AN EVALUATION OF THE NATIONAL INVASIVE SPECIES ACT TO SUPPORT ITS REAUTHORIZATION

Proceedings Document of the Symposium
Looking Forward, Looking Back:
Assessing Aquatic Nuisance Species Prevention and Control

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I. Preface

The invasion of nonindigenous aquatic nuisance species (ANS) threatens the ecological integrity, biological diversity and economic health of the Great Lakes-St. Lawrence system and inland waters, causing impacts that are frequently irreversible. Over the past decade, significant resources have been devoted to combat ANS invasions in this region and across the country. The ANS issue has been addressed on a national scale by Congress through the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA) and its reathorization as the National Invasive Species Act of 1996 (NISA). While these legislative acts have made progress on ANS prevention and control, there are a number of persistent and complex problems that need to be addressed to effectively continue the battle against ANS invasions into the future.

With reauthorization of NISA on the horizon, the Great Lakes Commission, in cooperation with the Great Lakes Panel on ANS, has taken the opportunity to evaluate the legislation through the conduct of the project, *Preparing for the Next Decade in ANS Prevention and Control.* The focus of the project was to assess regional progress and determine future needs under a decade of federal ANS legislation. The core of this initiative was the symposium, *Looking Forward, Looking Back: Assessing ANS Prevention and Control*, held in Ann Arbor, Mich., May 15-16, 2001 (see Appendix B for symposium agenda). This workshop examined the progress made under NISA, and identified gaps and unmet needs in the legislation, with an emphasis on ballast water management. A concerted effort was made to recognize emerging issues that will drive future ANS prevention and control programs. To develop regional consensus regarding the reauthorization efforts, significant time was spent to ensure that the appropriate stakeholders were involved in the symposium. Participants included representatives from U.S. and Canadian federal agencies, state and provincial agencies, regional organizations, user groups, tribal authorities, commercial interests, nongovernmental organizations and the university/research community.

Background research for the symposium summarized the major themes within the legislation: institutional framework/implementation, research and monitoring, ballast water and standards, information and education, and nonballast prevention and control. Speakers provided information on the legislative components within each of these themes, the progress that had been made, and any particular gaps or unmet needs within the legislation. These themes also provided the focal points during the breakout sessions, where symposium participants developed recommendations for consideration during the reauthorization process.

The two-day workshop began with keynote speakers providing broad overviews of ballast water issues and the implementation of ANS legislation. A series of panel presentations provided more specifics about legislative components and issues relating to ballast water. Finally, small group sessions were held with participants to brainstorm ways the legislation could be updated and strengthened. This format of plenary and break-out sessions provided the opportunity to build consensus on recommendations in support of NISA reauthorization. The document that follows contains abstracts of the presentations given during the symposium, along with the recommendations that evolved from the discussion sessions. The views expressed in the presentation summaries are those of the authors and do not necessarily represent the views of the Great Lakes Commission or the Great Lakes Panel on ANS.

Financial support for the project *Preparing for the Next Decade in ANS Prevention and Control* was provided by the U.S. Environmental Protection Agency (EPA), Great Lakes National Program Office. The project was conducted by the staff of the Great Lakes Commission's Resource Management Program, including Thomas Crane (program manager), Katherine Glassner-Shwayder (senior project manager) and Sarah Whitney (project manager). The proceedings document, based on the aforementioned workshop, was prepared by Sarah Whitney (primary author) with assistance from Katherine Glassner-Shwayder. Editorial support was provided by Kirk Haverkamp (program specialist, Communications and Internet Technology). Members of the Great Lakes Panel on ANS and other regional stakeholders participating in the workshop provided guidance, review and technical assistance. Their contributions were critical to the success of the project.

Questions and comments on this report can be directed to the Great Lakes Commission at: The Argus II Building, 400 Fourth St., Ann Arbor, MI, 48103, phone: 734-665-9135, fax: 734-665-4370.

Michael J. Donahue, Ph.D.
President/CEO
Great Lakes Commission

II. Poetic Interlude: *'Twas the Night Before NISA*: Dr. Philip Moy, Wisconsin Sea Grant
(with apologies to Clement Clarke Moore)

'Twas the night before NISA and all through the House,
not a creature was stirring, not even a fish louse.
The subsections were hung by the chimney with care
in hopes that St. NISA soon would be there.

Two ships, one a NOBOB the other in ballast
had just settled down for a cruise without malice.
When out on the lake there arose such a clatter
we sprang from our desks to see what was the matter.

Away to the Panel we flew like a flash,
we opened discussion, we threw up the cash.
Then what to our wondering eyes did appear
but an oceangoing vessel and invasive species oh dear!

The phantom at the helm, all clad in black –
you could see he was bad you could see in a snap.
More rapid than Dreissena, his exotics they came,
he hissed and shouted and called them by name:

Come BC come CP, come ruffe and round goby,
come lamprey, come alewife, come zebra and quagga,
come loosestrife, come milfoil, come curly leaf and taxifolia,
come snakehead, come black carp, come grass carp, come …
Well there was more than eight, you get the idea.

To the top of the lakes to the top of them all
dash away, dash away, dash away all!
As leaves before the hurricane fly,
we'll flow faster and faster to the Gulf lest we die!

So to Superior the 'vaders they flew,
the vessels full of 'xotics, and the black spectre too.
As I drew in my breath and was turning around,
down the canal came the wraith with a bound.

He was covered in spines from his head to his foot
and his clothes were all dirty with sediment and gook.
His spines they are sharp, his slime is so thick,
he has eyes like a toad, I'm gonna be sick

The eyespots like coal, the setae so hairy,
the eggs and the cysts, of the tail spine be wary.
His suctorial mouth has no jaw just a tongue,
and a bit of lake trout to his teeth yet was clung

He skulks near the bottom much like an eel
The trout they do watch him lest they be his meal.
Not bad where he comes from, oh he's just a Joe,
but here he's a menace, a nuisance and a foe.

With the bundle of eggs he had flung on his back,
he looked like a pengoi just opening her sac.
A rapid life cycle with myriad ova,
Their population expands like a super nova.

They ate and they fed, they went straight to their work,
and all the pipes filled and clogged with a jerk.
How can we stop them, they threaten our health
it takes more than NISA, it takes more than wealth

It takes heart, it takes will, it takes brawn and still more
it takes smarts, it takes know-how, it takes 'sprit des Corps.
So come on big business, feds, province and state
we must work together before it's too late.

We'll say some more words, we'll work in our groups,
but St. NISA is here, it's up to us troops.
Let's not come back here ten years to the date,
to look back again and say ah, it was fate.

It's a challenge to me and to you and to you
to think of it all, everything we can do.
Set standards, do research and rapid response,
treat ballast, build barriers we need them at once.

I challenge you, I challenge you right,
Merry NISA to all and to all a good fight!

III. Introduction: ***10 Years Under the National Invasive Species Act: NANPCA, NISA and Now***, Allegra Cangelosi, Northeast-Midwest Institute

Ten years into implementation of NANPCA, there is new awareness of the magnitude of the invasive species problem and the difficulty of the management task. NANPCA began the process of establishing a national program regarding the prevention, research, monitoring and control of invasive species in U.S. waters.

NANPCA established the ANS Task Force, a multiagency task force led by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service (USFWS), to develop and oversee the national program. NANPCA also called for a policy review of the impacts of intentional introductions of exotic species (such as for aquaculture or biological pest control), a zebra mussel demonstration project, and state aquatic nuisance management planning. The law created a regional entity, the Great Lakes Panel on ANS, to help coordinate federal, state, local and private-sector efforts to prevent and control exotic species within the Great Lakes basin. Other provisions addressed the brown tree snake, quarantine protocols for research on exotic species, and risk assessment. In addition, the act directed the U.S. Coast Guard (USCG) to promulgate regulations (to take force in 1993) to reduce the number of new alien species introductions into the Great Lakes via commercial vessels.

In 1996, NANPCA was reauthorized through NISA. NISA expanded the scope of the ballast management program beyond the Great Lakes to encompass the nation's waters. NISA also broadened the legislation from its focus on zebra mussels to ANS in general. Other components of NISA included ballast technology demonstrations, ecological and ballast discharge surveys to assess the risks and impacts of invasions, and the establishment of regional coordination panels for other regions of the country.

Has progress been made? How can progress at preventing something be measured? It is not easy, but it is an important task to learn. The real question is whether the invasion rate is slowing. Unfortunately, it is very difficult to ascertain changes in the invasion rate. It is particularly challenging to measure changes in the invasion rate over short periods of time, which must be done to coincide with the reauthorization time frame. However, there are a few measures that can be used as proxies to evaluate changes in the invasion rate. The first measure is the percentage of ships entering U.S. waters that are undertaking prevention activities, and the results of those prevention activities. A second measure is political will -- whether awareness of invasive species and a willingness to implement prevention and control activities are growing. A third area for assessment is the amount of funding devoted to ANS nationwide.

Experts are pioneering ways to assess changes in the ballast-mediated invasion rate. It is not possible to credit or charge NISA and NANCPA with all the changes (growth, stability or reductions) seen in the numbers of invaders in the Great Lakes over time. There are too many other variables at play, such as the dynamics of the shipping traffic as well as the condition of the receiving system. In addition, a prodigious lag period confounds efforts to identify precise dates of introduction for established species. The level of scrutiny and types of analyses also have changed over ten years, and these changes must be factored into cause and effect analyses. Historic data is largely counts of organisms which became established, while contemporary studies are often based on surveys of ship ballast water or harbors, counting all alien organisms present whether or not they take hold. To measure progress, it is important to account for any rate changes in both types of introductions before and after regulations are put in place.

