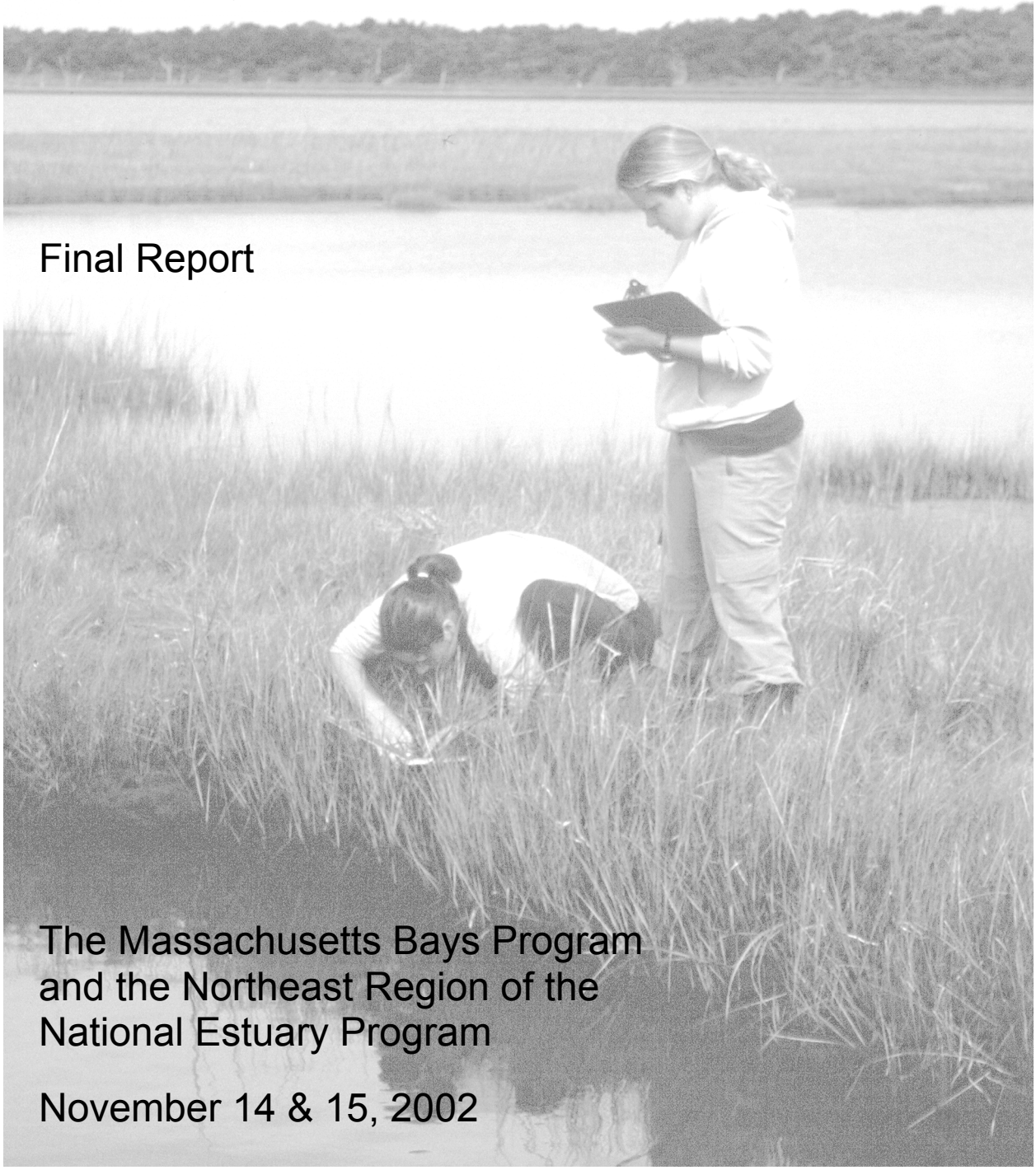
EYES ON THE ESTUARIES:

A Conference on Preventing and Detecting Marine Invasive Species in the Northeastern United States



Final Report

The Massachusetts Bays Program
and the Northeast Region of the
National Estuary Program

November 14 & 15, 2002

Final Report:

EYES ON THE ESTUARIES
Preventing and Detecting Marine Invasive Species

A Massachusetts Bays Program Regional Conference

November 14 & 15, 2002

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Massachusetts Bays Program
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Acknowledgements

The Massachusetts Bays Program (MBP) would like to thank the following organizations, agencies, and people:

The Environmental Protection Agency and the Association of National Estuary Programs for their generous support; without which this conference could not have happened.

The Massachusetts Office of Coastal Zone Management, the New England Aquarium, and Salem Sound Coastwatch for their generous staff support.

The northeast National Estuary Programs including the Buzzards Bay Project, the Casco Bay Estuary Project, the Long Island Sound Study, the Narragansett Bay Estuary Program, the New Hampshire Estuaries Project, the NY/NJ Harbor Estuary Program, and the Peconic Estuary Program for their assistance with conference planning and logistics.

All of the speakers who presented their important work at the conference, with a special *thank you* to Dr. Jim Carlton and Dr. Judy Pederson, two exceptionally talented and inspirational speakers on the subject of marine invasive species.

Special in-house thanks go to Shannon Weigle for coordinating and planning much of the logistics, and to MIT Sea Grant and Salem Sound Coastwatch for handling the conference finances and registration.

Final Report Compilation: Shannon Weigle, MBP and the Long Island Sound Study

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> "We must make no mistake: we are seeing one of the great historical convulsions in the world's fauna and flora. We might say, with Professor Challenger, standing on Conan Doyle's 'Lost World', with his black beard jutting out: 'We have been privileged to be present at one of the typical decisive battles of history--the battles which have determined the fate of the world.' But how will it be decisive? Will it be a Lost World? These are the questions that ecologists ought to try to answer."
> - Charles Elton (1958)

Table of Contents

	Page
Introduction	1
Program Agenda	3
Section 1: Speaker Presentations	5
Baker, Jason. Abstract and Presentation	7
Buchsbaum, Robert. Abstract and Presentation	18
Carlton, Jim. Abstract	26
Chapman, Annelise. Abstract	27
Harding, Juliana. Abstract	28
Pederson, Judith. Abstract	29
Rudnick, Deborah. Abstract and Presentation	31
Sinnott, Tim. Abstract and Presentation	37
Smith, Brian. Abstract and Presentation	43
Smith, L. David. Abstract	48
Stinner, Ron. Abstract and Presentation	49
Tyrell, Megan. Abstract and Presentation	54
Weigle, Shannon. Abstract	61
Whitlatch, Robert. Abstract	62
Section II: Panel Discussion	63
Panel Discussion Transcription	65
Section III: Break Out Groups	73
Break Out Group Summaries	75
Section IV: Contact Information	81

Regional environmental managers, educators, scientists, and others learn about the current status of marine invasive species in the northeast at the Eyes on the Estuaries Conference.

Introduction

Next to habitat destruction, invasive exotic species are the leading cause of decreased biological diversity in the United States and worldwide. Though the northeast has yet to witness an invasion as ecologically destructive as that of the mitten crab *Eriocheir sinensis* or the green alga *Caulerpa taxifolia*, numerous invasive species are threatening our coastal watersheds. Marine invaders can enter through a variety of pathways that are difficult to monitor and control. Since marine ecosystems are essentially borderless, invasive species can easily spread from estuary to estuary and state to state. Regional coordination and cooperation are necessary in order to effectively prevent and control future invasions of exotic marine species.

More than 150 government officials, scientists, nonprofit organization representatives, and citizen activists attended the 2003 Eyes on the Estuaries Conference. Dr. Jim Carlton began day 1 with the keynote address *Exotic Marine Species: Why They Matter, and the Value of Detection Monitoring, and Surveillance of Vectors and Invaders*. Dr. Carlton's presentation set the stage for further talks and discussions on the threat of invasive species to local marine biodiversity and the steps that can be taken on a regional level to prevent their introduction and spread. The morning presentations focused on species that have already invaded the northeast and the efforts that are underway to study their spread and impact. Afternoon presentations showcased a variety of local habitat monitoring efforts, ranging from volunteer monitoring programs to scientific studies, and the challenges that arise when incorporating invasive species monitoring into these efforts.

