status in juvenile male summer flounder, *paralichthys dentatus*. Aquatic Toxicology 52: 157-176.

Horowitz, D.B. and R.A. Haebler. 2001. Demonstration of *aspergillus sp.* in the common loon, *gavia immer:* incidence, progression, and severity. The Journal of Histotechnology 24(2): 101-106.

Zaroogian, G.E., G.R. Gardner, D.B. Horowitz, R. Gutjahr-Gobell, R.A. Haebler, and L.J. Mills. 2001. Effect of 17b-estradiol, o,p'-DDT, octylphenol, and p,p'-DDE on gonadal development and liver and kidney pathology in juvenile male summer flounder, *paralichthys dentatus*. Aquatic Toxicology 54(1-2): 101-112.

Fogg-Matarese, S., D.B. Horowitz, and G. Kass-Simon. 2001. An valuation of three conventional histological techniques for staining the *cerata* of *cratena pilata*. The Journal of Histotechnology 24(4): 255-258.

SARO JAYARAMAN
Environmental Scientist
401-782-9613
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B.A., Chemistry University of Kerala, India, 1967

Employment:

1997-present	Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1995	Chemist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Saro is an analytical chemist with interests in chemical stressors, such as persistent bioaccumulative toxicants, and eutrophication.

Selected Appointments/Honors/Major Awards:
American Chemical Society
U.S. EPA Science and Technology Achievement Awards, 2001

Selected Recent Publications:

Jayaraman, S., R.J. Pruell, and R.A. McKinney. 2001. Extraction of organic contaminants from marine sediments and tissues using microwave energy. Chemosphere 44: 181-191.

Nacci, D.E., S. Jayaraman, and J. Specker. 2001. Stored retinoids in populations of the estuarine fish *Fundulus heteroclitus* indigenous to PCB-contaminated and reference sites. Archives of Environmental Contamination and Toxicology 40: 511-518.

Nacci, D.E., L. Coiro, D. Champlin, S. Jayaraman, R.A. McKinney, T.R. Gleason, W.R. Munns, Jr., J.L. Specker, and K.R. Cooper. 1999. Adaptions of wild populations of the estuarine fish *Fundulus heteroclitus* to persistent environmental contaminants. Marine Biology 134: 9-17.

MARY W. JOHNSON
Technical Information Manager
401-782-3028
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B.A., Political Science (pending), University of Rhode Island, Kingston, RI, 2002
Master of Marine Affairs Program, University of Rhode Island, Kingston, RI
A.A., Liberal Arts, Bennett College, Millbrook, NY, 1965

Employment:

1993-present	Technical Information Manager, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1973-1993	Biological Laboratory Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1969-1973	U.S. Department of Interior, Federal Water Pollution Control Administration, West Kingston, RI

Research Expertise and Skills Relative to Agency Needs:
Mimi is biologist and information manager with expertise in lobster biology and culture, physiological measurement, and information management.

Selected Recent Publications:

Juinio, M.A., J.S. Cobb, D. Bengtson and M. Johnson, 1992. Changes in nucleic acids over the molt cycle in relation to food availability and temperature in *Homarus americanus* postlarvae. Marine Biology 114:1-10.

Zaroogian, G. and M. Johnson. 1989. Adenylate energy charge and adenine nucleotide measurements as indicators of stress in the mussel, *Mytilus edulis,* treated with dredged material. Bulletin of Environmental Contamination and Toxicology 43:428-435.

Zaroogian, G. and M. Johnson. 1989. Application of adenylate energy charge and adenine nucleotide measurements as indicators of stress in *Nepthys incisa* treated with dredged material. Bulletin of Environmental Contamination and Toxicology 43:261-270.

Zaroogian, G., P. Rogerson, G. Hoffman, M. Johnson. M. Johns and W. Nelson. 1988. A field and laboratory study using adenylate energy charge as an indicator of stress in *Mytilus edulis* and *Nepthys incisa* treated with dredge materials. TRD-88-4, U.S. Army Engineers Waterways Experiment Station, Vicksburg, MS.

Zaroogian, G., J. Heltshe and M. Johnson. 1985. Estimation of toxicity to marine species with structure-activity models developed to estimate toxicity to freshwater fish. Aquatic Toxicology 6:251-270.

Zaroogian, G. J. Heltshe and M. Johnson. 1985. Estimation of bioconcentration in marine species using structure-activity models. Environmental Toxicology and Chemistry 4:3-12.

Zaroogian, G. and M. Johnson. 1984. Nickel uptake and loss in the bivalves *Crassostrea virginica* and *Mytilus edulis*. Archives of Environmental Contamination and Toxicology 13:411-418.

Zaroogian, G. and M. Johnson. 1983. Copper Accumulation in the bay scallop, *Argopecten irradians*. Archives of Environmental Contamination and Toxicology 12:127-133.

Zaroogian, G. and M. Johnson. 1983. Chromium Uptake and loss in the bivalves *Crassostrea virginica* and *Mytilus edulis*. Marine Ecology Progress Series 12:167-173.

Zaroogian, G., J. Gentile, J. Heltshe, M. Johnson and A. Ivanovici. 1982. Application of adenine nucleotide measurements for the evaluation of stress in *Mytilus edulis* and *Crassostrea virginica*. Comparative Biochemistry and Physiology 71B(4):643-649.

Johnson, M. and J. Gentile. 1979. Acute toxicity of cadmium, copper, and mercury to larval american lobster, *Homarus americanus*. Bulletin of Environmental Contamination and Toxicology 22:258-264.

ROXANNE L. JOHNSON
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B.A., Chemical Science, Connecticut College, New London, CT 1965
M.S., Statistics, University of Rhode Island, Kingston, RI 1997

Employment:

1995 - present	Chemist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1984 - 1995	Associate Chemist, Science Applications International Corporation (SAIC), Narragansett, RI
1982 - 1984	Marine Research Specialist, University of Rhode Island Narragansett, RI
1975 - 1982	Research Assistant, Biochemistry Department, University of Rhode Island, Kingston, RI

Research Expertise and Skills Relative to Agency Needs:
Roxanne is a chemist with expertise in developing and applying quantitative methods to determine nutrient levels in estuarine systems, and the fate and effects of chemicals and mixtures of anthropogenic contaminants in microcosm and estuarine systems. Additionally she develops experimental designs for the analysis of benthic communities.

Selected Appointments/Honors/Major Awards:
USEPA Science and Technology Achievement Award, 2000

Selected Recent Publications:

Davey, E.W., K.T. Perez, J.A. Cardin, R.L. Johnson, and K.J. Rocha Application of 3D computer-aided tomography to the quantitative differentiation of marine benthic habitats. in preparation.

Johnson, R.L., K.T. Perez, E.W. Davey, J.A. Cardin, K.J. Rocha, E.H. Dettmann, and J.F. Heltshe. Discriminating the effects of anthropogenic point sources from salinity and nitrogen loading using benthic communities: a comparative estuarine approach. in preparation.

Perez, K.T, E.W. Davey, R.H. Moore, P.R. Burn, M.S. Rosol, J.A. Cardin, R.L. Johnson, and D.N. Kopans. 1999. Application of computer-aided tomography (CT) to the study of estuarine benthic communities. Ecological Applications 9(3): 1050-1058.

Perez, K.T., G.E. Morrison, E. W. Davey, N.F. Lackie, A.E. Soper, R.J. Blasco, D.L. Winslow, R.L. Johnson, P.G. Murphy, and J.F. Heltshe.1991. Influence of size on fate and ecological effects of Kepone in physical models. Ecological Applications 1(3): 237-24.

Davey, E.W., K.T. Perez, A.E. Soper, N.F. Lackie, G.E. Morrison, R.L. Johnson, and J.F. Heltshe. 1990. Significance of the surface microlayer to the environmental fate of di (2-ethylhexy) phthlate predicted from a marine microcosm. Marine Chemistry 31: 231-269.

Perez, K.T., E.W. Davey, G.E. Morrison, J.A. Cardin, N.F. Lackie, A.E. Soper, R.J. Blasco, R.L. Johnson, and S. Marino. 1990. Influence of organic matter and industrial contaminants in sewage effluents on marine ecosystems. Environmental Protection Agency internal report. Februrary 1990.

Perez, K.T., E.W. Davey, J. Heltshe, J.A. Cardin, N.F. Lackie, R.L. Johnson, R.J. Blasco, A.E. Soper, and E. Read. 1990. Recovery of Narragansett Bay, RI: A Feasibility Study. Environmental Protection Agency internal report for Office of Marine and Estuarine Protection. March 1990.

DARRYL J. KEITH
Research Oceanographer
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B.A., Geology, University of North Carolina, Chapel Hill, NC, 1977
M.S., Geological Oceanography, University of Rhode Island, Kingston, RI, 1986
Master of Marine Affairs, University of Rhode Island, Kingston, RI, 1993
Ph.D. Candidate, Biological Oceanography, University of Rhode Island, Kingston, RI

Employment

1990-present Research Oceanographer, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1990 Information Management Specialist., Computer Sciences Corporation, U.S. EPA Environmental Research Laboratory, Narragansett, RI
1987-1988 Oceanographer, National Marine Fisheries Service, U.S. NOAA, Narragansett, RI
1986-1987 Research Assistant III, Woods Hole Oceanographic Institution, Woods Hole, MA.
1984-1986 Science Coordinator, JOIDES/Ocean Drilling Program Office, Graduate School of Oceanography, University of Rhode Island, Kingston, RI
1982-1984 Graduate Research Assistant, Graduate School of Oceanography, University of Rhode Island, Kingston, RI
1977-1981 Research Assistant II, Woods Hole Oceanographic Institution,Woods Hole, Massachusetts.

Research Expertise and Skills Relative to Agency Needs:

Darryl is an oceanographer with expertise in integrating data from airborne and spacecraft mounted sensors to predict and map the distribution and abundance of phytoplankton biomass in coastal and estuarine environments. Darryl also has expertise in marine geology and coastal sedimentary processes and ocean disposal & dredge material management issues.

Selected Appointments/Honors/Major Awards:

Member, American Geophysical Union
Member, American Association of Limnology and Oceanography
Licensed Geologist - State of North Carolina
U.S. EPA/ORD/AED Representative:EPA/NASA Workshop on Water Monitoring, Remote Sensing, and Advanced Technologies; Washington, DC, 1996.
Remote Sensing Briefing for Congressman Patrick Kennedy (D-RI) at Brown University, 2001.
ORD/AED Representative: Region I Long Term Strategy Working Group for Historic Waste Dumping in Massachusetts Bay; Boston, MA, 1992.
Massachusetts Bay Dredged Material Capping Demonstration Working Group, Boston, MA, 1992.
Region I Massachusetts Bay Waste Task Force, Boston, MA, 1993.
Region I Massachusetts Bay Peer Review Panel, Boston, MA, 1993.
Providence River Shipping Channel Dredging Technical Advisory Committee, Providence, RI, 1994.
U.S. EPA Remote Sensing Working Group, 1996.
Review panel member: NOAA/National Undersea Research Program- Aquanaut Program 1993, 1995
Councilor: Marine Technology Society, NE Section 1994-1996
Mentor: NOAA/National Undersea Research- Aquanaut Program 1994, 1996.
American Society of Limnology and Oceanography (ASLO) Minorities Program, 2001.
Steering Committee Member "Expanding Opportunities in Ocean Science- A Conference to Strengthen the Links Between HBMSCU Undergraduates and Oceanic Graduate Studies in Marine and Atmospheric Sciences; Hampton University, VA (1995), Univ. of Md-Eastern Shore, MD (1999), and Jackson State University,

MS (2001)

Conference Co-chair, "Reducing the Uncertainties of Ecological Risk Assessment at Deeper Water Hazardous Radiation Waste Sites Through the Application of Advanced Technologies",Woods Hole, MA, 1997

Session Co-chair, EMAP Symposium, Pensacola, FL, April 2001

U S EPA Bronze Metal for work on radioactive contamination of Massachusetts Bay, Office of Reseach and Development, 1992

Selected Publications

Keith, D , J Yoder, S A Freeman 2002 Spatial and temporal distribution of colored dissolved organic matter (CDOM) in Narragansett Bay, Rhode Island implications for phytoplankton in coastal waters Journal of Estuarine, Coastal and Shelf Science, in press

Keith, D , H A Walker, J F Paul 2002 Terrestrial vegetation greenness of the Lower Galveston Bay watershed from satellite remote sensing and its relation to water use and the salinity regime of the Galveston Bay estuary (USA) International Journal of Remote Sensing, Vol 23, No 5, 905-916

Latimer, J S , W R Davis, and D J Keith 1999 Mobilization of PAHs and PCBs from in-place contaminated sediments during simulated resuspension events Estuarine, Coastal and Shelf Science, Vol 49, 577-595

Keith, D , H Coulton, J Lindsay, H Louft and L Stewart 1999 New technology for conducting radiation hazard assessments application of the underwater radiation spectral identification system at Massachusetts Bay industrial waste site Journal of Environmental Management and Assessment, Vol 54, 259-282

JOHN A. KIDDON
Physical Research Scientist
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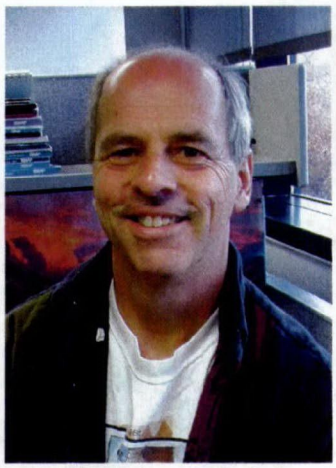

B.A., Chemistry, Lehigh University, Bethlehem, PA, 1974
M.S., Chemistry, Lehigh University, Bethlehem, PA, 1979
Ph.D., Oceanography, University of Rhode Island, Kingston, RI, 1993

Employment:

1995-present	Physical Research Scientist, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1994-1995	Scientist, Science Applications International Corporation (SAIC), Narragansett, RI
1993-1994	Assistant Professor, Maine Maritime Academy, Castine, Maine
1986-1993	Research Assistant and Student, Graduate School of Oceanography, University of Rhode Island, Kingston, RI
1979-1986	Research Engineer, Honeywell Inc, Minneapolis, MN

Research Expertise and Skills Relative to Agency Needs:

John brings experience in marine biology and geochemistry to the monitoring and assessment of estuarine and riverine ecosystems. His primary interests lie in applying monitoring data in order to develop and implement criteria that designate impairment in aquatic ecosystems. John also measures the concentration of stable isotopes in estuarine waters, sediments, and organisms in order to trace the origins and fates of nutrients and to reconstruct historic changes in estuarine processes.

Selected Appointments/Honors/Major Awards:

U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Office of Research and Development , 1998

U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Region III, 1998

Selected Recent Publications:

Lake, J.L., R.A. McKinney, F.A. Osterman, R.J. Pruell, J.A. Kiddon, S.A. Ryba and A.D. Libby. 2001. Stable nitrogen isotopes as indicators of anthropogenic activities in small freshwater systems. Canadian Journal of Fisheries and Aquatic Science 58: 870-878.

Paul J.F., J.A. Kiddon, C.J. Strobel, B.D. Melzian, J.S. Latimer, D.J. Cobb, D.E. Campbell and B.S. Brown. 2000. Condition of the Mid-Atlantic estuaries: production of a state of the environment report. Environmental Monitoring and Assessment 63(1): 115-29.

Paul, J.F., B.D. Melzian, B.S. Brown, C.J. Strobel, J.A. Kiddon, J.S. Latimer, D.E. Campbell and D.J. Cobb. 1999. MAIA project summary: condition of the Mid-Atlantic estuaries. US EPA Office of Research and Development, Washington, DC, December 1999, 6 pp. 600/SR-98/147.

USEPA. 1998. Condition of the Mid-Atlantic estuaries. United States Environmental Protection Agency, Office of Research Development, Narragansett, RI.

Paul, J.F., C.J. Strobel, B.D. Melzian, J.A. Kiddon, J.S. Latimer, D.E. Campbell and D.J. Cobb. 1998. State of the estuaries in the Mid-Atlantic region of the United States. Environmental Monitoring and Assessment 51: 269-284.

Kiddon, J., M.L. Bender, and J. Marra. 1994. Production and respiration in the 1989 North Atlantic bloom: an analysis of irradiance-dependent changes. Deep-Sea Research 42: 553-576.

Kiddon, J., M.L. Bender, J. Orchardo, J. Goldman, D.A. Caron, and M. Dennett 1993. Isotopic fractionation of oxygen by respiring marine organisms. Global Biogeochemical Cycles 73: 679-694.

ANNE KUHN
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B.S., Natural Resources/Aquaculture and Pathology, University of Rhode Island, Kingston, RI, 1980
M.S., Natural Resources/Aquacultural Nutrition, University of Rhode Island, Kingston, RI, 1988
Ph.D. Candidate, Wildlife Conservation Biology, University of Rhode Island, Kingston, RI, expected 2004

Employment:

1995-present	Research Physical Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Research Biologist/Work Assignment Manager Contaminated Sediments Program, Science Applications International Corporation (SAIC), Narragansett, RI
1990-1993	Lab Manager/Project Manager Environmental Testing Center, Science Applications International Corporation (SAIC), Narragansett, RI
1984-1990	Research Biologist/Work Assignment Manager Water Quality Criteria Program, Science Applications International Corporation (SAIC), Narragansett, RI
1982-1984	Marine Research Specialist, University of Rhode Island on location at ORD, U.S. EPA Environmental Research Laboratory, Narragansett, RI.
1981-1982	Aquacultural Specialist, Blue Gold Seafarms, Inc., Middletown, RI.

Research Expertise and Skills Relative to Agency Needs:
Anne is a research physical scientist with expertise in the assessment of population level effects of multiple stressors with various marine and estuarine vertebrate and invertebrate species. Anne has expertise in test method development and experimental design including the development of matrix population models which incorporate toxicity test measures of effects. Anne has evaluated and validated various population models using field and laboratory studies. Anne is currently involved in developing spatially-explicit population models which incorporate landscape structure and habitat quality for a variety of species (aquatic and avian). Anne also has expertise in the field of spatial statistics and is developing approaches for evaluating the relative risks from chemical and non-chemical stressors on spatially structured populations of various species across large eco-regions.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry
Member of Wildlife Society
Member of Society for Conservation Biology
Member of Ecological Society of America
Reviewer for Environmental Toxicology and Chemistry
U.S. EPA Science and Technology Achievement Awards, 1998 and 1999.

Selected Recent Publications:
Kuhn, A., W.R. Munns, Jr., J.R. Serbst, P. Edwards, M.G. Cantwell, T. Gleason, M. Pelletier, and W. Berry. 2002. Evaluating the ecological significance of laboratory response data to predict population-level effects for the estuarine amphipod *Ampelisca abdita* . Environmental Toxicology and Chemistry 21: 865-874.

Kuhn, A., W.R. Munns, Jr., D. Champlin, R. McKinney, M. Tagliabue, J. Serbst, and T. Gleason. 2001. Evaluation of the efficacy of extrapolation population modeling to predict the dynamics of *Americamysis bahia* populations in the laboratory. Environmental Toxicology and Chemistry 20: 213-221.

Kuhn, A., W.R. Munns, Jr., S. Lussier, D. Champlin, and S. Poucher. 2000. Prediction of population-level response from mysid toxicity test data using population modeling techniques. Environmental Toxicology and Chemistry 19: 2364-2371.

K. T. Ho, A. Kuhn, M. Pelletier, F. Mc Gee, R. M. Burgess, and J. Serbst. 2000. Sediment toxicity assessment: Comparison of standard and new testing designs. Archives of Environmental Contamination and Toxicology 39: 462-468.

JAMES L. LAKE
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B.A., Biology, Denison University, Granville, OH, 1967
M.A., Marine Science, College of William and Mary, Williamsburg VA, 1972
Ph.D., Marine Science, College of William and Mary, Williamsburg VA, 1977

Employment:

1980 - present	Research Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1977-1980	Research Chemist/Research Associate, Center for Bio-Organic Studies, University of New Orleans, New Orleans, LA; Location of Employment - Narragansett, RI
1977	Marine Scientist, Virginia Institute of Marine Science, Gloucester Pt. VA

Research Expertise and Skills Relative to Agency Needs:
Jim is an environmental scientist with expertise in developing quantitative relationships for estimating accumulation of mercury in freshwater and marine food webs. He also has expertise in the analysis of organic contaminants and mercury in environmental samples, in assessing and modeling bioaccumulation of contaminants and in the use of stable isotopic techniques to determine trophic positions of organisms.

Selected Appointments/Honors/Major Awards:
Reviewer for Environmental Science and Technology, Archives of Environmental Contamination and Toxicology, Marine Environmental Research.
Adjunct Professor Graduate School of Oceanography, University of Rhode Island. 1980-1985.
U.S. EPA Science and Technology Achievement Award, 1981
Sigma Xi (inactive)

Selected Recent Publications:
Lake, J.L., R.A. McKinney, F.A. Osterman, S.A. Ryba, M. Cantwell., R.Y. Tien., C. Brown, and L. Suprock. 2002. Mercury and stable isotopes of carbon and nitrogen in mink. Mercury in the environment: Providing the foundation for assessing and managing risks. Editors: Jeffrey Frithsen, Allan Ford, Jonathan Herrmann and William Stelz. American Chemical Society (Submitted).

McKinney, R.A., J.L. Lake, M.A. Charpentier, and S.A. Ryba. 2002. Using mussel isotope ratios to assess anthropogenic nitrogen inputs to freshwater ecosystems. Environmental Monitoring and Assessment 74: 167-192.

Lake, J.L., R.A. McKinney, F.A. Osterman, R.J. Pruell, J.A. Kiddon, S.A. Ryba, and A.D. Libby. 2001. Stable nitrogen isotopes as indicators of anthropogenic activities in small freshwater systems. Canadian Journal of Fisheries and Aquatic Science 58: 870-878.

Reddy, C.M., L.J. Heraty, B.D. Holt, N.C. Sturchio, T.I. Eglington, N.J. Drenzek, L. Xu, J.L. Lake, and K.A. Maruya. 2000. Stable chlorine isotope compositions of Aroclors and Aroclor-contaminated sediment. Environmental Science and Technology 34(13): 2866-2870.

RICHARD L. LAPAN, JR.
Safety, Health, and Environmental Management Program Manager
401-782-3009
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B.S., Geology, University of Rhode Island, 1972

Employment:

1986-present	Safety Health, and Environmental Management Program Manager, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
2002	Associate Director for Program Operations (Acting), Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1986-1991	Technical Information Manager, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1970-1986	Analytical Chemist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Expertise and Skills Relative to Agency Needs:
Rick serves as SHEMP Manager and Radiation Safety Officer for AED. He has served on a number of advisory committees to EPA's Safety, Health, and Environmental Management Division including Chemical Pharmacy Workgroup, Chemical Inventory Automation, Medical Monitoring, SHEM Audit Benchmarking and has provided technical assistance to NOAA/NMFS and OSHA Regional Offices, the University of Rhode Island, and various EPA facilities.

Selected Appointments/Honors/Major Awards:
Vice-Chairman Southeastern New England Federal Safety and Health Council
Member National Fire Protection Association
Member Board of Directors, Narragansett Council Boy Scouts of America, 1986-present
Member US EPA/BSA National Jamboree Executive Committee, 1989, 1993, 1997
U.S. DOL/OSHA Meritorious Achievement Award, Category III, 2000
U.S. EPA Bronze Medals, 1990, 1996, 1999
U.S. EPA Tributes of Appreciation, 1989, 1990, 1993
U.S. EPA Sustained Superior Performance Awards, 1992, 1995, 1997
U.S. EPA Special Act Cash Awards, 1999(2), 2000, 2001

JAMES S. LATIMER
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B.S.(cum laude), Chemistry, Syracuse University, Utica College of, 1979
M.S., Analytical Chemistry, University of Rhode Island, 1984
Ph.D., Chemical Oceanography, University of Rhode Island, 1989

Employment:

Oct 2000-present	Research Physical Scientist, Atlantic Ecology Division,National Health and Environmental Effects Laboratory, ORD, U.S. EPA, Narragansett, RI
Aug-Oct 2000	Acting Chief Ecological Response Branch, Atlantic Ecology Division, National Health and Environmental Effects Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-2000	Research Physical Scientist, Atlantic Ecology Division, National Health and Environmental Effects Laboratory, ORD, U.S. EPA, Narragansett, RI
1994-1995	Assistant Marine Research Scientist, Graduate School of Oceanography, Univ. of Rhode Island, Narragansett, RI.
1990-1994	Assistant Marine Scientist, Graduate School of Oceanography, Univ. of Rhode Island, Narragansett, RI.
1985-1990	Marine Research Associate, Graduate School of Oceanography, Univ. of Rhode Island, Narragansett, RI.
1982-1985	Marine Research Assistant, Graduate School of Oceanography, Univ. of Rhode Island, Narragansett, RI.

Research Expertise and Skills Relative to Agency Needs:

Jim has extensive experience in the study of the sources, transport, fate, and effects of environmental contaminants in marine systems. He has planned and executed major interdisciplinary studies involving the quantification of atmospheric inputs, freshwater sources, spatial and temporal distributions and ecological effects of nutrients, toxic organics, and inorganics in the coastal marine environment.