Compliance with existing regulations, which has been increasing over time, could be another way of detecting progress. To assess effectiveness of prevention efforts, scientists will need to develop improved methods of gathering data and recording how well ships perform ballast water management, as well as what conditions they are in when entering the Great Lakes system. This will provide a baseline to allow for future assessments of the effectiveness of the regulations.

Public attitude and political will regarding aquatic invasive species have certainly improved over the past ten years. Evidence of this is shown through the success of the Great Lakes Panel and the number of state ANS management plans from the Great Lakes region and elsewhere. The Canadian Shipping Federation and the Lake Carriers Association, among others, are setting up codes of conduct that implement best management practices above and beyond what is required in NISA. One of these practices is to undertake ballast water exchange anywhere the ship is plying, not just in the last leg of the journey before traveling into the Great Lakes. Conducting exchanges in this manner may well reduce the amount of sediments and residuals that cause difficulties. Sea Grant outreach efforts have provided basic information to the general public, so that people not involved with aquatic invasive species now understand their impacts. Environmental groups have begun to integrate an awareness of ANS into their ecosystem management efforts. Additional regional ANS panels have been developed for the west, the northeast, and the Gulf of Mexico.

There is evidence of a level of frustration, which could be taken as a positive sign of political will. California, Hawaii, Maryland, Washington, Virginia, Michigan, Minnesota, New York, Oregon all have activities at the state level to try to bridge the gap in effective ANS prevention and control programming.

Funding for NISA programs has grown over time, although not nearly to the extent that it should have. The ability to demonstrate program accomplishments, and ANS prevention and control results, will be key for future funding increases.

Future Needs

There are several pieces of information that should be tracked in order to gauge progress. Research efforts in 1993 began tracking the number of ships using ballast exchange. The number of ships using best management practices, in addition to ballast water exchange, should also be tracked. The percentage of ships using treatment technologies should be monitored, along with the effectiveness on a per voyage basis of any of these techniques.

As NISA begins the reauthorization process, now is the time to consider what tools, activities and programs need to be added or updated to carry ANS prevention and control efforts forward in the next decade. Selected opportunities for enhancing the legislation include:

- Strengthen and expand the ship ballast water management program
- Assess and prioritize all pathways for ANS introduction and spread
- Monitor for early detection and range expansion
- Develop a rapid, on-going response capability
- Develop a screening program for planned introductions
- Strengthen and broaden state ANS management plans
- Coordinate and target research efforts
- Define and implement program evaluation
- Research and develop prevention and containment technology

IV. Components of the National Invasive Species Act of 1996

Institutional Framework and Implementation: Sharon Gross, U.S. Fish and Wildlife Service

An increase in trade over the last decade has accelerated the invasive species problem to the point that ANS are now a major threat to natural resources in many countries. Ecologically, both aquatic and terrestrial invasive species have caused a significant loss of biodiversity and threaten the integrity of the structure and function of various ecosystems. The direct and indirect economic costs of invasive species are difficult to estimate. The pathways of ANS introduction, both intentional and unintentional, have increased in number and complexity because of the increase in global trade.

Despite the damage caused by exotics, many invasive species have been intentionally introduced for a variety of reasons and unintentionally introduced through a wide array of pathways. Many unintentional introductions occur through pathways such as ballast water, aquaculture, range expansion after introduction and ship hull fouling. Recreational activities such as boating and fishing also contribute to the spread of invasive species. Of the nonindigenous fishes found in the United States, 44 percent were stocked for sport fishing, 26 percent were introduced through aquarium release, 16.4 percent were from bait bucket releases, 3.5 percent were conservation releases (to reestablish endangered species populations), 2.1 percent were biological controls and 1.7 percent were transported in ballast water. Purple loosestrife (*Lythrum salicaria*) was introduced and sold as an ornamental flower. Salt cedar (*Tamarix* spp.) and kudzu (*Pueraria montana var. lobata*) were both introduced for erosion control.

Recognizing the complexity of managing and coordinating activities related to nonindigenous aquatic species introductions, the U.S. Congress enacted NANPCA, under which the following legislative provisions and institutional framework were established:

<u>Nonindigenous Aquatic Nuisance Prevention and Control Act</u>
The primary goal of NANPCA was to focus efforts in three key areas: 1) preventing the introduction of new ANS; 2) ensuring prompt detection of and monitoring changes in existing ANS; and 3) controlling established ANS in an environmentally sound manner. NANPCA focused on ballast water as a significant pathway and called for the development of ballast water management regulations for the Great Lakes. NANPCA also set up the ANS Task Force to help coordinate federal efforts relating to aquatic invasions. It laid the groundwork for the development of the ANS Program, which has helped federal agencies focus effort and activities. Two of the most important aspects of NANPCA were the establishment of regional panels and a provision for the development of state/interstate ANS management plans. Regional panels are critical in coordinating and prioritizing regional issues. States with state/interstate ANS management plans approved by the ANS Task Force may request funding from the USFWS for detection, monitoring, prevention and control activities. These two components of NANPCA have been helpful in mobilizing state efforts to address various ANS issues. In 1996, NANPCA was reauthorized as NISA. NISA broadened the focus to include geographic areas outside of the Great Lakes, increased coordination and other responsibilities related to ballast water. It also expanded the scope and role of the regional panels and expanded the State ANS Management Plan component to include interstate entities and tribal authorities.

ANS Task Force

The role of the ANS Task Force is to develop and implement the federal ANS program and reduce the threat from ANS through prevention, detection and monitoring, and control. The task force is comprised of seven federal agencies: USFWS, NOAA, USCG, U.S. Army Corps of Engineers, U.S. EPA, U.S. Department of Agriculture (Animal and Plant Health Inspection Service), and U.S. Department of State. The USFWS and NOAA serve as co-chairs for the task force. Other governmental entities are also represented as ex-officio members, which helps to keep discussions balanced as many of these members are either affected by ANS or by actions taken to address these species.

The task force is a coordinating entity and is dependent on funding and commitment from individual agencies to implement its activities. Supported by several committees, the task force brings affected entities together to deal with common problems, such as control and prevention plans or outreach and education efforts. State and regional participation is critical to success of the task force in addressing ANS issues.

Prevention is a primary focus of the task force, since the most cost-effective approach to combating invasive species is to keep them from becoming established in the first place. Once nonindigenous species become established and begin to spread, the battle is largely lost. Key components of prevention are early detection and monitoring, and the development of a rapid response program. These activities focus on preventing the spread of invasive species, not introduction. The USCG conducts the Ballast Water Management Program and coordinates its activities with the task force as a method to address ANS introductions through the pathway of shipping.

The Task Force has established committees to develop control and management plans for established populations of Eurasian ruffe (*Gymnocephalus cernuus*) and brown tree snake (*Boiga irregularis*), with plans under development for Green crab (*Carcinus maenas*), Chinese mitten crab (*Eriocheir sinensis*) and Asian swamp eel (*Monopterus albus*). These control and management plans are developed through a cooperative process and undergo public review. Successful implementation of these plans requires the participation of states and regional entities, in addition to federal agencies.

Coordination and cooperation between the federal, state and local entities are necessary to address possible gaps, weaknesses and inconsistencies, and to promote greater harmonization to address aquatic invasive species in the United States. The ANS Task Force strategies aim to develop and strengthen the legal and institutional framework at both the national and regional level. At the national level, the ANS Task Force will work with the National Invasive Species Council (NISC) to identify gaps and inconsistencies among federal programs and to develop and strengthen national measures for the prevention, eradication and control of invasive species. At the state and local levels, both the NISC and ANS Task Force are working together to promote better coordination and cooperation among the state and local agencies, federal agencies and affected entities.

ANS Task Force Regional Panels

NANPCA encourages the formation of regional panels as a tool to address ANS problems. The role of the regional panels is to establish regional priorities, coordinate activities and develop and implement action plans. Regional coordination efforts have been successful in pulling states together within watersheds or in similar geographic areas to address common problems from ANS. Communication between the task force and the regional panels is a critical feedback loop that contributes to the success of the program.

The regional panels that have been established as committees of the task force include the Great Lakes Panel (established in 1990), Western Regional Panel (established in 1996), Gulf of Mexico Panel (established in 1999), and Northeast Regional Panel (established in 2001). The ANS Task Force is also committed to establishing regional panels in other parts of the country not currently covered by an existing panel.

State/Interstate ANS Management Plans

NANPCA encourages the development of state/interstate ANS management plans. The development of these plans helps state resource agencies secure the necessary support from within their state to establish formal aquatic invasive species programs. The USFWS provides limited cost-share funding to states and tribes to assist in implementing state management plans that have been approved by the task force.

NANPCA authorizes and provides general guidance for the development of state ANS management plans. The task force developed guidance to help states develop their plans and the guidance is available on the ANS Task Force web site (www.anstaskforce.gov). Interstate plans were authorized through NISA, enabling the state governors and interstate entities (through the governors of involved states) to submit comprehensive management plans to the ANS Task Force and, if approved, request federal assistance for up to 75 percent of the cost of implementing such programs.

ANS state management plans identify technical, enforcement, or financial assistance for activities needed to eliminate or reduce the environmental, public health, and safety risks associated with ANS. They focus on identifying feasible, cost-effective management practices and measures that will be undertaken by state agencies, local programs, cooperating federal agencies and others to prevent and control ANS infestations in an environmentally sound manner.