Day 2 began with a presentation by Dr. Judy Pederson titled *Making Choices: Getting the Biggest Bang for the Buck.* Dr. Pederson addressed the variety of pathways that lead to marine invasions and the need to prioritize action in the region in order to most effectively prevent future invasions. The speakers that followed focused on invaders that may soon reach the northeast and the pathways through which they may be introduced. During the afternoon break-out sessions, participants worked together to develop strategies for regional habitat monitoring and pathway control.

In response to the conference, many groups in the northeast have begun to take action and develop strategies for preventing further invasions. Efforts are currently underway to create a northeast monitoring network for marine invasive species. Others are working with local industries at risk of introducing invasive species to develop best management practices aimed at curbing these risks. In addition to these innovative efforts, we still need more "eyes on our estuaries." To learn more and get involved, visit www.massbays.org!

Eyes on the Estuaries:
The Northeast Marine Invasive Species Conference

Thursday November 14, 2002

8:00 AM	Registration and Refreshments
8:30 8:50	Welcome: Jan Smith, Executive Director, Massachusetts Bays Program **Keynote Address:** Dr. Jim Carlton, Williams College - Mystic Seaport *"Exotic Marine Species: Why They Matter, and the Value of Detection* Monitoring, and Surveillance of Vectors and Invaders" 15 minutes for Q&A
9:45	Break
	THEY'RE HERE!!! INVASIVE SPECIES IN THE REGION **Moderator: Richard Ribb, Narragansett Bay Estuary Program**
10:15	Megan Tyrell, Massachusetts Office of Coastal Zone Management *"Impacts of two introduced crabs on the northern New England rocky intertidal community"*
10:45	Annelise Chapman, Dalhousie University *"The green algal invader* Codium fragile *ssp.* tomentosoides *in North America: 45 years and still going strong"*
11:15	Juliana Harding, Virginia Institute of Marine Science "*Current status and potential establishment range for the predatory marine gastropod* Rapana venosa *on the U.S. East Coast"*
11:45	Lunch
	APPROACHES TO INVASIVES MONITORING **Moderator: Karen Young, Casco Bay Estuary Program**
1:10	Judy Pederson, MIT Sea Grant College Program "*Northeast Rapid Assessment Survey"*
1:40	Brian Smith, Great Bay National Estuarine Research Reserve *"Biological monitoring as part of the National Estuarine Research Reserve System Wide Monitoring Program"*
2:10 2:40	Robert Buchsbaum, Massachusetts Audubon Society *"Monitoring marine invasive species and other organisms in the rocky intertidal zone using volunteers"*
3:10	Break
	Moderator: Joe Costa, Buzzards Bay Estuary Program
3:30	Robert Whitlatch, University of Connecticut *"Long-term monitoring coastal invasive invertebrate recruitment: linking climate change and biological invasions"*
4:00	Jason Baker, Massachusetts Coastal Zone Management *"The Marine Invader Database: A strategy for tracking the distribution of invasive species in the waters of the Northwest Atlantic"*
4:30	**Panel Discussion** *Integrating Invasive Species Monitoring into Ongoing Monitoring Programs* Panelists: Robert Buchsbaum, Massachusetts Audubon Society; Annelise Chapman, Dalhousie University; Anne Monnelly, Massachusetts Lakes and Ponds Initiative; Brian Smith, Great Bay NERR Moderator: Jan Smith, Massachusetts Bays Program
5:30 – 7:30 PM	Evening Reception, West Wing Gallery, New England Aquarium

Eyes on the Estuaries:
The Northeast Marine Invasive Species Conference

Friday November 15, 2002

8:00 AM	Registration and Refreshments
8:30	**Keynote Address:** Dr. Judith Pederson, MIT Sea Grant College Program *"Making Choices: Getting the Biggest Bang for the Buck"* 10 minutes for Q&A
	THEY'RE COMING!!! INVASIVE SPECIES ON THE WAY **Moderator: Peter Sattler, Interstate Environmental Commission**
9:15	Debbie Rudnick, University of California *"The Chinese Mitten Crab: Coming soon to an estuary near you?"*
9:45	David Smith, Smith College *"Identifying potential invaders among imported marine species"*
10:15	Break
	APPROACHES TO PATHWAY MONITORING **Moderator: Jennifer Hunter, New Hampshire Estuaries Program**
10:45	Shannon Weigle, Massachusetts Bays Program *"The live marine species trade and potential risks for exotic species introductions"*
11:15	Ron Stinner, North Carolina State University *"Developing an internet surveillance application and team"*
11:45	Tim Sinnott, New York State Department of Environmental Conservation *"The Northeast Regional Panel of the National Aquatic Nuisance Species Task Force"*
12:15	Lunch
1:15	**CONSTRUCTIVE COORDINATION** **Break-Out Groups** 1) *Coordinating Marine Monitoring Efforts and Data Management* Moderator: Jason Baker, MA Coastal Zone Management 2) *Pathway Monitoring and Prevention Strategies* Moderator: Michelle Tremblay, Northeast Aquatic Nuisance Species Panel 3) *2003 Northeast Rapid Assessment Survey of Intertidal Habitats* Moderator: Jan Smith, Massachusetts Bays Program
2:15	Break
2:30	*Break-Out Group Summaries*: Break-Out Group Moderators
3:00	*Closing Thoughts*: Jan Smith, Massachusetts Bays Program
3:15	Adjourn

Section I:
Speaker Presentations

Dr. Megan Tyrell talks about Hemisgrapsus sanguineus*, a recent invader to the northeast, at the Eyes on the Estuaries Conference.*

The Marine Invader Database: A strategy for tracking the distribution of invasive species in the waters of the Northwest Atlantic

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Increasing threats from marine biological invasions in the Northeastern US and Atlantic Canada have led scientists and natural resource managers to intensify marine invasive species (MIS) monitoring efforts. These short and long term biological monitoring programs provide information essential for the effective management of marine invasive species in the region. However, these data sets currently reside in a variety of locations and formats, resulting in an incomplete understanding of regional MIS distributions.

In response to the need for a collective approach to MIS data management, the Northeast Regional Aquatic Nuisance Species Panel (NEANS) and the Massachusetts Office of Coastal Zone Management (CZM) have begun developing a Marine Invasive Species Database for the Northeast Region (MarineID). MarineID will serve as a central repository and clearinghouse for MIS occurrence data, allowing scientists and managers to contribute data online, and download relevant information.

CZM and NEANS will achieve project goals through a strategic partnership with the Marine Invertebrate Diversity Initiative (MIDI). MarineID will capitalize on a proven web enabled data management foundation laid by MIDI while expanding its online mapping, visualization, and query capabilities. This partnership will also provide access to an existing network of researchers currently collecting biological data in the Northwest Atlantic.

Effective development and implementation of MarineID will require input and participation from a broad array of area researchers. MarineID project proponents have identified a limited number of relevant data sets for incorporation, and are actively seeking participation from those involved in biological monitoring efforts. In addition, the integration of disparate data sets and the incorporation of new monitoring efforts will require wide agreement on a MarineID data model. This presentation will outline planned MarineID project components, as well as opportunities for involvement by the marine research community.

Monitoring marine invasive species and other organisms in the rocky intertidal zone using volunteers

Robert Buchsbaum, Ph.D,* and April Ridlon, Massachusetts Audubon Society, 346 Grapevine Rd., Wenham, MA 01984, 978-927-1122, rbuchsbaum@massaudubon.org, and Karen Young and Rob Gough, Salem Sound Coastwatch, 201 Washington Street, Salem, MA 01970.

***presenter**

The Massachusetts Audubon Society began collecting baseline data in 1999 on the abundance and types of organisms found in tidepools along the rocky shoreline of the North Shore of Massachusetts. Our goals were to examine the presence and abundance of invasive species in these habitats, compare the present suite of organisms to those believed to have been present in the past, document seasonal changes of organisms, and examine the impact of human visitation and water quality on tide pool ecology. Recognizing the intrinsic interest of the public in these attractive habitats and their educational value, we added a volunteer monitoring component in 2000. In the spring of 2001, Salem Sound Coastwatch (SSCW) joined with MAS:NS to initiate the "Adopt-a-Tidepool" volunteer monitoring program that now includes about 50 tidepools from Cape Ann through Salem Sound.