Selected Appointments/Honors/Major Awards:

Adjunct faculty, University of Rhode Island, 1992-1995.
Associate Editor: Estuaries 1996-2001.
Conference Steering Committee: Conference Tracking and Exhibitor Chair, 14th International Conference of the Estuarine Research Federation, 1997.
Co-convener: "Assessing Ecosystem Change: Paleoecological Techniques in Coastal Marine Science," special session at the 14th International Conference of the Estuarine Research Federation, Providence, RI, 1997.
Estuarine Research Federation Certificate of Achievement for contributions to the ERF 1997 Conference.
Technical Advisory Committee: U. S. Army Corps of Engineers and the RI Port Authority and Economic Development Corporation on the Dredging of the Providence River Shipping Channel, 1993-1995.
Narragansett Bay National Estuarine Research Reserve. Research Advisory Committee Member, 1997-present.
RI Governor's Commendation for participation in Rhode Island Oil Spill Assessment,1995.
NHEERL Aquatic Stressors Nutrient research planning workgroup, 200-present.
AED representative:Rhode Island Workgroup on oil spill response, 2000-present.
National Park Service Vital Signs Monitoring Program Coastal and Barrier Network Estuarine Nutrient Enrichment Workgroup, 2001-present.
Region 1 Technical Assistance Group for nutrient criteria development for estuaries, 2000-present.
Office of Water, National Nutrient Coordinators Group, 2001-present.
Technical Advisory Group for the Providence and Seekonk River nutrient TMDL Development, 2002-present.
Long Island Sound Management Committee, 2001-present.
U.S. EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Office of Research and Development, 1998

U S EPA Bronze Medal for Development of the Mid Atlantic Integrated Assessment (MAIA) State of the Estuaries Report, Region III, 1998

U S EPA Scientific and Technological Achievement Award, 2002

Selected Significant Publications

Pospelova, V , G L Chmura, and J S Latimer 2002 Dinoflagellate cyst records and human disturbance in two neighboring estuaries, New Bedford Harbor and Apponagansett Bay The Science of the Total Environment, in press

Latimer, J S and J Zheng 2002 The sources, transport, and fate of PAHs in the marine environment In PAHs An Ecological Perspective, P E T Douben, Editor, in press

Walker, H A , J S Latimer, and E H Dettmann 2000 Assessing the effects of natural and anthropogenic stressors in the Potomac estuary implications for long-term monitoring Environmental Monitoring and Assessment 63 237-251

Latimer, J S , W R Davis, and D Keith 1999 Mobilization of PAHs and PCBs from in-place contaminated marine sediments during simulated resuspension events Estuarine and Coastal Shelf Science 49 577-595

Ho, K , L Patton, J S Latimer, R J Pruell, M Pelletier, R McKinney, and S Jayaraman 1999 The Chemistry and toxicity of sediment affected by oil from the North Cape spilled into Rhode Island Sound Marine Pollution Bulletin 38(4) 314-323

Latimer, J S 1997 The significance of atmospheric deposition as a source of PCBs and PAHs to Narragansett Bay In Atmospheric Deposition of Contaminants to the Great Lakes and Coastal Waters, J E Baker, Editor , SETAC Press Pensacola, FL, pp 227-243

Latimer, J S and J G Quinn 1996 Historical trends and current inputs of hydrophobic organic contaminants in an urban estuary the sedimentary record Environmental Science and Technology 30(2) 623-633

JOSEPH A. LiVOLSI, JR.
Quality Assurance Officer
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B.S., Environmental Science, The Catholic University of America, Washington, DC, 1982
M.S., Resource Chemistry (Organic Geochemistry specialization), University of Rhode Island, Kingston, RI, 1989

Employment:

1994-present	Environmental Scientist/Quality Assurance Officer, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1998-1999	Director of Quality Assurance (Acting), National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Research Triangle Park, NC
1991-1994	Associate Chemist, Science Applications International Corporation (SAIC), Narragansett, RI
1990-1991	Senior Chemist, EA Laboratories, Sparks, MD
1986-1990	Assistant Chemist/Associate Chemist, Science Applications International Corporation (SAIC), Narragansett, RI
1982-1983	Environmental Scientist, Office of Waste Programs Enforcement, U.S. EPA, Washington, DC

Expertise and Skills Relative to Agency Needs:

Joe's technical background and experience in organic analytical chemistry has provided a sound basis for addressing quality assurance (QA) and quality control (QC) needs in a research environment. He provides guidance and direction to the research staff members in order that they might adequately address the Agency's QA requirements. In support of these requirements Mr. LiVolsi has pursued a functional quality management system at AED and has lead and participated in numerous quality management system reviews and technical systems audits at AED and across NHEERL.

SUZANNE M. LUSSIER
Research Aquatic Biologist
401-782-3157
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B.A., Biology, University of Rhode Island, Kingston, RI, 1970
M.S., Aquaculture Science and Pathology, University of Rhode Island, Kingston, RI, 1986

Employment:

1992-present	Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1990-1992	ORD Regional Scientist, U.S. EPA, Region III, Philadelphia, PA
1989-1990	Risk Assessment Coordinator, Region III, U.S. EPA, Philadelphia, PA
1989-1989	Technical Liaison, Chesapeake Bay Program, U.S. EPA, Region III,Annapolis, MD
1971-1989	Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Suzanne is a research aquatic biologist with expertise in developing and applying quantitative methods for culture and toxicity testing of marine invertebrates, developing national water quality criteria, risk assessment, and watershed assessment.

Selected Appointments/Honors/Major Awards:
Member, Society of Environmental Toxicology and Chemistry (SETAC)
Member and former board member of SETAC North Atlantic Chapter (2000-2002)
Reviewer for Environmental Toxicology and Chemistry
Editorial Board of Environmental Toxicology and Chemistry, 2000-present
Member and contributing author of American Society for Testing and Materials (ASTM), chair ASTM E47 Workgroup (1995-1996)
Advisor, Aquatic Life Criteria Guidelines Committee (1992-1995)
Member and contributing author of American Public Health Association (APHA) Standard Methods Committee
Member, AED representative, and former trichair (1998-1999) of Biological Advisory Committee
U.S. EPA Bronze Medal, Region II project
U.S. EPA Science and Technology Achievement Award, 1983

Selected Recent Publications:
Lussier, S.M, H.A. Walker, G.G. Pesch, W. Galloway, R. Adler, M. Charpentier, R. Comeleo, and J. Copeland. 2001. Strategies for protecting and restoring Rhode Island's watersheds on multiple scales. Human and Ecological Risk Assessment: 7: 5, 1483-1491.

Lussier, S.M, D. Champlin, J. LiVolsi, S. Poucher, and R.J. Pruell, 2000. Acute toxicity of para-nonylphenol to saltwater animals. Environmental Toxicology and Chemistry, 19: 3, 617-621.

Lussier, S.M, W. S. Boothman, S. Poucher, D. Champlin, and A. Hemstetter. 1999. Comparison of dissolved and total metals concentrations from acute tests with saltwater organisms. Environmental Toxicology and Chemistry, 18: 5, 889-898.

Lussier, S.M, A. Kuhn, and R. Comeleo. 1999. An evaluation of the seven-day toxicity test with *americamysis bahia* (formerly *mysidopsis bahia*). Environmental Toxicology and Chemistry 18: 12, 2888-2893.

Lussier, S.M., and B. Finlayson.1998. Mysids section 8714. In Standard Methods for the Examination of Water and Waste Water, 20th edition, Washington, DC.

Lussier, S.M., D. Champlin, A. Kuhn, and J. F. Heltshe. 1996. Mysid (*mysidopsis bahia*) life-cycle test: design comparisons and assessment. In Environmental Toxicology and Risk Assessment: Biomarkers and Risk Assessment (5th Volume), ASTM STP 1306, David A. Bengtson and Diane S. Henshel (eds.), American Society for Testing and Materials, Philadelphia, PA.

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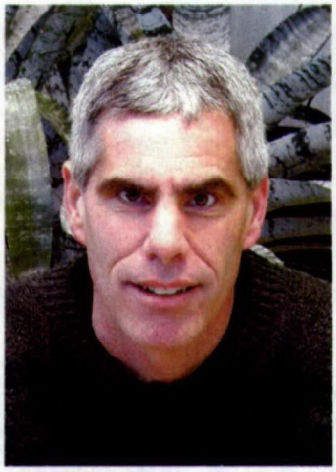

B.S., Chemistry, University of Rhode Island, Kingston, RI, 1979
M.S., Chemistry, University of Rhode Island, Kingston, RI, 1997

Employment:

1995-present	Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Work Assignment Manager, Analytical Chemistry Support Group, Science Applications International Corporation (SAIC), Narragansett, RI
1988-1993	GC/MS Laboratory - Operator, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Rick is responsible for development and implementation of research plans and approaches to investigate relevant problems in marine ecological risk assessment. He is currently principle investigator for projects investigating the effects of alteration of critical habitats on patterns of habitat utilization by wildlife species in coastal marine ecosystems.

Selected Appointments/Honors/Major Awards:
Member Ecological Society of America, American Geophysical Union
Reviewer for Environmental Science and Technology, Marine Environmental Research, Chemosphere
U.S. EPA Science and Technology Achievement Awards, 1997 and 2001

Selected Recent Publications:
McKinney, R.A., and C. Wigand. Salt marsh plant species richness along anthropogenic and physical gradients. Journal of Environmental Quality, in review.

McKinney, R.A., J.L. Lake, M. Charpentier, and S. Ryba. 2002. Using mussel isotope ratios to assess anthropogenic nitrogen inputs to freshwater ecosystems. Environmental Monitoring and Assessment 74: 167-192.

Wigand, C., R. Comeleo, R. McKinney, G. Thursby, M. Chintala, and M. Charpentier. 2001. Outline of a new approach to evaluate ecological integrity of salt marshes. Human and Ecological Risk Assessment 7(5): 1541-1554.

McKinney, R.A., W.S. Nelson, M. Charpentier, and C. Wigand. 2001. Ribbed mussel nitrogen isotope signatures reflect nitrogen sources in coastal salt marshes. Ecological Applications 11(1): 203-214.

McKinney, R.A., J.L. Lake, M. Allen, and S. Ryba. 1999. Spatial variability in mussels used to assess base level nitrogen isotope ratio in freshwater ecosystems. Hydrobiologia 412:, 17-24.

McKinney, R.A., R.J. Pruell, and R.M. Burgess. 1999. Ratio of the concentration of anthraquinone to anthracene in coastal marine sediments. Chemosphere 38(10): 2415-2430.

Burgess, R.M. and R.A. McKinney. 1999. Importance of interstitial, overlying water and whole sediment exposures to bioaccumulation by marine bivalves. Environmental Pollution 104: 373-382.

BRIAN D. MELZIAN
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B.S., Wildlife & Fisheries, University of Michigan, Ann Arbor, MI, 1968
Graduate Studies, Marine Biology/Oceanography, Stanford University, Hopkins Marine Station, Monterey, CA, 1971
M.S. Program, Marine Biology/Oceanography, University of the Pacific, Stockton & Dillon Beach, CA, 1971-1972
Ph.D., Biological Oceanography, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, 1982

Employment

1998-present	Special Assistant (Oceanographer/Project Officer) to the Director, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1998	Oceanographer/Project Officer, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1989-1992	Research Oceanographer, on detail from Region 9 to the Environmental Research Laboratory-Narragansett, ORD, U.S. EPA, Narragansett, RI
1983-1993	Environmental Scientist, U.S. EPA, Region 9, San Francisco, CA
1980-1981	Marine Specialist II, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI
1977-1980	Research Biologist, Environmental Research Laboratory-Narragansett, U.S. EPA, Narragansett, RI
1975-1977	Biological Technician, Environmental Research Laboratory-Narragansett, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Brian is a biological oceanographer with expertise in marine toxicology, histopathology, evaluating the effects of oil pollution on estuarine/marine organisms, developing and implementing estuarine and marine monitoring/research programs, and communicating scientific information.

Selected Appointments/Honors/Major Awards:
President-Elect of the Northeastern Association of Marine and Great Lakes Laboratories, 2002-present
Senior Scientific Editor for Environmental Monitoring and Assessment, 2001-present
Scientific Editor for Environmental Monitoring and Assessment, 1997-2000
U.S. EPA Representative on the Insular Pacific and California NOAA/EPA Regional Marine Research Boards, 1992-1993
U.S. EPA Bronze Medal for "Demonstrating exceptional skill, creativity and attention to partner and stakeholder involvement in completing an assessment of the current environmental condition of the mid-Atlantic estuaries", 1998
U.S. EPA Bronze Medal for "Significant contributions toward maintaining and improving the science and technology base for environmental and natural resource issues through production of the Region III (mid-Atlantic) state of the estuaries report", 1998
U.S. EPA Bronze Medal for "Significant achievement in the rapid response to *Pfiesteria* outbreaks, resulting in the protection of human health-threatening conditions and effective coordination of an immediate response by the Federal government", 1998
U.S. EPA Bronze Medal for "Creativity, scientific excellence, and endurance in creating the nation's first comprehensive assessment of the ecological condition of a very important natural resource" (EMAP Estuaries Team), 1997
U.S. EPA Bronze Medal for "Dedicated service to EPA and the public by completing an extensive study of Hawaii sugar mill discharges, thereby contributing to continuing compliance with existing effluent guidelines and

preventing potentially severe environmental impacts", 1989

U S EPA Bronze Medal for "Outstanding leadership and initiative in the development and application of a marine sediment testing program for the San Francisco Bay", 1987

Selected Recent Publications

Melzian, B D , V Engle, M McAlister and S Sandhu (eds) (in press) Coastal Monitoring Through Partnerships Proceedings of the Fifth Symposium on the Environmental Monitoring and Assessment Program (EMAP), Environmental Monitoring and Assessment

Paul, J F , J A Kiddon, C J Strobel, B D Melzian, J S Latimer, D J Cobb, D E Campbell, and B S Brown 2000 Condition of the Mid-Atlantic Estuaries Production of the State of the Environment Report Environmental Monitoring and Assessment 63 115-129

Sandhu, S S , B D Melzian, E R Long, W G Whitford and B T Walton (eds) 2000 Monitoring Ecological Condition in the Western United States Proceedings of the Fourth Symposium on the Environmental Monitoring and Assessment Program (EMAP), Environmental Monitoring and Assessment 64(1), 447 p

Paul, J F , C J Strobel, B D Melzian, J A Kiddon, J S Latimer, D E Campbell, and D J Cobb 1998 State of the estuaries in the mid-Atlantic region of the United States Environmental Monitoring and Assessment 51 269-284

U S EPA 1998 Condition of the Mid-Atlantic Estuaries EPA 600-R-98-147, Office of Research and Development, Washington, DC, 50 p

Sandhu, S , L Jackson, K Austin, J Hyland, B Melzian and K Summers (eds) 1998 Monitoring Ecological Condition at Regional Scales Proceeding of the Third Symposium on the Environmental Monitoring and Assessment Program (EMAP), Environmental Monitoring and Assessment 51(1-2), 603 pp

LESA MENG
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B.S., Biological Sciences, California State University, Sacramento 1988
Ph.D., Ecology, University of California, Davis 1992

Employment:

1995-present	Ecologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1992-1995	Fisheries Biologist, U.S. Fish and Wildlife Service, Sacramento, CA
1991-1992	Postgraduate Researcher, University of California Davis, CA

Research Expertise and Skills Relative to Agency Needs:
Lesa is a fish ecologist with expertise in developing field-related techniques and multivariate statistical methods for evaluating fish communities and fish habitat on many scales.

Selected Appointments/Honors/Major Awards:
Member American Fisheries Society and the Estuarine Research Federation
Program Chair for the Southern New England Chapter of the American Fisheries Society
Reviewer for Marine Ecology Progress Series, Transactions of the American Fisheries Society, The Environmental Biology of Fishes, Journal of Experimental Marine Biology and Ecology, Estuaries
Editorial Board of the American Water Works Association, Standard Methods, 2000-present
Reviewer for the California-Federal Coalition to restore San Francisco Bay, 2000-present
Special Recognition Award, U.S. Fish and Wildlife Service 1995
Special Achievement Awards, American Fisheries Society, 1999 and 2001
EPA diver since 1996

Selected Recent Publications:
Meng, L., C.D. Orphanides, and J.C. Powell. 2002. Use of a fish index to assess habitat quality in Narragansett Bay, RI. Transactions of the American Fisheries Society 131: 731-742.
Meng, L., J.C. Powell, and B. Taplin. 2001. Using winter flounder growth rates to assess habitat quality across an anthropogenic gradient in Narragansett Bay, RI. Estuaries 24: 576-584.
Meng, L. 2001. Research implementation plan for characterization and categorization of juvenile fish rearing habitats project. Ecological Integrity 3a. 600/X-98/011.
Meng, L. and S.A. Matern. 2001. Native and introduced larval fishes of Suisun Marsh, California: The effects of freshwater flow. Transactions of the American Fisheries Society 130: 750-765.
Meng, L., C. Gray, B. Taplin, and E. Kupcha. 2000. Using winter flounder growth rates to assess habitat quality in Rhode Island's coastal lagoons. Marine Ecology Progress Series 201: 287-299.
Meng, L., J.C. Powell. 1999. Linking juvenile fish and their habitats: An example from Narragansett Bay, RI. Estuaries 22: 905-916.

SHEILA A. MEUSE
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B.A., Liberal Arts and Sciences, The University of Connecticut, Storrs, CT, 1977
M.A., Communications, The University of Texas at Austin, Austin, TX, 1980
M.H.A. equivalent, Health Services Management, The University of Alabama at Birmingham and The University of Mary-Hardin Baylor, 1993
Ph.D., Communications, The University of Texas at Austin, Austin, TX, 1984

Employment:

2002-present	Associate Director for Program Operations, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1999-2002	Chief Business Office, Department of Veterans Affairs, Tampa, FL
1993-1999	Management Analyst, Office of the VA, ACIO Health System Specialist, Department of Veterans Affairs, Temple, TX
1984-1999	Assistant Professor (adjunct faculty), Texas A&M University, College of Medicine, College Station, TX
1984-1993	Speech Language Pathologist, Department of Veterans Affairs, Temple, TX
1983-1984	Assistant Professor, West Virginia University, Morgantown, WV

Expertise and Skills Relative to Agency Needs:
Sheila has approximately 19 years of government experience and has recently joined the EPA. Her most recent experience has been in leading and managing clinical and administrative support programs for the Department of Veterans Affairs. She has had varied experiences and education in management and organizational dynamics, and has been recognized for her leadership in managing and leading change and as a champion of new initiatives.

Selected Appointments/Honors/Major Awards:
Directors Commendation, Department of Veterans Affairs, 1999
Honor Society of Phi Kappa Phi

Publications:
Several publications, including a book chapter, in the field of communications.

LESLEY J. MILLS
Research Biologist
401-782-3050
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B.S., Biology, Florida Institute of Technology, Melbourne, FL, 1974
M.S., Biological Sciences, University of Rhode Island, Kingston, RI, 1982
PhD. Candidate, Biomedical Sciences, University of Rhode Island, Kingston, RI

Employment:

1995-present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1984-1995	Biologist/Senior Scientist, Science Applications International Corporation (SAIC), Narragansett, RI
1981-1984	Research Associate, University of Rhode Island, Kingston, RI
1979-1981	Visiting Scientist, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1976-1979	Student 1040 Appointment, Environmental Research Laboratory, U.S. EPA, Narragansett, RI
1974-1976	Biologist, Marine Research Incorporated, Falmouth, MA

Research Expertise and Skills Relative to Agency Needs:
Lesley is a research biologist with a background in the diverse areas of molecular biology, plankton biology, carcinogenesis and toxicology. She currently serves as project lead for research at AED on endocrine disrupting chemicals (EDCs). This research was initiated in response to EDCs being identified as one of six high-priority research areas in ORD's Strategic Plan. The project is investigating the impact of EDCs found in estuarine and marine waters on fish populations. Current research is focusing on interspecies extrapolation and, in collaboration with scientists in an NHEERL health division, is examining whether specific EDCs work through similar mechanisms of action in a mammalian and a fish species.

Selected Appointments/Honors/Major Awards:
Member - Society of Toxicology
Guest reviewer for Environmental Toxicology and Chemistry and the Water Resources Council

Selected Publications:

Mills, L.J., R.E. Gutjahr-Gobell, D. Borsay-Horowitz, N.D. Denslow, M. Chow, and G.E. Zaroogian. 2002. Relationship between reproductive success and male plasma vitellogenin levels in cunner, *Tautogolabrus adspersus*. Environmental Health Perspectives, *in press*.

Mills, L.J., R.E. Gutjahr-Gobell, D. Borsay-Horowitz, R Haebler, R Pruell, S. Jayaraman, R McKinney, G. Zaroogian. 2001. Effects of estrogenic (*o,p*'-DDT, octylphenol) and anti-androgenic *(p,p*'-DDE) chemicals on indicators of endocrine status in juvenile male summer flounder (*Paralichthys dentatus*). Aquatic Toxicology 52: 157-176.

Gutjahr-Gobell, R.E., M. Huber, D. Borsay-Horowitz, G. Zaroogian, and L.J. Mills. 2001. A temperate reef fish, *Tautogolabrus adspersus*, as a potential model species for laboratory studies evaluating reproductive effects of chemical exposure. Environmental Toxicology and Chemistry 21(2): 380-389.

Zaroogian, G., G. Gardner, D. Borsay-Horowitz, R. Gutjahr-Gobell, R. Haebler, and L. Mills. 2001. Effect of 17β–estradiol, *o,p*'-DDT, octylphenol and *p,p*'-DDE on gonadal development and liver and kidney pathology in juvenile male summer flounder, (*Paralichthys dentatus*). Aquatic Toxicology 54: 101-112.

Mills, L.J., S.N. Nelson, and A.R. Malcolm. (1994). Effects of selected anti-tumor promoting chemicals on metabolic cooperation between Chinese hamster V79 cells. Toxicology and Applied Pharmacology 126: 338-344.

Mills, L.J., D.L. Robson, and A.R. Malcolm. 1991. Interactive effects of aldrin, cyclohexylamine, 2,4-diaminotoluene and two phorbol esters on metabolic cooperation between V79 cells. Carcinogenesis 12(7): 1293-1299.

MATTHEW G. MITRO
Population Ecologist
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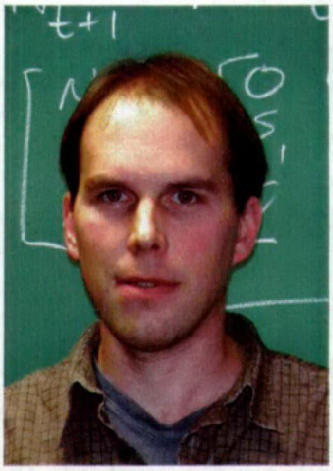

B.A., Biology, Colgate University, Hamilton, NY, 1992
M.S., Wildlife and Fisheries Biology, University of Vermont, Burlington, VT, 1995
M.S., Statistics, Montana State University, Bozeman, MT, 1999
Ph.D., Fish and Wildlife Biology, Montana State University, Bozeman, MT, 1999

Employment:

2000-present	Population Ecologist (Postdoc), Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1999-2000	Stock Assessment Biologist, Atlantic States Marine Fisheries Commission, Wakefield, RI

Research Expertise and Skills Relative to Agency Needs:
Matt is a population ecologist with expertise in fish and wildlife ecology, using mark-recapture to quantify population parameters, developing and applying matrix population models, and applying statistical methods for population analysis.

Selected Appointments/Honors/Major Awards:
Member of American Fisheries Society, American Institute of Biological Sciences, and Ecological Society of America
Reviewer for Canadian Journal of Fisheries and Aquatic Sciences
Mentor, MentorNet E-Mentoring Network for Women in Engineering and Science, 2001-present
Recipient, S-Award for contributions to the Atlantic Ecology Division's wildlife risk assessment research program, U.S. EPA, Narragansett, RI, 2001
Recipient, Gary Lynch Memorial Scholarship, Outstanding Biology Department Graduate Student, Montana State University, Bozeman, MT, 1999
Honorable Mention, American Fisheries Society/Sea Grant Outstanding Student Paper Award for Paper presented at the American Fisheries Society 128th Annual Meeting, Hartford, CT, 1998
Recipient, Skinner Memorial Award, American Fisheries Society, 1998

Selected Recent Publications:
Mitro, M. G. In Internal Review. Population analysis and management of the diamondback terrapin in Narragansett Bay, Rhode Island. To be submitted.
Mitro, M. G., A. V. Zale, and B. A. Rich. 2002. The relation between age-0 rainbow trout abundance and winter discharge in a regulated river. Canadian Journal of Fisheries and Aquatic Sciences, in press.
Mitro, M. G., and A. V. Zale. 2002. Seasonal survival, movement, and habitat use of age-0 rainbow trout in the Henrys Fork of the Snake River, Idaho. Transactions of the American Fisheries Society 131: 271-286.
Mitro, M. G. and A. V. Zale. 2002. Estimating abundances of age-0 rainbow trout by mark-recapture in a medium-sized river. North American Journal of Fisheries Management 22: 188-203.
Munns, W. R., and M. G. Mitro. 2001. Assessing risks to populations at superfund sites: characterizing effects on populations. Ecological Risk Assessment Support Center, Request No. 6., U.S. EPA. 62 pp.
Mitro, M. G. 2001. Ecological model testing: verification, validation, or neither? Bulletin of the Ecological Society of America 82: 235-237.
Mitro, M. G., and A. V. Zale. 2000. Predicting fish abundance using single-pass removal sampling. Canadian Journal of Fisheries and Aquatic Sciences 57: 951-961.
Mitro, M. G., and A. V. Zale. 2000. Use of distance sampling to estimate rainbow trout redd abundances in the Henry's Fork of the Snake River, Idaho. Intermountain Journal of Sciences 6: 223-231.

WILLIAM GLENN MOORE III
Environmental Protection Specialist
401-782-3024
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B.S., History/Naval Science, Jacksonville University, Jacksonville, FL, 1977
MMA, Marine Affairs, University of Rhode Island, Kingston, RI, 1989
Graduate/PhD Studies, Marine Affairs and Natural Resource Science, University of Rhode Island, Kingston, RI, ongoing

Employment:

2000-present	Special Assistant to the Director for Coastal Zone Management and Security Manager, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1998-2000	Associate Director for Program Operations, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1996-1998	Program/Management Analyst, Office of Marine Investigations, US Coast Guard Headquarters, Washington, DC
1990-1996	Program/Management Analyst, Office of Vessel Inspection, US Coast Guard Headquarters, Washington, DC
1987-1989	Simulation Systems Analyst, Pacer Systems, Inc, US Naval War College, Newport, RI
1983-1986	Lieutenant USN, Operations Program Officer (Intelligence, Security, Training and Readiness), Commander Service Group Two Staff, Norfolk, VA
1982-1983	Lieutenant USN, Communications Officer, USS Arkansas (CGN-41), Norfolk, VA
1980-1982	Lieutenant USN, Assistant CIC Officer, USS America (CV-66), Norfolk, VA
1977-1980	Lieutenant, Junior Grade USN, Assistant First Lieutenant, USS Canisteo (AO-99), Norfolk, VA

Expertise and Skills Relative to Agency Needs:
Glenn has over twenty-five years of experience in program management, operations, planning and analysis, with expertise in federal and international marine programs and policy development, federal/congressional programming and budget, organizational development, and security management. He also has extensive experience in IT systems and data base R&D, national defense operations and intelligence, and naval engineering.

Selected Appointments/Honors/Major Awards:
U.S. EPA Quality Performance Award
US Coast Guard Commander's Awards for Civilian Service (2)
US Coast Guard Commandant's Letter of Commendation
US Coast Guard Public Service Commendation
US Coast Guard Meritorious Team Commendation (4)
US Coast Guard Distinguished Service Award (3)
DOT Outstanding Service Medal
US Navy Navy Commendation Medal
US Navy Navy Achievement Medal (2)
US Navy Flag Letter of Commendation

WAYNE R. MUNNS, JR.
Associate Director for Science
401-782-3017
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B.A., Zoology, University of Washington, Seattle, WA, 1977
Ph.D., Biological Sciences, University of Rhode Island, Kingston, RI, 1983

Employment:

2000-present	Associate Director for Science, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1997-2000	Chief, Indicator Development Branch, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Research Ecologist (Ecological Risk Assessor), Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1991-1995	Senior Scientist/Division Manager/Assistant Vice President, Science Applications International Corporation (SAIC), Narragansett, RI
1983-1991	Scientist/Senior Biologist/Senior Scientist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

Wayne is a marine ecologist with expertise in developing and applying quantitative methods for ecological risk assessment, modeling population dynamics, integrating ecological and human health risk assessments and research, and incorporating socioeconomic considerations in risk management support systems.