The Task Force reviews submitted management plans and may either approve a plan or return it with recommended modifications. Eight states/interstate entities (New York, Ohio, Michigan, St. Croix National Scenic Waterway, Washington, Iowa, Illinois, and Lake Champlain Basin) currently have plans approved by the ANS Task Force. Several other states are developing ANS management plans.

Research and Monitoring*:* Dr. David Reid, National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory

There are seven sections identified in NISA regarding research and monitoring. The following summarizes the content, status and comments related to each of the seven sections. Comments do not represent those of the author, but rather are a compilation of views received from colleagues around the Great Lakes basin in response to a solicitation.

Under Section 1102, the ANS Task Force and the Department of Transportation are responsible for conducting ecological surveys in Chesapeake Bay, San Francisco Bay, Honolulu Harbor and other nationally significant estuaries susceptible to invasion due to ballast water discharge and vessel operations. These surveys are required to examine patterns of invasion and estimate the effectiveness of management guidelines and regulations. As of 2001, the surveys in San Francisco Bay, Chesapeake Bay and for the state of Florida have been completed. The Department of Transportation and the ANS Task Force are also charged under Section 1102 with surveying ballast water discharge rates and practices in Chesapeake Bay, San Francisco Bay, Honolulu Harbor and other nationally significant estuaries

susceptible to invasion due to ballast water discharge and vessel operations. As part of the survey, the rates and trends of ballast water discharge should be determined as well as the effectiveness of voluntary guidelines and regulations in altering discharge practices. In addition, Section 1102 calls for ecological and ballast water discharge surveys to be conducted for the Columbia River system. The Chesapeake Bay survey has been completed and the Columbia River ecological survey is in progress.

The Ballast Water Management Demonstration Program, outlined in Section 1104, allows for the demonstration of technologies and practices that may prevent ANS from being introduced and spread via ballast water. The program has a Great Lakes focus, but "other waters of the U.S." are also included. It is the responsibility of the departments of Interior, Commerce and Transportation, and action is ongoing by way of a proposal process being conducted by the NOAA and USFWS. Treatment technologies, including ozone injection, ultraviolet light, on-shore treatment, filtration and centrifugation (Voraxial separator), have been tested as part of the program. Funding for the demonstration programs has varied over the years. In FY98, $500,000 was appropriated for Chesapeake Bay only; in FY98 the USFWS allocated $150,000 and $500,000 in FY99 with no geographic restriction; and in FY99-01, $850,000 was appropriated per year for the Great Lakes and Chesapeake Bay only. Total federal funds for the program to date are $3.7 million.

As part of the National Ballast Water Management Information Program under Section 1102, NOAA was authorized to annually fund regional research proposals on ANS prevention and control through competitive, peer-reviewed grants to universities and research institutions. The regional distribution of authorized funding is as follows: Chesapeake Bay, $750,000; Gulf of Mexico, $500,000; Pacific Coast, $500,000; Atlantic Coast, $500,000; and San Francisco Bay Estuary, $750,000. In FY98 and FY99, $420,000 was spent each year via competitive requests for proposals. NOAA ceased further action on this program as the results were not satisfactory.

There are a few programs in NISA regarding research and monitoring that were never implemented or only implemented on a limited basis. The Dispersal Containment Analysis, outlined in Section 1202, calls for the identification of environmentally sound dispersal control methods. Funds of $500,000 were authorized for U.S. EPA whereby U.S. EPA's Great Lakes National Program Office spent $250,000 on a one-time study regarding a dispersal barrier in the Chicago Sanitary and Ship Canal. In addition, $1 million was authorized through Section 1301 for research on prevention, monitoring and control in Narragansett Bay, Rhode Island. Funds for this program have never been appropriated.

Gaps/Needs/Future Directions

A majority of efforts within NISA are focused on ballast water as a vector and zebra mussels as the primary invasive species of concern. It is recommended that the reauthorization of NISA expand the scope of the legislation to recognize the role that other vectors, such as the aquaculture industry, aquarium trade, biological control, recreational boating, recreational fisheries enhancement, bait industry and horticultural practices have in introducing and spreading invasive species, and the threat and impacts of all applicable invasive aquatic organisms. In addition, reauthorization efforts should work to streamline the structure of the legislation. It currently ranges from a broad, national perspective to very specific local targets, often driven by politics alone.

The biggest deficiency in NISA regarding research and monitoring is a lack of funding on two fronts. First, there is a dramatic discrepancy between what is authorized in the legislation and what is actually

appropriated. Congress needs to fund what it authorizes if it wants reasonable progress and results. Secondly, authorization levels should be updated and expanded as invasive species are expensive – expensive to understand, expensive to prevent and even more expensive to control.

***Ballast Water and Standards**:* Dr. Richard Everett, U.S. Coast Guard

NISA addresses ballast water in four main ways. Specifically, the legislation acknowledges that ships are an important vector for the introduction of ANS. It also authorizes studies to refine the understanding of the patterns and processes involved in the introduction and spread of ANS via ballast water and their subsequent impacts; directs the promulgation of regulations to prevent and control ANS invasions via ballast water discharges; and authorizes support for the development of effective technologies and practices to prevent ANS introductions via ballast water.

Ships as Vectors

NISA clearly acknowledges that ballast water is an existing or potential problem for the fresh, estuarine and marine waters of the United States and that the ship vectors are associated with foreign, coastal and inland waterways shipping. Furthermore, NISA indicates that, in addition to foreign ballast water discharges, the ballasting practices of ships declaring no ballast on board (NOBOB) and aspects of ship operations other than ballast water movements are of concern. These latter aspects include biological fouling of exterior hulls and interior surfaces, and water and sediment accumulated in chain lockers.

Studies of Ballast Water

NISA authorized a suite of studies that directly or indirectly address issues related to ships and ballast water as mechanisms of introducing ANS to U.S. waters. These include (with the agency/entity assigned responsibility):

- Crude Oil Tanker Ballast Facility Study (USCG)
- Ballast Exchange Study (ANS Task Force)
- Shipping Study (USCG)
- Ecological Surveys (ANS Task Force)
- Ballast Discharge Surveys (USCG)
- Sea Grant Research on ANS Prevention and Control (NOAA)
- Ballast Water Management Demonstration Program (USFWS and NOAA)
- National Ballast Information Clearinghouse (USCG and Smithsonian Environmental Research Center, SERC)

The first three studies have been completed and are available from the USCG or the ANS Task Force, as indicated. The ballast facility study examined the capability of the oily ballast water reception facility at Valdez, Alaska, to prevent introductions of ANS. The ballast exchange study examined, through models and review of oceanographic data, the environmental effects of ballast water exchange on the receiving waters and the availability of locations within the coastal zone where ballast exchange could be conducted in the event that mid-ocean exchange is not possible for reasons of safety or route. The shipping study was the first attempt by the federal government to investigate the extent to which shipping contributes to ANS introductions into U.S. waters and to identify potential options for preventing such introductions.

The ecological and ballast discharge surveys were intended for estuaries determined by the ANS Task Force to be susceptible to invasion via ballast water-mediated introductions or requiring further study. Several sites were identified for initial study, including Chesapeake Bay, San Francisco Bay, Columbia River and Honolulu Harbor. Ecological surveys were intended to examine attributes and patterns of invasions and estimate the effectiveness of guidelines and regulations in abating invasions. To date, surveys have been done for Chesapeake Bay, San Francisco Bay and Delta, Florida, Great Lakes, Hudson River, and Valdez, Alaska. Ballast discharge surveys were to examine the rate and trends in ballast water discharged to U.S. waters and assess the effectiveness of guidelines and regulations in altering ballast discharge practices. The San Francisco ballast discharge survey was completed, but the Chesapeake Bay and Honolulu Harbor discharge surveys were subsumed into the ongoing national ballast survey conducted by the National Ballast Information Clearinghouse (NBIC). Has the intent of the surveys been achieved? Both the ecological and ballast surveys were intended to estimate rates, describe patterns, and detect changes in both. However, as one-time assessments, only historical patterns are discernable. Ongoing monitoring of existing populations, as well as for new invasions, is required to estimate rates and recognize changes in patterns.

Ballast Water Regulations

The original legislation, NANPCA, required vessels with ballast tanks entering the Great Lakes and Hudson River upstream of the George Washington Bridge, after operating beyond the exclusive economic zone (EEZ) to: 1) exchange ballast water mid-ocean, 2) exchange ballast water in alternate areas, or 3) use alternative ballast water management methods approved by the USCG. In 1996, NISA reauthorized NANPCA, and extended the ballast water management program to vessels and ports not covered by NANPCA. Vessels entering U.S. waters after operating outside of the EEZ are required to keep and submit to the USCG records of ballast water management activities. Furthermore, vessels entering other U.S. waters are requested to follow the suite of ballast water management practices required of vessels entering the Great Lakes ecosystem.

To assess the effectiveness of the regulations and recommendations specified in NISA, Congress directed the USCG and SERC to cooperatively develop and operate the NBIC. The NBIC collects, stores, and analyzes ballast water management data submitted by vessels and reports on ballasting practices and compliance with guidelines and regulations. Based on the NBIC analyses, the USCG prepares a report to Congress every two years summarizing patterns of ballast water delivery and management, and invasions resulting from ballast water.