Trainings were held to introduce volunteers to the organisms, teach identifications, and demonstrate the methods. We asked volunteers to select from 1-4 tide pools for repeated visits and to note their position within the intertidal zone (low, mid, and high). Volunteers were asked to provide measurements of the physical characteristics of their tide pools (size, depth) so that we could relate these characteristics to the types of organisms found within. For recording species, volunteers visited tidepools at least once a season and estimated percent cover of organisms with an encrusting or bushy growth pattern (e.g., barnacles, mussels, colonial tunicates, all seaweeds) or number of individuals (e.g., snails, crabs, sea stars, anemones). Data sheets provided to the volunteers contained names of organisms and categories of abundances and cover that could be easily checked off. Because some marine organisms are notoriously difficult to identify, we did not require our volunteers to identify everything to the species level. As a quality control method, MAS and SSCW staff periodically visited the tidepools with the volunteers.

As of September 2002, the volunteers have identified 65 taxa in all the tide pools. Forty eight are native, 11 are non native and 6 are of unknown origin. Individual tidepools contained 10 to 40 species with most having 20-30. Low tide pools contained the highest number of species. Our preliminary analysis indicates little seasonal difference in the number of species, nor differences that could be related to how remote the tidepool is from human disturbance. Most tidepools contained similar distributions of native v non-native species. The most widespread encrusting organisms and seaweeds were all native, however about half the individual snails and 2/3 the crabs were non-native.

Funding for this program has come from The EnTrust Fund, the B.J. Anderson Foundation, the Fund for the Environment of the Boston Foundation, the Essex County Ecology Center, and the Massachusetts Environmental Trust.

Exotic Marine Species: Why They Matter, and the Value of Detection, Monitoring, and Surveillance of Vectors and Invaders

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Non-native marine protists, invertebrates, mammals, fish, birds, algae, and seagrasses have extensively impacted marine and estuarine coastal ecosystems all over the world, often fundamentally altering the ecosystem seascape as well as having first-order societal impact. These invasions began 500 and more years ago, long before the first scientific collections were made of regional biotas (resulting in a potentially very large underestimation of the actual number of introduced species in most areas of the world, and thus an underestimation of their actual impact). Invasions continue steadily in November 2002 due to the synergism of a number of phenomena, including large-scale expansions of global trade and services to support an increasing human population, combined with a broad menu of environmental modifications of the coastal environment.

This steady invasions flow is now being addressed through (1) the detection of vectors and what species they may potentially transport, (2) the questions, challenges and implementation of vector management, (3) the assessment of the number of some of the exotic species that are now members of selected marine and estuarine communities (and the experimental elucidation for a few species of their community-level roles), and (4) the early detection, monitoring, surveillance, and potential eradication of founder populations. Realistic funding, deep education of the public, press, and political communities, coordinated survey and collection approaches and superb, scholarly taxonomy and systematics form parts of the foundation to achieve some of these goals.

The green algal invader *Codium fragile* ssp*. tomentosoides* in North America: 45 years and still going strong

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The Japanese seaweed *Codium fragile* ssp *tomentosoides* has been introduced to many coastal areas of temperate oceans since the early 1900s. Whereas it has become established and spread almost everywhere it was recorded, including throughout Europe, in New Zealand and south western Australia and in south western North America, it has proven to be especially invasive in north eastern North America where individuals grow to 1m in size and form large populations in intertidal pools and the shallow subtidal zone. Regionally, native kelp beds have been replaced entirely by dense *Codium* meadows. The range of *Codium* in eastern North America now extends from North Carolina to northeastern New Brunswick.

Many 'weedy' properties of *Codium* make it a potentially invasive species, but the ecological attributes of each recipient species community appear to contribute significantly to the success of the species in a new environment. In northeastern North America, establishment of *Codium* in the shallow subtidal zone of rocky shores always coincides with a reduction of the dominant native vegetation canopy of kelps. Mechanisms responsible for kelp canopy decline include herbivory by sea urchins and defoliation through the invasive bryozoan *Membranipora membranacea*. On soft sediment shores, *Codium* might be limited by the availability of suitable attachment substratum.

Nearly half a century after invasive *Codium fragile* ssp *tomentosoides* was first recorded in North America, its ecological consequences are still not fully understood. Recognized negative economic effects of this pest species are primarily related to the fouling of harvested shellfish (e.g. oysters, mussels, bay scallops) – both in natural beds and in aquacultures.

At present, a few surveys have established *Codium* distribution in limited areas. However, there is no systematic monitoring for *Codium* anywhere in Canada; and there is no monitoring program for the purpose of early detection of alien marine species in general. A few localized containment and eradication efforts of *Codium* in the past have proven unsuccessful, mainly because of the immense regeneration potential of the species from even microscopic fragments. In order to limit further distribution of *Codium*, preventative efforts should target the main anthropogenic transport vectors. Hence, quarantines for translocated wild or cultivated shellfish are equally important as addressing the problem of hull fouling on various types of vessels. Finally, management approaches of *Codium fragile* ssp *tomentosoides* in the region need to be integrative and consider ecological interactions with other bioinvaders and the native species community.

Current status and potential establishment range for the predatory marine gastropod *Rapana venosa* on the U.S. East Coast

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The Asian gastropod *Rapana venosa* Valenciennes was first reported in 1998 for eastern North America in the lower Chesapeake Bay and James River, Virginia, U.S.A. This represents a transoceanic range expansion for this species, which had previously been introduced to the Black, Adriatic, and Aegean Seas. Ballast water transport of larval stages from the eastern Mediterranean or Black Sea is the suspected vector of introduction into the Chesapeake Bay. Since 1998 over 4300 specimens have been collected from hard sand, shell and mud bottom types in depths ranging from 5 to 20 m and at salinities of 18 to 28 ppt. Successful reproduction of *R. venosa* in the Chesapeake Bay is supported by the presence of multiple size classes in extant populations, collection of egg cases from the field, and successful culture of larval stages through metamorphosis in the laboratory under prevailing local conditions of temperature and salinity. Both laboratory and field data indicate the ability of the invader to prey on local bivalve species, often leaving a characteristic signature scar. We suggest that signature scars can be used as an indicator of the presence of *Rapana* in the absence of direct collections. This is particularly important in that juvenile *Rapana* are easily mistaken for native species in field surveys. Salinity tolerance of pelagic larval stages was examined in conjunction with temperature and extant nearshore and estuarine current data, to estimate possible rates of dispersal and range expansion from the current invading epicenter. Counter clockwise, gyre-like circulation within the Chesapeake Bay will, we predict, distribute larvae northward along the bay side of the DelMarVa peninsula, and eventually to the lower sections of all the major subestuaries of the western shore of the bay. Dispersal onto and along the coastal shelf outside of the bay mouth may be influenced by both northward and southward flowing residual current depending on depth, and wind conditions. Establishment over a period of decades from Cape Cod to Cape Hatteras by natural dispersal is considered a high probability.

The VIMS rapa whelk web site (www.vims.edu/mollusc/research/merapven.htm) contains the most current research information on rapa whelks in North America including distribution maps as well as information on related educational resources.

Northeast Rapid Assessment Surveys

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Records of nonindigenous species in New England are buried in scientific literature going back to the late 1800s (and earlier) and forward to the present, often in specialized journals and the gray literature. A compilation of species, their relative abundance, and general distribution is necessary for defining the scope of the problem and assisting managers and policy makers in formulating approaches to prevent, manage and control unwanted species. In August 2000, a Rapid Assessment Survey of nonindigenous and native species found as fouling communities was conducted in Massachusetts and Rhode Island. The approach, based on surveys conducted on the West Coast, involves taxonomic experts to identify macroalgae and invertebrates at sampling locations along the coast. Twenty-three nonindigenous species and 48 cryptogenic species of a total approximately 283 species were identified in Massachusetts. Four new species were identified and one species, the ascidian, *Didemnum* sp., has made a dramatic and apparently simultaneous appearance in several locations around the world.

During the summer of 2003, a broader survey will examine habitats in National Estuary Programs from Casco Bay, Maine through Pekonic, Long Island Sound. The purpose is two-fold; identify native and non-native species at representative sampling sites on fouling structures and hard and soft substrates and to enter the data in a New England database. Sampling additional habitat types will require modification of the approach to accommodate intertidal and subtidal habitats and to manage the distances of the survey in a reasonable amount of time. Other monitoring approaches to identify nonindigenous species will be compared to a Rapid Assessment Survey.