Selected Appointments/Honors/Major Awards:

Member Society of Environmental Toxicology and Chemistry
Reviewer for Ecology, Environmental Toxicology and Chemistry, Environmental Health Perspectives, Environmental Toxicology and Water Quality, Critical Reviews in Toxicology, Human and Ecological Risk Assessment, Journal of Aquatic Ecosystem Stress and Recovery
Editorial Board of Environmental Toxicology and Chemistry, 1998-2000
Guest Editor for Human and Ecological Risk Assessment, 2002
NRC Research Associateship Program, Local Site Representative and Advisor
U.S. EPA Risk Assessment Forum, Eco-Risk Oversight Group
USGS Biological Resources Division Peer Review Interagency Panel
World Health Organization Steering Group for Approaches to Integrated Risk Assessment
Adjunct Associate Professor, University of Rhode Island, Department of Biomedical Sciences
U.S. EPA Bronze Medal for Innovation in Water Quality Criteria for the Protection of Aquatic Life: Saltwater Dissolved Oxygen, 2002
U.S. EPA Science and Technology Achievement Awards, 2000 and 2001

Selected Recent Publications:

Munns, W.R., Jr., R. Kroes, G. Veith, G.W. Suter II, T. Damstra, and M. Waters. 2002. Approaches for integrated risk assessment. Human and Ecological Risk Assessment, in press.
Suter, G.W. II, T. Vermeire, W.R. Munns, Jr, and J. Sekizawa. 2002. A framework for the integration of health and ecological risk assessment. Human and Ecological Risk Assessment, in press.
Munns, W.R., Jr. 2002. Axes of extrapolation in risk assessment. Human and Ecological Risk Assessment 8: 19-29.
Munns, W.R., Jr., W. Berry, and T. DeWitt. 2002. Toxicity testing, risk assessment, and options for dredged material management. Marine Pollution Bulletin 44: 294-302.

DIANE E. NACCI
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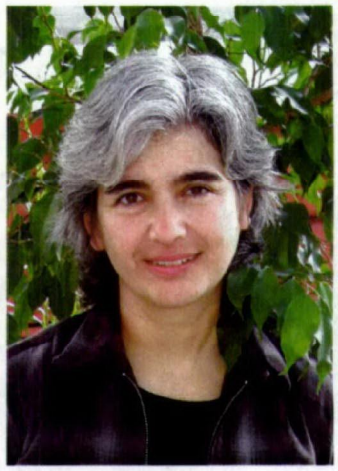

B.S., Zoology, University of Rhode Island, Kingston, RI, 1975
M.S., Biological Sciences, University of Rhode Island, Kingston, RI, 1984
Ph.D., Biological Sciences, University of Rhode Island, Kingston, RI, 2000

Employment:

1995-present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1984-1995	Senior Scientist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Diane is a biologist with expertise in developing and applying quantitative methods to support ecological risk assessment,including methods to assess the evolutionary effects of environmental stressors.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry
Reviewer for Ecology, Environmental Toxicology and Chemistry, Environmental Toxicology and Chemistry, Aquatic Toxicology, Marine Environmental Research, Canadian Journal of Fisheries and Aquatic Sciences, Hudson River Foundation
Advisor for post-doctoral fellows through NRC Research Associateship Program
Mentor for under- and graduate student interns through: Rhode Island State Government Intership Program, EPA-Morgan State University Summer Intern Program, National Network for Environmental Management Studies Program, University of Rhode Island Cooperative Agreement Projects, University of Rhode Island Coastal Fellows Program
U.S. EPA Science and Technology Achievement Awards, 2000 and 2001

Selected Recent Publications:
Nacci, D., T. Gleason, and W.R. Munns, Jr. 2002. Evolutionary and ecological effects of multi-generational exposures to anthropogenic stressors. Human and Ecological Risk Assessment 8(1): 91-97.
Nacci, D., M. Kohan, L. Coiro, and E. George. 2002. Effects of benzo(a)pyrene exposure on a PCB-adapted fish population. Aquatic Toxicology 57: 203-215.
Nacci, D., L. Coiro, D. Champlin, S. Jayaraman, and R. McKinney. 2002. Predicting responsiveness to contaminants in wild populations of the estuarine fish *Fundulus heteroclitus*. Environmental Toxicology and Chemistry 21(7): 1525-1532.
Nacci, D., S. Jayaraman, and J. Specker. 2001. Stored retinoids in populations of an estuarine fish, *Fundulus heteroclitus*, indigenous to highly PCB-contaminated and reference sites. Archives Environmental Contamination and Toxicology 40(4): 511-518.
Nacci, D., T. Gleason, R. Gutjahr-Gobell, M. Huber, and W.R. Munns, Jr. 2001. Effects of environmental stressors on wildlife populations. In Coastal and Estuarine Risk Assessment: Risk on the Edge. M.C. Newman, Editor, CRC Press/Lewis Publishers, Washington, DC, pp. 247-272.
Nacci, D., L. Coiro, D. Champlin, S. Jayaraman, R. McKinney, T. Gleason, W.R. Munns, Jr., J. Specker and K. Cooper. 1999. Adaptation of wild fish populations to dioxin-like environmental contamination. Marine Biology 134: 9-17.
Nacci, D., L. Coiro, A. Kuhn. D. Champlin, W.R. Munns, Jr., J. Specker and K. Cooper. 1998. A fish embryonic EROD bioassay. Environmental Toxicology and Chemistry: 17(12): 2481-2486.

WILLIAM (SKIP) NELSON
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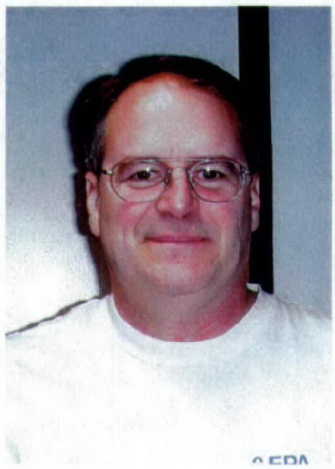

B.A., Biology, University of Bridgeport, Bridgeport, CT, 1974
M.S., Biology, University of Bridgeport, Bridgeport, CT, 1978
Ph.D., Biological Sciences, University of Rhode Island, Kingston, RI, 1987

Employment:

1987-present	Research Physiologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1984-1987	Scientist/Senior Biologist, Science Applications International Corporation (SAIC), Narragansett, RI
1981-1984	Marine Specialist, University of Rhode Island, Narragansett, RI
1978-1981	Aquatic Research Scientist, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1976-1978	Biological Technician, National Marine Fisheries Service, Milford, CT

Research Expertise and Skills Relative to Agency Needs:
Skip is a biologist with extensive experience in designing and implementing monitoring programs related to Superfund remedial dredging projects, including quantifying both the short-term effects of remedial activities (e.g., resuspension) as well as measuring the long-term ecological effects necessary to assess the overall effectiveness of remediation.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry
Member Estuarine Research Federation
ORD Representative for U.S. EPA "Contaminated Aquatic Sediment Remedial Guidance Document"
U.S. EPA Community-Based Environmental Protection Champion Award , 1996
U.S. EPA Science and Technical Achievement Award, 1996
U.S. EPA Bronze Medal Award, 1990

Selected Recent Publications:
Bergen, B.J., W.G. Nelson, J.G. Quinn, and S. Jayaraman. 2001. Relationships among total lipid, lipid classes, and PCB concentrations in two indigenous populations of ribbed mussels (*Guekensia demissa*) over an annual cycle. Environmental Toxicology and Chemistry 20: 575-581.

Bergen, B.J., K. Rahn, and W.G. Nelson. 1998. Remediation at a marine Superfund site: Surficial sediment PCB concentrations, composition and redistribution. Environmental Science and Technology, 32: pp. 3496-3501.

Bergen, B.J., W.G. Nelson, and R.J. Pruell. 1996. Comparison of non-planar and co-planar PCB congener partitioning in seawater and bioaccumulation in blue mussels (*Mytilus edulis*). Environmental Toxicology and Chemistry 15 (9): 1517-1523.

Nelson, W.G., B.J. Bergen, S.J. Benyi, G. Morrison, R.A. Voyer, C.J. Strobel, S. Rego, G. Thursby, and C.E. Pesch. 1996. New Bedford Harbor long-term monitoring assessment report: Baseline sampling. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, ORD, Atlantic Ecology Division, Narragansett, RI. EPA/600/R-96/097.

Nelson, W.G., B.J. Bergen, and D.J. Cobb. 1995. Comparison of PCB and trace metal bioaccumulation in the blue mussel, *Mytilus edulis*, and the ribbed mussel, *Modiolus demissus*, in New Bedford Harbor, MA. Environmental Toxicology and Chemistry 14 (3): 513-521.

Nelson, W.G. and D.J. Hansen. 1991. Development and use of site-specific chemical and biological decision criteria for assessing the New Bedford Harbor pilot dredging project. Environmental Management 15(1): 105-112.

MATTHEW C. NICHOLSON
Ecologist
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B.S., Natural Resources Science, University of Rhode Island, Kingston, RI, 1984
M.S., Natural Resources Science, University of Rhode Island, Kingston, RI, 1988
Ph.D., Wildlife Ecology, University of Alaska, Fairbanks, Fairbanks, AK, 1995

Employment:

2002-present	Ecologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1998-2001	Assistant Professor, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL
1996-1998	Research Assistant Professor, Department of Natural Resources Science, University of Rhode Island, Kingston, RI
1992-1996	Postdoctoral Fellow in Mammalian Ecology, Center for Vector-borne Disease Research, University of Rhode Island, Kingston, RI

Research Expertise and Skills Relative to Agency Needs:
Matt is a landscape ecologist with experience in the application of geographic information systems and other spatial monitoring and analysis tools to the study and conservation of nature. His expertise includes monitoring and assessing spatial patterns in nature and quantifying wildlife-habitat relationships.

Selected Appointments/Honors/Major Awards:
Consultant to Grupo Lobo in efforts to conserve the Iberian Wolf in Portugal
Phi Kappa Phi honor society
Centers for Disease Control panel to develop a national Lyme disease risk map
Postgraduate Internship with Oak Ridge Institute for Science and Education
Review Panelist, EPA Science to Achieve Results (STAR) Fellowship Grant Program
Reviewer for Alces, California Wildlife Conservation Bulletin, Journal of Mammalogy

Selected Recent Publications:
Kie, J.G., R.T. Bowyer, M.C. Nicholson, B. B. Boroski, and E. R. Loft. 2002. Landscape heterogeneity at differing scales: effects on spatial distribution of mule deer. Ecology 83: 530-544.

Bowyer, R.T., M.C. Nicholson, E.M. Molvar, and J.B. Faro. 1999. Moose on Kalgin Island: are density-dependent processes related to harvest? Alces 35: 73-89.

Nicholson, M.C., R.T. Bowyer, and J.G. Kie. 1997. Habitat selection and survival of mule deer: tradeoffs associated with migration. Journal of Mammalogy, 78: 483-504.

Mather, T.N., M. C. Nicholson, E.F. Donnelly, and B.T. Matyas. 1996. An entomological index to human risk of Lyme disease. American Journal of Epidemiology, 144: 1066-1069.

Mather, T.N., M.C. Nicholson, R. Hu, and N.J. Miller. 1996. Entomological correlates of *babesia microti* prevalence in an area where *ixodes scapularis* (*acari: ixodidae*) is endemic. Journal of Medical Entomology, 33: 866-870.

Nicholson, M.C., and T.N. Mather. 1996. Evaluating Lyme disease risks using geographic information systems and geospatial analytical methods. Journal of Medical Entomology, 33: 711-720.

Bleich, V.C., R.T. Bowyer, A.M. Pauley, M.C. Nicholson, and R.W. Anthes. 1994. Mountain sheep *ovis canadensis* and helicopter surveys: ramifications for the conservation of large mammals. Biological Conservation, 70: 1-7.

CURT NORWOOD
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B.S., Mathematics, Rensselaer Polytechnic Institute, Troy, NY, 1970
M.S, Geochemistry, Brown University, Providence, RI, 1974
Ph.D., Biological Sciences, University of Rhode Island, Kingston, RI, 1995

Employment:

1974-present	Research Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

Curt is an analytical biochemist with expertise in mass spectrometry, capillary electrophoresis, gas chromatography, high pressure liquid chromatography and various types of sample preparation. His research interests include petroleum hydrocarbons, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, dioxins, DNA adducts, endocrine disrupting chemicals, and nutrients. His mathematical skills include various statistical methods and modeling.

Selected Appointments/Honors/Major Awards:

Member, American Society of Mass Spectrometry
U.S. EPA Science and Technology Achievement Award, 1997

Selected Recent Publications:

Barry, JP, C. Norwood, and P. Vouros. 1996. Detection and identification of benzo[a]pyrene diolepoxide adducts to DNA utilizing capillary electrophoresis-electrospray mass spectrometry. Analytical Chemistry 68:1432-1438.

Norwood, C. and P. Vouros. 1994. DNA modifications: investigations by mass spectrometry. In Mass Spectrometry: Clinical and Biomedical Applications, Volume 2, D.M. Desiderio (ed.) Plenum Press, New York, NY, pp. 89-133.

Norwood, C., E. Jackim, and S. Cheer. 1993. DNA adduct research with capillary electrophoresis. Analytical Biochemistry 213: 194-199.

FRANK A. OSTERMAN
Physical Science Technician
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B.A., General Studies: Rhode Island College, 1984

Employment:

1975-present	Physical Science Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1967-1975	Biological Laboratory technician, National Marine Water Quality Laboratory West Kingston, R.I.

Research Expertise and Skills Relative to Agency Needs:
Frank is a physical science technician with experience in chemical analytical techniques and environmental sampling. His current interest is in the area of aquatic ecosystems.

Selected Appointments/Honors/Major Awards:
U.S. EPA Superior Accomplishment Recognition, 1999

Selected Recent Publications:

Lake, J.L., R. McKinney, F. Osterman, R. Pruell, J. Kiddon, S. Ryba, and A. Libby. 2001. Stable nitrogen isotopes as indicators of anthropogenic activities in small freshwater systems. Canadian Journal of Fisheries and Aquatic Sciences 58(5): 870-878.

Lake, J.L., R. McKinney, F. Osterman, and C. Lake, 1996. C-18 coated silica particles as a surrogate for benthic uptake of hydrophobic compounds from bedded sediment. Environ. Toxicol. Chem. 15: 2284-2289.

Lake, J.L., R. McKinney, C. Lake, F. Osterman, and J. Heltshe. 1995. Comparisons of patterns of polychlorinated biphenyl congeners in water, sediment, and indigenous organisms from New Bedford Harbor Massachusetts. Arch. Environ. Contam. Toxicol. 29: 207-220.

Lake, J.L., R. Pruell, and F. Osterman, 1992. An examination of dechlorination processes and pathways in New Bedford Harbor sediments. Mar. Environ. Res. 33: 31-47.

MARGUERITE C. PELLETIER
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B.A., Aquaculture and Fisheries Technology, University of Rhode Island, Kingston, RI, 1989
M.S., Biological Sciences, University of Rhode Island, Kingston, RI, 1995
Ph.D. studies, Natural Resources, University of Rhode Island, Kingston, RI, anticipated graduation: 2006

Employment:

1995-present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1993-1995	Biologist/Task Manager, Science Applications International Corporation (SAIC), Narragansett, RI
1990-1993	Biologist, Science Applications International Corporation (SAIC), Environmental Testing Center, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Marguerite (Peg) is a marine biologist with expertise in development of toxicity identification evaluation procedures, and use of multivariate statistical procedures to assess benthic community condition. Most recently, she has been involved in the development of methods to allow the diagnosis of impacts to estuarine waterbodies in support of the TMDL process.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry
Member American Association for the Advancement of Science
Diagnostics Core Workgroup member
U.S. EPA Science and Technology Achievement Awards, 1999 and 2001

Selected Recent Publications:
Ho, K.T., R.M. Burgess, M.C. Pelletier, J.R. Serbst, S.A. Ryba, M.G. Cantwell, A. Kuhn, and P. Raczeloski. 2002. An overview of toxicant identification in sediments and dredged materials. Marine Pollution Bulletin 44: 286-293.

Pelletier, M.C., K.T. Ho, M. Cantwell, A. Kuhn-Hines, S. Jayaraman, and R. Burgess. 2001. Use of *Ulva lactuca* to identify ammonia toxicity in marine and estuarine sediments. Environmental Toxicology and Chemistry 20: 2852-2859.

Pelletier, M.C., R.M. Burgess, J.R. Serbst, M. Cantwell, K.T. Ho, and S. Ryba. 2000. Importance of maternal transfer of photo-reactive PAHs from benthic adults bivalves to their pelagic larvae. Environmental Toxicology and Chemistry 19: 2691-2698.

Ho, K., L. Patton, J.S. Latimer, R.J. Pruell, M. Pelletier, R. McKinney, and S. Jayaraman. 1999. The chemistry and toxicity of sediment affected by oil from the North Cape spilled into Rhode Island Sound. Marine Pollution Bulletin 38: 314-323.

Ho, K.T., A. Kuhn, M.C. Pelletier, T.L. Hendricks, and A. Helmstetter. 1999. pH Dependent toxicity of five metals to three marine organisms. Environ. Toxicol. 14: 235-240.

Pelletier, M.C., R.M. Burgess, K.T. Ho, A. Kuhn-Hines, R. McKinney, and S. Ryba. 1997. Phototoxicity of individual PAHs and petroleum to marine invertebrate larvae and juveniles. Environmental Toxicology and Chemistry 16(10): 2190-2199

KENNETH T. PEREZ
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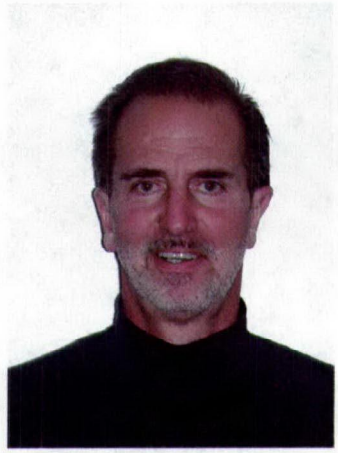

B.S., Biology, SUNY, Stony Brook, 1965
M.S., Zoology, University of North Carolina, Raleigh, 1969
Ph.D., Zoology, University of North Carolina, Raleigh, 1971

Employment:

1973-present	Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1971-1973	Ford Foundation Fellow, University of British Columbia, Canada

Research Expertise and Skills relative to Agency Needs:
Ken is an ecologist with experience in the development and application of living physical models to assess the ecological effects and fate of toxic chemicals in aquatic environments. Also, Ken has developed estuarine experimental methods to discern anthropogenic point source effects from both natural factors and materials from non-point sources.

Selected Appointments/Honors/Major Awards:
Member of Ecological Society of America
Reviewer for NOAA , NSF, SETAC and Organization for Economic Cooperation and Development Test Guidelines Program, OPPTS, U.S. EPA
Adjunct Professor, Dept. Natural Resources, University of Rhode Island
NRC Research Associateship Program, Ecology
U.S.EPA Science and Technology Awards, 1990, 1991, 1995, 1999

Selected Recent Publications:
Perez, K.T., E.W. Davey, R.H. Moore, P.R. Burn, M.S. Rosol, J.A. Cardin, R.L. Johnson, and D.N. Kopans. 1999. Application of computer-aided tomography (CT) to the study of estuarine benthic communities. Ecol. Appl. 9(3): 1050-1058.

Perez, K.T. 1995. Role and Significance of scale to ecotoxicology. Ecological Toxicity Testing, J. Cairns, Jr. and B.R. Niederlehner eds., Scale, Complexity and Relevance, Chapter 4, pp. 49-72, Lewis Publishers, Boca Raton, FL.

Perez, K.T., G.E. Morrison, E. W. Davey, N.F. Lackie, A.E. Soper, R.J. Blasco, D.L. Winslow, R.L. Johnson, P.G. Murphy, and J.F. Heltshe. 1991. Influence of size on fate and ecological effects of Kepone in physical models. Ecol. Appl. 1(3): 237-248.

Davey, E.W., K.T. Perez, A.E. Soper, N.F. Lackie, G.E. Morrison, R.L. Johnson, and J.F. Heltshe. 1990. Significance of the surface microlayer to the environmental fate of di(2-ethylhexy) phthlate predicted from a marine microcosm. Mar. Chem. 31: 231-269.

Perez, K.T., G.E. Morrison, N.F. Lackie, C.A. Oviatt, S.W. Nixon, B.A.Buckley, and J.F. Heltshe. 1977. The importance of physical and biotic scaling to the experimental simulation of a coastal marine ecosystem. Helgol. Wiss. Meeresunters 30: 144-162.

CAROL E. PESCH
Research Aquatic Biologist
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B.S., Biology, Marietta College, Marietta, Ohio, 1967
M.S., Biology, Purdue University, 1968

Employment:

1970-present	Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1968-1970	Scientist, Immunology Dept., Burroughs Wellcome, Tuckahoe, NY

Research Expertise and Skills Relative to Agency Needs:

Carol is a marine toxicologist with expertise in developing sediment testing protocols and culture methods for marine polychaetes. Her recent work has focused on developing historical ecology as an educational tool for scientists, managers, and the general public, and to be used as a community-based approach to environmental protection.

Selected Appointments/Honors/Major Awards:

U.S. EPA Bronze Medal for Development of a Technically Rigorous Basis to Assess Environmental Risk of Metals in Sediments Using AVS:SEM and Interstitial Water Metal Concentrations, 1999

U.S. EPA CBEP Champion Award for Significant Contributions to Community-based Approaches to Environmental Protection, 1996

U.S. EPA Science and Technology Achievement Awards, 1980, 1981, 1982, 1998

Member Standard Methods Committee, to review and update *Standards Methods for the Examination of Water and Wastewater*, 1982 - present

Member Estuarine Research Federation

Past Member Society of Environmental Toxicology and Chemistry

Reviewer for Environment Canada and Environmental Protection Department, Hong Kong Special Administration Region Government for polychaete sediment test methods

Selected Recent Publications:

Pesch, C.E. and J. Garber. 2001. Historical Analysis, a valuable tool in community-based environmental protection. Marine Pollution Bulletin 42: 339-349.

Pesch, C.E., R.A. Voyer, J. Copeland, G. Morrison, and J. Lund. 2001. Imprint of the Past: Ecological History of New Bedford Harbor. U.S. EPA Region 1, New England, EPA /901-R-01-003.

Pesch, C.E. Imprint of the Past: Ecological History of New Bedford Harbor. www.epa.gov/nbh

Voyer, R. A., C.E. Pesch, J. Garber, J. Copeland, and R.Comeleo. 2000. New Bedford, Massachusetts: A story of urbanization and ecological connections. Environmental History 5: 352-377.

Hansen, D.J., W.J. Berry, J.D. Mahony, W.S. Boothman, D.M. Di Toro, D.L. Robson, G.T. Ankley, D. Ma, Q. Yan, and C.E. Pesch. 1996. Predicting the toxicity of metal-contaminated field sediments using interstitial concentration of metals and acid-volatile sulfide normalizations. Environ. Toxicol. Chem. 15: 2080-2094.

Pesch, C.E., D.J. Hansen, W.S. Boothman, W.J. Berry, and J.D. Mahony. 1995. The role of acid-volatile sulfide and interstitial water metal concentrations in determining bioavailability of cadmium and nickel from contaminated sediments to the marine polychaete *Neanthes arenaceodentata*. Environ. Toxicol. Chem. 14: 129-141.

Pesch, C.E., W.R. Munns, and R. Gutjahr-Gobell. 1991. Effects of a contaminated sediment on life history traits and population growth rate of *Neanthes arenceodentata* (Polychaeta:Nereidae) in the laboratory. Environ. Toxicol. Chem. 10: 805-815.

GERALD PESCH
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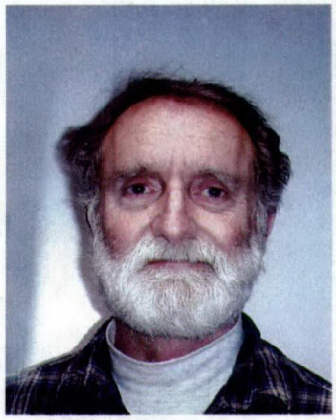

B.S., Biology, Queens College, City University of New York, 1963
M.S., Biological Oceanography, University of Rhode Island, 1966
Ph.D., Biological Oceanography, University of Rhode Island, 1972
M.B.A., Executive MBA Program, University of Rhode Island, 1994

Employment:

1997-present	Research Aquatic Biologist, Atlantic Ecology Division, National Health and Environmental Effects Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1996	Regional Scientist, Office of the Regional Administrator, Region I, U.S. EPA, Boston, MA
1989-1995	Chief Ecological Response Branch, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1972-1989	Research Aquatic Biologist, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Jerry has a background in marine ecology and oceanography as well as marine monitoring and assessment. His work has also focused on working with other EPA/ORD facilities, EPA Office of Water and the Regional Offices on practical applications of science & technology for priority issues in the coastal environment.

Selected Appointments/Honors/Major Awards:
Chair, Regional Association for Research on the Gulf of Maine Policy Board
Adjunct Professor, Graduate School of Oceanography, URI
NY/NJ Harbor Estuary Program Management Committee
Past Chair, OEPER Promotion Review Board
Past member of URI's Institutional Biosafety Committee.
Past member of the EPA/COE Technical Committee on Criteria for Dredged and Fill Material
U.S. EPA Outstanding/Exceptional ORD Technical Assistance to Regions or Program Offices, EMAP Survey Design Team, 2001
U.S. EPA Bronze Medal for First National Coastal Condition Survey, 2001
U.S. EPA Science and Technology Achievement Award, 1981

Selected Publications:
Pawcutuck Watershed Partnership. 1998. The Pawcutuck watershed report. United States Environmental Protection Agency, Region I, Boston, MA.

MacGregor, J., L .D. Claxton, J. Lewtas, R. Jensen, W.R. Lower, and G.G. Pesch. 1994. Monitoring environmental genotoxicants, Chap. 5. In Methods for Genetic Risk Assessment, D.J.Brusick (ed.), Lewis Publishers, Boca Raton, FL, pp. 171-243.

Gentile, J. H., G. G. Pesch, K.J. Scott, W.G. Nelson, W.R. Munns, and J.M. Capuzzo. 1990. Bioassessment methods for determining the hazards of dredged material disposal in the marine environment. In In Situ Evaluation of Biological Hazards of Environmental Pollutants. S.S.Sandhu, W.R.Lower, F.J.deSerres, W.A. Suk, and R.R.Tice, (eds.) Plenum Press, New York, pp. 31-47.

Pesch, G. G.,. 1990. Sister chromatid exchange and genotoxicity measurements using polychaete worms. Reviews in Aquatic Sciences, Vol.2(1), pp. 19-25.