NISA contains provisions for regular review and revision of ballast water regulations and guidelines. The USCG was directed to report to Congress, no sooner than 24 months and no longer than 36 months, on an assessment of compliance with the reporting requirement and voluntary guidelines, and an evaluation of the effectiveness of the guidelines in reducing the risk of biological invasions. In the event that the USCG determines that compliance is inadequate to evaluate the effectiveness of the guidelines, NISA directed that the regulations be revised and enforced as necessary, based on the best scientific information available. For the first two years of the national requirements, no penalties were authorized for noncompliance. For the Great Lakes, and the nation following revision of requirements if necessary, enforcement sanctions of civil penalties up to $25,000 per day and criminal penalties up to a class C felony were authorized, along with revocations of customs clearances. NISA also provided for special review and revision of regulations governing ballast water and other ship operations. At the request of the

ANS Task Force, NISA authorized the USCG to assess the need for regulations and guidelines to cover coastal and inland waterways.

How effective have the regulatory provisions in NISA been at reducing the risks of biological invasions via ballast water discharges? For the Great Lakes, the widely held opinion is that the existing regulations do not adequately address the problem of vessels entering the lakes and in NOBOB status. Indications are that exchange is not necessarily effective at removing nonindigenous organisms in the residual water and sediments within these vessels, and subsequent ballast water movements within the lakes may result in the release of these organisms. There has been a poor response to the national regulations requiring reporting of ballast water exchange. Only about 25 percent of the regulated vessels reported during the first year the requirements were in effect and of the vessels reporting an intent to discharge, less than 30 percent reported conducting a complete exchange of ballast water as requested. Furthermore, there is a widely held belief that NISA's lack of coverage for vessels engaged in voyages between U.S. ports is a critical shortcoming.

Development of Management Technologies and Practices

In NISA, Congress authorized a ballast water management demonstration program to demonstrate technologies and practices to prevent ANS introductions via the discharge of ballast water. The purpose of the program is to evaluate technologies and practices that are: 1) suitable for shipboard or land-based installation, 2) operationally practical and safe, 3) environmentally sound and cost effective, and 4) monitorable and effective. Congress further instructed that the program focus on technologies and practices identified as promising by the National Research Council's (NRC) Marine Board study. In their report, *Stemming the Tide*, the NRC panel recommended filtration, biocides (oxidizing and nonoxidizing), and thermal treatment as the most promising approaches for treating ballast water. Following federal funding for the development of a project plan, the Great Lakes Protection Fund has provided extensive financial support for a project collaboratively managed by the Northeast-Midwest Institute and the Lake Carriers' Association. In addition, NOAA and the USFWS have been funding, through the National Sea Grant Program, a number of projects directed at developing and evaluating ballast water treatment systems.

The USCG has initiated several efforts to facilitate development of effective and practical ballast water treatment systems. The three primary components of this work focus on: 1) the capability of basic treatment processes (such as UV, filtration, etc) to effectively remove or inactivate the broad range of organisms found in ballast water, 2) the evaluation, through third party scientific audits, of the "state of the science" in projects testing the efficacy of treatment systems at intermediate or full scales, and 3) the development of a program through which ship owners could receive conditional approval for treatment systems installed for experimental purposes.

NISA on Standards

There are no provisions within NISA that specifically address standards for ballast water treatment or discharge. NISA does stipulate that, in lieu of mid-ocean exchange, vessels in the Great Lakes may use ballast water management practices that are determined by the Secretary of Transportation to be as effective as ballast water exchange in preventing and controlling ANS infestations. However, the process by which the secretary is to make such a determination is not specified. In the most straightforward approach, vessels wanting to use alternative methods would be required to provide evidence that the alternate prevents invasions to the same degree as mid-ocean exchange. This would be an onerous task

to require of all individual vessels, given the complexities of conducting such a comparison. Therefore, the USCG is working to develop standards for ballast water discharge and protocols for evaluating the performance of alternative treatment systems for use in lieu of mid-ocean exchange. This work started with discussions within the Ballast Water and Shipping Committee of the ANS Task Force, continued through subsequent technical workshops conducted by the International Maritime Organization (IMO) and the USCG, and will result in an advance notice of proposed rule-making that will present a set of alternative quantitative ballast water discharge standards. In addition, the USCG and U.S. EPA have established an agreement to add ballast water treatment technologies to the Environmental Technology Verification Program. In addition to providing a service to the technical marketplace, this collaborative effort will also assist in the development of technical protocols for testing the performance and efficacy of treatment systems, and thus directly support the development of the regulatory program.

***Information and Education**:* Joe Starinchak, U.S. Fish and Wildlife Service

ANS became a recognized issue with the zebra mussel invasion of the Great Lakes ten years ago. However, the issue has since grown into one that is much more than zebra mussels. ANS are now considered an emerging global problem. Invasion rates are increasing and pathways for introduction are numerous and complex. In terms of information and education, the ANS issue is driven by multiple values, including economics, ecology, and human and ecosystem health. It is this point that the Communication, Education and Outreach (CEO) Committee of the federal ANS Task Force plans to focus on to raise awareness and increase ownership.

The fact that ANS are generally "out of sight" means that they are frequently "out of mind" for the general public. However, invasive species are an extremely important issue. The problem of invasive species is second only to habitat loss as a factor affecting declines in biodiversity. The ANS Task Force and related entities have the ability to successfully address lack of the public awareness. With its diverse and experienced membership, the task force can effectively coordinate information/education activities within its existing infrastructure. At each level, this federal entity can leverage supplemental outside resources to enhance and build upon national outreach activities. Additionally, the timing and climate are right to develop, implement and evaluate a nationally-coordinated outreach program.

The CEO Committee of the ANS Task Force is a logical and necessary step in achieving the type of results desired. Operationally, the CEO Committee used the original legislation and the ANS program as guidance. These documents helped establish the committee's mission, which as interpreted by the members consists of:

- Expanding the ANS issue to broader audience
- Engaging the public (when applicable) to adopt prevention behaviors
- Making the best use of limited resources
- Ensuring that efforts do not reinvent the wheel
- Creating marketing strategies for existing products
- Strategically targeting efforts to raise the most awareness

Members of the CEO Committee have determined that their overall efforts need to focus on raising public awareness of the ANS issue. In order to do so, they want to expand state and regional awareness of the ANS Task Force and its mechanisms for helping state and regional entities address ANS problems. Their secondary concerns focus on working collaboratively with all efforts (Invasive Species Council, Invasive

Species Advisory Committee, state management agencies, state Sea Grant programs, regional ANS panels) who have been successful in raising ANS awareness. Members of the CEO Committee also believe it is important to present a unified image of the task force, and to use the task force's 10th anniversary to effectively enhance outreach efforts by highlighting prior successes.

Part of the CEO efforts also focus on helping the task force improve its coordination. The CEO Committee will rely upon existing task force-related products that empower specific target audiences to address the ANS issue. The committee also will help build upon regional successes by transferring them to a national level. By using social market planning processes, the CEO Committee will market these existing products and empower audiences to become part of the overall solution to prevent and control ANS.

***Non-Ballast Prevention and Control**:* Pam Thiel, U.S. Fish and Wildlife Service

Preventing ANS from entering an ecosystem is always more cost-effective and environmentally sound than trying to control them after they arrive. Once invasive species are introduced, they are virtually impossible to eliminate and very difficult to control. For example, the binational effort to control sea lampreys (*Petromyzon marinus*) costs approximately $14 million annually and may more appropriately be called the sea lamprey suppression program. Science and management agencies have made substantial progress with prevention and control efforts since the NANPCA, but much effort is still needed to slow the growing threat of ANS.

The interagency ANS Task Force, co-chaired by the USFWS and NOAA, was created by NANPCA to coordinate governmental efforts related to ANS. As part of the nonballast prevention and control measures called for in NISA, the task force formed a committee to produce voluntary guidelines on recreational activities. They were developed in 1999 and the USCG published them in the *Federal Register* in 2000. Both generic and specific guidelines were provided for boating, seaplanes, scuba diving, waterfowl hunting, and fishing with and without live bait.

Ruffe (*Gymnocephalus cernuus*), a percid native to Europe and Asia, was first collected in 1986 in the St. Louis River estuary of western Lake Superior. They have since expanded their range into other portions of lakes Superior and Huron. The Ruffe Control Committee was formed and the ANS Task Force approved the Ruffe Control Program in 1993. One of the components of the Ruffe Control Plan is surveillance. USFWS offices in Ashland, Wis., Alpena, Mich., and Amherst, N.Y., along with the Ontario Ministry of Natural Resources, have conducted monitoring since 1989 and produce an annual report that also includes data on the round goby (*Neogobius melanostomus*). The Ruffe Control Program has delayed the spread of ruffe in the Great Lakes, but is unable to prevent their unassisted range expansion. Ruffe will likely colonize all the Great Lakes and connected waters, but the program can prevent ruffe from being transported into waters not connected to the Great Lakes.

The man-made connection between the Great Lakes and Mississippi River via the Illinois Waterway makes the entire midcontinent vulnerable to ANS invasion. Once invasive species make that connection and travel down the Illinois River to the confluence with the Mississippi River, they can either move upstream or downstream and into major tributaries like the Ohio and Missouri rivers. This is the pathway that zebra mussels (*Dreissena polymorpha*) followed, and they are now distributed from the Twin Cities, Minnesota to New Orleans, Louisiana, and as far west as Oklahoma. The connection between the basins

is also a two-way street where invasive species like Asian carp can move from the Mississippi drainage into the Great Lakes.