Making Choices: Getting the Biggest Bang for the Buck

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Shipping, as ballast water and ship fouling, is one of the most significant vectors that introduce non-native species. Recent legislation (Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 and the Nonindigenous Species Act of 1996) focuses on reducing or eliminating ballast water introductions. However, many other vectors are potential sources of unintentional releases of nonindigenous species into marine environments. These include; aquaculture, bait industry, biological suppliers, education and research, fisheries (commercial and recreational), live seafood, public aquaria, restoration, saltwater aquarium industry, and several other vectors. The challenge is to identify those vectors that represent the greatest risk and to adopt a variety of approaches to mitigate unintentional introductions.

The approach to managing ballast water discharges is through mandatory exchange for ships entering the Great Lakes, mandatory reporting requirements of ballast releases and treatment for all foreign ships entering the Exclusive Economic Zone, and voluntary exchange of ballast water at sea or treatment for vessels entering the EEZ. In the Northeast, reporting compliance is a mere 30% with only 50% of those reporting releases also reporting some type of ballast water treatment. New legislation would require mandatory treatment, reporting and treatment for coastal vessel traffic, and opportunities to adopt alternative treatment. However, many of the rule-making and proposed legislative changes are years from being implemented. A Regional Ballast Water Working Group is being formed to identify an approach to reducing ballast water releases in the Northeast. The issue of ship fouling remains a challenge.

Non-shipping vectors and releases pose a different set of issues. My collaborators and I have been involved in an effort to identify relative risks of selected pathways that introduce species into New England waters. Release points, identified as opportunities for species to be introduced to the marine environment, range from none for releases from aquarium pet stores (they are not on the water) to over 40 for the live and fresh seafood trade. Releases from non-shipping vectors are usually unintentional or occur from a lack of awareness of potential consequences by those involved in the activity. Education and outreach programs have been proven to be an effective approach to minimizing releases from non-shipping vectors, but are not applied to all vectors.

There are some issues, e.g. internet sales, that will require another type of approach, possibly legislation to mandate change. Another example is identification of organisms. Only researchers reported organisms (mussels, clams, or worms) by their genus and species names, others referred to them by common names. Yet, in order to assess risk, it is necessary to know the species, e.g., to target those that are greatest risks of becoming invasive given the geographic location and other factors. New and innovative approaches and a commitment to change are need if these gaps are to be closed.

The Chinese mitten crab: Coming soon to an estuary near you?

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The recent arrival of the Chinese mitten crab (*Eriocheir sinensis*) to the San Francisco Estuary has been a cause of widespread concern. Native to the coastal and riverine ecosystems of China and North Korea, this crab has achieved a global distribution throughout the last century that includes several countries in western and central Europe. This species is highly valued for consumption among several Asian cultures. Both ballast water and direct human transport of the crab are possible vectors for its spread. The mitten crab displays a catadramous life cycle unique among crustacea found in North America, beginning its life as an estuarine pelagic larva, then settling to the bottom and migrating into freshwater streams, where it may spend one to several years before returning to the coast to breed. This crab may cover hundreds of kilometers during its migrations, rapidly spreading throughout a new ecosystem.

The mitten crab is known to cause several ecological and economic impacts in countries into which it has been introduced. The crab is omnivorous, consuming a wide variety of plant, invertebrate and scavenged animal material. Juvenile mitten crabs dig burrows in muddy banks of streams and marsh channels, and in some areas these burrows become so dense they lead to bank slumping and erosion. The crab has been known to interfere with a variety of commercial and recreational fishing efforts, including bait stealing and damaging fishing gear and catch. As a benthic scavenger, the crab may be a vehicle for toxin bioaccumulation, which raises concerns about health effects both for humans and for the diversity of wildlife that uses the crab as a prey source.

A broad range of physiological tolerances, plasticity of behavior, and multiple vectors for transport have made this species a successful invader in a wide variety of ecosystems. The juvenile and adult stages of the mitten crab are able to withstand a broad range of temperatures and flourish over a range of habitats. A few requirements for survival include the need for a saline (>15ppt) environment to breed, and some larval stages may not survive very low temperatures and salinities. Based on what is known about transport vectors, distribution and environmental tolerances of the mitten crab, it is possible that this species could be introduced to and established in estuaries of the Northeastern US. Outreach to targeted sectors of the public to raise awareness about the crab, regulations to prohibit introduction and transport, and early detection and response plans are all tools that should be considered in areas in which the mitten crab has not yet become established.

The Northeast Regional Panel of the National Aquatic Nuisance Species Task Force

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The movement of invasive species is not hindered by political boundaries. All of the states in a common region or along a length of contiguous shoreline must share the same level of concern about invasive aquatic and marine species and their impacts if individual states are to achieve success in preventing and controlling them. The Northeast Aquatic Nuisance Species Panel was formed to promote, foster, and encourage the regional coordination and cooperation necessary for successful ANS control and management programs throughout the Northeastern States and Canadian provinces.

The Nonindigenous Aquatic Prevention and Control Act (NANPCA) of 1990 coined and defined the term "Aquatic Nuisance Species." It also established the National ANS Task Force, the Great Lakes Regional ANS Panel, and the program for approving and funding State ANS Management Plans. The National Invasive Species Act (NISA) of 1996 expanded the original legislation by authorizing other regional ANS Panels as well as inter-state ANS Management plans for watersheds that cross multiple state boundaries.

The Northeast ANS Panel was officially formed and recognized by the National ANS Task Force on July 25, 2001. The Gulf of Maine Council volunteered to serve as the host agency, and provides administrative support to the panel on a contract basis. The panel membership includes: a freshwater and saltwater representative from each of the six northeastern states (ME, NH, VT, MA, RI, CT& NY); representatives from Federal agencies; regional governmental entities; and regional non-governmental organizations such as environmental groups and marine/aquatic-related trade groups. The Northeast ANS Panel strongly encourages Canadian participation, and several Federal, Provincial, and Canadian non-governmental organizations and trade groups are also included in the panel membership.

The Northeast ANS Panel is governed by a Steering Committee consisting of marine and freshwater Co-Chairpersons, and the co-chairpersons of the standing committees. The bulk of the work conducted by the panel is accomplished by the three standing committees: Policy and Legislation; Communication, Education and Outreach; and Science and Technology. Ad hoc committees for special projects can be formed whenever needed. While membership on the panel itself is limited, any interested party can request to join one of the standing committees. Any interested person is also invited to join Panel e-mail lists. The Panel maintains a public website at www.northeastANS.org. The Northeast ANS Panel members are optimistic that the Panel will be successful in educating regional policymakers of the seriousness of ANS issues, encouraging northeastern states to develop and implement their own state ANS Management Plans, and that a strong, well-coordinated regional ANS management program will result.

Biological monitoring as part of the National Estuarine Research Reserve System Wide Monitoring Program

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The National Estuarine Research Reserve system (NERR) is composed of 25 sites representing a variety of habitats along the Atlantic, Pacific, and Gulf coasts of the United States. This complex of estuarine protected areas covers locations from Alaska to Puerto Rico and the Great Lakes. In 1995 The NERR System Wide Monitoring Program (SWMP) was launched focusing on describing short-term variability and long-term change at each site in the system. Currently weather, water quality, and nutrient components of the NERR SWMP plan have been implemented. Biological monitoring under SWMP is in the early stages of development. In January of this year a workshop was sponsored by the NERRS to develop a framework for a national estuarine invasive species monitoring program as a potential part of a biological monitoring component of SWMP. The forty workshop participants included an expert panel of scientists involved in invasive species research, representatives from potential partner agencies, and NERR research coordinators. The importance of monitoring trends in native and non-native species richness and abundance was a recurring theme at the invasions workshop. Two specific projects already addressing this theme within the NERRS include monitoring of native and non-native crab species at ten sites and larval recruitment at two locations. Upon successful pilot trials of these monitoring projects similar, if not identical, protocols may be implemented at many NERR sites to facilitate the collection of comparable data across broad geographic ranges.

The Great Bay, NH NERR is currently participating in the larval recruitment monitoring. Larval recruitment collectors, similar to those deployed at the Kachemack Bay NERR over the past two seasons, were deployed in July of 2002 at four locations in the Great Bay Estuary. Preliminary data show patterns in spatial and temporal distribution of larval organisms settling on the recruitment collectors. The preliminary data was partitioned into five gross taxonomic categories including barnacles, crabs, amphi/isopods, bivalves, and snails. Qualitative comparisons using physical parameters such as temperature, tidal amplitude, and salinity have been conducted. More rigorous analyses, including advanced spatial analyses and multivariate statistics, are planned in the future as the amount of data and level/confidence in taxonomic identification continue increase.