TOM PHEIFFER
Environmental Scientist
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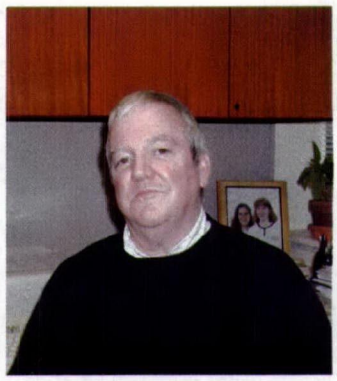

B.S., Agronomy, Delaware Valley College, Doylestown, PA 1966
M.A., Education, Lehigh University Bethlehem, PA 1967

Employment:

1995-present	Environmental Scientist (MAIA), Atlantic Ecology Division, National Health and Environmental Effects Laboratory, ORD, U.S. EPA, Fort Meade, MD
1991-1995	National Environmental Service Officer, Office of the Administrator (Regional Operations), U.S. EPA, Washington, DC
1990-1991	Environmental Scientist, Office of Modeling, Monitoring Systems, and Quality Assurance, Office of Research and Development, U.S. EPA, Washington DC
1985-1990	Technology Transfer Director, Office of Solid Waste and Emergency Response, U.S. EPA, Washington, DC
1980-1985	National Program Manager, Municipal Wastewater Research, Office of Research and Development, U.S. EPA, Washington DC
1976-1980	Technical Coordinator, Chesapeake Bay Program, Region 3, U.S. EPA, Annapolis, MD

Research Expertise and Skills Relative to Agency Needs:
Tom is a senior environmental scientist with expertise in environmental monitoring design and implementation. He has special expertise in conducting ground-water and surface-water studies.

Selected Appointments/Honors/Major Awards:
U.S. EPA Silver Medal for ORD Laboratory Study, 1992
U.S. EPA Bronze Medal for the MAIA Integrated Assessment Team, Region III, 1999
Numerous Citations of Recognition for leadership in conducting assessments radium and cancer concerns in Anne Arundel County, Md by Maryland Legislature and AA County Health Department

Sected Recent Publications:
Bolton, D.A.,T. Pheiffer, and J. Grace. 2000. Radium in Maryland coastal plain ground water: an emerging issue resulting from a multi-agency study of carcinogens. In Well Water, Proceedings of NWQMC National Monitoring Conference.

RICHARD J. PRUELL
Research Chemist
401-782-3091
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B.A., Biology, Merrimack College, North Andover, MA, 1974
M.S., Marine Biology, Southeastern Massachusetts University, North Dartmouth, MA, 1977
Ph.D., Chemical Oceanography, University of Rhode Island, Kingston, RI, 1984

Employment:

1995-present	Research Chemist, Atlantic Ecology Division, National Health and Environmental Effects Laboratory, ORD, U.S. EPA, Narragansett, RI
1994-1995	Chief, Exposure Research Branch, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1987-1994	Research Chemist, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1984-1987	Senior Chemist, Science Applications International Corporation (SAIC), Narragansett, RI
1984-1984	Laboratory Automation Specialist, Computer Sciences, Narragansett, RI
1978-1984	Marine Research Assistant, Graduate School of Oceanography, University of Rhode Island, Kingston, RI
1976-1977	Research Biologist, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Richard is a research chemist with expertise in the biogeochemistry of organic contaminants in the marine environment and the use of stable isotopes to study ecological questions in the marine environment.

Selected Appointments/Honors/Major Awards:
U.S. EPA Science and Technology Achievement Awards, 1995, 2000 and 2001
Adjunct Professor of Oceanography, Graduate School of Oceanography, University of Rhode Island
Organizing committee for the National Sediment Bioaccumulation Conference, 1996
Steering Committee for workshop on "PCBs in Fish Tissues" sponsored by EPA's Office of Water, 1990
U.S. EPA Bronze Medal for work done on the Quincy Bay Study, 1989
Expert Testimony - New Bedford Harbor Superfund Litigation, 1988
Member of the American Chemical Society

Selected Recent Publications:
Pruell, R.J., B.K. Taplin, and K. Cicchelli. Stable isotope ratios in archived striped bass scales suggest changes in trophic structure. Fisheries Management and Ecology. in press.

Lake, J.L., R.A. McKinney, F.A. Osterman, R.J. Pruell, J. Kiddon, S.A. Ryba, and A.D. Libby. 2001. Stable nitrogen isotopes as indicators of anthropogenic activities in small freshwater systems. Canadian Journal of Fisheries and Aquatic Science 58: 870-878.

Mills, L.J., R.E. Guthajr-Gobell, R.A. Haebler, D.J. Borsay Horowitz, S. Jayaraman, R.J. Pruell, R.A. McKinney, G.R. Gardner, and G.E. Zaroogian. 2001. Effects of anti-androgenic (*p,p*'-DDE) and two estrogenic (*o,p*'-DDT; octylphenol) chemicals on indicators of endocrine status in juvenile summer flounder (*Paralichthys dentatus*). Aquatic Toxicology 52: 157-176.

Jayaraman, S., R.J. Pruell, and R. McKinney. 2001. Extraction of organic contaminants from marine sediments and tissues using microwave energy. Chemosphere 44: 181-191.

Pruell, R.J., B.K. Taplin, D.G. McGovern, and S.B. Norton. 2000. Organic contaminant distributions in sediment, polychaetes (*Nereis virens*) and the American lobster (*Homarus americanus*) in a laboratory food chain experiment. Marine Environmental Research 49:19-36.

STEVEN A. REGO
Biologist
401-782-3177
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B.S., Natural Resources Management/Wildlife Biology, University of Rhode Island, Kingston, RI, 1990

Employment:

1995-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1991-1994	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

Steve is a biologist with expertise in marine science, ecology and GIS, particularly in developing and applying spatial methodologies using Geographic Inforation Systems (GIS) for wildlife and marine water research. He has specialized experience with oceanographic sensing and data logging instrumentation and technologies.

Selected Appointments/Honors/Major Awards:

U.S. EPA, Community Based Environmental Protection Champion Award - New Bedford Harbor, MA, Superfund Remediation, 1996

Selected Recent Publications:

Burgess, R.M., B.A. Rogers, S. Rego, J. Corbin, G.E. Morrison. 1994. Sand spiked with copper as a reference toxicant material for sediment toxicity testing: a preliminary evaluation. Environmental Contamination and Toxicology 26: 163-168.

Hale, S.S., M.M Hughes, J.F. Paul, R.S. McAskill, S.A. Rego, D.R. Bender, N.J. Dodge, T.L. Richter, and J.L. Copeland. 1998. Managing scientific data: the EMAP approach. Environmental Monitoring and Assessment 51: 429–440.

Nelson, W.G., B.J. Bergen, S.J. Benyi, G. Morrison, R.A. Voyer, C.J. Strobel, S. Rego, G. Thursby, and C.E. Pesch. 1996. New Bedford Harbor long-term monitoring assessment report: baseline sampling. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division (AED), EPA/600/R-96/097.

KENNETH J. ROCHA
Biologist
401-782-9612
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B.S., Biology, University of Massachusetts, MA 1985

Employment

1997-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Biological Science Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1991-1994	Biologist / Quality Assurance Officer, New England Bioassay Inc., Manchester, CT
1986-1990	Aquatic Biologist, Springborn Laboratories Inc., Wareham, MA

Research Expertise and Skills Relative to Agency Needs:
Ken has a background in marine ecology and aquatic toxicology. His current research interest is in the environmental monitoring and assessment of estuaries.

Selected Appointments/Honors/Major Awards:
Partnership Award, Coastal America, Eelgrass Mapping Team, 1997

Selected Recent Publications:

Johnson, R.L., K. Perez, E. Davey, J. Cardin, K. Rocha, E. Dettmann, and J.Heltshe. Discriminating the effects of anthropogenic point sources from salinity and nitrogen loading using benthic communities: A comparative estuarine method. in preparation.

Davey, E.W., K. Perez, J. Cardin, R. Johnson, and K. Rocha. Application of 3D computer-aided tomography to the quantitative differentiation of marine benthic habitats. in preparation.

NORMAN I. RUBINSTEIN
Life Scientist
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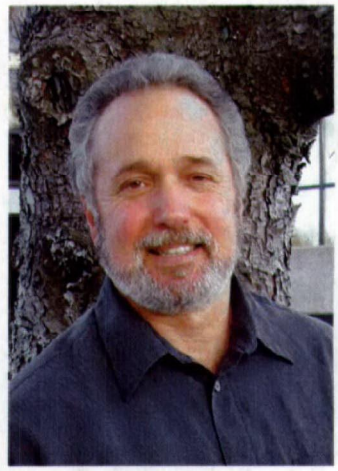

B.S., Biology, City College of New York, 1968
M.S. Marine Biology, University of West Florida, 1976

Employment:

2000-present	IPA: University of Rhode Island, Coastal Institute, Department of Natural Resource Sciences.
1995-2000	Director (Acting), Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1994-1995	Deputy Director, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1989-1994	Chief Exposure Research Branch, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1983-1989	Research Aquatic Biologist, Environmental Research Laboratory, ORD, U.S. EPA, Narragansett, RI
!979-1983	Research Aquatic Biologist, Environmental Research Laboratory, ORD, U.S. EPA, Gulf Breeze, FL

Research Expertise and Skills Relative to Agency Needs:
Norm is a marine biologist and research manager with expertise in developing and managing environmental monitoring and assessment programs. He serves as the Agency's representative on the Cooperative Ecosystems Studies Unit, National Coordinating Council. Norm also serves as a national and international expert on the ecological impacts of dredging and dredged material disposal in aquatic systems.

Selected Appointments/Honors/Major Awards:
Election to Sigma Xi Honor Society, 1976
U.S. EPA Special Achievement Award, 1983, 1984, 1985, 1986, 1988, 1991, 1994, 1995, 1996
U.S. EPA Scientific and Technological Achievement Award (Level III), 1985
U.S. EPA Scientific and Technological Achievement Award (Honorable Mention), 1994
U.S. EPA Bronze Medal, 1994
Lee Thomas Award for Excellence in Management, 1999

Selected Recent Publications:
Rubinstein, N.I. 1996. Reference sediment approach for determining sediment contamination. Proceedings of the National Sediment Bioaccumulation Conference, Bethesda, MD.

Pruell, R.J., N.I. Rubinstein, B.K. Taplin, J.A. LiVosi and R.D. Bowen. 1993. Accumulation of polychlorinated organic compounds from sediment by three infaunal benthic marine species. Archives of Environmental Contamination and Toxicology 24:290-297.

Munns, W.R., Jr. and N.I. Rubinstein. 1990. Environmental risks of ocean disposal. In: Cleaning Up Our Coastal Waters: An Unfinished Agenda (M.T. Southerland, ed.), Dynamac, Rockville, MD, pp 515-531.

Rubinstein, N.I., R.J. Pruell, B. Taplin, J. LiVolsi, and C. Norwood. 1990. Bioavailability of 2,3,7,8-TCDD, 2,3,7,8-TCDF and PCBs to marine benthos from Passaic River sediments. Chemosphere 20:1097-1102.

STEPHAN A. RYBA
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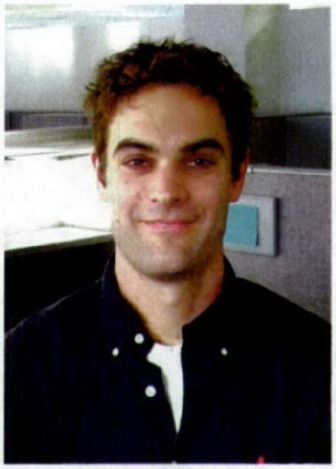

B.S., Resource Development, University of Rhode Island, Kingston, RI, 1992

Employment:

1997-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1997	Physical Science Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1994-1995	GC Technician, Laboratory Resources, Inc., Eastern Scientific Division, Brooklyn, CT.
1992-1994	Biologist, Northeast Environmental Testing Laboratories, Inc., Cranston, RI
1991	Research Assistant, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

Stephan is involved in research focusing on the utilization of stable isotope levels to assess the trophic position of fish and aquatic dependent wildlife and relating contaminant (e.g. Hg) data in order to measure the extent of biomagnification. This work will be used to develop predictive relationships for estimating fish contaminant levels in untested systems, and thereby allow for the development of an exposure field for piscivorus wildlife so that impacts on mink, snapping turtle and bird populations can be examined. He is also working as part of a research team focusing on the development of diagnostic tools for the identification of toxic stressors in the environment. .

Selected Appointments/Honors/Major Awards:

Member of North Atlantic Chapter of Society of Environmental Toxicology and Chemistry.

Selected Recent Publications:

Ryba, S.A. and R.M. Burgess. 2002. Effects of sample preparation on the measurement of organic carbon, hydrogen, nitrogen, sulfur and oxygen concentrations in marine sediments. Chemosphere 48: 139-147.

McKinney, R., J.L. Lake, M.A. Charpentier, and S. Ryba. 2002. Using mussel isotope ratios to assess anthropogenic nitrogen inputs to freshwater ecosystems. Environmental Monitoring and Assessment 74: 167-192.

Ho, K.T., R.M. Burgess, M. Pelletier, J. Serbst, S.A. Ryba, M. Cantwell, A. Kuhn, and P. Raczelowski. 2002. An overview of toxicant identification in sediments and dredged materials. Marine Pollution Bulletin 44: 286-293.

Lake, J.L.,R. McKinney, F. Osterman, R. Pruell, J. Kiddon, A. Libby, and S. Ryba. 2001. Stable nitrogen isotopes as indicators of anthropogenic activities in small freshwater systems. Canadian Journal of Fisheries and Aquatic Sciences 58: 870-878.

Burgess, R.M., S.A. Ryba, M.G. Cantwell, and J.L. Gundersen. 2001. Exploratory analysis of the effects of particulate characteristics on the variation in partitioning of nonpolar organic contaminants to marine sediments. Water Research 35: 4390-4404.

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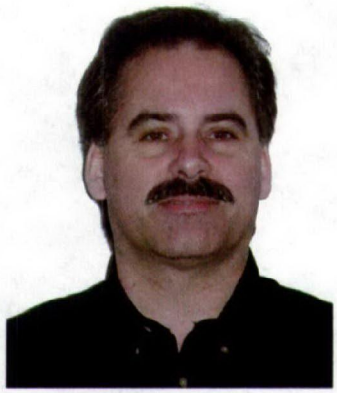

B.S., Biology, University of Azores, Portugal, 1980
M.S., Food Science, University of Rhode Island, 1989
Ph.D., Biological Sciences, University of Rhode Island, 1994

Employment:

1996-present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1997-1999	Laboratory Supervisor, Ceimic Corporation, Narragansett, RI
1996-1997	Senior Chemist, Ceimic Corporation, Narragansett, RI
1994-1996	Coordinator of Brazilian Operations, Ceimic Analizes Ambientais, Sao Paulo, Brazil
1992-1994	Analytical Chemist, Ceimic Corporation, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Antelmo is studying the effects of nutrient loadings on phytoplankton assemblages using CHEMTAX and HPLC pigment analysis and the relationships between nutrient enrichments and food webs.

Selected appointments/Honors/Major Awards:
Member Society for Environmental Toxicologists and Chemists
Member Estuarine Research Federation

Selected Publications:
Santos, A. and S. Jayaraman. 2002. High performance liquid chromatographic analysis of phytoplankton pigments using a C16-Amide column, in review.

Chmura, G.L., A. Santos, V. Pospelova, Z. Spasojevic, R. Lam, and J. Latimer. 2002. Changes in estuarine primary production in response to watershed forest clearance, urbanization and industrialization. Science of the Total Environment, in press.

JONATHAN R. SERBST
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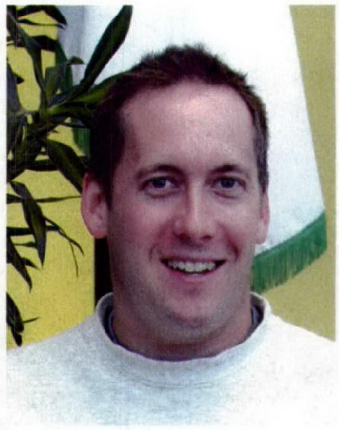

B.S., Zoology, University of Rhode Island, Kingston, RI, 1989

Employment:

1995-present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1991-1995	Biologist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:

Jonathan is a Biologist with the United States Environmental Protection Agency, Office of Research and Development, Atlantic Ecology Division in Narragansett, Rhode Island. Jonathan holds a B.S. in Zoology from the University of Rhode Island. His research has focused primarily on the marine toxicology and ecology, test method development, chronic and acute testing of contaminated sediments, influences of environmental stressors on community structure, population assessment of estuarine fish and amphipods, environmental monitoring of coastal estuaries. Additionally, Jonathan is responsible for the culture of test organisms.

Selected Appointments/Honors/Major Awards:

Selected Recent Publications:

Serbst, J.R., R.M. Burgess, A Kuhn, P.E. Edwards, M.G. Cantwell, M.C. Pelletier, and W.J. Berry. 2002. Interstitial water sampling of metals: precision of the dialysis (Peeper) method. Arch Environ Contam Toxicol, submitted.

Kuhn, A., W.R. Munns, Jr., J. Serbst, P. Edwards, P. Edwards, M.G. Cantwell, T. Gleason, M.C. Pelletier, and W. Berry. 2002. The chronic effects of cadmium on the amphipod, *Ampelisca abdita*. Environmental Toxicology and Chemistry 21: 865-874.

Ho, K.T., R.M. Burgess, M.C. Pelletier, J.R. Serbst, S.A. Ryba, M.G. Cantwell, A. Kuhn, and P. Raczelowski. 2002. An overview of toxicant identification in sediments and dredged materials. Mar. Poll. Bull. 44: 286-293.

Kuhn, A., W.R. Munns, Jr., D. Champlin, R. McKinney, J. Serbst, M. Tagliabue, and T. Gleason. 2001. Evaluation of the efficacy of extrapolation population modeling to predict the dynamics of *Americamysis bahia* populations in the laboratory. Environmental Toxicology and Chemistry 20: 1.

Pelletier, M.C., R.M. Burgess, M.G. Cantwell, J.R. Serbst, K.T. Ho, and S.A. Ryba. 2000. Importance of maternal transfer of the photoreactive polycyclic aromatic hydrocarbon fluoranthene from benthic adult bivalves to their pelagic larvae. Environmental Toxicology and Chemistry 19: 2691–2698.

Nacci, D.E., J.R. Serbst, T.R. Gleason, S. Cayula, G.B. Thursby, W.R. Munns, Jr., and R.K. Johnston. 2000. Biological responses of the sea urchin, *Arbacia punctulata*, to lead contamination for an estuarine ecological risk assessment. Journal of Aquatic Ecosystem Stress and Recovery 7: 187-199.

Ho, K.T., A. Kuhn, M. Pelletier, F. McGee, R.M. Burgess, and J. Serbst. 2000. Sediment toxicity assessment: comparison of standard and new testing designs. Archives of Environmental Contamination and Toxicology 39: 462-468.

Burgess, R., M.G. Cantwell, M.C. Pelletier, K.T. Ho, J.R. Serbst, H.F. Cook, and A. Kuhn. 2000. Development of a toxicity identification evaluation (TIE) procedure for characterizing metal toxicity in marine sediments. Environmental Toxicology and Chemistry 19: 982 - 991.

Berry, W.J., M. Cantwell, P. Edwards, J. Serbst, and D.J. Hansen. 1999. Predicting the toxicity of sediments spiked with silver in the laboratory. Environmental Toxicology and Chemistry 18: 40-48.

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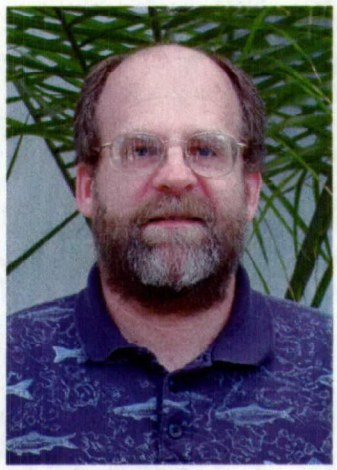

B.S., Biology, State University of New York at Stony Brook, 1976
M.S. Biology, Adelphi University, 1978
Ph.D. Studies, Marine Science, College of William and Mary, 1978 - 1985

Employment:

2002-present	Acting Branch Chief, Ecosystem Analysis & Simulation Branch, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-2002	Biologist/Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1985-1995	Biologist/Senior Biologist, Science Applications International Corporation (SAIC), Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Charles is a marine biologist with expertise in developing and implementing large-scale environmental monitoring programs, and the development of ecological indicators.

Selected Appointments/Honors/Major Awards:
Member of Estuarine Research Federation, Steering Committee for ERF'97 international meeting, Session Chair for ERF '01 Biocriteria Session
U.S. EPA Bronze Medal for Commendable Service, 1997
U.S. EPA Outstanding Performance Award, 1997
U.S. EPA Bronze Medals (2) for Commendable Service, 1998
U.S. EPA Special Accomplishment Recognition Award, 2000
U.S. EPA Bronze Medal for Commendable Service, 2000
U.S. EPA Statesmanship Award, 2002

Selected Recent Publications:
Paul, J.F., K.J. Scott, D.E. Campbell, J.H. Gentile, C.J. Strobel, R.M. Valente, S.B. Weisberg, A.F. Holland, and J.A. Ranasinghe. 2001. Developing and applying a benthic index of estuarine condition for the Virginian Biogeographic Province. Ecological Indicators 1: 83-99.

Paul, J.F., J. Kiddon, C.J. Strobel, B. Melzian, J. Latimer, D. Cobb, D. Campbell, and B. Brown. 2000. Condition of the Mid-Atlantic estuaries: production of a state of the environment report. Environ. Monit. Assess. 63: 115-129.

Strobel, C.J. 2000. Coastal 2000-Northeast Component: Field Operations Manual. U.S Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, RI. EPA/620/R-00/002.

Strobel, C.J. and J. Heltshe. 2000. Dissolved oxygen concentration as an indicator of the extent of hypoxia in estuarine waters. Evaluation Guidelines for Ecological Indicators, L.E. Jackson, J.C. Kurtz, and W.S. Fisher, Eds. US Environmental Protection Agency, Office of Research and Development, Research Triangle Park, NC. EPA/620/R-99/005.

Strobel C.J., H.W. Buffum, S.J. Benyi, and J.F. Paul. 1999. Environmental monitoring and assessment program: current status of Virginian Province (US) estuaries. Environ. Monit. Assess. 56: 1 - 25.

Strobel, C.J., J.F. Paul, and B.S. Brown. 1999. Spatial variability of selected ecological parameters in small estuaries of the Mid-Atlantic region of the United States. Environ. Monit. Assess. 63: 223-236.

US EPA. 1998. Condition of the Mid-Atlantic estuaries. EPA 600-R-98-147. US Environmental Protection Agency, Office of Research and Development, Washington DC. (Prepared by J.F. Paul, C.J. Strobel, D. Cobb, D. Campbell, J. Latimer, J. Kiddon, B. Melzian, and B. Brown).

Strobel, C.J., H.W. Buffum, S.J. Benyi, E.A. Petrocelli, and D.J. Keith. 1995. Statistical summary: EMAP-estuaries Virginian Province - 1990 to 1993. U. S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Narragansett, RI. EPA/620/R-94/026.

MARK D. TAGLIABUE
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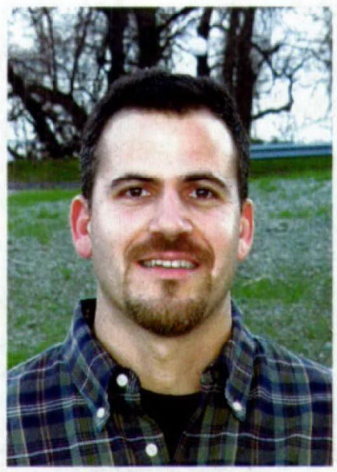

B.S., Biology, University of Rhode Island, Kingston R.I., 1987

Employment:

1995 - Present	Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1995	Biologist, Science Applications International Corporation, Science Applications International Corporation (SAIC), Narragansett, RI
1986-1988	Biologist, University of Rhode Island (Botany Dept.), Kingston RI
1984-1986	Animal Handler/Aquarist, Mystic Marinelife Aquarium, Mystic, CT.

Research Expertise and Skills Relative to Agency Needs:
Nutritional requirements of marine organisms.; culture of marine organisms, including fin fish, invertebrates, and marine macro algae.

Selected Appointments/Honors/Major Awards:
Society of Environmental Toxicologists and Chemists

Selected Recent Publications:

Burgess, R.M., K.T. Ho, M.D. Tagliabue, A. Kuhn, R. Comeleo, P. Comeleo, G. Modica, and G. E. Morrison. 1995. Toxicity characterization of an industrial and municipal effluent discharging into the marine environment. Marine Pollution Bulletin 30: 524-535

Burgess, R.M., R. Comeleo, M. D. Tagliabue, C. Sheehan, A.S. Kuhn-Hines, and D.K. Phelps. 1993. Water column toxicity from contaminated marine sediments: effects on multiple endpoints of three marine species. In Environmental Toxicology and Risk Assessment, ASTM STP 1179. W.G. Landis, A.S. Hughes, and M.A. Lewis (eds.), American Society for Testing and Materials, Philadelphia, PA. pp. 303-315.

BRYAN K. TAPLIN
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B.A., Biology and Geology, University of Rhode Island, Kingston, RI, 1983
M.S., Water Resources, University of Rhode Island, Kingston, RI, 1991

Employment:

1998-present	Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1995-1998	Physical Science Technician, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1995	Chemist, Science Applications International Corporation (SAIC), Narragansett, RI
1985-1988	Research Biologist, University of Rhode Island, Narragansett, RI

Research Expertise and Skills Relative to Agency Needs:
Bryan is a physical scientist with a background in measuring stable isotopes and chemical stressors in ecological systems. His work involves developing chemical and isotopic fingerprints that characterize estuarine and marine habitats for juvenile and adult fish populations. His interest lies in otolith microchemistry and stable isotopic chemistry.

Selected Appointments/Honors/Major Awards:
Member Society of Environmental Toxicology and Chemistry

Selected Recent Publications:

Pruell, R.J., B. Taplin, and K. Cicchelli. Stable isotope ratios in archived Striped Bass scales. Fisheries Management and Ecology. in press.

Taplin, B.K., R. Pruell, R. McKinney, and J. Kiddon. Changes in the $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios in the American lobster, *Homarus americanus*, in response to a change in diet. in preparation.

Meng, L., J. Powell, and B. Taplin. 2001. Using winter flounder growth rates to assess habitat quality across an anthropogenic gradient in Narragansett Bay, RI. Estuaries 24: 576-584.

Meng, L., C. Gray, B. Taplin, and E. Kupcha. 2000. Using winter flounder growth rates to assess habitat quality in Rhode Island's coastal lagoons. Marine Ecology Progress Series 201: 287-299.

Pruell, R.J., B. Taplin, D. McGovern, R. McKinney, and S. Norton, 1999. Organic contaminant distributions in sediments, polychaetes (*Nereis virens*) and the American lobster (*Homarus americanus*) in a laboratory food chain experiment. Marine Environmental Research 48: 1-18.

Gutjahr, R., D. Black, L. Mills, R. Pruell, B. Taplin, and S. Jayaraman. 1999. Feeding the mummichog, *Fundulus heteroclitus*, a diet spiked with non-ortho and mono-ortho substituted polychlorinated biphenyls: accumulation and effects. Environmental Toxicology and Chemistry 18(4): 699-707.

Pruell, R.J., N. Rubinstein, B. Taplin, J. Livolsi, and R. Bowen. 1993. Accumulation of polychlorinated organic contaminants from sediment by three benthic marine species. Archives of Environmental Contamination and Toxicology 24: 290-297.