The round goby is a benthic fish that resembles a sculpin. They can reach a length of 12 inches and spawn every 20 days from April through October. They are known for their aggressive feeding and defensive behavior and have had significant impacts on native fish and anglers' catches. Round gobies were first collected in the St. Clair River in 1990 and rapidly expanded into all of the Great Lakes. Gobies were discovered in the Illinois Waterway in 1993 and were poised to enter the Mississippi Basin. Because of this impending threat by round goby, NISA mandated the U. S. Army Corps of Engineers, in consultation with the ANS Task Force, to identify and investigate environmentally sound methods of reducing the dispersal of ANS between the Great Lakes and Mississippi River drainages. NISA authorized funds for the development of a dispersal barrier demonstration project. The Dispersal Barrier Advisory Panel was formed and considered the constraints on and obstacles to the development of a barrier. An electrical barrier was selected because it would not impede navigation or water allocation, and there would be few permitting issues. A prototype electrical barrier was tested at the USGS Great Lakes Science Center in Ann Arbor, Mich. as well as in a field setting at the Shiawassee River, Michigan, and the results were promising. The electrical barrier is a nonlethal deterrent for all fish, not just round goby.

Since 1996, an interagency team led by the USFWS has monitored the downstream leading edge of the round goby in the Illinois Waterway. Round gobies have moved downstream and are now 50 miles inland from Lake Michigan and 15 percent down the length of the Illinois Waterway. They are at least 11 miles downstream from the electrical barrier construction site. Even though gobies are past the barrier site, the barrier will help deter other fish like ruffe coming from the Great Lakes and fish such as bighead carp (*Hypophthalmichthys nobilis*) moving toward Lake Michigan. This pilot project's greatest contribution, now that gobies are past the site, is to test its effectiveness as a potential technique for controlling other invasive fish in riverine settings.

The USFWS, along with the New York Thruway Authority Canal Corporation, is conducting the multi-faceted Erie Canal Initiative. The public awareness component includes outreach and workshops for science educators. They are collecting fish, benthos, zooplankton, and plant data. After discovering water lettuce (*Pistia stratioites*) in the canal, they implemented a control and monitoring project.

The 100th Meridian Initiative is a large-scale project designed to prevent the westward spread of zebra mussels and other ANS. Partners include state, provincial, and federal agencies, private industries and user groups. Trailered boats are the primary vector that zebra mussel and invasive aquatic plants will use to spread westward, so outreach is targeted at recreational boat users. Data has been collected on the major east-west highways and at high-use boat ramps and lakes. To date, 36 boats have been detected in the western states with zebra mussels attached, including some that were still alive. However, no living zebra mussels have been collected in western waters.

Caulerpa taxifolia is a colonial marine alga which can develop a dense mat that spreads as fast as a few inches a day and displaces diverse communities of native algae and flowering marine plants. The rapid response plan associated with its initial discovery in the United States is at least a partial success story that has applications to the Great Lakes basin. This rapid response plan worked when most others have failed for several reasons. *C. taxifolia* was recognized as a species that caused devastating damage in

the Mediterranean Sea and more than 100 scientists requested that the U.S. Secretary of Interior take action to prevent its spread in U.S. waters. A prevention program was developed in 1999 and less than one month after early detection monitoring discovered it near San Diego, field operations began to eradicate the invasive alga. Another reason for the swift and successful response is that California is experienced in instituting pest eradication programs. The control effort exemplified and depended on a coordinated multiagency approach, and emergency funds of nearly $1 million were available. This success serves as a model for broader rapid response strategies for other incipient invasive species. However, the success is tempered with the fact that this invasive alga has been found in another California harbor, illustrating the continual battle that must be waged against all invasive species.

To prevent invasive species from entering the United States and crossing state borders, we must promulgate legislation to strengthen state and federal authorities and reauthorize NISA. Outreach efforts should be enhanced and identify the threats caused by invasive species, as well as the probable results from not preventing their entry. On the regional level, interjurisdictional policy, such as the *Great Lakes Action Plan for Prevention and Control*, should be implemented. These three actions will assist in controlling ANS. In addition, rapid response plans that will facilitate the timely implementation of eradication and control measures must be developed prior to an invasion. Rapid response plans, in conjunction with early detection programs, will function as the first line of control in the event of a new infestation. Early detection is paramount to the successful control of any invasive species. At the same time, more research is needed to develop new chemical, biological and mechanical technologies and eradication strategies to use on new species. Analyses are necessary to inform the public and policymakers on the economic and ecological consequences of controlling species versus the cost of not controlling them. This is a partial list of where our vision should take us as we move forward in solving this large, growing global problem.

V. ***The Emerging Management Challenge: Ballast Water and No Ballast on Board Issues****:* Philip Jenkins, Philip T. Jenkins and Associates Ltd.

Since the issue of ANS introductions through ballast water was first addressed, two crucial steps have been taken towards mitigating the problem.

The first step has been to bridge what was a sizable communication gap between the scientific, shipping and legislative/regulatory communities. There was a lack of understanding regarding the ANS issue, ship operations, and the complexity of developing a solution for preventing ANS introductions through ballast water. Nowhere was the communication gap more evident than on the ships. Masters approaching the Great Lakes were requested to perform open ocean ballast exchange, an inherently risky operation. This request was made without much explanation from the Canadian and U.S. authorities as to why this needed to be done. The request was also made without proper information as to how it should be done, given the structural limitations of each ship, and the wind and sea conditions that prevail in the North Atlantic. It is to their credit that most masters went looking for the explanation on their own. Even before the existence of these recommendations and requirements, those who traded more frequently to areas where ballast water discharge regimes existed had developed their own management strategy and record-keeping process.

The second crucial step has been to provide these masters and crews with the tools that they need to do their job effectively as front line managers. The IMO resolution calls for ballast management plans that include procedures for handling both ballast and sediment, and information from port states about where to avoid taking ballast. The information from port states is based on scientific knowledge of known species habitat, sewage outflow locations, rain runoff and tidal turbidity. Training in the most effective use of the plan must come from the vessel owners or managers.

This has now been taken further by at least one of the major classification societies, Lloyds Register, who will provide ship-specific approval of the ballast management plan with respect to structural safety. In addition, the newer ships have been fitted with better ballast systems, with stripping pumps or eductors enabling a more complete evacuation of each tank. It is worth noting that there have been 25 new ships introduced into the trade by two of the major stakeholders in the last five years.

It is becoming apparent that many masters are prepared to act beyond the formal management plans and are utilizing the ballast cycle to address the complete range of migration issues. Masters are endeavoring to reduce the risk of ballast-mediated ANS introductions to the best of their ability by undertaking a variety of measures to judiciously ballast. These measures include exchanging ballast whenever the occasion presents throughout their international voyaging, limiting intake to the extent practicable in turbid waters and maximizing intake in areas of high salinity or where thermal shock could be used to help kill organisms.

With ballast management currently the best available defense, these observations will hopefully underscore the need to keep an international emphasis on the problem and to provide the best possible tools to the front line managers who are both able and willing to make a major contribution to the reduction of invasions.

Research Initiatives and Future Directions

Assessment of Transoceanic NOBOB Vessels and Low-Salinity Ballast Water as Vectors for Nonindigenous Species Introductions to the Great Lakes: Dr. David Reid, National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory

A new $1.9 million three-year research program involving collaboration between six institutions is being conducted by a U.S. and Canadian team of scientists. The program is led jointly by NOAA's Great Lakes Environmental Research Lab and the University of Michigan's Cooperative Institute for Limnology and Ecosystems Research. The primary goals of this three-year project are to provide the scientific knowledge needed to understand the risk of invasive species introductions posed by transoceanic vessels entering the Great Lakes as NOBOBs; to provide a basis for assessing effective preventive measures and for developing policies and biological standards for ballast water treatment; and to experimentally determine the effectiveness of open-ocean ballast exchange with special attention to low-salinity or fresh water initial ballast.

Specific tasks will: (1) Characterize the biological communities (invertebrates, phytoplankton, and microorganisms) present in NOBOB tanks and evaluate the relationships among ship management practices, mud accumulation and invasion risk. This task will involve a special focus on the importance of invertebrate, phytoplankton, and microbial resting stages as they relate to invasion potential. (2) Conduct experiments in ballast tanks of operating vessels to determine the potential for introduction of nonindigenous organisms when Great Lakes water is added to a NOBOB tank containing residual sediment and water, and later discharged. (3) Quantify the effectiveness of open-ocean exchange in decreasing the diversity and concentration of live biota in ballast water, especially targeting fresh or low-salinity ballast water originating from Europe.

Background and Issues

A ship taking on ballast water in a foreign port for purposes of trim and stability also takes on the biota and sediment in that water. When a ship with foreign ballast water enters the Great Lakes it carries foreign biota with it, unless measures have been taken to remove or kill the biota. NANPCA requires that ships coming into the Great Lakes "in ballast" after having operated outside the U.S. EEZ must exchange the ballast water at sea, conditions permitting, or use an alternative ballast water treatment approved by the USCG. Presently, open-ocean ballast exchange or exchange at an approved alternate exchange site are the only approved treatments. The purpose of requiring ballast water exchange is to reduce the risk of introducing invasive species to the Great Lakes via ballast water discharge. However, statistics reveal that more than 75 percent of vessels entering the Great Lakes declare that they have no pumpable ballast water on board and are not subject to ballast management regulations.

Studies have shown that these "empty" ballast tanks in NOBOB vessels often contain an unpumpable residual mixture of foreign sediment and water accumulated from previous ballasting operations. Only a few studies have examined the biological content in NOBOB tanks, finding that these tanks may contain thousands of live organisms, their resting stages (eggs and cysts), and microorganisms, including human pathogens.