Identifying potential invaders among imported marine species

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As a major center of commerce and research, New England imports large quantities and a high diversity of live marine species through different pathways. Many of these organisms have the potential to establish if they are released in New England waters. To minimize the risk of unwanted introductions, information is needed about: (1) which species are being imported, (2) the likelihood of their establishing in New England waters, and (3) their potential for causing harmful ecological, economic, or health effects. My collaborators and I are beginning to gather such information with support from National and MIT Sea Grant. To date, we have identified a number of imported species from questionnaires administered to New England organizations (e.g., seafood companies, bait shops, pet aquarium dealers, researchers), from regulatory agency databases, and from websites. As a first cut, we have classified those species likely to survive in the annual range of temperatures found in New England estuarine and coastal waters. For each species meeting this criterion, we are creating a database using library and website resources that includes information on:

- geographic origin
- general habitat requirements
- life history characteristics and dispersal strategy
- trophic interactions and diet
- associated parasites and diseases
- history of invasions and impacts in other regions.

A major problem in assembling a comprehensive database is inadequate and uneven reporting of species by almost all pathways surveyed. For example, species names were provided by 64% of researchers in our surveys, but by none of the seafood respondents. Databases maintained by regulatory agencies also report common, rather than scientific, names for many imports. Clearly greater taxonomic resolution is needed if we are to begin to develop predictive models of invasion risk for New England or for other regions.

Developing an internet surveillance application and team

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An urgent need to identify, contact and deter Internet sources from shipping invasive species into and within the U.S. is being addressed by the development of software to spider, download, index and track the potential sale of these organisms. This customizable software, Agricultural Internet Monitoring (AIM) will allow regulators to identify these sites, contact the owners and track compliance. The system uses a database containing taxonomic names (scientific and common), connector terms (e.g., for sale, VISA, order form) and cooperator information, together with the website index to maintain a complete record of potential violations and actions taken.

An important part of the system is the identification and use of Subject Matter Experts (SMEs), both within USDA/APHIS and outside, to help define and refine search terms, and to provide human screening of those sites initially targeted by the software. Once targeted by the software and SMEs, regulators will be able to send fully customized and recorded correspondence to site owners, initially as an informational notice, and, if needed, as a warning of potential prosecution. The system will also allow adding specific web links in all correspondence to aid in education on the risks of invasive species.

Impacts of two introduced crabs on the northern New England rocky intertidal community

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Two introduced crab species can currently be found in rocky habitats of northern New England, *Carcinus maenas* and *Hemigrapsus sanguineus*. *Carcinus* has been in this region for over a century, while *Hemigrapsus* is just beginning to establish populations along the northern New England coast. In other regions where *Carcinus* has invaded (U.S Pacific coast, South Africa, New Zealand), there has been speculation regarding the community-wide impacts of its introduction. In contrast, research into the impacts of *Carcinus* in northern New England has thus far been on a species by species basis. *Hemigrapsus* reaches high densities in southern New England and its continued population growth in northern New England could have substantial consequences for potential competitors and prey.

Microcosm experiments were used to assess the community-wide impacts of the new and old crab invaders. The two crab species consumed similar prey including: *Semibalanus balanoides*, *Mytilus edulis*, *Spirorbis* sp. and various species of ephemeral algae. Monitoring of rocky intertidal community structure was also conducted to document the temporal stability of community structure prior to the establishment of large populations of *Hemigrapsus* in the region. As populations of *Hemigrapsus* continue to increase in northern New England, various prey species are expected to decline due to increased *Hemigrapsus* predation as they likely did following the establishment of *Carcinus*.

The live marine species trade and potential risks for exotic species introductions

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Introductions of nonindigenous species (NIS) can adversely affect marine ecological communities. To prevent unwanted introductions, it is critical to identify current invasion pathways and to understand their dynamics. While ballast water transport is a primary mechanism, it is not the only one, and its relative importance may vary from region to region. Our study was designed to (1) identify non-shipping pathways for marine invasive species into and out of New England coastal states, (2) rank these as to relative risk of unintentional release, and (3) work with stakeholders to mitigate risks.

We assessed potential risks associated with the following pathways: seafood companies, aquaculture facilities, bait shops, pet stores, marine research laboratories, public aquariums, and wetland restoration projects. We compiled a database of organizations for each pathway and administered a general survey to subsets of these organizations to gather comparative data on: points of origin or destination of NIS, identity of the species, frequency and volume of trade, mode of transport, likelihood of inclusion of non-target organisms in trading activities, organization's awareness of problems related to NIS, existing safeguards to prevent accidental release, and economic value of NIS transfers to the overall operation.

Study results demonstrated that each of the seven pathways were moving live marine species into New England and they varied in the types of risky features that may lead to an exotic species introduction. In order to enact effective control measures for marine bioinvasions in New England, a pathway-specific approach to risk management is needed. Findings from this study are being used to guide invasive species prevention strategies and management actions for non-shipping pathways in the northeastern United States.

Long-term monitoring coastal invasive invertebrate recruitment: linking climate change and biological invasions

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For the past decade we have been monitoring benthic epifaunal invertebrate recruitment at a protected coastal sampling site located in southeastern Connecticut. On a weekly basis, we deploy a set of fouling panels to collect recruiting epifaunal organisms. The panels examined in the laboratory and all individuals recruiting on the substrates are identified and enumerated. (about 30 species of ascidians, sponges, barnacles and bryozoans).

Motivation for the monitoring program includes early detection of invading species and understanding of the invasion process. As an example, we compare our long-term record of weekly sessile invertebrate recruitment with inter-annual variation in water temperatures to assess the likely effect of climate change on the success and spread of introduced species. For the three most abundant introduced species of ascidians, the timing of recruitment was strongly negatively correlated with winter water temperature, indicating that invaders arrived earlier in the season in years with warmer winters. Total recruitment of introduced species during the following summer also was correlated positively with winter water temperature. In contrast, the magnitude of resident ascidian recruitment was correlated negatively with winter water temperature (more recruitment in colder years) and the timing of recruitment was unaffected. By giving introduced species an earlier start, and increasing the magnitude of their growth and recruitment relative to residents, global warming may facilitate a shift to dominance by nonnative species and accelerate the homogenization of the global biota.

Section II:
Panel Discussion

Panelists Anne Monelly, Robert Buchsbaum, Annelise Chapman, and Brian Smith discuss invasive species monitoring at the Eyes on the Estuaries Conference.

Panel Discussion

Integrating Invasive Species Monitoring into Current Ongoing Marine Monitoring Programs

Moderator:
Jan Smith, Massachusetts Bays National Estuary Program

Panelists:
Anne Monnelly, Department of Environmental Management's Lakes and Ponds Initiative
Robert Buchsbaum, Massachusetts Audubon Society
Annelise Chapman, Dalhousie University
Brian Smith, Great Bay National Estuarine Research Reserve

Disclaimer: This panel discussion was not professionally recorded. The following text provides a general overview of what was stated, but quotes may not be completely accurate.

Panelists were asked to provide an overview of their program and address some of the challenges that they have faced.

Anne Monnelly, DEM's Lakes and Ponds Initiative

Program Overview

The Massachusetts Lakes and Ponds Initiative has a rapid response program for aquatic invasive species that was modeled after Maine and New Hampshire's volunteer monitoring programs. Their focus is on preventing the spread of aquatic invasives. To achieve this goal, they have developed a training packet for volunteers that includes a green guide with pictures and a key to species. Volunteers go out every other week and hit the hot spots where these species might be introduced such as at the boat ramp or other places around the pond. Once a season they conduct a complete pond survey. They send their reports electronically back to the program. This summer the staff of the Lakes and Ponds Initiative trained over 150 people with over 30 ponds. They are currently working to set up a response network. They have a loose network of people at the state where volunteers can send a collection sample to have the species identification confirmed. They are also developing numerous education and outreach materials on stopping the spread of aquatic invasives. These materials include new boat signs, a new brochure, and a new website. If you want more information about starting up a weed watcher group or additional information about freshwater invasives in Massachusetts, please contact Anne.