Tracey, G.A., B.Taplin, D. Cobb, W. Berry, D. Keith, W. Boothman, and N. Rubinstein. 1991. Dredge material assessment methods: evaluation of the Revised Implementation Manual for Section 103 of the Marine Protection Research and Sanctuaries Act of 1972 (PL92-532). Technical report for the Army Corps of Engineers, New York. Environmental Research Laboratory, U.S. EPA, Narragansett, RI.

GLEN B. THURSBY
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B.A., Biology & Art, University of North Carolina, Chapel Hill, NC, 1974
M.S., Botany, University of Florida, Gainesville, FL, 1976
Ph.D., Biological Sciences, University of Rhode Island, Kingston, RI, 1983

Employment:

1995-present	Research Biologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1988-1995	Director, Environmental Testing Center, Science Applications International Corporation (SAIC), Narragansett, RI
1983-1988	Research Assistant Professor, Botany Department, URI, Kingston, RI
1978-1980	Biologist, Environmental Research laboratory, ORD, U.S. EPA, Narragansett, RI
1977-1978	Instructor, Botany Department, URI, Kingston, RI

Research Expertise and Skills Relative to Agency Needs:
Glen is a marine botanist with expertise in the physiological ecology of marine seaweeds, submerged aquatic vegetation (SAV) and saltmarsh plants. He is one of EPA's experts in the development and application of water quality criteria, with a particular emphasis on dissolved oxygen.

Selected Appointments/Honors/Major Awards:
Member Phycological Society of America
Treasurer of Northeast Algal Society, 1997-2002
Reviewer for Environmental Toxicology and Chemistry, U.S. Geological Survey, American Water Works Association, Chemosphere, Rhodora, Journal of Toxicology and Environmental Health, Advances in Evironmental Research, Environmental Pollution, New Hampshire Sea Grant, NOAA, US EPA,
Adjunct Associate Professor, University of Rhode Island, Department of Biological Sciences
U.S. EPA Science and Technology Achievement Awards, 1984 and 1998.
Invited participant in SETAC Pellston workshop on whole effluent toxicity, 1995.
Member of Research Advisory Committee for the Narragansett Bay National Research Reserve, 1997-1998.
CBEP Champion Award for significant contributions to community-based approaches to environmental protection, 1996
U.S. EPA Bronze Medal for Innovation in Water Quality Criteria for the Protection of Aquatic Life: Saltwater Dissolved Oxygen, 2002
U.S. EPA Honor Award for Exceptional/Outstanding ORD Technical Assistance to the Regions or Program Offices, 2002

Selected Recent Publications:
Thursby, G.B., M. Chintala, D. Stetson, C. Wigand, and D. Champlin. 2002. A rapid, non-destructive method for estimating aboveground biomass of salt marsh grasses. Wetlands. in press.
Thursby, G.B., E. Stern, K. Scott, and J. Heltshe. 2000. Survey of toxicity in ambient waters of the Hudson/Raritan estuary USA: Importance of small-scale variations. Environmental Toxicology and Chemistry 19: 2678-2682.
Thursby, G.B., D. Miller, S. Poucher, L. Coiro, W. Munns, and T. Gleason. 2000. Ambient aquatic life water quality criteria for dissolved oxygen (saltwater): Cape Cod to Cape Hatteras. EPA Report No. 822-R-00-012.
Thursby, G.B., J. Heltshe, and K. Scott. 1997. Revised approach to toxicity test acceptability criteria using a statistical performance assessment. Environmental Toxicology and Chemistry 16: 1322-1329.

HENRY A. WALKER
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B.A., Biology, Colby College, Waterville, ME, 1971
M.S., Marine Sciences, University of Massachusetts, Amherst MA, 1976
M.S., Experimental Statistics, University of Rhode Island, Kingston, RI, 1979
PhD, Biological Oceanography, University of Rhode Island, Kingston, RI, 1991

Employment:

1986- present	Research Environmental Scientist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1985-1986	Work Assignment Manager. Science Applications International Corporation
1984-1985	Technical Project Leader. Applied Technology Division, Computer Sciences Corporation
1983-1984	Research Associate. Institute for Statistical and Mathematical Modeling, University of West Florida, Pensacola, Florida

Research Expertise and Skills Relative to Agency Needs:

Henry is a biological oceanographer and statistician with expertise in ecological risk assessment. Recent research has involved developing and applying methods to distinguish between anthropogenic and natural changes in coastal ecosystems for use in integrated assessments of the joint effects in coastal receiving waters of anthropogenic changes in nutrient loading, regional climate variability, and potential consequences of regional climate change.

Selected Appointments/Honors/Major Awards:

U.S. Steering Committee for Global Change Observing System
Steering Committee, Estuarine Research Federation Initiative in Biocomplexity
Member, Adaptation Workgroup of theClimate Change Steering Committee for the New England Governors and Eastern Canadian Premiers
U.S. EPA Bronze Medal for the National Assessment Team for production of the first U.S. National Assessment Report: "Climate Change Impacts on the United States", 2001

Selected Recent Publications:

Walker HA, Keim B, and Arndt MB. 2001. Chapter 3: Natural and anthropogenic factors affecting global and regional climate. In Preparing for a Changing Climate: The New England Regional Assessment Foundations Report. B. Rock (ed.),108 pp.

Walker HA. 2001. Understanding and managing the risks to health and environment from global atmospheric change: a synthesis. Human and Ecological Risk Assessment 7(5): 1195-1209.

Walker, H.A., J. S. Latimer, and E. H. Dettmann. 2000. Assessing the effects of natural and anthropogenic stressors in the Potomac estuary: implications for long-term monitoring. Environmental Monitoring and Assessment, 63: 237-251. EPA Contribution # ERLN-2056.

Najjar, R G., H.A.Walker, P.J. Anderson, E.J. Barron, R. Bord, J. Gibson, V.S. Kennedy, C.G. Knight, P. Megonigal, R. O'Connor, C.D. Polsky, N.P. Psulty, B. Richards, L.G. Sorenson, E. Steele and R.S. Swanson. 2000. The potential impacts of climate change on the Mid-Atlantic coastal region. Climate Research. CR Special 7 14(3): 219-233. EPA Contribution # ERLN-2125.

Keith, D.J., H.A. Walker, and J. F. Paul. 2002. Terrestrial vegetation greenness of the Lower Galveston Bay watershed from satellite remote sensing and its relation to water use and the salinity regime of the Galveston Bay estuary (USA). International Journal of Remote Sensing. 23(5): 905-916.

CATHLEEN WIGAND
Ecologist
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Education:
B.S., Biology, Iona College, New Rochelle, N,Y 1982
M.S., Biology, Adelphi University, Garden City, NY, 1984
Ph.D., Marine Estuarine and Environmental Studies, University of Maryland, College Park, MD, 1994

Employment:

1998 - present	Ecologist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1997 (summer)	Instructor (Wetland Ecology), Graduate School of Environmental Studies, Bard College, Annandale-on-Hudson, NY
1994 - 1997	Postdoctorate Researcher, (Mary Flagler Cary Fellow), Institute of Ecosystems Studies, Millbrook, NY
1994 - 1995	Postdoctorate Researcher, Institute of Biology, Odense University, Odense, Denmark
1990 - 1993	Graduate Research Assistant, Horn Point Environmental Laboratory, University of Maryland, Cambridge, MD
1987 - 1989	Research Assistant (Marine Sciences), State University of NY at Stony Brook, Stony Brook, NY

Research Expertise and Skills Relative to Agency Needs:
Cathy is a wetland ecologist with expertise in developing and applying quantitative methods for assessing the integrity of wetland habitats and the aquatic life use support that they provide.

Selected Appointments/Honors/Major Awards:
EPA Special accomplishment recognition award 8/31/2001
EPA Time-off award for wetlands research efforts 4/24/2001
EPA Special act award 8/27/2000: "Strategy for Evaluating Ecological Integrity of Salt Marshes (APM 552)"
EPA Special act award for leadership role in the wetlands project 1/02/2000
EPA Time-off award for work with Ecological Integrity planning group 9/12/1999
EPA Quality Step Increase 9/27/1998
Mary Flagler Cary Postdoctoral Fellowship 1994-1997
Estuarine Research Federation "Best Student Talk" Award 1984
Iona College Senior Biology Award
Iona College Freshman Chemistry Award 1979
Iona College 4-year academic scholarship 1978-1982

Selected Recent Publications:
Findlay, S., C. Wigand, and W. Nieder. 2002. Submersed macrophyte distribution and function in the tidal freshwater Hudson River. The Hudson River Ecosystem, (ed) J.S. Levinton. in review.

Lackey, R.T., G. Cicchetti, C. Wigand, R. Devereux, J. Macauley, J. Brazner, A. Trebitz, J. Power, and P. Wigington. 2002. Habitat alteration chapter: Aquatic Stressors, Framework and Implementation Plan For Effects Research. Internal EPA - NHEERL document: 1-35.

McKinney, R., W. Nelson, M. Charpentier, and C. Wigand. 2001. Ribbed mussel nitrogen isotope signatures reflect nitrogen sources in coastal salt marshes. Ecological Applications 11: 203-214.

Wigand, C., R. Comeleo, R. McKinney, G. Thursby, M. Chintala, and M. Charpentier. 2001. Outline of a new approach to evaluate ecological integrity of salt marshes. Human and Ecological Risk Assessment 7: 1541 -1554.

Wigand, C., M. Finn, S. Findlay, and S. Fischer. 2001. Submersed macrophyte effects on nutrient exchanges in riverine sediments. Estuaries 3: 398-406.

Van Hoewyk, D., C. Wigand, and P. Groffman. 2001. Endomycorrhizal colonization of *Dasiphora floribunda*, a

native plant of calcareous wetlands in eastern New York State, USA Wetlands 21 431-436
Wigand, C , J Wehr, K Limburg, B Gorham, S Longergan, and S Findlay 2000 Effect of *Vallisneria americana* on community structure and ecosystem function in lake mesocosms Hydrobiologia 418 137-146
Wigand, C and G Thursby 2000 Strategy for evaluating ecological integrity of salt marshes APM 552 Internal EPA - NHEERL document 1-17
Nielsen, S L , I Thingstrup, and C Wigand 1999 Apparent lack of Vesicular Arbuscular Mycorrhiza (VAM) in the seagrasses *Zostera marina* L and *Thalassia testudinum* Banks ex Konig Aquatic Botany 63 261-266
Breitburg, D L , J Baxter, C Hatfield, R Howarth, C Jones, G Lovett, and C Wigand 1998 Understanding effects of multiple stressors ideas and challenges Successes, Limitations and Frontiers in Ecosystem Science, M L Pace and P M Groffman, editors Springer-Verlag, New York 1-499
Christensen, K K , H Jensen, F Andersen, C Wigand, and M Holmer 1998 Interferences between root plaque formation and phosphorus availability for isoetids in sediments of oligotrophic lakes Biogeochemistry 43 107-128
Christensen, K K and C Wigand 1998 Formation of root plaques and their influence on tissue phosphorus content in *Lobelia dortmanna* Aquatic Botany 61 111-122
Holmer, M , H Jensen, K Christensen, C Wigand, and F Andersen 1998 Sulfate reduction in lake sediments inhabited by the isoetid macrophytes *Littorella uniflora* and *Isoetes lacustris* Aquatic Botany 60 307- 324
Templer, P , S Findlay, and C Wigand 1998 Sediment chemistry associated with native and non-native emergent macrophytes of a Hudson River ecosystem Wetlands 18 70-78
Wigand, C , K Christensen, H Jensen, F Andersen, and M Holmer 1998 Endomycorrhizae of isoetids along a biogeochemical gradient Limnology and Oceanography 43 508-515

ELLEN T. ZAMBRANO
Purchasing Agent
401-782-3056
Zambrano.Ellen@epa.gov

A.S., Business Management, Community College of Rhode Island, Warwick, RI

Employment:

2002-present	Simplified Acquisition Contracting Officer, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1998-2002	Procurement Technician for Naval Facilities Engineering Command, Newport, RI
1989-1998	Procurement Technician for Supply Department, Naval Station Newport, Newport, RI

Expertise and Skills Relative to Agency Needs:
Ellen has worked for the Government for 13 years, and has recently started working for the EPA. Her expertise includes purchasing, and construction and facilities support contracting.

Selected Appointments/Honors/Major Awards:
Administrative Employee of the Year for Naval Facilities Engineering Command, Atlantic Division, 2001

GERALD E. ZAROOGIAN
Chemist
401-782-3079
zaroogian.jerry@epa.gov

B.S., Pharmacy, University of Rhode Island, Kingston, RI, 1958
M.S., Microbiology, Purdue University, West Lafayette, IN, 1960
Ph.D., Biochemical Toxicology, Purdue University, West Lafayette, IN, 1963

Employment:

1967-present	Chemist, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, ORD, U.S. EPA, Narragansett, RI
1964-1967	Assistant Professor, University of Rhode Island, Kingston, RI
1963-1964	Biochemical Toxicologist, United Fruit Company, Norwood, MA

Research Expertise and Skills Relative to Agency needs:

Gerald is a biochemical toxicologist with expertise in developing and performing assays and tests to determine the effect of anthropogenic compounds on marine fish and invertebrates.Primary interests focus on physiology and biochemistry of stress , mechanisms of pharmacologically active compounds and biomarkers of sublethal effects. Presently, studies are concentrated on the effect of endocrine disrupting compounds on fish populations with consideration given to extrapolation to human health.

Selected appointments/Honors/major Awards:

Member Society of Environmental Toxicology and Chemistry; Society of Toxicology; AAAS; AIBS; Industrial in Vitro Toxicology; Phi Sigma Society; Sigma Xi; American Pharmaceutical Association and Phi Kappa Phi.
Editorial Board of Bulletin of Environmental Contamination and Toxicology, 1995-present
Reviewer for Environmental Toxicology and chemistry; Canadian Journal of Fisheries and Aquatic Sciences; Cell Biology; Comparative Biochemistry and Physiology; Bulleti of Environmental Contamination and Toxicology and Toxicology
U.S.EPA Science and Technology Achievement Award, 1994
Sustained superior performance awards, 1990, 1994
Special achievement award, ERL, Narragansett, 1984
Employee of the Year, ERL, Narragansett, 1978

Selected Recent Publications:

Zaroogian, G. and C. Norwood. 2002. Glutathione and metallothionein status in an acute response by Mercenaria mercenaria brown cells in vivo. Ecotoxicology and Environmental Safety, in press.

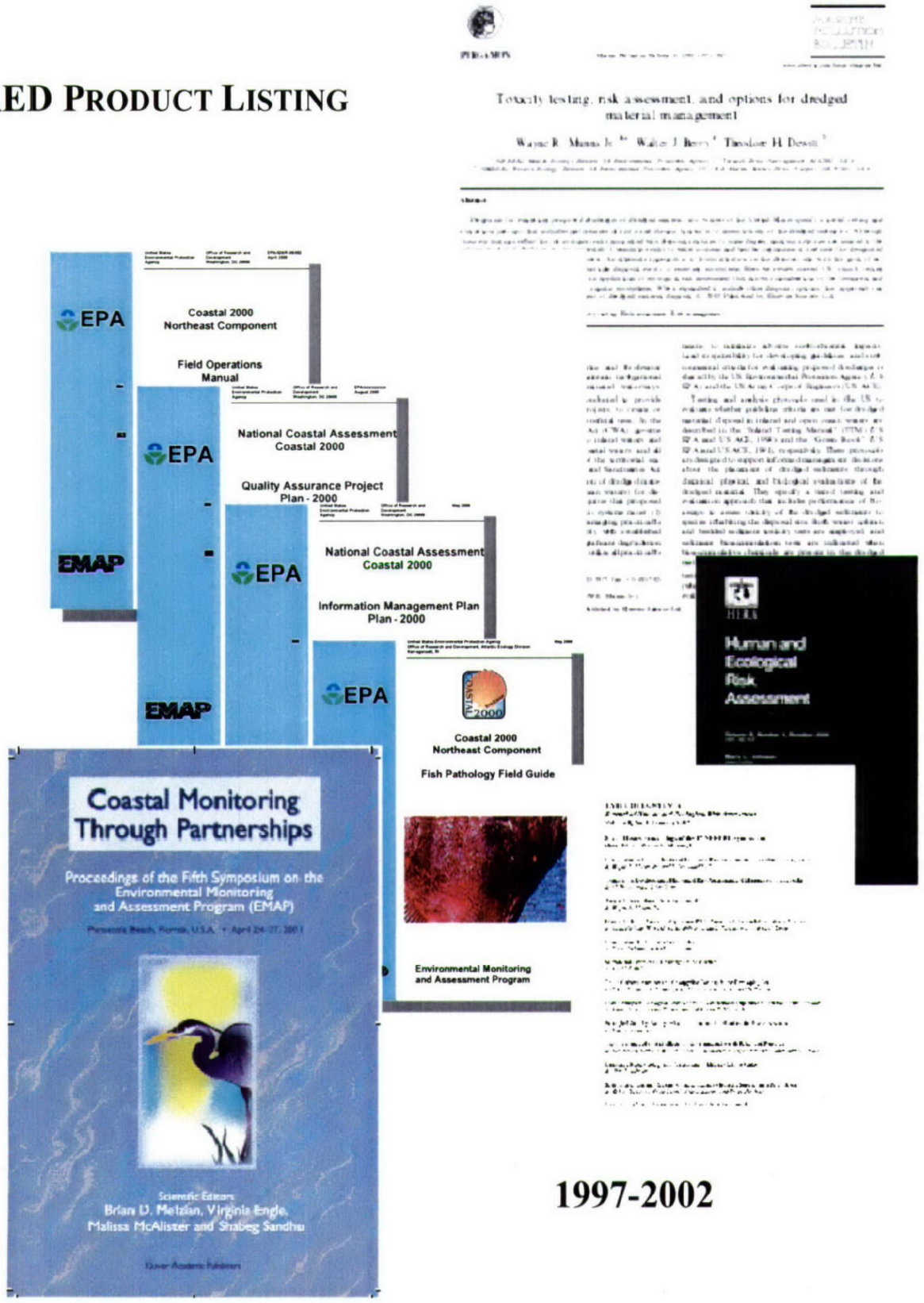
Gutjahr-Gobell, R., G. Zaroogian, M. Huber, D. Borsay-Horowitz, and L. Mills. 2002. A temperate reef fish, *Tautogolabrus adspersus*, (Walbaum) as a potential model species for laboratory studies evaluating reproductive effects of chemical exposure. Environmental Toxicology and Chemistry 21: 380-389.

Zaroogian, G., G. Gardner, D. Borsay Horowitz, R. Gutjahr-Gobell, R. Haebler, and L. Mills. 2001. Effect of 17β-estradiol, o,p'-DDT, octylphenol and p,p'-DDE on gonadal development and liver and kidney pathology in juvenile male summer flounder (*Paralichthys dentatus*). Aquatic Toxicol. 54: 101-112.

Zaroogian, G. and E. Jackim. 2000. In vivo metallothionein and glutathione status in an acute response to cadmium in *Mercenaria mercenaria* brown cells. Comp. Biochem and Physiol. (C)127: 251-261.

Mills, L., R. Gutjahr-Gobell, D. Borsay Horowitz, and G. Zaroogian. 2001. Effects of estrogenic (o,p'-DDT, octylphenol) and anti-androgenic (p,p'-DDE) chemicals on indicators of endocrine status in juvenile male summer flounder (*Paralichthys dentatus*). Aquatic Toxicol. 52: 157-176.

AED PRODUCT LISTING



1997-2002

AED Product Listing 1997-2002

Sorted by GPRA and Research Area

(AED authors indicated in bold)

GPRA Goal 2 - Water Quality

Nutrients

1997

Jaworski, N.A., R.W. Howarth and L.J. Hetling. 1997. Atmospheric deposition of nitrogen oxides onto the landscape contributes to coastal eutrophication in the northeast United States. Environmental Science and Technology 31(7):1995-2004.

1998

Thursby, G.B., D.C. Miller, S.L. Poucher, **L. Coiro, W.R. Munns, Jr.** and **T.R. Gleason**. 1998. Protection of saltwater animals from low dissolved oxygen: Cape Cod to Cape Hatteras. EPA/600/X-98/041, Office of Water, Washington, DC.

1999

McKinney, R.A., J.L. Lake, M Allen, and **S.A. Ryba**. 1999. Spatial variability in mussels used to assess base level nitrogen isotope ratio in freshwater ecosystems. Hydrobiologia 412:17-24.

2000

Coiro, L., S.L. Poucher and **D.C. Miller**. 2000. Hypoxic effects on growth of *Palaemonetes vulgaris* larvae and other species: using constant exposure data to estimate cyclic exposure response. Journal of Experimental Marine Biology and Ecology 247:243-255.

Walker, H.A., J.S. Latimer and **E.H. Dettmann**. 2000. Assessing the effects of natural and anthropogenic stressors in the Potomac Estuary: implications for long-term monitoring. Environmental Monitoring and Assessment 63:237-251.

2001

Barrera, J., R. Cantilli,, I. Davis, **E.H. Dettmann**, J. Fisher, D.A. Flemer, T. Gardner, G. Gibson, D. Hart, **J. Latimer**, S. Libby, G. Smith, C. Siciliano and J. Word. 2001. Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters. EPA/822/B-01/003, U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Dettmann, E.H. 2001. Effect of water residence time on annual export and denitrificaion of nitrogen in estuaries: a model analysis. Estuaries 24(4):481-490.

Dettmann, E.H. 2001. Appendix C: Additional information on flushing in estuaries. In: Barrera, J , et al. Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters Report No. EPA/822/B-01/003, U.S Environmental Protection Agency, Office of Water, Washington, DC.

McKinney, R.A., W.G. Nelson, M.A. Charpentier and **C. Wigand**. 2001. Ribbed mussel nitrogen isotope signatures reflect nitrogen sources in coastal salt marshes. Ecological Applications 11(1):203-214.

2002

McKinney, R.A., J.L. Lake, M.A. Charpentier and **S.A. Ryba**. 2002. Using mussel isotope ratios to assess anthropogenic nitrogen inputs to freshwater ecosystems. Environmental Monitoring and Assessment 74:167-192.

Miller, D.C., S.L. Poucher and **L. Coiro**. 2002. Determination of lethal dissolved oxygen levels for selected marine and estuarine fishes, crustaceans, and a bivalve. Marine Biology 140:287-296.

Altered Habitat

1998

Christensen, K.K. and **C. Wigand**. 1998. Formation of root plaques and their influence on tissue phosphorus content in *Lobelia dortmanna*. Aquatic Botany 61:111-122.

Holmer, M., H.S. Jensen, K.K. Christensen, **C. Wigand** and F.O. Andersen. 1998. Sulfate reduction in lake sediments inhabited by the isoetid macrophytes *Littorella uniflora* and *Isoetes lacustris*. Aquatic Botany 60:307-324.

Wigand, C., F.O. Andersen, K.K. Christensen, M. Holmer and H.S. Jensen. 1998. Endomycorrhizae of isoetids along a biogeochemical gradient. Limnology and Oceanography 43(3):508-515.

1999

Meng, L. and J.C. Powell. 1999. Linking juvenile fish and their habitats: an example from Narragansett Bay, Rhode Island. Estuaries 22(4):905-916.

Nielsen, S.L., I. Thingstrup and **C. Wigand**. 1999. Apparent lack of vesicular-arbuscular mycorrhiza (VAM) in the seagrasses *Zostera marina* L. and *Thalassia testudinum* Banks ex Konig. Aquatic Botany 63:261-266.

2000

Cicchetti, G. and R.J Diaz. 2000. Types of salt marsh edge and export of trophic energy from marshes to deeper habitats. In: Concepts and Controversies in Tidal Marsh Ecology (M.P. Weinstein and D. A Kreeger, eds.), Kluwer Academic Publications, Dordrecht, The Netherlands, pp 515-541.

Meng, L., C Gray, **B.K. Taplin** and E. Kupcha. 2000. Using winter flounder growth rates to assess habitat quality in Rhode Island's coastal lagoons Marine Ecology Progress Series 201:287-299.

Wigand, C., J. Wehr, K. Limburg, B. Gorham, S. Logergan and S. Findlay. 2000. Effect of *Vallisneria americana* (L.) on community structure and ecosystem function in lake mesocosms. Hydrobiologia 418:137-146.

2001

Chintala, M.M. and J.P. Grassle. 2001. Comparison of recruitment frequency and growth of surfclams, *Spisula solidissima* (Dillwyn, 1817), in different inner-shelf habitats of New Jersey. Journal of Shellfish Research 20(3):1177-1186.

Meng, L. and S.A. Matern. 2001. Native and introduced larval fishes of Suisun Marsh, California. the effects of freshwater flow. Transactions of the American Fisheries Society 130:750-765

Meng, L., J.C Powell and **B.K. Taplin**. 2001. Using winter flounder growth rates to assess habitat quality across an anthropogenic gradient in Narragansett Bay, Rhode Island. Estuaries 24(4):576-584.

VanHoewyk, D., **C. Wigand** and P.M. Groffman. 2001. Endomycorrhizal colonization of *Dasiphora floribunda*, a native plant species of calcareous wetlands in eastern New York State, USA. Wetlands 21(3):431-436.

Wigand, C., M. Finn, S. Findlay and D. Fischer. 2001. Submersed macrophyte effects on nutrient exchanges in riverine sediments. Estuaries 24(3):398-406.

Wigand, C., R L. Comeleo, **R.A. McKinney, G.B. Thursby, M. Chintala** and M.A. Charpentier. 2001. Outline of a new approach to evaluate ecological integrity of salt marshes. Human and Ecological Risk Assessment 7(5):1541-1554.

2002

Meng, L., C.D. Orphanides and J.C. Powell. 2002. Use of a fish index to assess habitat quality in Narragansett Bay, Rhode Island. Transactions of the American Fisheries Society 131:731-742.

Thursby, G.B., M. Chintala, D. Stetson, C. Wigand and D. Champlin. (in press). Nondestructive estimates for aboveground biomass for the wetland grasses *Spartina alterniflora* and *Phragmites australis*. Wetlands.

Toxic Chemicals (including Loon/Hg)

1997

American Society for Testing and Materials. 1997. Standard guide for conducting life-cycle toxicity tests with saltwater mysids. E1191–97. In: Annual Book of ASTM Standards, Vol 11.05. Philadelphia, PA, pp. 445-460. (prepared by **S.M. Lussier**)

Ho, K.T. 1997. Toxicity-based approach to environmental protection. European Water Pollution Control 7:49-52.

Ho, K.T. and D. Caudle. 1997. Ion toxicity and produced water. Environmental Toxicology and Chemistry 16(10):1993-1995.

Jones, K.W., **W.J. Berry, D.J. Borsay**, H.T. Cline, W.C. Conner and C.S. Fullmer. 1997. Applications of synchrotron radiation-induced X-ray emission (SRIXE). X-Ray Spectrometry 26:350-358.

Pelletier, M.C., R.M. Burgess, K.T. Ho, A. Kuhn, R.A. McKinney and **S.A. Ryba**. 1997. Phototoxicity of individual polycyclic aromatic hydrocarbons and petroleum to marine invertebrate larvae and juveniles. Environmental Toxicology and Chemistry 16(10):2190-2199.

Rhodes, L.D., **G.R. Gardner** and van Beneden R.J. 1997. Short-term tissue distribution, depuration and possible gene expression effects of [3H]TCDD exposure in soft-shell clams (*Mya arenaria*). Environmental Toxicology and Chemistry 16(9):1888-1894.