In addition, when a NOBOB vessel unloads cargo in the Great Lakes, Great Lakes water is pumped aboard to maintain the stability of the vessel. Thus, Great Lakes water mixes with the residual ballast

water (and organisms) already in the ballast tanks. Vessels often move between a succession of ports, unloading foreign cargo and loading domestic goods for export. As a result, ballast water may be pumped on and off the ship several times during its stay in the Great Lakes and foreign organisms or their resting stages can thus be discharged into the lakes during these ballasting operations.

The effectiveness of open ocean ballast water exchange in minimizing species introductions has not been well tested or evaluated. Most ships sampled during 1995 at the entrance to the Great Lakes carried an assortment of live marine, brackish and freshwater fauna, despite having fully exchanged ballast water on the open ocean. A Canadian study determined that up to one-third of ships that declared mid ocean exchange still contained live, freshwater-tolerant zooplankton. Another study found only a 48 percent difference in the densities of diatom and dinoflagellates between exchanged and unexchanged ballast tanks. The euryhaline fishhook waterflea, *Cercopagis pengoi*, invaded Lake Ontario in 1998, well after implementation of open-ocean exchange. New introductions since the implementation of mandatory ballast exchange have raised questions about the effectiveness of ballast exchange in protecting the lakes. On the other hand, new organisms could have entered from a NOBOB tank that was ballasted and discharged after entering the lakes.

Despite popular perception, there exist very few quantitative studies that have measured the preventative value of exchange. Those that have been documented were restricted to just a few vessel types and only assessed the effect of exchange for a small subset of entrained taxa. Furthermore, most of these previous studies were restricted to broad taxonomic groups of large planktonic organisms and ignored microorganisms and those taxa that form cysts.

A crucial consideration for the Great Lakes is the effectiveness of open-ocean ballast exchange when the original ballast is fresh or low-salinity water. The organisms and resting stages in fresh or low-salinity ballast water pose the greatest invasion risk to the Great Lakes. The freshwater regions of Europe, especially the coastal regions of the Baltic and Black Seas, have been implicated as source regions for many ballast-related Great Lakes invaders found since 1985 (zebra mussel, quagga mussel, round goby, tubernose goby, amphipod *Echinogammarus ischnus*, the fishhook waterflea, *Cercopagis pengoi*, and the diatom *Thalassiosira baltica*). Many of the aquatic organisms found in these regions are (a) euryhaline and can survive exposure to moderate salinity and (b) form resting stages that accumulate in bottom sediments and are difficult to remove with exchange. Therefore, the effectiveness of exchanging freshwater from these regions for open-ocean saltwater is an important, largely unresolved question.

Understanding Patterns of Supply and Invasion by Nonindigenous Species: Dr. Greg Ruiz, Smithsonian Environmental Research Center

For the most part, the general public is surprised when they learn about a new invasive species being discovered. However, the research and management communities have moved beyond surprise, as hundreds of non-native species have now invaded the waters of the United States. Much of the information about those invasions comes from ecological studies, such as the ones promoted under NISA. Generally, the source of the data for these ecological studies is not field-based surveys but rather a synthesis of information that is available in the literature. One could call it “by-catch data,” because the data comes from what is brought up in the net when someone is towing, or what someone happens to find on the shore. Even so, this data provides a great deal of information, documenting that hundreds of non-native species have invaded our ecosystems.

Based on this data, there are about 500 known invasive species that are established in the coastal marine systems of North America. This information has led to the development of a national estuarine and marine database for non-native species, which contains information regarding species identity, invasion history (species origin, pathway for introduction, time of first record), life history, population information, and ecological and economic impacts. This database is now being used to analyze patterns of invasion to determine what information the by-catch data can provide about invasions in space and time and invasion as a function of taxonomic group. Analyses are also being conducted to learn about vector pathways, the source regions of these invaders, and invasion impacts.

Examining the database for invertebrates and algae in North American coastal marine systems shows that most of the species are crustaceans and mollusks. Annelids and algae are not uncommon, and very few of the small organisms are known. Bacteria and viruses do not appear in the database. An apparent pattern emerges that most invasions are by large, conspicuous organisms. There is reason to believe this is not true but rather represents a bias of detections driven by size and the ability to recognize what is new and what is not.

Vector analysis of invertebrates and algae attributes most of the species to shipping, which is a composite of ballast water and hull fouling. Historically, fisheries management and fish stocking have played a role but much less so than shipping. There is quite a large number of species for which the vector of introduction is unknown. There is an apparent phenomenal increase in the rate of invasions over time. A comparison of invasion rates and vectors shows that the increase for coastal marine systems is driven predominantly by shipping. The fisheries vector has leveled off or even declined in the last 30 years.

There are several hypotheses that explain the increase in the rate of invasions. The first is that there is bias over time. Both the ability to detect new invasions and the amount of time spent searching for new species have increased in recent years. The data available are very dependent on who is looking, where they are looking, what they are looking at and how hard they look, all of which are uneven. For example, data show very few non-native species established in marine systems in the Gulf of Mexico as compared to the West Coast and the East Coast, but there is no reason to expect that invasions are not occurring in the Gulf of Mexico as they are everywhere else.

The other hypotheses that explain these patterns in space or time propose that there are differences in propagule supply. It could be that more propagules are delivered to particular locations, resulting in more invasions. The rapid increase in invasions could also be fueled by more propagules being delivered over time. There also may be differences in "invisibility" in space or in time - the same propagule supply may provide a different response function at different locations.

Currently, the relationship between propagule supply and invasion rate is unknown. This relationship is important from a basic research point of view and key from a management standpoint. Understanding this relationship will allow managers to set goals for reducing the number of propagules and determining targets for acceptable numbers of propagules for a system to receive.

Propagule Supply

A fair amount is now known about how much ballast water is delivered and where it comes from. Research on this topic began in 1995 with Jim Carlton's shipping study focusing on the amount of ballast water delivered to major ports in the United States in 1991. This study indicated that bulk carriers deliver

the largest volume of ballast water from outside the EEZ to U.S. ports. However, volume isn't everything. The most important information relates to the waterborne propagules and how management practices affect this propagule supply in space and time. Research has come far in understanding propagule supply and what is actually coming in. Most of the research efforts have focused primarily on zooplankton. There has been some research on phytoplankton and, with the exception of a few analyses, almost nothing on protists, bacteria and viruses.

Very little is known about microorganisms in ballast water. What is know is that these organisms are the most abundant, most species rich, and occur in the greatest number in ballast tanks. For Chesapeake Bay, the concentration of bacteria and viruses (measured as number of organisms per milliliter) is many orders of magnitude greater than what is found for zooplankton. Concentrations of 10^{5th},10^{6th}, and 10^{7th} microorganisms per milliliter have been found, whereas for zooplankton, organisms are measured in the hundreds per cubic meter. Scientists know that the large organisms are invading. Most likely, these small organisms are invading too and the research just has not shown it yet.

In terms of zooplankton, we know that the delivery rate is quite variable, depending on the source region. A study of unexchanged ballast water in oil tankers traveling to Port Valdez showed a significant difference in the total density of zooplankton depending on the source port. The source ports for this study included Puget Sound, San Francisco Bay, LA/Long Beach, Honolulu, and Oceanic (exchanged ballast water).

Research has also examined how particular voyages -- not only source port but also voyage duration - influence what is actually delivered to a recipient port. A study of a ship traveling from Israel to Chesapeake Bay in 1996 showed that the concentration of organisms in ballast tanks is quite dynamic and changes over time. This data suggest that not only is source port important but voyage duration is also key to understanding what is actually delivered to a recipient port. The concentration of zooplankton in ballast from coastwise, or domestic traffic, has been compared to that in foreign traffic through studies in Chesapeake Bay, Prince William Sound and Valdez. Not surprisingly, the concentration of zooplankton in the ballast water of domestic traffic is much greater than the concentration in foreign traffic, probably because the voyage duration is much shorter. A shorter voyage duration yields a larger concentration of organisms. It is incorrect to think that transferring organisms within the United States is not a problem. Biogeographic boundaries dictate that there are naturally occurring species in one area and not elsewhere. These species can be transferred through ballast water to breach those boundaries. Of equal importance is the potential for a leapfrog effect. A species may be deposited in San Francisco Bay and invade the area. The Bay is then a major source for the species, and the species can be spread to other locations via coastwise traffic. From both a research and a management point of view, coastwise traffic is very important and deserves a great deal of attention.

Scientists are beginning understand how management practices affect or interrupt the propagule supply. The marine invasions research group at SERC has conducted exchange experiments on about 12 vessels, primarily oil tankers going to Prince William Sound, but also on bulk carriers traveling across the Atlantic. This group will also be conducting exchange experiments on eight container vessels going across the Pacific over the next two years and will be doing some exchange experiments on ships coming in to the Great Lakes.

One of the experiments the group has completed is to add rotamine dye, which functions as a tracer, into the ballast tanks on oil tankers. For these experiments there are three tanks -- a control tank, an empty-refill tank where the water is dumped and the tank is refilled, and a flow through tank where the water is pushed through the tank displacing resonant water. The tracer shows what the water mass is doing. The results demonstrate that both methods are fairly effective for exchanging the ballast water. On the flow-through tank, roughly 85 percent of the water is exchanged. Using the empty-refill exchange method, 95 percent or more of the water is exchanged. Similar effects are found for the zooplankton being examined. There is still the challenge of examining the organisms that sink to the bottom sediments, as well as the fate of some of the more mobile organisms, such as fish and the rapidly swimming decapod larvae.