Challenges

1. *Identifying lakes and ponds that aren't currently infested with invasive macrophytes.* Initially focused on emergent, submergent and floating leafs - aquatic macrophytes that you would find in freshwater ponds including Eurasian Milfoil, Fanwort and most recently Hydrilla. They currently have baseline data on 200-300 of the 1000 ponds in Massachusetts. They plan to collect data on the other ponds so that they can identify ponds that don't have any invasives and focus their energy on prevention in those ponds.

2. *In order to respond to an infestation, they must go in front of the conservation commission. This slows down their ability to respond rapidly.*
   Working to develop SOPs (standard operating procedures) that volunteers can use if they find an initial infestation. These mainly include hand pulling and putting down some benthic barriers. Hopefully, the SOPs will enable them to respond quickly to a small infestation without having to wait months for the con-coms approval.

3. *Lack of funding for follow up if an infestation is found.*
   Used to have a lake and pond grant that could be put towards this but the funding was cut.

4. *Species identification by volunteers is sometimes tough.*
   There are three different species of milfoil - two non-native, one native. It is sometimes difficult for volunteers to distinguish between the species. Volunteers may need some booster training.

Robert Buchsbaum, Massachusetts Audubon Society

Program Overview

The Massachusetts Audubon Society has developed a volunteer tidepool monitoring program on the north shore of Massachusetts. Robert stated that one of the main advantages to volunteer monitoring is that you get a lot of geographic coverage and the workers are often very enthusiastic. Volunteer monitoring is a great way to engage and educate the public. Funding-wise, volunteer monitoring programs are often appealing to foundations and other types of sponsors. And practically speaking, if you have a low program budget, it is certainly more economical to work with volunteers than to higher additional staff. Robert is concerned that, in general, we are losing our taxonomic expertise. We used to have a lot citizen naturalists but this is no longer a part of our culture. He feels that volunteer monitoring efforts, like the tidepool program, is a good way to inspire a new generation of citizen naturalists and taxonomists.

Challenges

1. *The coordinating organization needs to be well organized.*
   It takes a lot of time for an organization to work with volunteers. Volunteers need coordination, support, and feedback. Robert thinks that a lot of organizations don't give enough time to volunteers because they think that it is something for nothing but it really isn't. A volunteer monitoring program can be great but organizations need to take it seriously and provide the funding to coordinate it. With a program like the tidepool monitoring program where you get a lot of geographic coverage from the volunteers, you also need to think about data management. Robert mentioned that many programs have a lot of data sheets gathering dust because the data entry and analysis doesn't get done in a timely fashion.

2. *Data credibility.*
   It is important to use the same QA standards that you would use for scientific or professional data gathering. If this is done correctly the program will grow and gain credibility. Some volunteers may eventually become real experts on this. There are legitimately different levels of expertise among the volunteers and different levels of time that they can dedicate to the program. Robert hopes that over time, they can build up the level of expertise so that people can differentiate things at a higher level. Since there are no field guides for new invasives one can't expect most people to be

able to easily identify new invasives. Because of this, there needs to be coordination with taxonomic experts. So, the goal with this program is to get people to the point where they recognize that there is a new species present and that it is necessary to consult a taxonomic expert.

3. *Sustaining long term funding, whether it's a volunteer project or a project being carried out by a state agency or professionals, is a problem.*

Annelise Chapman, Dalhousie Univerisity

There are a limited number of monitoring groups in Canada. Annelise attributes this mostly to the lack of funding. Though Annelise is not currently part of a monitoring program, if funding were available, her group would develop a benthic species monitoring program with three components:

1) Monitoring of benthic species on settlement plates - address the shipping vector near shipping ports and high aquaculture activity.
2) Direct monitoring or surveillance of vectors – ships ballast, ship hulls, aquaculture operations.
3) Monitoring high risk entry areas for pre-identified species such as *Hemigraspus* and the Rapa whelk. Believes that this is a good way to involve volunteers and general public – problem. Stressed that you need to have a balance between taxonomic experts and volunteers - some aspects of monitoring should only be done by experts but others can be done by volunteers.

Annelise also mentioned Andrea Locke, a conference attendant from DFO Atlantic Canada, who does a lot of monitoring in the region.

Challenges

1. *There has been a lot of "passing the buck" on this issue with the Canadian government.*
   For example, Environmental Canada has the Environmental Monitoring Assessment Network that could cover these invader aspects but they have passed it onto DFO. A recent report on the environment and sustainable development by the Commissioner described the federal and provincial government's inability to adequately address the issue of invasives. Annelise hopes that more funding will become available as a result of this report

Brian Smith, Great Bay National Estuarine Research Reserve

Program Overview
See Brian Smith's abstract for an overview of the NERR's program.

Challenges

1. *Taking on a monitoring program takes a lot of time – it is a full-time position.*

2. *It is difficult for scientists and professionals to come to a consensus about monitoring details.* Some questions include, what order should we go through these organisms? What criteria do we use? The NERR's group is moving forward and they hope to have some good data in the next few years.

Questions from the audience:

Audience: I noticed today that you talked a lot about monitoring the ecosystems and not necessarily the vectors. I was wondering if you could say something about whether you are getting positive or negative feedback from the aquaculture industry and the fishing industry? What are they saying about this? Are they trying to impede you? Are they encouraging you? Are they interested in the type of data that you are providing?

Jan Smith: I think to some extent we might be hearing about this tomorrow. Shannon Weigle will be talking about this.

Chapman: And maybe I can just say that with aquaculture, they are not only the cause of a lot of the problems but they are also the victims in many cases. For example, the club tunicate in PEI is causing a lot of problems for the aquaculture industry. So the aquaculturists there are actually interested in mitigating the situation.

Audience: In Massachusetts, every coastal town has a shellfish constable who is out on the water all the time. Though a lot of them are more fisheries oriented, there are several like myself who are more science oriented. That may be an association that you could contact for volunteers. Invariably, people come up to me and say "I just found this out shellfishing, what is it?" People are always finding things. That's how we identified *Hemigrapsus* for the first time, caught at high tide in a bay scallop drag brought into the constable. That might be a source of volunteers that could do good quality data collecting.

Buchsbaum: I've done talks on other topics for their annual meeting and you are right, it is a useful forum. It is good to get people who are out there all the time at least aware of the problem so they know who to turn to, they know the network. That's a very good suggestion.

Monnelly: I would just add on the freshwater side, we've been trying to add some training with the environmental police because they are also out on the water all the time. To train them on how to do a boat trailer inspections and how to look for invasives and what the plants are. It's a great idea.

Buchsbaum: Another group that's a good source for this are scuba divers.

Jan Smith: I think there are a lot of user's groups out there that we can interest. At a workshop organized by Judy Pederson at MIT, we had a bait dealer get up and talk about how some of the recreational fishermen that he sells bait to had brought him things that he didn't know what it was. The fishermen didn't know what it was and he didn't know what it was either. It sounded like it may have been a snakehead fish. I'm not sure that we know for sure by the description but clearly this is a useful approach.

Audience: I happened to make contact with an officer in the department of national defenses reserves who is in charge of a diving crew that goes out on training dives on regular basis. That might be a useful resource.

Chapman: The Ecology Action Centre is developing a pamphlet to hand out to ship's crews that come in. Often, the crews are not aware of the whole fuss about ballast water. So, we hope that by addressing them directly and involving them, we can get them involved. I actually traveled from Britain to Canada on a container ship and I was

amazed by how everyone on that ship was interested in marine life in general. They wanted to know everything.

Jan Smith: I think some of us have also talked about trying to interest some of the Homeland Security folks about some of the biological threats that might result from invasions. I don't know how realistic that is but it certainly seems to me that it might fit in somewhere on that agenda.

Audience: My name is Bill Dunn. I'm an EOEA Watershed Team Leader. To justify funding for our monitoring, when we found sources of pollution, we would institute BMPs or control measures to find the source and clean up the pollution. From what I've seen today and read about invasive species, some of the species are already here and the eradication measures are very radical. I wonder if it is difficult for us to raise funds for invasive species monitoring because of the notion that if we find these things, there seems to be nothing that we can do about them. Perhaps preventing them from coming may be the better way to go.

Brian Smith: I think it depends on the perspective of the potential funding agent as well. There are sources of funds that are more interested in long-term ecological relationships of organisms. If you have a program that is looking at the biota in general that may be a way to access some of those funds.