Thursby, G.B., J.F Heltshe and K.J. Scott. 1997. Revised Approach to toxicity test acceptability criteria using a statistical performance assessment. Environmental Toxicology and Chemistry 16(6):1322-1329. ***(STAA Level III Award)***

Zaroogian, G.E. 1997. Use of monochlorobimane to determine the *in vivo* effect of cadmium, copper and lead on glutathione status in *Mercenaria mercenaria* brown cells. Comparative Biochemistry and Physiology 116c(2):117-123.

1998

Lussier S.M and B. Finlayson. 1998. Mysids Section 8714 In: Standard Methods for the Examination of Water and Wastewater, 20th Edition (M.H. Franson, ed.), American Public Health Association, Washington, DC, pp. 8-91–8-100.

1999

Ho, K.T., A. Kuhn, M.C. Pelletier, T.L. Hendricks and A. Helmstetter 1999. pH dependent toxicity of five metals to three marine organisms. Environmental Toxicology 14.235-240.

Lussier, S.M., W.S. Boothman, S L. Poucher, **D. Champlin** and A. Helmstetter. 1999. Comparison of dissolved and total metals concentrations from acute tests with saltwater organisms. Environmental Toxicology and Chemistry 18(5):889-898.

Lussier, S.M., A. Kuhn and R.L. Comeleo. 1999. An evaluation of the seven-day toxicity test with *Americamysis bahia* (formerly *Mysidopsis bahia*). Environmental Toxicology and Chemistry 18(12):2888-2893.

Spehar, R.L., S.L. Poucher, L. T Brooke, **D.J. Hansen, D. Champlin** and D.A. Cox. 1999. Comparative toxicity of fluoranthene to freshwater and saltwater species under fluorescent and

ultraviolet light. Archives of Environmental Contamination and Toxicology 37:496-502.

2000

Lussier, S.M., D. Champlin, J.A. Livolsi, S L. Poucher and **R.J. Pruell**. 2000. Acute toxicity of para-nonylphenol to saltwater animals. Environmental Toxicology and Chemistry 19(3):617-621

Pelletier, M.C., R.M. Burgess, M.G. Cantwell, J.R. Serbst, K.T. Ho and **S.A. Ryba**. 2000. Importance of maternal transfer of the photoreactive polycyclic aromatic hydrocarbon fluoranthene from benthic adult bivalves to their pelagic larvae. Environmental Toxicology and Chemistry 19(11):2691-2698.

Sarakinos, H.C., N. Birmingham, **P.A. White** and J.B. Rasmussen. 2000. Correspondence between whole effluent toxicity and the presence of priority substances in complex industrial effluents. Environmental Toxicology and Chemistry 19(1):63-71.

Thursby, G.B., E A. Stern, K.J. Scott and J.F. Heltshe. 2000. Survey of toxicity in ambient waters of the Hudson/Raritan Estuary, USA: importance of small scale variations. Environmental Toxicology and Chemistry 19(11):2678-2682.

Zaroogian, G.E. and **E. Jackim**. 2000. *In vivo* metallothionein and glutathione status in an acute response to cadmium in *Mercenaria mercenaria* brown cells. Comparative Biochemistry and Physiology Part C 127.251-261.

2001

Borsay Horowitz, D.J. and **R.J. Haebler** 2001. Demonstration of *Aspergillus* sp. in tissues of the common loon, *Gavier immer*: incidence, progression, and severity. The Journal of Histotechnology 24(2):101-106.

Gundersen, J.L. 2001. Separation of isomers of nonyphenol and select nonyphenol polyethoxylates by high-performance liquid chromatography on a graphitic carbon column. Journal of Chromatography A 914:161-166.

Pechenik, J.A., R Berard, D. Daniels, **T.R. Gleason** and **D. Champlin**. 2001. Influence of lowered salinity and elevated cadmium on the survival and metamorphosis of trochophores in *Capitella* sp. I. Invertebrate Biology 120(2):142-148.

Pechenik, J.A., **T.R. Gleason**, D. Daniels and **D. Champlin**. 2001. Influence of larval exposure to salinity and cadmium stress on juvenile performance of two marine invertebrates (*Capitella* sp. I and *Crepidula fornicata*). Journal of Experimental Marine Biology and Ecology 264:101-114.

2002

Burgess, R.M. (in press). Ammonia. In: The Encyclopedia of Water (J.H. Lehr, ed.), John Wiley & Sons, New York.

Mount, D., G. Ankley, K. Brix, W. Clements, G. Dixon, A. Fairbrother, C. Hickey, R. Kent, W. Landis, R. Lanno, C. Lee, **W. Munns**, B. Ringer, J. Stavely, C. Wood, R. Erickson, and P. Hodson. (in press). Effects assessment. In. Reevaluation of the State of the Science for Water Quality Criteria Development, SETAC Special Publication Series, Society of Environmental Toxicology and Chemistry, Pensacola, FL.

Diagnostics (see TIE products under Goal 5 listing)

1999

Suter, G., B.L. Antcliffe, **W.R. Davis**, S Dyer, J. Gerritsen, G. Linder, K. Munkittrick and E. Rankin. 1999. Conceptual approaches to identify and assess multiple stressors. In: Multiple Stressors In Ecological Risk and Impact Assessment (J.A Foran and S. A Ferenc, eds.), SETAC Press, Pensacola, FL, pp.1-88.

GPRA Goal 4 - Safe Communities

1997

Munns, W.R., Jr., D.E. Black, T.R. Gleason, K. Salomon, D.A. Bengtson and **R.E. Gutjahr-Gobell**. 1997. Evaluation of the effects of dioxin and PCBs on *Fundulus heteroclitus* populations using a modeling approach. Environmental Toxicology and Chemistry 16(5):1074-1081.

Nacci, D.E., L. Coiro, A. Kuhn, D. Champlin, W.R. Munns, Jr., J.L. Specker and K.R. Cooper. 1998 Nondestructive indicator of ethoxyresorufin-O-deethylase activity in embryonic fish Environmental Toxicology and Chemistry 17(12):2481-2486.

1998

Black, D.E., R.E. Gutjahr-Gobell, R.J. Pruell, B.J. Bergen, L.J. Mills and A.E. McElroy. 1998. Reproduction and polychlorinated biphenyls in *Fundulus heteroclitus* (Linnaeus) from New Bedford Harbor, Massachusetts, USA. Environmental Toxicology and Chemistry 17(7):1405-1444. ***(STAA Level III Award)***

Black, D.E., R.E. Gutjahr-Gobell, R.J. Pruell, B.J. Bergen and A.E. McElroy. 1998. Effects of a mixture of non-ortho- and mono-ortho-polychlorinated biphenyls on reproduction in *Fundulus heteroclitus* (Linnaeus). Environmental Toxicology and Chemistry 17(7):1396-1404. ***(STAA Level III Award)***

Gutjahr-Gobell, R.E. 1998. Growth of juveniles and egg production of mummichogs fed different diets in the laboratory. The Progressive Fish Culturist 60:276-283.

1999

Gutjahr-Gobell, R.E., D.E. Black, L.J. Mills, R.J. Pruell, B.K. Taplin and **S. Jayaraman**. 1999. Feeding the mummichog (*Fundulus heteroclitus*) a diet spiked with non-ortho- and mono-ortho-substituted polychlorinated biphenyls: accumulation and effects. Environmental Toxicology and Chemistry 18(4):699-707.

2001

Kuhn, A., W.R. Munns, Jr., S L. Poucher, **D. Champlin** and **S.M. Lussier**. 2000. Prediction of population-level responses from mysid toxicity test data using population model techniques. Environmental Toxicology and Chemistry 19(9):2364-2371.

Kuhn, A., W.R. Munns, Jr., D Champlin, R.A. McKinney, M. Tagliabue, J. Serbst and **T. Gleason**. 2001. Evaluation of the efficacy of extrapolation population modeling to predict the dynamics of *Americamysis bahia* populations in the laboratory. Environmental Toxicology and Chemistry 20(1):213-221.

2002

Gutjahr-Gobell, R.E., M. Huber, D.J. Borsay Horowitz, G.E. Zaroogian and **L.J. Mills**. 2002. A temperate reef fish, *Tautogolabrus adspersus* (Walbaum), as a potential model species

for laboratory studies evaluating reproductive effects of chemical exposure. Environmental Toxicology and Chemistry 21(2):380-389.

Kuhn, A., W.R. Munns, Jr., J.R. Serbst, P.A. Edwards, M.G. Cantwell, T.R. Gleason, M.C. Pelletier and **W.J. Berry**. 2002. Evaluating the ecological significance of laboratory response data to predict population-level effects for the estuarine amphipod *Ampelisca abdita*. Environmental Toxicology and Chemistry 21(4):865-874.

Nacci, D.E., D. Champlin, L. Coiro, R. McKinney and **S. Jayaraman**. 2002. Predicting the occurrence of adaptation to dioxin-like compounds in populations of the estuarine fish, *Fundulus heteroclitus*. Environmental Toxicology and Chemistry 21(7):1525-1532.

Nacci, D.E., M. Kohan, **M. Pelletier** and E. George. 2002. Effects of benzo[a]pyrene exposure on a fish population resistant to the toxic effects of dioxin-like compounds. Aquatic Toxicology 57(4):203-215.

GPRA Goal 5 - Contaminated Sites

Contaminated Sediments (including contaminated sediment products developed under GPRA Goal 2 before 2002)

1997

Burgess, R.M., J.B. Charles, **A. Kuhn, K.T. Ho, L.E. Patton** and **D.G. McGovern**. 1997. Development of a cation-exchange methodology for marine toxicity identification evaluation applications Environmental Toxicology and Chemistry 16(6):1203-1211.

Burgess, R.M. and **R.A. McKinney**. 1997. Effects of sediment homogenization on interstitial water PCB geochemistry. Archives of Environmental Contamination and Toxicology 33: 125-129. (***STAA Honorable Mention***)

Gundersen, J.L., W.G Macintyre and R.C. Hale. 1997. pH-dependent sorption of chlorinated guaiacols on estuarine sediments: the effects of humic acids and TOC. Environmental Science and Technology 31(1):188-193.

Ho, K.T., R.A. McKinney, A. Kuhn, M.C. Pelletier and **R.M. Burgess**. 1997. Identification of acute toxicants in New Bedford Harbor sediments. Environmental Toxicology and Chemistry 16(3):551-558. (***STAA Honorable Mention***)

Huber, M., M.C. Pelletier, J.B. Charles and **R.M. Burgess**. 1997. Ammonia tolerance of the bivalve *Mulinia lateralis* sublethal sediment toxicity test. Environmental Contamination and Toxicology 59:292-297.

Peddicord, R, T. Chase, T. Dillon, J. MacGrath, **W.R. Munns**, K. van de Gucthe, and W. van der Schalie. 1997. Navigational dredging. In: *Ecological Risk Assessments of Contaminated Sediments* (C.G. Ingersoll, T. Dillon, and G A. Biddinger, eds.), SETAC Special Publication Series, Society of Environmental Toxicology and Chemistry, Pensacola, FL, pp. 41-71.

1998

Abdelrhman, M.A., B.J. Bergen and **W.G. Nelson**. 1998. Modeling of PCB concentrations in water and biota (*Mytilus edulis*) in New Bedford Harbor, Massachusetts. Estuaries 21(3):435-448.

Bergen, B.J., K A. Rahn and **W.G. Nelson**. 1998. Remediation at a marine Superfund site: surficial sediment PCB congener concentration, composition, and redistribution. Environmental Science and Technology 32(22):3496-3501. (***STAA Honorable Mention***)

Bothner, M.H., P.W. Gill, **W.S. Boothman**, B.B. Taylor and H.A. Karl. 1998. Chemical gradients in sediment cores from an EPA reference site off the Farallon Islands - assessing chemical indicators of dredged material disposal in the deep sea. Marine Pollution Bulletin 36(6): 443-457.

Burgess, R.M. and **S.A. Ryba**. 1998. Comparison of colloid-contaminant C18-based isolation techniques using PCB contaminated humic substances and interstitial water. Chemosphere 36 (11):2549-2568.

Davis, W.R., J.A.F. Draxler, **J.F. Paul** and J.J Vitaliano. 1998. Benthic biological processes and eh as a basis for a benthic index. Environmental Monitoring and Assessment 51:259-268. ***(STAA Honorable Mention)***

Latimer, J.S. and J.G. Quinn. 1998. Aliphatic petroleum and biogenic hydrocarbons entering Narragansett Bay from tributaries under dry weather conditions. Estuaries 21(1):91-107.

Munns, W.R., Jr. 1998. Use of bioaccumulation data in aquatic life risk assessment. Proceedings of the National Sediment Bioaccumulation Conference, EPA-823-R-98-002, U.S. EPA Office of Water, Washington, DC, pp 6-3–6-8.

Rubinstein, N.I. 1998. Reference sediment approach for determining sediment contamination. Proceedings of the National Sediment Bioaccumulation Conference, U.S. EPA Office of Water, Washington, DC, EPA 823-R-98-002.

1999

Berry, W.J., M.G. Cantwell, P.A. Edwards, J.R. Serbst and **D.J. Hansen**. 1999. Predicting toxicity of sediments spiked with silver. Environmental Toxicology and Chemistry 18 (1):40-48.

Burgess, R.M. and **R.A. McKinney**. 1999. Importance of interstitial, overlying water and whole sediment exposures to bioaccumulation by marine bivalves. Environmental Pollution 104:373-382.

Ho, K.T., L.E. Patton, J.S. Latimer, R.J. Pruell, M.C. Pelletier, R.A. McKinney and **S. Jayaraman**. 1999. Chemistry and toxicity of sediment affected by oil from the North Cape spilled into Rhode Island Sound. Marine Pollution Bulletin 38(4):314-323. ***(STAA Honorable Mention)***

Ho, K.T., A. Kuhn, M.C. Pelletier, R.M. Burgess and A. Helmstetter. 1999. Use of *Ulva lactuca* to distinguish pH-dependent toxicants in marine waters and sediments. Environmental Toxicology and Chemistry 18(2): 207-212.

Klamer, H., C.A. Schipper, **R.M. Burgess**, J.H. de Vries and J. Stronkhorst. 1999. *Standard Operating Procedures: Mutatox™ Genotoxicity Sediment Extract Toxicity Test.* National Institute for Coastal and Marine Management/RIKZ. The Hague, The Netherlands.

Latimer, J.S., W.R. Davis and **D.J. Keith**. 1999. Mobilization of PAHs and PCBs from in-place contaminated marine sediments during simulated resuspension events. Estuarine, Coastal and Shelf Science 49(4):577-595.

Lebo, J.A., J.N. Huckins, J.D. Petty and **K.T. Ho**. 1999. Removal of organic contaminant

toxicity from sediments -- early work towards development of a method for use in toxicity identification evaluations. Chemosphere 39·389-406

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1997 PEER REVIEW REPORT

RESPONSE TO THE 1997 PEER REVIEW OF NHEERL'S ATLANTIC ECOLOGY DIVISION

OVERVIEW

A scientific peer review was held at The National Health and Environmental Effects Laboratory's Atlantic Ecology Division (AED) from October 20-22, 1997 The charge to the reviewers was to conduct a review "in such a manner as to allow for the evaluation of the three primary divisional functions, namely research (major focus), advice/review to support Agency offices, and scientific leadership activities". The purpose of this report and action plan is to respond to the general findings of the Peer Review Panel and to outline a plan of action that will describe how AED will proceed to further our role in fulfilling our stated mission to: **"perform research to understand better and to quantify the ecological effects of anthropogenic stressors on the coastal waters and watersheds of the Atlantic seaboard".**

Our analysis of the Overview section of the Peer Review Report revealed several salient points. First, several major strengths were recognized by the Peer Review Panel Included among them are: the appropriateness of our thematic areas; the excellent facilities and source of seawater for conducting nationally-recognized research; and a bright and enthusiastic research staff who "exhibit good teamwork".

The Committee recognized the significant changes that the Division has undergone since the 1995 reorganization of ORD and relatively little time for the research to respond to the new mission and its responsibilities. Given the new responsibilities, the Panel identified areas of research that should be augmented using all vehicles available to the Federal government. In addition, it was suggested that several of the research approaches that are being pursued may be too narrow to encompass the chasm of scientific uncertainty when measuring ecological condition

Lastly, a number of opportunities were suggested by the Panel to expand AED's influence within the scientific community and to enhance our leadership of that community, of Atlantic coastal State and Regional regulatory agencies, and of EPA's national programs. The following response addresses the issues related to AED's strengths and opportunities as perceived by the Peer Review Panel.

GENERAL RESPONSE

Strengths

We are extremely gratified by the Panel's opinion that the "bottom-up" approach AED used to select our current research themes has accurately captured the important issues in marine

environmental quality related to our Agency and Divisional mission. As described in the briefing book provided to the Panel, development of AED's thematic research program required over 18 months and considerable effort. Our current thematic areas encompass a spectrum of research questions spanning a wide range of ecological organization. Included are· research to aid the Office of Water, Regions, and states to assess the ecological risks of contaminated sediments and movement of these contaminants in living coastal resources (Bioavailability); development of extrapolation methods to help environmental regulators to interpret toxicity test results in a population and community context (Ecological Significance); investigations concerning how coastal ecosystems function and development of useful indicators of system integrity (Ecological Integrity); and development and application of sound scientific procedures that integrate ecological monitoring and other data into appropriate courses of regulatory or management action (Integrated Assessment).

We agree with the Panel that two of our four themes, Bioavailability and Integrated Assessment, have foundations in AED's programs that precede the 1995 reorganization. These research themes have a tradition of close programmatic ties with the Office of Water and EPA Regional Offices, and Integrated Assessment has a basis in the national EMAP program. Our two remaining themes represent new directions for AED. The Ecological Significance Theme is a natural outgrowth of the long history of aquatic toxicology at Narragansett This theme attempts to answer several "so what" questions that are often are asked by the environmental community, such as the relevance of the toxicity tests to the receiving systems, and the relationships between short-term toxicity test results and population response of the same or other species in the field. Perhaps the most challenging change in research direction from AED's past is the Ecological Integrity Theme, which endeavors to develop ecological indicators of ecosystem-level response. Issues raised specific to these themes will be covered in separate sections below.

We also agree that the facilities at AED provide for excellent opportunities to conduct "cause and effect" research and represent a national resource. The water quality is excellent, and our proximity to other research institutions offers excellent opportunities for collaboration The staff at AED has worked very hard to maintain and enhance our physical plant and our research vessel fleet, and to incorporate (or utilize) new and innovative technologies (GIS, remote sensing, CAT scan techniques). These efforts have been instrumental, over the past several years, in attracting to our Federal staff the "bright and enthusiastic" scientists that the Peer Review Panel noted, including promising young scientists with cutting-edge training. In addition to hiring highly-talented scientists, we have dedicated significant resources for training our new and veteran scientists. As outlined in the briefing book, four of our staff have received long-term training since 1992. Additionally, the majority of our scientific staff have benefitted from EPA-sponsored formal training (undergraduate or graduate courses) and in-house training (technical writing, team-building) within the last five years.

Opportunities

Most of the comments from the "Opportunities" section of the Peer Review Report emphasize the importance of expanding AED's leadership role in areas reflected in our new mission of ecological effects research. The essence of this challenge is to enhance our visibility as leaders in the fields of ecology and coastal research, and to incorporate more fully into our research program established scientists who have national or international reputations and experience. We are encouraged to recruit aggressively and widely, to expand our research efforts to the entire Atlantic Coast, to build networks and collaborations with other research organizations with strong ecological programs, and to strengthen the relationships with our clients, including the Regions and states.

We agree that AED needs to develop "greater visibility and demonstrate greater leadership in eco-risk studies of coastal ecosystems" We believe that leadership can be fostered in a number of ways:

1) encourage our staff to organize, chair relevant sessions at, and participate in national scientific meetings that emphasize the thrust of our new mission;

2) submit our manuscripts to highly regarded journals of coastal ecosystem research,

3) serve as editors for reputable scientific journals,

4) hold offices in relevant professional organizations;

5) serve on interagency panels related to coastal research,

6) serve as adjunct professors for universities that have significant coastal research programs;

7) "show the AED flag" by presenting seminars of our research at other coastal institutions;

8) expand and nurture our pre- and post-doctoral research programs and maintain an active visiting scientist program within the organization;

10) act as a "national resource" by expanding our information management function so that we are the prominent (if not preeminent) data and information resource for the condition of the Nation's coastal environment;

11) forge stronger relationships with the clients and "end users" of AED's research products.

We are pursuing all of the above approaches for developing leadership in the field, though admittedly, some of these efforts are in their early stages. It should be noted that items 1-6 are among the primary criteria that ORD's Technical Qualifications Board uses to evaluate our staff for promotion to the higher ranks in the scientific grades.

Since ORD's reorganization, we have been limited in our opportunity to hire new employees beyond the original contract conversion process which reflected our former mission in environmental toxicology and chemistry. However we are making progress in acquiring critical skills through our strategic hiring plan. We recently hired a Wetlands Ecologist and a Research Biologist to develop a new Wetlands project within the Ecological Integrity Theme Current recruitment actions for term positions include a Landscape Ecologist, a Systems Ecologist, and a Population/Community Ecologist, and we are using the NRC postdoc program to bring in several ecologists. Recruitments for these positions have been advertised nationally to obtain the very best qualified scientists. AED is taking advantage of every opportunity available to increase the critically-needed expertise in the ecological sciences.

The Panel observed that "the scientific staff should publish more and in a wider variety of journals". We strongly agree. Many of our staff are highly trained aquatic toxicologists and before the reorganization were conducting research that favored existing toxicological research journals (*Environmental Toxicology & Chemistry, Environmental Science & Technology, Aquatic Toxicology*). The new AED mission should move us into the more ecologically-oriented journals (*Limnology & Oceanography, Ecology, Conservation Ecology, Estuaries,* etc.) and journals that emphasize ecosystem monitoring (*Environmental Monitoring & Assessment*) The scientific staff are being strongly encouraged to publish more often, to broaden the list of candidate journals, and to attain a greater visibility through publication in these journals.

Other issues raised by the Committee include the need to better integrate research among the four research themes. We agree, in part, that better integration will be a strategic goal. To this end, active discussions are occurring between the Ecological Integrity and Integrated Assessment themes, and we are in the process of identifying specific environmental problems and settings that will focus the research attention of all four themes on common issues. Our planned focus on Regions 1 and 2 offers the opportunity to integrate our thematic research around significant environmental problems that require a spectrum of research approaches to solve AED's Science Council currently serves as an excellent vehicle for identification and communication of potential integration opportunities; these efforts will be enhanced once a permanent Associate Director for Research is named as chair of the Council. Through active planning and communication, we also will ensure that AED's research program is better integrated with those of our sister divisions in NHEERL.

We are continuing to develop our capability in the areas of information management. In addition to our recently completed Information Management Center, which houses state-of-the-art computing, GIS, and presentation equipment and software, we are ramping up our automated data processing support function through the addition of contract staff. Building on our historic expertise in environmental information management, we are also in the early stages of organizing a Coastal Environmental Information Center to complement our research in regional environmental assessment.

Finally, we believe that AED scientists are especially effective in cultivating research and client relationships with regional and state agencies This is most evident with the current Mid-Atlantic Integrated Assessment (MAIA) Program with EPA Region III and associated states. As

mentioned, we are now laying the groundwork for a similar involvement with EPA Regions 1 and 2 and this will eventually expand to include all coastal systems of the Atlantic seaboard. Historically, this facility has been a consistent contributor of technical assistance to coastal Regions and states throughout the U.S. and will continue to do so.

RESPONSES TO INDIVIDUAL THEME REVIEWS

Bioavailability

The reviewers of the Bioavailability Theme provided several constructive comments regarding ways to improve our Theme. The area most emphasized was equilibrium partitioning (EqP) theory which is used by our Theme to predict effects from concentrations of known stressors. They felt that further research to challenge EqP theory should be performed, and that our group was in a unique position to carry out this research We are using this opportunity to change our strategy from elucidating the underpinnings of equilibrium partitioning to challenging the theory of equilibrium partitioning. Our approach is not to determine whether or not EqP theory is "correct", but whether it is useful. We believe a practical question to ask is "In what percentage of contaminated sediments is EqP theory useful for predicting effects?" We recognize this is not a trivial task and are just beginning to develop a strategy for answering this question. We propose to challenge the usefulness of the theory on two levels· 1) the organismal level and 2) the ecosystem level.

At the organismal level, we are discussing experimental designs that challenge the usefulness of EqP theory in predicting effects. These experiments may incorporate different modes of exposure (e.g. absorption via respiratory surfaces vs. ingestion), exposures of organisms to sediments that contain different types and levels of organic carbon, and determining the importance of other sediment phases on bioavailability In addition to in-house resources, we propose the use of new post-doctoral positions to encourage different perspectives in evaluating the theory. We are also considering putting out an informal call to selected long-standing critics of the theory, challenging them to design "the definitive experiment" that would demonstrate whether the theory is useful or not.

The second approach is on a larger ecological scale and also benefits the theme by moving it ahead to it's stated goal of testing laboratory theories in the field. Possible approaches include use of the EMAP, MAIA and similar data sets where a number of factors needed to predict effects using EqP theory have been measured. From these measurements we can predict effects and compare the predicted to observed results. This will give us a spatial and geographical sense of the usefulness of the theory and allow us to pinpoint specific ecosystems where additional unmeasured factors controlling effects may be explored Using the framework of testing EqP theory in different ecological and geographical areas will allow us to follow through on some previously discussed large-scale experiments in different areas of the country with a group like SERG (Sediment Effects Research Group). This project may include researchers from the different Effects Divisions measuring field factors in differing ecosystems. From this data we may determine the usefulness of EqP theory in predicting observed effects. The resources to

successfully complete this project, and demonstrate the usefulness of EqP theory which underlies water and sediment regulations in EPA, include an additional $20K of travel money to allow inter-divisional collaboration, and additional skills (new term appointments) in spatial modeling and benthic ecology. Initial contacts, email and phone calls, have been performed. We anticipate at least two inter-divisional meetings over the next year, hosted at different eco-effects divisions to discuss project design and implementation. Another complementary method of examining the usefulness of EqP is a field experiment with the objective of examining ecosystems which include the end-members of steady-state sediments. For example, we may choose three ecosystems: the first in steady state (e.g. sheltered subtidal sediments); the second, in an area where we expect some perturbation, and the third in an area we expect to be constantly perturbed such as a tidal influenced salt marsh. Measuring factors that control the bioavailability of contaminants over the course of different seasons for as long as a few years will give us an understanding of the limits of EqP theory to predict effects over seasonal changes in different ecosystems. Other experiments include manipulations of field sediments in the laboratory, or sediment transfer experiments, to define the time it takes to reestablish equilibrium in a perturbed sediment.