The Ballast Water Clearinghouse

NISA established the National Ballast Water Clearinghouse, which is intended to track ballast water management activities and ballast water discharge to ports throughout the country. NISA requires the USCG to report back to Congress on the results from information collected through the clearinghouse, including the ballast discharge pattern, changes over time and how the pattern might influence the risk of invasion.

The clearinghouse is set up to receive reports from all vessels arriving at U.S. ports from outside the EEZ. This data is compared to information collected from the customs database, which allows for a comparison of compliance. The USCG is also conducting surveys to validate the quality of this data. This information is compiled into a database from which a series of queries can be run regarding how much water is coming in to each port by vessel type, source region, season, and tank. The system will be able to provide very specific information on any spatial and temporal scale, across any ship type for ships arriving from outside the EEZ. The clearinghouse is not currently in place for domestic/coastwise traffic.

Compliance in reporting to the clearinghouse has not been good. The program began in 1999 and only 25 percent or less of ships submitted reports. Breaking down the results by region shows an interesting jump in the level of reporting in California, where the state recently required that ships report under penalty of law.

Future Needs

Much of the data available regarding invasive species originates from people looking haphazardly in the field. While a great deal of information can be learned through this approach, the research community should be moving to a more quantitative, rigorous, repeatable set of measures that provide information on how the rate of invasions is changing.

The marine invasions research group at SERC has implemented a field-based survey examining fouling communities across many different bays and estuaries in North America. The goal is to survey roughly 20 different bays. This will help develop a baseline for non-native species in those systems. It will also allow us to compare the number of invasions to the historic supply of propagules and look for the relationship between invasion and supply.

Management Options and Unmet Needs

The Evolution of Michigan's Ballast Water Bill: Georges Robichon, Fednav Limited

Fednav Limited is a Canadian company, controlling approximately 50 percent of dry bulk ocean shipping in the Great Lakes.

Sen. Ken Sikkema's Bill No. 955 introduced in the Michigan Senate on February 1, 2000, required all vessels transiting Michigan waters (encompassing four of the five Great Lakes) to have their ballast water sterilized. As there is no known technology that can effectively sterilize ballast water, Bill 955, had it become law as introduced and been upheld constitutionally and enforced, would have prohibited all commercial shipping in the Great Lakes. Since the introduction of Senate Bill 955, the ocean shipping industry has responded to Sen. Sikkema's challenge to demonstrate a commitment to reducing the risk of invasive species introductions via ballast water.

On May 15, 2001 the Michigan Senate Committee on Natural Resources and Environmental Affairs adopted Senate Bill 152, which Sen. Sikkema called a "radically different" piece of legislation. Senate Bill 152 represents a cooperative effort on the part of the maritime industry and Sen. Sikkema to craft legislation that responded to industry's insistence on a regional approach to the ANS problem without unilateral state regulation.

What occurred in the 18 months between? How did the partnership come into being and why was Sen. Sikkema willing to accept a radically different bill? Three things happened. First, state politicians became more aware of the issues surrounding ocean shipping in the Great Lakes. Second, the maritime industry demonstrated a willingness to acknowledge and address the ANS problem in the Great Lakes. It provided evidence of this commitment by voluntarily agreeing to implement ballast water management practices. Fednav itself has addressed ANS issues by incorporating the latest in ballast tank design, including the use of stripping eductors, and requiring strict adherence to ballast water management practices in the 14 new seaway size bulk carriers built by the company since 1995. Finally, agreement was reached on a reasonable time frame for the broad application of ballast water management practices by both domestic and ocean carriers. The parties also reached agreement on a time frame for testing the effectiveness, safety and practicality of three prospective onboard ballast treatment technologies, including the testing of copper ion and chlorine on a Fednav bulk carrier and the possible testing of a filter/UV system on a product tanker.

In conclusion, it is not through unilateral state regulation that the ANS problem in the Great Lakes will be addressed in an effective way. Instead, it will be through the cooperative effort of the maritime industry and the public sector as currently demonstrated in Michigan. These efforts will be augmented by the involvement of Canadian and U.S. federal authorities to assess the merits of the various treatment technologies.

Ballast Water in the Great Lakes: George J. Ryan, Lake Carriers' Association

The Lake Carriers' Association is a trade association representing U.S.-flag vessel operators on the Great Lakes. The Association is made up of 11 American companies that operate 56 U.S.-flag self propelled vessels ("lakers") and integrated tug/barge units. Ships of the members of the Lake Carriers'

Association carry approximately 115 million net tons of cargo each year to provide the steel industry, electric power utilities, construction industry, and other basic manufacturing industries with the raw materials needed to sustain the regional economy and related employment.

This presentation will examine the importance of ballast water, steps that carriers are taking to implement best management practices for ballasting, and what needs to be done to address unmet needs for ballast water management.

Ships need to use water as ballast. On most voyages, ships carry cargo in only one direction. On the return leg, they carry ballast water in their tanks to help maintain the structural integrity of the ship. Ballasting is essential to the safety of the crew and ship. The water must be distributed properly so there are no stresses that could lead to structural failure of the hull. The water must be taken on whenever and wherever the ship is empty of cargo. At times, ballast water is being loaded during discharge of cargo in order to keep the vessel stable and in trim.

Because they only operate in the Great Lakes and St. Lawrence River, Great Lakes ships, both Canadian and U.S.-Flag, have never introduced a nonindigenous species into the system. Once a nonindigenous species is introduced to the waters of the Great Lakes and there is no natural predator, nothing can stop the migration of that species. It will eventually spread to all the Great Lakes. Nothing can prevent fish from swimming, recreational boats from being trailered to inland lakes, or diving ducks from transferring biota. Since this is the case, all waters of the Great Lakes should be considered one body of water. There is no reason to make a distinction between water in one state and the adjacent waters of other states or provinces with regard to nonindigenous aquatic invasive species.

In recent years, vessel operators have developed a series of best management practices which may reduce the risk of introducing or spreading aquatic invasive species in and around the Great Lakes region. In March 2000, the state of Michigan convened a meeting of vessel operators from all trades, who reached an agreement to formalize a set of best management practices that could be carried out by vessels entering or operating on the Great Lakes. Members of the Lake Carriers' Association and Canadian Shipowners Association, plus all other significant shipowners, have endorsed these practices.

The best management practices call for ship masters to take on only the minimum amount of ballast necessary to safely depart a port, to minimize pumping onboard sediment or ANS that may be in the port water. There is now a commitment to inspect for and remove sediment accumulations in ballast tanks and to record these actions. It should be noted that it is not always possible to significantly stop the inflow of sediment, since vessels operate very close to the bottom of ports and connecting channels, and the ballast intake is frequently near the keel. In addition, the best management practices for oceangoing vessels call for not taking on water in areas where there are outbreaks of known populations of harmful aquatic organisms, pathogens or toxic algal blooms such as red tide, as well as ballasting only during the daytime.

While the vessel operators have made a good-faith commitment to implement the best management practices for ballast water management, further advancement to reduce the risk of ANS introductions via ballast water is significantly hampered by the lack of a standard for ballast water treatment. Both the IMO and the USCG are working towards the development of international and U.S. standards, but until a standard is proposed the technology for ballast water treatment will not advance as quickly as it could. In

addition to a standard, a focused effort for field testing of ballast water treatment technology onboard ships needs to be implemented. This research will require a considerable amount of funding. Research must also be undertaken to better understand the technical, environmental and economic feasibility of flushing NOBOB tanks into treatment facilities, either shoreside or floating. Intuitively, many in the industry find the recommendation unfeasible. Nevertheless, since the recommendation is on the table, industry, working with government agencies, should commence research on this subject.

Shipping is an important source of economic activity in the Great Lakes, and it can safely be said that virtually every region of the country benefits from Great Lakes shipping. The shipping community, regulators, and policymakers will need to continue to work with each other to maintain the economic benefits from shipping while working to reduce the risk of ANS introductions through ballast water.

NISA Reauthorization: Answering Questions to Improve Ballast Management*:* Scott Smith, Washington Dept. of Fish and Wildlife

Developing a Ballast Management Program

Who is going to do what, to whom, with whoever's money, and when are they going to do it? These are questions that those involved with ballast management would like to see answered. Unfortunately it is not a simple set of questions to answer. Several conditions must be in place in order to develop a successful ballast water program. The program must be developed as a cooperative endeavor and there must be adequate funding and authority for implementation. The ballast water program itself must be as consistent as possible, while at the same time as biologically effective as possible. Impacts to government and industry must be minimized, and program implementation must be verifiable with minimal bureaucracy.

The next question is whether it is possible for one entity to develop a ballast water program alone. The answer is no. NISA should promote partnerships among the USCG, the IMO, the states, the regional panels, the maritime industry and the port authorities. The statutes and authorities involved in ballast water management must be in synchrony: the IMO responsible for establishing conventions, NISA for outlining national law, the USCG for implementing national rules, states for defining and implementing state rule, ports for determining port practices, and maritime associations for setting the industry standards.

Some federal authorities feel that states should not be included in the process, arguing that it is difficult to reach agreement among the states, which could decrease the consistency of the ballast water program. However, states are responsible for protecting their waters and they are accountable to their citizens. States also can offer additional resources if included as a partner in the program and can provide an understanding of the different regional ecosystems and needs of their landscape. One way to provide state involvement and maximize consistency is to allow for regional differences within a national law. The regional panels could be used to coordinate and build consensus among the states, and the USCG could be given the final authority in the matter.