Audience: Are there a lot of funds for this type of thing?

Brian Smith: Not a ton, no.

Audience: I wonder if it would be more attractive if a program were more oriented towards protection and prevention?

Jan Smith: I think that prevention is one of the key issues that we are trying to address. Jim Carlton mentioned that though it is difficult to control species that are here and established. By finding out where they are, we may be able to infer how they got here. This information will be helpful in controlling some of the vectors. Regulatory agencies have talked about classifying invasive species as pollutants or contaminants. EPA was considering the idea of identifying watersheds where there are invasive species and perhaps asking for a TMDL of invasives. I'm not sure how appropriate that is but something along that line might be useful.

Buchsbaum: There's also talk of considering ballast water as a regulated discharge.

Chapman: There's no reason why we shouldn't take the example of the Canadian Food Inspection Agency, which has developed surveillance programs and has the capability to act on a lot of things. They still say they are under funded but their programs have been developed and a lot of research has gone into them.

Buchsbaum: I agree that it is difficult to understand funders but I think that it is important to convey the scope of the problem. Take a look at the terrestrial side. Dealing with invasives is one of the key priorities of the National Park Service. We still have a lack in knowledge of the severity of the problem in aquatic and marine systems. Nobody thinks that we can wipe out all terrestrial invasives but we can reduce the invasives and get back some semblance of a native ecosystem.

Audience: The reason I raise these questions is a lot of monitoring programs will want to know, what is the purpose of them?

Chapman: What I find incensing in these debates is that the governments have committed to this problem a long time ago and its clear that prevention is the way to go. Science has shown that part of prevention is early detection yet I feel like we keep going back and back and reinventing the wheel. We need to look at other countries like New Zealand that are so far advanced.

Jim Carlton: I have one reason for doing general surveillance and monitoring. We are now in an era where we are looking at more and more vector management especially with some of the new ballast water regulations. The question that inevitably comes from that is, 'How is this management doing at reducing the number of invasions?' This is the type of question that I am getting from D.C. so we need to have some kind of understanding of this.

Jan Smith: Right, it's very important these days in government to show results. How are we measuring that we are achieving these goals?

Audience: I'm more familiar with the freshwater invasive macrophytes. Depending on the human use of the water body and the amount of nutrient loading, natives can become invasives. Is this part of anybody's monitoring, looking at natives becoming invasives?

Monnelly: We do deal with that with the Lakes and Ponds Initiative. There are some natives that can behave invasively and we have many homeowners that contact us and want to eradicate it even though it is a native species. We generally put the highest priority on controlling non-natives. But when it comes to natives, we do try to look at the sources and ask what is causing it? Is the growth being exacerbated by nutrients coming in? It's a tough line to walk because we have always tried to emphasize the preservation of native species but when they get out of hand it's a tough balancing act. We try to suggest different uses such as clearing a waterway or swimming area, but leaving the native species. It's sort of on a case-by-case basis but there are definitely some native species that are on our radar screen.

Audience: I'm wondering is that also the case in the saltwater environment? Is there a use that is being deterred because of native invasives?

Chapman: The example that I can think of is an ascidian that is overgrowing shellfish, *Ciona intestinalis*. This has caused some problems similar to the introduced club tunicate but it's a native species, or maybe cryptogenic. When this occurs, perhaps we can study the ecological patterns and determine if the native invasion is due to the fact that a non-native species invaded or something else happened that caused a huge population explosion. In that case, for example, it may be the sudden provision of an aquaculture environment and a limited source of a hard substratum that's utilized by many benthic species. It can be a chance for ecologists to study these species in a particular situation.

Audience: I wonder if we can relate this question back to Bill's question. If you have a native invasion occurring what is the source of this abundance and can it be related back to some human activity?

Jan Smith: Gretchen Lambert was here a couple of weeks ago teaching a tunicate workshop. She was thinking that some of these tunicate explosions might be in response to nutrient loading in coastal waters.

Audience: *Pfisteria* is a great example of what we are talking about. And, there's quite a bit of money going into it. So, I think the question is at what level does it become part of the public consciousness.

Buchsbaum: I guess the rationale is that unlike natives, like Poison Ivy, there is less of a chance any natural control existing for non-natives within the system.

Chapman: And, also I think terminology is a problem. I think the word invasive on the government level is defined by species that have an impact – and impact is usually economic rather than ecological.

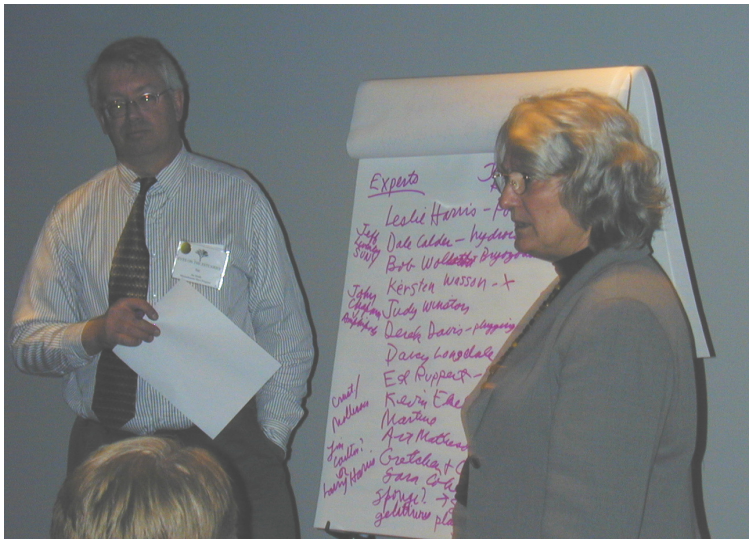
Audience: Part of the beauty of your monitoring program is that you are including native species in it. I work at the Aquatic Nuisance Species Clearinghouse. We've gotten into the terminology heavily. Nuisances can be natives gone opportunistic or it can be an invasive that is nuisance. The volunteer networks are a marvelous idea yet this provides a bias – we are going to lose the small things. The only way we can monitor some of those species is with microscopes and trained people - this is where you need your expertise.

Audience: If you can make linkages between certain invasive species and other problems such as eutrophication that would be a way of gaining additional support. The Coalition for Buzzards Bay has a great citizen's monitoring program on nutrients. If you want to look at the relationship between a particular invasive – here you have a resource of people going out and getting monitoring samples perhaps they could also go out and put out tiles for invasives. This might be a great opportunity to form relationships between scientists and citizen groups.

Buchsbaum: I think that the data that Bob Whitlatch is presenting on global warming is also very interesting. People have been saying that global warning will insinuate invasives but there is actually some support for this in the marine environment.

Jan Smith: Well, I think we've had some great presentations today. Really good and new information has been presented. We've talked about some of the challenging issues and a lot of new ideas have been discussed. I think that we can go back and think about and talk more about this evening. Thank you to all of the speakers and the panelists.

Section III: Break-Out Group Discussions



Jan Smith and Judy Pederson lead a break-out group discussion on the 2003 Rapid Assessment Survey.

Break-Out Group #1:
Development of a Regional Monitoring Network

Moderator: Jay Baker, Massachusetts Office of Coastal Zone Management

1) **Is there a need for a regional monitoring network? If so what questions or issues would we like to address with the network?**

   Responses: There are many questions that could be answered through a regional monitoring approach, many relate to some key management issues.

   Potential issues to address:
   - Baseline data: current distributions of both introduced and native/cryptogenic species
   - Impacts from bioinvaders
   - New introductions (identifying hot spots for new invasions)
   - Links to transport vectors
   - Using monitoring data to predict species spread and distribution
   - Identifying special areas for protection

2) **What are the fundamental components to a monitoring network?**

   Responses: A monitoring network would require (and implies) a coordinated approach and the development of standard monitoring protocols.

   The effort would include monitoring for invasions through space (geographic area as well as variety of habitat and depths) and time (temporal changes in species composition).

   Key elements of data collection efforts must be consistent. Minimum standards for monitoring data should be agreed upon and simple.

   Quality assurance: All data should pass through a gatekeeper to apply agreed upon quality assurance protocols. Training should precede monitoring efforts. Taxonomists should verify the identification of many or all of the species

3) **Should the approach be vector based, species based, or habitat based?**

   Responses: Vector based monitoring should not be altogether separate from ecosystem monitoring. Both are essential and not necessarily independent efforts.