In addition to comments regarding EqP theory, the panel pointed out the lack of research being performed on "the transfer of bioaccumulative contaminants from in-place sediments through benthic organisms into higher trophic levels in coastal waters " The panel believed that marine systems may be significantly different from freshwater systems, thereby making extrapolation from freshwater systems impossible, and necessitating separate study. The principal focus of the Biota Sediment Accumulation Factor (BSAF) research in our Theme was to examine the extent of transfer of contaminants from sediment into benthic organisms. One of the principal drawbacks of the BSAF approach is that its application to higher trophic level organisms is limited. To overcome this limitation research linking trophic position with contaminant accumulation was planned and has started. These studies were started in fresh water because the problem of migration of top level predators is avoided, and because the capability to replicate exposures is greater in confined fresh water systems. However, the long term goal of the trophic positioning research is to allow prediction of the extent of bioaccumulation in both fresh and salt water systems. Results from the fresh water studies will allow a more narrow focus when research is started in the more complex estuarine systems. We believe we have the in-house resources to devote to the majority of this research but we may require additional funding ($50K) for IAGs with State and/or local organizations to facilitate sampling.

While the panel did not specifically indicate the need for further integration with groups outside of our Theme, we continue our efforts to integrate research among the four Themes in the laboratory. In addition to our ongoing research with the Ecological Significance Theme in effects measurement, and the Ecological Integrity Theme in bioaccumulation research, we have started a new effort with the Integrated Assessment Theme to use large scale system theory to help us understand mixtures of stressors and their effects at an ecosystem level. We have submitted an abstract to the workshop on Modeling and Measuring the Vulnerability of Ecosystems at Regional Scales for Use in Ecological Risk Assessment and Risk Management in Seattle focusing on integrating mixed stressors in ecosystems.

Finally, we appreciate the effort of the panel to understand our research and the positive tone of their review. We plan to continue research in the areas where the panel indicated our strengths lie such as studying photo-enhanced toxicity, developing methods for identification of toxicants in marine sediments, and measuring effects. As stated in our Theme, we plan to focus our objective of understanding the bioavailability of stressors in the marine system towards levels of higher biological organization and increased ecological complexity.

Ecological Significance

The Ecological Significance Team (ES) would like to express appreciation for the valuable comments provided by the AED peer review committee. Though we believed all along that our internal AED research planning process had insured that we were on the right track, there is some comfort in the knowledge that our scientific peers reached a similar conclusion. The constructive criticisms provided by the peer review committee in many cases served to reinforce measures that were already in progress. The major points identified by the peer review committee that will be addressed below are: a) over-extension, b) needed expertise, c) client connections and d) inter-theme collaborations.

One of the primary points raised by the peer review was that because of the limited number of staff in this theme, we should narrow our research focus by reducing the number of experimental systems under study. While we recognize that our goals have been ambitious, we believe that this comment was at least partially due to the way that we defined our activities For example, within Project 1, all five activities use the same research approach to predict ecological effects from biological data derived from diverse species. In fact, the activities within Project 1 are tightly integrated, conducted by the same core staff members and of a relatively short term nature. The completion of Project 1 in FY98-99, will reduce the number of activities in ES by 50%. The remaining Projects (2, 3, and 4) have highly integrated activities using similar experimental systems to address in a multidisciplinary fashion biological and ecological responses to chronic anthropogenic stress. The integration of research across levels of biological organization was specifically called out by the peer review as a critical research need that we were addressing. While it is certainly important to guard against over committing our resources, it is equally important that we set challenging goals that push our scientists, our team, and the science forward. We believe that rather than narrow our focus to compensate for a limited number of staff, as suggested by the peer review panel, that we should instead identify and acquire critical expertise that could permit us to effectively address the difficult questions and important questions being asked by the ES theme.

We agree with the peer review committee that we have too few ecologists and modelers associated with this research team Though we must point out that the reason for this is not because we have underestimated the complexity of ecological systems, rather we have developed a new research team with new research directions (focus on ecology) and have not yet had the opportunity to hire additional personnel with these skills. Long before the peer review convened, we were proactive in addressing this issue from two directions. From an immediate perspective, we have been targeting post doctoral candidates through the infrastructure funded

AED post-doc program and anticipate bringing in one population ecologist/modeler (physiologically-based modeling) and molecular ecologist (genetic diversity) this summer. The infrastructure funded post doctoral program represents an important mechanism for bringing in talented scientists and we sincerely hope that this program will continue to be supported by NHEERL. We have identified two positions in the recent NHEERL wide term post doc competition, population/community ecologist with expertise in spatially explicit population modeling (AED-2) and aquatic ecologist (AED-4). The addition of these four positions would provide the ES team with a dynamic core of ecologists and modelers and quite frankly would position this research team squarely on the leading edge of the field. While the post-doc program has the advantage of being an immediate fix, these positions are by nature short-term. From a longer term perspective, we are working through the AED-Strategic Hiring Process to commit full time FTE's to positions with these skills. The obvious drawback to the strategic hire process is the slow pace at which positions become available in the federal system. We expect that by utilizing both approaches that we can fulfill needs in the short-term through the various post doctoral mechanisms, while we work through the longer term strategic hire process.

Another approach to increase the number of ecologists and modelers involved with our research would be to establish collaborative efforts across NHEERL divisions and outside of EPA. Cross divisional collaborations could be fostered through the population modeling work group. This could conceivably occur immediately The drawback associated with this approach is that most people are committed to research within their own division, so that any such collaboration would occur at a low level of effort. Potential remedies include the recognition of the importance of such cross divisional collaborative efforts at the NHEERL level, and restructuring of priorities as necessary. Identification and support of post-doctoral positions to help bridge the gaps between the divisions could make cross divisional collaboration work for all parties External collaboration in ecological modeling could also be an important mechanism for improving our capacity to conduct such research. A well planned workshop on ecological modeling (roughly $75K) would represent a valuable investment towards establishing NHEERL as a partner and leader in the field of ecological modeling. Following up this workshop with an internal competitive grant process would be a valuable mechanism to provide resources to foster the collaborative research efforts that would be developed through the workshop.

We concur with the peer review panel that the ES Theme must clearly identify and communicate with the clients for our research. Since ES represents a new research direction, it does not have the longstanding programmatic ties within EPA that some of the older research themes have. The ES Team is developing a strategy for identifying and communicating with clients for our research. The primary activities presently under consideration include; establishing active communications with the appropriate ALDs, establishing active communications with the Regional Offices, and enhancing communications with the scientific community. Increased communications with the ALD's (annual visits to the Ecology Divisions) could help to identify clients in the Program Offices and could potentially smooth the transition between the top-down and bottom-up research planning processes. Strengthening communication with the Regional Offices and Program Offices will assure that our research directly supports the mission of EPA (knowledge for a purpose), while also assuring that these offices have an appreciation of the value of our research. We will continue to develop ties to the scientific community through

participation in professional societies, participating in scientific meetings and workshops, and where possible by sponsoring seminar speakers Our success in these activities will depend, in part, on a greater commitment of resources for travel.

The peer review panel raised the issue of increasing inter-theme collaborative research efforts. We have been pursuing several project and activity level collaborative activities with other AED Themes. One mechanism that we have been using to foster inter-theme collaboration is to identify post-doc opportunities that support multiple themes. For example the molecular ecologist (genetic diversity) position identified previously would support activities in ES and the Ecological Integrity theme. The spatial population modeling position identified earlier would support a joint project between ES and the Bioavailability theme addressing the spatial aspects of sediment contamination and ecological effects. This research would likely include input from SERG and the population modeling work group and would thus have cross divisional components. A recent and exciting development is that researchers from each of the four AED Research Themes have initiated discussions that are being directed towards the development of a cross thematic research project that would integrate each of the Themes. Present discussions are centered around New Bedford Harbor, Massachusetts where several of the research teams are conducting research The new cross thematic project would explicitly integrate the existing activities as well as new research efforts around a core set of research questions. The proposed study would represent a pilot study for integrating research across a wide range of spatial scales and biological organization.

In conclusion, we appreciate the comments of the peer review panel and believe that their criticisms by in large were constructive and objective. We appreciate the peer review's acknowledgment that we are asking difficult but important questions. It is our intention to use the comments from the peer review along with our internal review processes to continue to strengthen the research conducted by the Ecological Significance Team. In particular we intend to add core ecological expertise, improve communications with clients, and continue to pursue research that integrates across levels of biological organization. We look forward to the next peer review and the opportunity to demonstrate how we have responded and developed in the interim.

Ecological Integrity

The overall conclusion of the peer-review committee is that the Ecological Integrity theme needs to be "re-focused." The primary response to this comment is that the theme has been undergoing a re-focusing process over the past year, most intensively during the past six months. We believe that an update on this process will demonstrate that the theme has made significant progress in addressing not only this general comment, but also many of the other specific criticisms.

As discussed during the review, the approach of developing indicators of ecological integrity is new to AED. It is reflective of the overall change in mission from an aquatic toxicology laboratory to one focused on broader ecological questions. This peer-review

occurred two years into a multi-year research program, therefore, evaluation and response to the peer-review comments must be understood in that context. Many of the specific peer-review comments reflect this "newness" and will continue to be addressed as the theme evolves. Peer-reviewers observed a lack of: (1) integration among projects, (2) a common field site, (3) communication with EPA program and regional offices, and (4) publications in appropriate ecological journals. These are all consequences of the **newness** of the theme, not the intended **direction** of the theme. Each of these major criticisms will be addressed individually in this response.

Project Integration: As pointed out correctly, the current projects were selected initially based on a loose connection to the theme goal, not on the basis of how well they could be integrated. The limitations of personnel, relative to both numbers and specific scientific disciplines, precluded identifying specific research areas, then identifying the appropriate personnel. This deficiency was recognized prior to the peer-review and was pointed out during the Ecological Integrity theme presentation. Steps toward resolving this problem have been on-going over the last six months by providing a common focus for each project, consistent with the theme goal, and also compatible with sound ecological theory and programmatic relevance for EPA ("Science For a Purpose"). Four elements were gleaned from the theme goal. Each existing project, or proposed new research indicator, must address all of these elements: level of ecological organization the project will quantify, how the project quantifies ecological integrity (completeness and expectations), how the indicator response distinguishes between natural vs anthropogenic impacts, and the specific regulatory/management applicability (ultimate user of the indicator). This approach specifies those elements which must be common to each project, as well as identifies those activities which do not meet these criteria. An internal mini-review of all EI projects was conducted this past April (1998) to determine how well each addressed these elements. Appropriate modifications to each project have begun to ensure consistency with the four theme elements.

Common Field Site: From the theme's inception, it was recognized that in order for this research to be most effective, all projects would eventually have to work in at least one common system. However, it was recognized that requiring each project to sample in a common system during the first year or two would be disruptive to on-going research, especially given the theme's evolving focus. The theme has now developed sufficiently that planning is underway to identify at least one estuarine system that all projects will work in. This does not preclude projects working in multiple independent systems, rather, it ensures that there is at least one system common to all projects. Furthermore, monthly meetings are being held with the project leaders to identify exactly how each existing project will contribute to an understanding of the system's ecological integrity. This process will be completed this fall and a common site selected for sampling next spring. At that point, this approach will be incorporated into both the overall theme description as well as the individual project research implementation plans.

Communication with Program and Regional Offices: Because of the embryonic status of the theme, it was premature to develop well-connected links with program offices/regions until the specific indicators were more developed and tested. Preliminary discussions were conducted with environmental managers initially; however, not to the degree that other more well-established themes have (e.g., Bioavailability Theme and the Office of Water). As stated previously, the theme has evolved to include four common elements, one of which is regulatory/management applicability. This requires each project to develop more formal links to program and regional offices. For example, several individuals within the theme Wetlands project have met with the Office of Wetlands and Watersheds (OWOW) and presented the theme design and initial project results. Feedback from OWOW was incorporated into the project, thereby increasing it's programmatic relevance. In addition, this process provided OWOW managers with a better understanding of the state-of-the-art relative to wetlands research Similar discussions are on-going with personnel in EPA's Regional Offices.

Publications in Ecological Journals: The number of publications in the peer-reviewed ecological literature will increase commensurate with time working in that research area. As pointed out by the review committee, the shift in research direction from toxicology to ecology has only occurred at AED within the past three years. The lag time involved in selecting a new area of research, the implementation of that research, and the appearance of published journal articles is greater than this time-frame Many of the projects have presented initial research results at national ecological meetings (e g , Ecological Society of America, Estuarine Research Federation). Manuscripts from these presentations currently are being produced. As part of an internal planning exercise, twenty-two peer-reviewed manuscripts are anticipated from this thematic research during FY'2000, less than two years away. Furthermore, the addition of personnel more intensively trained in ecology will increase the number of publications in "ecological" journals While personnel changes usually occur slowly within the Federal system, since the peer-review, a full-time wetlands ecologist has been added to the theme as well as two cooperative agreement pre-doctoral degree students pursuing ecologically-oriented research projects. Opportunities to hire additional pre- and post-doctoral students, as well as Federal term appointees, will be pursued vigorously in the future as funding allows.

In summary, we believe that most of the peer-reviewer's comments, while valid, are more a consequence of the timing of the review relative to the theme's development. The actions taken to re-focus the theme began well before the results of the peer-review were received and are remarkably consistent with the concerns which the reviewers expressed. Therefore, we believe the modifications to the theme and it's projects have addressed the overall tenor of the reviewers comments.

Integrated Assessment

The major comments from the AED peer review specifically directed toward the Integrated Assessments Theme are. (1) The work is a logical extension of EMAP work previously accomplished by AED. There are some interesting science projects being planned in connection with the MAIA efforts. (2) Management links need to be fortified and further communication with managers needs to be emphasized. Hopefully some useful suggestions in this regard will emerge from the work task to define assessment questions. (3) The integrated assessment framework project may become a dead end if further planning is not initiated soon, including the discussion of results with EPA regional offices. (4) The data management project is well designed and will facilitate the exchange of data and information collected under EMAP and other projects.

Research in the Integrated Assessments Theme will continue in connection with the ongoing MAIA efforts. In addition to continuing with existing projects, (1) research will focus on analysis of field data collected during 1997 and 1998 through the collaborative efforts of the many organizations participating in the MAIA-Estuaries project, and (2) research will be initiated in conducting cross ecological resource assessments with the MAIA data collected for estuaries, surface waters, forests, and terrestrial landscapes. AED was a major collaborator in the design of and implementation of estuarine field activities in 1997 and 1998. AED is also maintaining the summary data base for all of the MAIA-Estuaries data, and is taking the lead in the analysis for the MAIA-wide assessments. It is anticipated that a two-year statistical data summary will be produced in 1999, with an assessment report to be used for the next version of the State of the Estuaries Report available the following year. If travel funds are available, the Integrated Assessment Theme members will be making numerous presentations at the upcoming MAIA Working Conference to be held 30 November to 2 December 1998 in Baltimore. Cross resource assessment is a new area of research for the Theme, building upon the landscape association projects already underway, and will incorporate data collected in many of the other natural resource areas.

The management questions included in the theme plan emerged from the original EMAP work conducted through AED. The generic environmental management questions actually grew out of the User Network Exchange Workshop, held in 1991 in Ocean City, Maryland, with environmental managers from across the region participating. The specific research that the theme has been conducting in MAIA has been planned in conjunction with the regional environmental managers. This point was not overemphasized in the theme plan since we were concerned that we did not want to give the impression that the environmental managers were directing our research. The reviewers point is well taken, and we need to give proper emphasis to the interactions we had, and will continue to have, with environmental managers in planning and conducting our research. We will use our interaction in the production of the State of the Estuaries Report as a solid example of the link with the managers. To help bridge the communication gap between scientists and decision-makers, two actions are underway within the Integrated Assessment Theme: (1) the community-based members from the

former AED Coastal Futures Theme (Jerry Pesch, Walt Galloway, and Suzanne Lussier) have been added, and (2) the AED Community-Based Assessment Team in Annapolis is expected to be made members of the IA Theme. These actions will complement the existing expertise of the Theme.

The proposed integrated assessment framework was developed as a result of AED's involvement with EMAP. It was proposed as a process to consistently address assessment questions. The framework used in MAIA, will be evaluated for its effectiveness as a process for addressing environmental management concern, and will be refined to address identified inadequacies. Workshops for environmental managers are proposed for 1999 and beyond to review our application of the framework for conducting MAIA assessments and to discuss how this process can be effectively utilized by the managers. The refined framework will be used by AED for other geographic studies that will be conducted An example of future studies at AED is one currently being planned for the Gulf of Maine. We are initiating the planning by having our community-based members solicit information from regional and state environmental managers for their current and anticipated future environmental information needs.

We appreciate the comments on our efforts in information management. We are now building upon our accomplishments to (1) continue the existing effort in EMAP and MAIA by maintaining the resource level necessary keep it successful, (2) transfer what we have developed in information management for MAIA to the EPA Region 3 staff for continuance and expansion, (3) transfer the experience in developing an information management system for a geographic study to the EMAP Western pilot, which is currently in the planning stage, and (4) pursue the expansion of the AED efforts in information management by taking on the role of an Atlantic Coast Environmental Information Center, whose purpose would be to identify, gather, document, and manage relevant environmental information and to provide for its broad dissemination. This last item would require a significant commitment of federal staff and resources to implement

The Integrated Assessment Theme members thank the peer-review group for their constructive comments on our research Our plans are to continue in and expand upon the areas identified as being our strengths (building upon EMAP experience, MAIA connection, and information management) and institute changes that will address our weaknesses (bridge between science and management, and future plans for assessment framework).

Review of

U.S. Environmental Protection Agency's

ATLANTIC ECOLOGY DIVISION

October 20-21, 1997

Narragansett, Rhode Island

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OVERVIEW

The mission of the Atlantic Ecology Division (AED) at Narragansett is to perform research to understand better and quantify the ecological effects of anthropogenic stressors on the coastal waters and watersheds of the Atlantic seaboard. AED's strategy for accomplishing this mission was set forth in several forms, including: (1) a clear and concise statement that defines the AED's vision; (2) a well-articulated mission statement reflection the mission assigned by the EPA Office of Research and Development through the parent Nation Health and Environmental Effects Research Laboratory (NHEERL); (3) a list of strategic principles which serve as guideposts for developing programmatic goals; and (4) presentation of programmatic goals designed to keep the AED and its research staff continually focused on the defined mission.

The AED has undergone some major and challenging changes as a result of its incorporation within NHEERL and contractor conversion. These have affected the scope and focus of the laboratory's work and how it is accomplished. The traditional focus and strengths of the Narragansett Laboratory have been in environmental chemistry, aquatic toxicology, and the effects of stress on individuals and populations as determined from controlled laboratory studies. These studies focused on Narragansett Bay and the northeast. In addition, the Narragansett Laboratory has in more recent years been heavily involved in the Environmental Monitoring and Assessment Program (EMAP), particularly related to estuaries in the Mid-Atlantic region. Under the NHEERL reorganization, the laboratory no longer has a lead responsibility for aquatic toxicology and is being asked to address the broad and challenging objective of understanding, measuring and predicting the effects of human activities on the integrity of Atlantic coast

ecosystems. This requires new approaches, different skills and experience, and a wider geographic perspective. In addition, as in other NHEERL divisions, the AED has recently undergone the termination of on-site scientific contractors together with an expansion of EPA scientific staff, who are now required to be more hands-on researchers than contract administrators. These transitions of scope and mechanisms are still underway, in many respects deserving a grade of "incomplete." However, the planning is addressing the right scientific issues and building on the new staffing arrangement. In general, we feel that the AED is heading in the right direction.

The peer review panel was impressed with the overall presentation and found a great deal of excellent research going on. Much effort has been expended in setting criteria for pursuing research projects and in evaluating progress in reaching goals. It was clear that considerable thought and energy had been expended in building thematic teams of researchers. The complex and interdisciplinary nature of the research questions makes the team approach very appropriate for the AED. However, the panel is not sure that the four theme areas are completely natural divisions of what, in effect, represent a continuum of levels of biological organization and scales of ecological effects. In any case, because this is a continuum considerable efforts are still required for intra-theme integration. The themes and their teams vary in their coherence and productivity, with those that were largely ongoing before the redefinition of the laboratory's mission (Bioavailability and Integrated Assessment) being more mature and the two new constructs (Ecological Significance and Ecological Integrity) being not yet settled and more challenging.

From a tradition of laboratory studies, it appears that an overarching objective within the AED is the development of integrative indices of ecosystem structure and function that are applicable in the field. It seems that many projects are directed toward finding some magic number that will define the health of an ecosystem, akin to taking the temperature or blood pressure of a human subject. While useful integrative measures may certainly be developed and should be sought, and while regulatory and legal requirements may demand them, this approach runs the danger of

oversimplification of complex biological systems to the point where they have diminished usefulness for correctly assessing ecological conditions. The panel counsels consideration of alternative strategies, rather than this singular one, that evaluate both the complexity and predictability of dynamic coastal ecosystems and the ecology of species that are particularly important in maintenance of the integrity of ecosystems, or keystone species.

Very many of the projects seem to be conducted over a one to two year duration. For some, this is perfectly appropriate, but there are concerns that important dynamics due to events that recur over longer time periods or that affect similarly longer term ecosystem recovery cannot be addressed under this constraint. While university-based researchers are frequently constrained by these short timeframes of project support, as a federal laboratory with predictable support and long-term objectives the AED has the opportunity to gain distinction by emphasizing longer-term studies. For example, a few important long-term sampling sites could be established at which studies from several or all of the themes could concentrate.

The AED mission encompasses coastal waters and watersheds. However, there is precious little coastal watershed work being done at present. Because Atlantic coastal ecosystems are so heavily influenced by their watersheds (nonpoint source pollution, changes in freshwater inflow and sediments, etc.), this should be corrected with the addition of strategic watershed studies linked with those in estuaries.

The AED also faces a conundrum that will challenge priority setting and logistical execution. It has superb experimental facilities along side of a natural laboratory, Narragansett Bay. This has been the laboratory's traditional geographic focus and continues to be a distinct asset, especially in terms of integrating studies across the themes. However, the Division has been given the mission to address Atlantic coastal ecosystems more generally. These systems are diverse and expansive. How, then, should the AED balance locally intensive studies and studies applicable throughout the Eastern seaboard? In the view of the panel, this requires the development and nurturing of partnerships between the AED and academic, state governmental, and federal

research institutions throughout the region. The AED should strive to provide assistance, foster communication and collaboration, and participate in interpersonnel exchanges to accomplish this.

In conclusion, the panelists offer the following brief statements concerning the Division's "strengths" as well as the still-to-be-developed areas that represent opportunities as well as challenges:

Strengths

- The strategic themes developed for the AED appropriately address important issues in marine environmental quality related to the EPA mission.
- The research under the Bioavailability and Integrated Assessment themes is already strong and appears to have good connections with clients and users of information.
- The AED facilities for experimental research and laboratory analysis are excellent and constitute a nationally important resource.
- The location of the AED on the Narragansett Bay campus offers excellent opportunities for interaction and collaboration with other appropriate organizations such as the University of Rhode Island and the National Marine Fisheries Service.
- The combination of outstanding experimental facilities and very good water quality conditions allow for cause and effect research, especially in conjunction with the URI mesocosm facilities next door.
- The scientific staff is bright and enthusiastic and exhibits a good spirit of team work.

Opportunities

- The AED needs to develop greater visibility and demonstrate more leadership in eco-risk studies of coastal ecosystems. This requires a stabilized mission.
- The scientific staff should publish more and in a wider variety of journals (i.e. beyond the SETAC media and community) in order to develop its reputation in ecological effects research.

- There should be more integration and interaction among the themes. The Science Council, seminars, etc. should help.
- The Ecological Significance and Ecological Integrity themes should be more fully and solidly developed by nurturing leadership, encouraging more interaction with the outside community, hosting post-doctoral and senior visiting researchers, externships for AED scientists, and sponsoring meetings and workshops.
- The experience of the scientific staff is somewhat parochial, with many having been trained at URI or having had most of their professional experience at Narragansett. Recruitment should be more nationally aggressive.
- It is important to build networks with clients and users of information, including the EPA Regions and state agencies and particularly for the newer themes.
- The new AED mission gives it the unusual opportunity to pursue multidisciplinary approaches to questions of ecosystem health and risks through longer-term field research.
- At the same time, the AED must seek to make contributions over the entire Atlantic coastal region. This requires approaches which are larger scale than the states, effective collaboration with academic and state agency scientists, synthesis efforts, and development of management-oriented tools based on the work of others.

ECOLOGICAL SIGNIFICANCE

Description:

The objective of this theme appears to be to discover the physiologic responses of single species populations at the individual, cellular, and sub-cellular levels. However, the description makes it hard to see how this will be done in an integrated manner. Questions posed on the effects of stressors on the structure and function of ecosystems are important, but we are no where near being able to answer them. Projects addressing these questions seem more ideas for future consideration than well-conceived research projects. Why are the in situ fates of bioassay

indicator organisms necessarily important to know? Might there be other species not chosen as laboratory models whose fates are more important for ecosystem functioning?

Critique:

This is a group with a good pool of human resources - these investigators are energetic and intelligent. The overall theme of linking cellular/subcellular and other laboratory metrics with population processes in the field highlights a significant area of need in the research community. This theme is a critical link (levels of biological organization) in the overall mission of AED. Success in this area will require more of a focus than is presented in the research plan. In other words, the group needs less breadth and more depth. Consolidation to a more narrow focus along the major theme lines is strongly encouraged. For example, the researchers should work in fewer systems or with fewer species. Recognizing the limitations of hiring, this group needs more input from ecologists.

The researchers are taking an extremely important step in trying to move beyond determining proximate responses of toxicants to ask what these responses will mean in the natural environment. This is a difficult task, but one that is critical if we are going to be able to understand and predict the real-world effects of contaminants in coastal systems.

Two changes in the range of projects should be considered. Aa mentioned above, there are too many projects for the number of senior staff on the team. On the other hand, over the long term, the scope of this theme could be improved by moving beyond contaminants and endocrine disruptors to determine whether population-level predictions might be different with other kinds of stressors (e.g. climate change, eutrophication, etc.).

A lot of attention needs to be paid to alternative methods of population-level extrapolation and processes. For example, different kinds of conceptual and mathematical models that have different assumptions (density dependence, frequency dependence,increasing or decreasing

populations, environmental variability) should be tested and explored. The stage-classified matrix model is a good starting place, but not a good stopping point. In addition, a continued emphasis on comparisons between field data, lab experiments and models is important.

A number of the projects look quite interesting. In particular, the issue of genetic adaptation in contaminated sites is particularly intriguing. In addition, the role of compensatory mechanisms in either exacerbating or masking contaminant effects will be critical to making the extrapolation from lab to field settings. Other conceptual models besides incremental levels of stress leading to increasingly expensive forms of resistance need to be considered. For example, highest diversity and productivity often occur at intermediate levels of natural stress; perhaps this is also true of anthropogenic stress.

In sum, much of the basic information needed to assess the role this group plays in delivering advice to the agency and others is difficult to extract from the document provided. An overall sense is that the level of exchange could be expanded. The group has unrealized potential to provide scientific leadership. The Team members should work to broaden their connections with scientists along the Atlantic coast, looking for opportunities to interact with colleagues outside of the RI region and bringing more experts in for seminars.

The following bullets offer several questions/comments (areas of uncertainty and observations) about several aspects of the theme:

1. Extrapolation of short-term bioassay endpoints to indicators of population response (Munns, Gleason, Kuhn, Mills, Nacci, Champlin, McKinney, Serbst, Tagliabue).