4) **Should the monitoring efforts be bi-products of other research efforts or should they be independent programs?**

   Responses: A regional monitoring effort can take advantage of a variety of monitoring efforts with a minimum set of commonly agreed upon protocols.

There are different types of monitoring efforts to be considered when identifying basic monitoring protocols

- Watchdog monitoring
- Routine monitoring
- Monitoring for new introductions (requires the greatest amount of taxonomic expertise

5) **How should the data from the monitoring efforts be organized and presented? Who would be the users of the database?**

Responses: Those involved in the development of the monitoring network should work with other stakeholders to create a user-friendly online database.

Stakeholders may include:

- Water-based industry representatives
- Natural resource managers
- Regional scientists
- Educators
- Students
- Citizens
- Internet technicians

6) **Initial steps for the development of the marine monitoring network**

Responses: Begin by developing a list of taxonomic experts, assemble existing data, and look at what other regions have done. Organize a steering committee to develop a monitoring protocol.

Once these steps are completed, organize a regional workshop to present the protocol and other components of a regional monitoring network.

Break-Out Group #2:
Pathway Monitoring and Prevention Strategies

Moderators: Michelle Tremblay, Northeast Aquatic Nuisance Species Panel and Shannon Weigle, Massachusetts Bays Program

1. How do we monitor the pathways? Who should collect the data?

Responses: Recruit volunteers to look for invasive species in public markets (supermarkets, bait shops, etc.).

May result in a lot of false alarms because volunteers who aren't taxonomic experts might have a hard time identifying species of concern. However, may be able to set up a system that includes spot-checking by experts.

Public markets may not be the best place to look for invasives.

2. Should there be a regulatory reporting requirement for companies that import exotic species?

Responses: Current reporting systems should be modified to reduce risk of invasive introductions.

For example, as part of the National Pollution Discharge Elimination System (NPDES), certain companies already need to report how they handle particular species. However, NPDES managers have not yet provided comprehensive lists of invasive species.

Seafood companies need to report which species they sell however, they generally only use broad market names when reporting. Scientific names should be used in addition to market names.

Additional reporting systems should begin with voluntary participation – if effective, regulatory requirement may not be necessary.

The Global Marine Aquarium Database (GMAD) is a potential model for a voluntary reporting system. GMAD was developed by the pet industry in order to encourage more environmental responsibility.

The Aquatic Nuisance Species Hazard Analysis and Critical Control Point (ANS HACCP) program is another example of a voluntary industry program. With ANS HACCP, the aquaculture industry is working to develop best management practices to limit introductions of invasive species.

In order for companies to provide reports, they need to be given the right tools such as taxonomy training. Managers may want to consider developing black lists, gray lists, or white lists or ask companies to report all live or fresh species that they import. Scientists can then use these lists to identify species of concern.

3. **What are our research needs?**

Responses: In order to develop a reporting system for the industries, additional research is needed to identify potential future invaders and their pathways.

Need to determine which domestic species are of risk to the local region. Should begin by compiling current invasive species lists and criteria.

Since lists of terrestrial species seem to be more organized and complete, aquatic species managers may wish to follow the example of terrestrial species managers. UCONN has a good list on terrestrial plants – potential model.

In order to create lists, we need to know what species are being imported. Need people from each industry who are willing to work with researchers to compile the lists

This information can than be used to create black, gray, and white lists. Exceptions to lists may include species with no access to open marine systems or species that have no risk of becoming established.

Responses: Need to review and evaluate current invasive regulations or other regulations that may be pertinent.

Les Mehroff (UCONN) and Northeast Regional Panel of the Aquatic Nuisance Species Task Force (NEANS) have matrices of regulations for invasive marine species.

4. **How do we convey the concern of marine invasions to local industries that may be at risk of introducing invasive species to our local waterways?**

Responses: Need to educate both the industry and the consumer.

Begin by making sure that invasive species managers and advocates agree on outreach approach and messages.

Important to recognize cultural differences when developing outreach messages and materials.

Difficult to convey the importance of biodiversity to diverse populations. Teaching invasive species message at schools may help to overcome language and cultural barriers.

Companies may be able to offer simple creative solutions to minimize the risk for invasive species introductions, such as using wet newspaper instead of fresh seaweed as packing material.

When suggesting new industry practices, good to provide alternatives and incentives. Consider green certification programs, some businesses want to be eco-friendly.

Break-Out Group #3:
2003 Northeast Rapid Assessment Survey of Intertidal Habitats

Moderators: Judith Pederson, MIT Sea Grant and Jan Smith, Massachusetts Bays Program

1) What sites should we sample and how should we choose them?

Responses: The 2003 rapid assessment survey has a larger region to cover than the previous survey - perhaps we should split up the team in order to cover more area at one time. Need all experts at each site and the drive from NY to NH may waste time

Have collectors other than the taxonomists bring the samples to a base laboratory. The National Estuary Programs (NEP) may be able to help in the collection process and can set up base camps at local laboratories.

Generally, the taxonomists want to view the site - it helps them to understand which types of organisms may be found there.

Because it takes approximately 1.5 – 2 hours per site, two sites should be chosen for each day. Both study sites and reference sites are needed.

Selection for sites should consider gradient of disturbance – eelgrass bed versus artificial substrates. Should look for signs of human impacts and recognize that a site that appears to be pristine may actually be impacted.

Sites should have good access and available parking.

If possible, involve the local media during collections.

Sites should be based near potential vectors for introduction. Potential vectors to consider when selecting sites include: shipping, aquaculture, fish markets, recreational fishing (bait), transportation, research laboratories, cruise ships, and yachts.

2) What habitats should be monitored and why?

Responses: Select several habitat types – a few consistent types from site to site. Habitats should include previously studied habitats and new habitats. May wish to repeat sites that were done before – useful in comparing data over numerous years.

Soft sediments have not been sampled. The challenge with this habitat type is that they need to be sampled during low tide. Instead of wasting high tide, may also wish to sample fouling subtidal communities and salt marshes.

Should consider exposure to wave action when selecting site.

May also wish to collect macroalgae and submerged aquatic plants.

Consider making the sampling quantitative with some standardized collection methods.

3) **Who should be part of the sampling team and what training is needed?**

Responses: Teams should include taxonomic experts, support staff, and apprentices. Graduate students make good apprentices. Limit # of people on each trip – space, people management.

Potential taxonomic experts:
Amphipods - John Chapman
Ascidians - Gretchen and Charlie Lambert
Bryozoans – Bob Wollaston
Crustaceans, Mollusks – Jim Carlton, Larry Harris
Gelatinous plankton – Barb Sullivan, Jack Costello
Hydroids – Dale Calder
Polychaetes - Leslie Harris, Kevin Eckelbarger
Sponges – someone from the Smithsonian?

Other invasive experts:
Kersten Wasson, Judy Winston, Derek Davis, Darcy Longdale, Ed Ruppert, Martine Villalard, Art Matheson, Sara Cohen, John Whitman, Ken Sebens, Jeff Leviton

Other resources:
Divers - Robert Miller

4) **What methods should we use?**

Responses: We should agree on 4-5 techniques and standardize them. Consult with taxonomists on sampling techniques.

Prepare site before experts arrive so minimal time is wasted.

Samples need to be presorted by phylum or class. Should conduct presorting training with collectors.

Some organisms will need to be identified on site because they do not preserve well in the voucher jars.

Important to look for smaller things that are not immediately obvious.

Experienced students may be able to deal with the quantitative depth in sediment.

Equipment that needs to located and borrowed:
bottom grabs, scrapers, plankton nets, camera for photo documentation and CD, equipment for soft bottom transects - to create a matrix, specialized tools like “John Chapman’s super scraper 6000,” equipment for graveling and grass sampling, coolers with labels for storing samples, glass jars and liquids for library of preserved sample

Thanks again to all of our conference sponsors and participants! We hope you enjoyed Eyes on the Estuaries: Preventing and Detecting Marine Invasive Species in the Northeastern United States.

We leave you with this final thought

"If you can't beat 'em, eat 'em."
- Michele L. Tremblay, Northeast Panel of the ANS Task Force

Jim Straub of Massachusetts Department of Environmental Management enjoying a Hydrilla *and ham sandwich.*