- How does AED address acute and sublethal chronic endpoints vs. population, community and ecosystems responses?
- What short-term endpoints maximize accuracy of predictions at higher levels?
- Why is AED using 4 species - urchin, amphipod, mysid and fish to evaluate these questions?

The goal of linking short-term endpoints with population level effects is tangible. This group of researchers (as far as can be determined from the info provided) seems suited to address this goal with most of the members having published some previous work in the area. BUT, the extrapolation to higher levels of organization (community, ecosystem) is beyond the reach of this group as presently constituted. Current efforts present enough of a challenge without going this far.

2. Cellular and subcellular endpoints vs. organismal and population response (Mills, Nacci, Zaroogian, Guthajr-Gobell, Borsay, Haebler, Pruell, McKinney, Jayaraman, Gardner).

- How is AED going to be able to go beyond predictive indicators at cellular/subcellular level for population effects?
- How are impacts at lower levels expressed or repressed at higher levels?

The focus on EDs and retinoids in a characteristic estuarine fish seems appropriate. The members of this group are demonstrating a relatively high level of research productivity within the area of cellular and subcellular endpoints.

3. Extrapolation of laboratory endpoints to field population responses (Gleason, Champlin, Rocha, Edwards, Nacci, Rego, Serbst, Munns, Gutjahr-Gobbell).

- What about impacts at lower levels vs. organism/population?
- Are changes in population growth vs. population persistence and community dynamics being (going to be) addressed?
- How will AED address concerns regarding laboratory setting vs. field?
- Attention should be paid to the mummichog along PCB gradient, *Ampelisca* population dynamics.

To a degree, this project supports projects 1 and 2 - extrapolating more to the field. Themes are

similar. This is a good idea. This is a good example of a project area where more depth and less breadth will be critical for success. There is a need for site replication in multiple years.

4. Compensatory responses of natural populations to environmental stress (Nacci, Coiro, Champlin, Pelletier, Gleason, Munns).

- Note concerns regarding lower level vs. higher level responses.
- What are the mechanisms at various levels that compensate for environmental stress?
- Do homeostatic and genetic compensatory mechanisms mitigate stress effects?What about reduced plasticity due to stress?, The role of behavioral modifications?, Algae?
- In using using mummichog model, distinguish between stressed vs. unstressed.

Extrapolation past the population level is probably beyond the reach of this group as presently constituted. Overall, this project area has some strong projects and some that seem to have less focus towards the overall theme/goals. Dr Nacci 's work is outstanding.

5. Influence of environmental stressors on community and ecosystem function.

- What kinds of system changes affect ecological structure, function and health?
- What are the useful metrics for these changes?
- How much change before structure and function are significantly altered?

These are good questions, but also very significant questions. AED can not address this area effectively as staffed and would need many new people to do this work.

Resources and facilities:

Commitment of senior personnel to ecology and modeling is too low. For example, a total of 0.65 Research Biologist/Ecologist FTEs were allocated for the 5 studies for Project 1. This

reflects a serious underestimate of the difficulty and complexity of the ecological questions being addressed.

As new hires are made, additional senior personnel need to be added to this team. Special effort should be made to add personnel with expertise in modeling and theoretical/conceptual issues in ecology.

Facilities, however, seem excellent. The Team has access to a great deal of instrumentation and wet labs. Some other resources are hard to evaluate based on info given.

Summary and Conclusions:

The Panel makes the following recommendations which can potentially enhance these efforts:

1) Improve active collaboration with non-AED scientists. For example, there has been a large EPRI-funded program at Oak Ridge. Collaboration with scientists that have been involved with the CompMech program would greatly benefit the ES researchers.

2) Do not underestimate the complexity of the ecological issues. It is important to consider multiple options for population-level processes.

INTEGRATED ASSESSMENTS

Description:

The goal is the "development and application of methods to conduct integrated ecological resource assessments across large regional spatial scales." As presented/defined, an integrated assessment is a technical evaluation that combines various data into one overall assessment. The advantage being that an integrated analysis of a suite of variables will provide more insight into

ecological conditions than interpreting individual parameters. The major focus of this effort is to provide tools that can be applied at large spatial scales (e.g., the Virginian Province of EMAP) and that can be used to evaluate the influence of ecological resources on one another (e.g., the influence of land use of a watershed to water quality conditions in an adjoining estuary).

Critique:

Much of the focus of this theme seems to be an outgrowth of the EMAP program. In particular, criticism was leveled at the program by the National Science and Technology Council's Committee on Environment and Natural Resources (CENR) and the National Research Council (NRC). The NRC was concerned that clients for EMAP information were never clearly identified and the relationship between managers' concerns and EMAP activities was "tenuous." The CENR recommended more focused attention be given to geographic regions (in a rotating fashion) to address specific questions related to the condition of environment resources, how they are changing, why and whether environmental policies are working.

In response to these comments and the new ecological directions suggested by ORD, AED has reacted with a program to: (1) develop a framework to conduct integrated assessments (with emphasis on coordinating with managers); (2) develop new assessment tools and conducting a geographically specific, large scale assessment of the mid-Atlantic region to address CENR questions; and (3) create an information management system for EMAP.

(Note: The write-up contained in the notebook for this program theme was the only one that didn't list authors. However, the two Research Implementation Plans (RIPs) provided on diskette did provide additional information about staff commitments. In future reviews, all personnel should be clearly identified with the programs they are working on. One of the most important components of any technical proposal is the qualifications of the investigator(s). Just a listing of grade levels and job titles at the end of each chapter is insufficient to judge the full capabilities and resources devoted to the projects. Also, neither the notebooks nor the RIPs provide

information about project costs.)

Regarding (1) above, AED has responded to criticism by devoting considerable effort (in terms of pages of text -- not clear how much money is invested in this effort) to developing a framework to plan and conduct integrated assessments, with emphasis given to researching how integrated assessment questions can be framed to assist both managers and scientists. The underlying assumption for this work task (and theme) is that integrated assessments conducted over large spatial scales will be useful to managers. This is probably true, but no examples are used to demonstrate the potential utility of the tools. Are there many managers really out there that deal with decisions at these scales? Decision-makers are the true "managers." There needs to be better communication between scientists and decision-makers. Does AED have the in-house expertise to bridge this apparent communication gap?

The MAIA work may determine how successful this assessment approach will be. But it is not clear to me whether any of work on developing a framework will be used for the MAIA initiative. It appears that the MAIA approach will be evaluated and appropriate new guidance will be prepared after critical MAIA decisions and /or assessments have already been made. What will happen to the new guidance? Who is it intended for? Will any new research projects at AED use it?

The MAIA project appears to be a logical and needed extension of EMAP. Even though the research is addressing some interesting science questions, the management link is missing in the Project 2 descriptions (Development of Assessment Tools).

The data management task seems to be well designed to promote the exchange of data and information. It is consistent with other data management efforts within the National Estuary Program.

GIS approaches have great potential as exploratory tools and may provide significant insights

into first order effects. But, some aspects of system structure and function may be `emergent properties' that can not be elucidated via simple correlations.

Overall, the tasks in this theme respond very well to comments and criticisms made in connection with past activities. Some of the investigators have fine track records and will likely continue to produce high quality products. It would be nice to see a bit more vision in where AED believes integrated assessments will take them. What lies beyond MAIA? Who will responsible for implementing the newly developed framework?

The success of this theme research will be measured in large part by its utility in assisting managers. Reviewers are not convinced by the write-ups that substantive dialogue is occurring between AED and the management community. All of the reports are either technical manuals or peer reviewed articles. Will managers read any of this? Why aren't meetings and briefings with EPA regional staff part of the plan?

Some of the scientists involved in this program have indeed shown leadership in arranging meeting and symposia, and being part of larger planning exercises -- particularly those involved in EMAP. Again, at this point it is difficult to gauge the full success since all of the participants are not clearly delineated.

The group needs to focus on linking in both directions (science/management). The goal of interfacing to management is good. But, the total process is dependent on the indices being used to evaluate ecosystem health. These indices have soft spots. AED is in an excellent position to evaluate the weaknesses of the approach. If the goal is to reduce uncertainty then the focus should be on moving the approaches (e.g. assessment based on indices) forward using in-house talent and by drawing expertise from the external community.

Resources and Facilities:

Budgets are not listed for the individual tasks. Personnel are not specified as noted above, making an assessment difficult.

Summary and Conclusions:

The work under this theme is a logical extension of EMAP work previously accomplished by AED. There are some interesting science projects being planned in connection with the MAIA efforts. Management links need to be fortified and further communication with managers needs to be emphasized. Hopefully some useful suggestions in this regard will emerge from the work task to define assessment questions. The integrated assessment framework project may become a dead end if further planning is not initiated soon, including the discussion of results with EPA regional offices. The data management project is well designed and will facilitate the exchange of data and information collected under EMAP and other projects.

ECOLOGICAL INTEGRITY

Description:

The goal of this theme is to develop a framework and indicators to characterize, understand, and predict the ecological integrity of Atlantic Coast estuarine ecosystems. The term "integrity" was used in the 1972 Clean Water Act which stipulated that the physical, chemical and biological integrity of our Nation's waters be preserved. This theme sets out to define "integrity" and develop indicators to measure and assess ecological integrity in estuaries. An ecosystem has integrity, the team says, if it has the species composition and function of relatively undisturbed communities. This is a useful definition, but its current if not final usefulness may be limited by other regulatory or legislative understandings of the term.

Critique:

While the theme of ecological integrity was presented as: definition of emergent properties within a framework that would lead to indicators that reflect ecosystem response, there does not seem to be much integration between projects. This theme is, instead, an outgrowth of the former Cumulative Effects Research Program (CERP) at AED. Were the projects conceived as the post hoc rationalization of the PI's or as an integrated approach to development of EI? Project leaders need to work together to select field sites that will provide opportunities for synergistic interactions, field sites should be at the same places and times.
This would speed the selection of methods that work and help in the interpretations of results.

This theme has six project elements that are supposed to address the three questions articulated on p. 9 of the write-up. Question 1 asks, "Is it possible to develop a quantifiable, scientifically defensible definition of ecological integrity for estuarine systems?" Except for the introductory remarks, a work element that attempts to answer this question is not present. I assume that the answer must be yes.

The second question asks, "What is the best framework for organizing and aggregating the complexity of estuarine systems to identify system-level ecological indicators?" The first project titled "Energy System Models to Define and Evaluate Ecological Integrity Indicators" is billed as "developing the overall conceptual model for the theme..." This project will use a systems ecology approach to elucidate important components (based upon energy flow) of ecosystem integrity. Much of this work is theoretical in nature, and emanates from recent work of Odum and others. This appears to be a new area for AED, but at least one AED scientist has experience in this type of modeling. Has any consideration been given to extramural funding to bring in researchers like Odum to help with this task?

The third question asks, "Is it possible to develop system-level indicators of ecological integrity and what is the selection process for identifying which indicators should be developed?" The

first project (described above) will address both of parts of this question while the remaining 5 projects only deal with the first part -- developing indicators. Projects 2-6 seem to be completely independent of Project 1. It is not clear how the indicators in these projects were selected for further development.

With the exception of Project 4 (Point Source Effects to Soft Bottom Communities) and Project 5 (Wetland Plant Index), the other three involve the further refinement of methods developed by others. It is not clear how these methods will be integrated into overall assessment of integrity. In some cases, like the core work, it appears that the outside scientific community might be in a better position to refine this tool.
Regarding Project 5 (Development of a Coastal Wetland Plant Condition Index), I have my doubts whether a condition index will be a valuable tool. Who will really use it? What are the management implications? What are the functional implications of this? Since wetlands have some many varied functions, how will plant condition be factored into an assessment of other wetland functions?

There is little, if any, reference to the application of the indicators to EPA programs. There appear to be no plans to communicate the research results to EPA regional offices.In general, For many of the activities, it is not clear whether the primary intent is exploratory and method development (energy modeling?), attempts to adapt current research tools to broader-scale assessments (historical reconstruction?), efforts to improve existing approaches (benthic index?), or application of existing techniques to specific situations (fish index?). (Note: perceived goal of projects is in parentheses). In addition, more attention needs to be focussed on insuring that measures of integrity distinguish between natural and anthropogenic stressors.

A much greater level of coordination between the various projects is needed if one of the goals is truly to 'develop and evaluate' approaches to describing and evaluating ecosystem or ecological integrity. An important way to compare and coordinate the various activities would be to select a suite of 4-5 sites that vary in their level of anthropogenic impact and to use the entire suite of

approaches at all of those sites. This would allow the AED team to evaluate how well the various approaches to measuring ecological integrity work, under what circumstances they agree, and to what extent and why they make different predictions about the integrity of the same systems.

Similarly, the importance of comparing predictions of 'emergent' properties with those of physiological and organismal-to-species level properties should be emphasized and seen as a strength. The relative usefulness of emergent properties and lower-levels of ecological organization as indicators of integrity should be an important aspect of this research that can be determined by the current research projects. It may be that there are truly emergent properties that are the best descriptors of the 'integrity' of estuarine systems. On the other hand, the older approach of changes in the abundance, distribution, fecundity or physiological state of sensitive species may be more reliable. I realize that your orientation is towards emergent properties, however, there is nothing wrong with a conclusion that a focus on sensitive species works better (if it does).

The focus on developing historical reconstruction as a more routine & widespread technique is extremely important. We are not likely to get away from the problem of the idiosyncratic nature of individual systems. Historical reconstruction to determine the magnitude and time horizon of change is invaluable in determining how a system has deviated from its 'natural' state as a result of both anthropogenic and climatic influences.

The theoretical basis for relating some of the measures of integrity to the level of degradation of the system was not always clear. For example, the trophic complexity and the length of food webs may be influenced by a host of physical processes, the regional species pool, or the habitat in which an individual is collected in addition to the extent to which a system is degraded by anthropogenic activities. Similarly, a lot of thought needs to be put into how energy would be expected to differ in systems with different levels of anthropogenic degradation.

Resources and Facilities:

The physical plant is outstanding and support staff seems very keen and up to date. Financial support from management seems good for most projects. The wet lab and potential for experimentation are strongest elements of the lab.

How well the team concept is working could not be assessed. It is still unclear who does what on each project and the theme overall has almost twice the number of senior FTEs as the ES theme. Consequently, one must question if this was a conscious decision or an historical accident of staffing.

Summary and Conclusions:

The group felt, in general, that these are all worthy projects, but wondered if scope should be broadened. There is a significant chance that there may be no one adequate measure of the multitude of possible outcomes following ecosystem disturbance. An assumption in the team's work seems to be that there are equilibrium states for coastal marine communities that can be used as reference points for measuring the effects of anthropogenic stressors. But it may be that many bottom communities possess no equilibrium state, but are continually varying in various states of recovery from past disturbances. Furthermore, other researchers have good evidence for the proposition that while community dynamics may be determined, that is, they follow rules, future states of the community may be unpredictable. Marine communities may be chaotic systems with a different set of metrics than the team anticipates. Second, if history plays an important but unpredictable role in ecosystem structure and function, it may be that biological narratives are in some cases the best descriptors of stressor effects. The goal of conducting multi-year studies of the natural histories of the dominant and functionally significant species in coastal systems would then be of great importance. It could be done by extramural projects when in-house expertise is absent, and in any case is another activity that would make this federal lab distinctive.

The project teams, with a few exceptions, are young and very energetic, but not well recognized

as leaders in their fields. Initiation of a senior visiting scientist program would go a long way to providing the knowledge base that the project teams need to be on the cutting edge of what they are doing. This is particularly true for the benthic community program (4) and historical conditions program (2).

The EI theme is composed of six loosely connected projects some of which are not up on what is happening outside of this lab. Project groups need to mine the work of others and select key elements that advance the theme of EI. Initiation of a monthly seminar series, each focused on a project activity, would be most helpful. The team describes six projects:

1] find the pattern if energy input to habitats and compare clean vs. dirty habitats
2] chronicle the pollution history of estuaries using various measures of sediment cores
3] use N- isotopes to measure food chain structure
4,5,6] develop indices of health for benthos, wetlands, and fish communities.

The research in project 1 is worth pursuing. However, it might assume that there are equilibrium energy states to be measured and that they produce equilibrium communities and it may not be safe to do that. Project 2 has the advantage that in addition to estuarine chronologies, it utilizes the lab's well developed measurement skills and will likely result in new or better measures of several sediment components. Project three is exciting. But, in project 3.3 how does the team propose to measure food chain length (and is it a 'chain'?) and whether other food web characteristics ought to be considered. And in project 3.4 - are mussels and snails the base of the food web?

In project 4, three sediment characteristics - pore water ammonia, tube density, and sediment compaction - are proposed as rapidly assessed measures of benthos community structure and function. While the approach is good, the selection of these particular measures is questionable. What leads the team to think these are the best indicators? There might be other sediment properties (e.g.,redox discontinuity, sulphide) that are useful. (Perhaps it would be prudent to

organize a conference on the topic!). Second, when measuring the indicators *in situ,* it seems likely that differences in communities might not be due solely to anthropogenic stressors, but also to time varying local natural disturbances. Woodwell hypothesized as long ago as 1969 that some community responses are invariant with respect to the source of disturbance. Finally, has the team considered using temperature-adjusted sediment mixing rate or oxygen consumption or pore water flux of chemical species as proxy measures for benthic community function?

In project 5, it may be obvious to botanists, but why *not* use plant yellowing as a measure of *Spartina* stress? It simple and might show up in remote sensing. It is not clear how project 6 fits the overall theme and connects with the other projects. Most all of these projects have a 2 year duration. The team should also look at the idea of monitoring their sites for a longer time period.

In general, this theme, while purporting to be cohesive, is clearly not. A great deal of research is being done under the EI theme. Research is weakly interconnected, possibly reflecting the newness of the EI organization. Interdisciplinary interaction need to fostered. The EI theme is not on the cutting edge of advancing knowledge for a purpose. For EI to work the development of projects needs to be driven by seminal questions within the individual research areas. For example, benthic community activities do not seem to be current with national and international work on indicators or bioturbation. Also, more weight needs to be given to what each indicator is going to be used for, who will eventually use the indicator and how it can guide other indicator work. It may also be a prudent question to assess whether EPA should be getting so heavily involved in the ecological methods refinement business when there are many academic institutions that can do it better. Again, the ecological systems project could use more outside support and guidance. Panelists question if existing AED staff can work on this problem alone.

If one looks at leadership as measured by publication rate, it is minimal. For the credibility of the EI theme to rise, publication rates must rise. Few will take the programs seriously with out peer recognition. Basically, EI theme needs to refocused. The development of a conceptual

frame work on which to hinge each of the activities is needed. The ecosystem modeling would be a good starting point.

With regard to personnel, there is a very high percentage of URI graduates. Cross fertilization and different mentor imprinting that different schools can provide is lessened by the high proportion of URI grads. This is not to say URI grads are not top notch, but that diversity of background and training are important to maintain.

BIOAVAILABILITY

Description:

The stated goal of the *Biological Availability of Contaminants in Sediments and Waters of Aquatic Systems* (Bioavailability) Research Theme is to develop (i) innovative measures of biological and chemical impact, (ii) methods to identify chemical stressors in complex mixtures using a biologically directed chemical fractionation approach, and (iii) tools for predicting fundamental equilibrium partitioning processes.

Critique:

The description is well-written and well justified. The researchers seem to have a wide and competent network of collaborators, reflecting perhaps the historical expertise of the lab. The description does get a lot more vague when describing field verification of methods. They seem to have a good handle on sediment chemistry, and the sediment colloid work and resuspension episode study are particularly exciting as is the idea of participating in an inter-division working group like SERG. It would be a useful activity for all the thematic groups.

The write up presented three project areas that cooperatively are to be used to achieve the

bioavailability theme goals. These are: method development for effects measurement, identification of stressors causing adverse effects, and predicting adverse effects of stressors. The project areas will each contribute to the program goals; however, Project 2 - which focuses on demonstrating causality by identifying stressors that cause effects through biologically directed fractionation was not clearly described in the research work plan. Nonetheless, this work, which centers around the toxicity identification and evaluation methods (TIE), was well described in the presentation and overall, the bioavailability presentations were well done and helpful in assessing this program.

Is the program asking the right questions? In general the answer to this question is yes. Reviewers were particularly impressed with efforts to evaluate phototoxicity, quality of sediment organic carbon in addressing the bioaccumulation of sediment-associated contaminants, and the work on dioxin-like compounds. However, an area of concern is the breadth and depth to which this group is pursuing some of the scientific questions being posed. The primary example of this is the tendency to rely on the equilibrium partitioning approach to predicting the bioavailability of sediment-associated contaminants. Rather than continue to conduct assessments and compare the results to what EqP predicts, this group should be challenging the theory. Only in this way, by proving a theory stands up to rigorous scientific testing and/or by revealing its limitations, can the program adequately provide advice to the EPA. In addition, there are emerging scientific issues relevant to the areas of research in the bioavailabilty theme that should be considered by these scientists in proceeding with their research. Some specific suggestions are outlined below.

The chemical indicator activity should be thinking about ways to identify sources of contaminants (e.g. PAHs) in addition to developing new methods for measuring pollutant levels. There are various indications in the recent scientific literature that PAH source (i.e. soot particles, creosote treated wood - see McGroddy and Farrington, Gustafsson et al.) is related to sediment-pore water partitioning and bioavailability. Thus, efforts to identify contaminant sources using compound, isomer or isotope ratios will be extremely useful in interpreting bioavailability, particularly for field sediments. Additionally, an emerging idea to consider as a

novel tool for measuring bioavailability of contaminants is the work of L. Mayer and D. Weston on the use of benthic invertebrate digestive juices.

Some issues other than contaminant source to consider in examining the bioavailability of organic chemicals are availability of the sediment organic carbon (i.e. surface sorbed/digestible - see work of L. Mayer, J. Hedges, Keil) for contaminant partitioning and the metabolic capability of the benthic invertebrates. These factors will affect bioavailability, as well as predicted bioaccumulation via EqP. The group would also be able to gain much more information by examining compound classes, which range in partition coefficients, rather than representative compounds from various pollutant groups. Finally, wide ranges in organic carbon quality (e.g. as evidenced by C/N ratio or lipid biomarkers) should be used in testing EqP.

The following more project-specific comments hopefully provide some insights on problems and omissions that can be addressed to enhance an otherwise impressive group/program:

Project 1. Biological and chemical indicator development. The biological indicator development work as proposed is first rate and reflects the state of the science. The text describing 'community level assays' in the out years is vague (what are community level endpoints?), but the PIs are well aware of the potential approaches and problems.

The chemical indicator development section is very cursory and unimaginative. Perhaps this activity would be more appropriately couched in terms of an analytical service facility (comparable to the operation of the seawater facility) rather than a research project. The development of 'novel tools' (C18, SPMD) to explore bioavailable fractions is potentially interesting, but the text does not cite the large amount of recent literature on the subject and does not mention the use of microfiber sampling, likely the most promising approach.

Project 2. Identification of stressors. Continuation of productive research area. Impressed with the New Bedford Harbor TIE paper (recently published in *Environmental Toxicology and*

Chemistry).

Project 3. Predicting adverse effects of stressors. Test equilibrium partitioning. Equilibrium partitioning theory has been a great help to the initial development of sediment quality criteria. The use of organic carbon and AVS normalization reduces intersite variability. However, it has limits. There are many skeptics of EqP, and I am concerned that it is accepted at AED as the best approach for sediment quality criteria. EPA is going forward with SQC using EqP, and there may be a natural tendency within the agency not to question the approach during this time. However, AED scientists should be the harshest critic of EqP, even as they continue to refine the technique. They should be developing the next generation of approaches to assessing sediment quality criteria, even higher risk efforts with potentially long maturation times.

In several places in the written document, relevant recent literature is not cited. Whether this is an oversight or reflects a poor understanding of the literature is unclear. Specific examples include:

a. The proposed work on bioavailability of ionic organic chemicals does not cite any of the voluminous literature on the sorption of cationic and anionic chemicals to soils and sediments. See recent work by John Westall and co-workers and by Walter Giger.

b. The proposed work on bioavailability of non-ionic organic chemicals, particularly the binding of organic chemicals to different types of organic matter and to colloids seems to repeat work that was done more than ten years ago (Chiou, Brownawell).

It would have been more appropriate that the 'non-equilibrium' systems section be weighted more heavily, as this is probably the largest area of uncertainty in contaminated sediment management in coastal areas. Are contaminants released during sediment dredging or storm-induced resuspension events? What about during seasonally-varying redox changes? This is an opportunity for AED to make a difference.

There is also an overall and potentially a serious gap in the overall program as proposed. A significant National concern is the transfer of bioaccumulative contaminants from in-place sediments through benthic organisms into higher trophic levels in coastal waters. This is not addressed in the AED themes, nor apparently anywhere else (for marine food webs) within ORD. This is a serious oversight, as it will not allow a balanced development of sediment risk management that includes both *in situ* toxicity and bioaccumulative risks. It is not clear that the freshwater bioaccumulation work conducted at the Duluth laboratory could be extrapolated to coastal food webs, which are dominated by migratory species involved in active osmoregulation. Substantial new research has demonstrated the controlling influence of food web structure (Rasmussen et al; Kidd et al.), animal behavior (*e.g.*, migration) and trophic condition (*e.g.*, extent of eutrophication) on the efficiency of food web transfers of bioaccumulative pollutants. AED should be allocated the resources to conduct this important research.

The work proposed to used stable nitrogen isotopes to characterize food webs is presented here in the context of using trophic depth and/or breadth as an indicator of ecosystem integrity. The feasibility of this is questionable, but the same food web structure analysis, coupled with the other contaminated sediment bioavailability work proposed here, would provide the basis for a 'sediment bioaccumulation' activity within the Bioavailability Theme.

(Minor comments on Project 3)

A. They note that 'several studies show metals bioaccumulation in sediments with SEM-AVS>1' which 'contradicts our predictions based on sulfide binding' (pg 22). However, there isn't any discussion in the plan about specific research efforts to examine these sediments.

B. Proposed work on arsenic cycling (pg. 23) should refer to the recent work on As cycling in the Aberjona watershed (Aurillo, Mason, and Hemond, *Environ. Sci. Technol.*, 28, 577-585; Spliethoff, Mason, and Hemond, *ES&T*, 29, 2157-2161).

C. Rates of FeS and MnS oxidation are fairly well known, and the literature should be consulted before deciding whether to pursue this research (pg. 23-24).

Resources and Facilities:

Resources and facilities appear adequate with the comments noted above and in summary and conclusions section.

Summary and Conclusions:

The written and oral presentations of the bioavailability theme appear to indicate that this program area is a priority function to support Agency goals. It is unclear how the information from this program are being translated to the Agency; however, this group does appear to be publishing, presenting their results at scientific meetings, and interacting with other agencies via regular conference calls. It is as an active, enthusiastic group that is poised to make significant strides in advancing the state of the art in environmental science and risk assessment. There are several people who are likely to develop as leaders in the field. To do this they should be challenging current paradigms, as noted above. Individuals in this group should also continue work on publishing in the peer reviewed literature, presenting information at a variety of scientific meetings, and organizing symposia etc. at both the national and international level.

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