Washington State's Ballast Water Law

On June 8, 2000, Washington state's ballast water law went into effect. The rule basically makes the USCG voluntary reporting program mandatory in Washington. Vessels entering Washington waters are now required to conduct an open-sea exchange prior to discharging ballast with a safety exemption. Washington also requires vessels involved in coastal trade to report and to conduct a ballast water

exchange at least 50 miles offshore. Vessels are required to file a ballast water management report 24 hours prior to discharging ballast in state waters.

The law is administered by the Washington State Department of Fish and Wildlife (WDFW). The law also authorizes exchanged ballast water to be tested. After July 2002, the law will require unexchanged ballast water to be treated. There are several proposed rules still to be implemented regarding reporting requirements, including the interim ballast water treatment technology approval process and standards, and the ballast water exchange verification program.

The state is working to create a reporting program that provides information needed by authorities to monitor compliance on a local level and meets long-term data needs on a national level. Partners in the development of this reporting program include the merchants exchange of Portland, the marine exchange of Puget Sound, the Puget Sound Steamship Operators Association, the Columbia River Steamship Operators Association, WDFW and SERC. The reporting program will be designed to increase compliance and costs will be minimized by utilizing partnerships.

The Interim Ballast Water Treatment Technology Approval Process will set a target standard for ballast water treatment to meet. A target standard is a standard that may not be achievable or verifiable with existing systems, but serves as a meaningful goal to strive for. The approval process will involve manufacturers submitting technology data, a scientific advisory panel analyzing the scientific data, and a maritime advisory panel advising on safety and practicality issues of the technology. Technology vendors will submit an application for review which includes technical information on their equipment and all available research data. The scientific advisory panel will review this information with regard to the capacity of the technology to inactivate or remove viable organisms, including zooplankton, phytoplankton and bacteria. They will also assess the capacity of each technology to meet the target standard, be environmentally sound, and be operationally verifiable. The maritime advisory panel will review available information on the system to evaluate its ability to meet the practical needs of the industry related to safety, practicality and cost-effectiveness. WDFW has several options available after consideration of the panels' findings. WDFW can approve the technology for general use for a set time period (for example, five years). Another option is to grant conditional approval for use on a set number of vessels under certain conditions and require further full-scale testing. WDFW also holds the authority to deny approval for use of the technology. This approval process provides certainty to vessel owners and promotes the installation of promising technology. It enables the commercial application of treatment technologies, which will ultimately improve their efficiency and reduce cost to the industry.

Washington state's ballast water exchange verification program currently uses salinity testing. Research is underway to develop new protocols for evaluating ballast water exchanges. Testing will be conducted to evaluate the effectiveness of the protocols once they are developed. According to Washington's ballast law, vessels that cannot consistently conduct an adequate exchange after July 2002 could be asked to adjust their exchange practices or change to some form of treatment.

In conclusion, NISA should empower the USCG to form partnerships that cooperatively fund and implement a reasonably consistent national program containing the flexibility needed to address regional concerns. Regional panels could have a role in identifying unique regional concerns that promote consensus among states while balancing the need for consistency and efficiency. An interim technology approval program, with time frames for implementation, should be established. The use of the best

available treatment technologies should be mandated if exchange cannot be adequately conducted. Finally, financial support should be provided to build the capacity for more rigorous evaluation of treatment technologies and environmental risks in the future.

Aquatic Nuisance Species: Pollution Prevention and an Ecosystem Approach: Jennifer Nalbone, Great Lakes United

As efforts continue to prevent invasions by ANS, environmental soundness and pollution prevention must be adopted as working principles.

"Environmental soundness" is based on an ecosystem approach -- looking at how human actions affect the well-being of the entire Great Lakes ecosystem and maintaining the biological, physical and chemical integrity of the ecosystem as we satisfy the needs of the human species. Achieving environmental soundness recognizes that our cultures, societies, and economies are part of the ecosystem. Humans functioning within an ecosystem must resolve not to destabilize or irreparably damage it. Soundness takes into account that we cannot address an environmental issue -- even one as critical as ANS -- solely by focusing on trying to fix the problem, rather than modifying the practices that cause the problem. Great Lakes ANS may be an indication that a cultural, social or economic practice is unsustainable and should be modified. The alternative is losing the integrity and value of this unique freshwater environment.

The actions taken to prevent and control ANS will have repercussions. The challenge is to ensure that these repercussions do not create or accelerate other forms of environmental degradation. NISA applies this concept when it urges the use of "*methods, efforts, actions or programs to prevent introductions or control infestations of aquatic nuisance species that minimize adverse impacts to the structure and function of an ecosystem and adverse effects on nontarget organisms and ecosystems and emphasize integrated pest management techniques and nonchemical measures*."

Furthermore, there has been a growing shift in thinking about how to address environmental issues. The historical way of thinking was that a certain level of health or environmental damage was acceptable, and that a certain degree of proof of that damage was needed before taking action to mitigate it. In this scenario, risk assessment is the best mechanism to determine harm. A newer way of thinking, embraced by international bodies such as the United Nations Environmental Program and the International Joint Commission, addresses environmental issues from a prevention paradigm and uses the precautionary principle as its foundation. This principle states in part that, "*environmental measures must anticipate, prevent and attack the causes of environmental degradation. Where there are threats of serious or irreversible environmental damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation*."

If we commit to adopting the ecosystem approach and precautionary pollution prevention, we must examine all options to stop the primary vector for ANS introductions into the Great Lakes. If one approach is adopted, such as ballast water treatment, we must choose to develop and use treatments that do not exacerbate chemical pollution in the basin.

It is apparent that the Great Lakes region has not adopted the ecosystem approach when dealing with ANS, because the feasibility of alternatives to ballast water treatment are not being critically examined. Such alternatives could include banning untreated ballast water discharge into the Great Lakes from

foreign ships, facilitating the establishment of modified trading patterns, or developing transfer stations to preempt the need for foreign ships to enter the Great Lakes at all. At the very least, commitment to the ecosystem approach in the Great Lakes would mandate a serious examination of options beyond ballast water treatment. The current approach taken by the region to prevent ANS introductions via ballast water is limited to developing ballast water treatments and technologies while maintaining the current trade patterns and the ability of foreign ships to discharge ballast water in the Great Lakes. This appears to be the only approach available to North American coastal waters, which are also undergoing irreparable damage from ANS. However, for the Great Lakes this limited approach constrains our ability to examine whether a more sustainable mechanism to move goods exists, both economically and environmentally. It also assumes that access to the waters of the Great Lakes is identical to access to the coastal waters of North America, and that improvements in ballast water management on the Great Lakes must be identical to improvements on the coastal waters of North America.

If ballast water treatment is going to remain the focus of efforts to prevent the introduction of ANS via ballast water into the Great Lakes, then the region must remain in harmony with the environmental issue on which pollution prevention was founded, that is, chemical pollution prevention. What follows is a brief presentation of the constraints and restrictions that will be encountered if a popular potential biocide -- chlorine-based disinfectants -- were used for ballast water treatment.

There are many regulations on the use of chlorine, sodium hypochlorite and chloramines to cleanse drinking water. Chlorine-based disinfectants effectively kill many microorganisms. They also have a strong tendency to react with organic material, creating trihalomethanes (THMs). THMs are cancer-causing and the U.S. EPA regulated THM exposure to a maximum concentration of 100 parts per billion in drinking water. They also set zero as the maximum contaminant level goal for some individual THMs, which is the level of exposure where there are no known or expected health risks.

In addition to readily reacting with organic material to form THMs, chlorine also has an even stronger propensity to react with metals. This means that chlorine products have the potential to corrode ballast tanks and discharged chlorine-treated ballast water can contain residuals that kill fish. Fish obtain oxygen directly out of the water, by binding oxygen to iron in their bloodstream. Even small amounts of chlorine residuals can bind to this iron and starve the fish of oxygen, effectively suffocating the fish. If ballast water were to be treated with chlorine-based disinfectants, regulations would likely require treated ballast water to contain extremely low concentrations of residual chlorine in the discharge water in order to protect fish – levels possibly comparable to human drinking water standards.

Not only are there regulations for the application of chlorine-based disinfectants, progressive policies around the world are stressing the need to move away from the restricted cost-benefit use of chemicals towards nonchemical alternatives and pollution prevention. To that effect, the United States Congress adopted a pollution prevention policy, U.S. Code, Title 42, Chapter 133, which states:

> *The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.*

In addition to the constraints of federal policy and regulations to control toxic exposure, there are social factors constraining the use of chlorine-based disinfectants as ballast water biocides. Communities throughout the basin recognize that there is a lack of information on the impacts from the prevalent use of chemicals in the workplace and environment, and that in the face of ignorance precaution is warranted.

Many examples exist that illustrate community-level efforts to prevent chemical pollution from entering the Great Lakes basin's fresh water supply. The Toronto Environmental Alliance is an active proponent of pollution prevention and has worked with the city of Toronto to adopt chlorine-free purchasing policies. They also encouraged Toronto to incorporate chlorine-free disinfection alternatives, such as ultraviolet radiation, in their water treatment facility upgrade plans. Canadian Auto Workers, Local 200, in Windsor, Ontario, was instrumental in getting the city of Windsor's water treatment plant to significantly reduce the amount of chlorine used by incorporating ozone treatment into its facility. Groups such as these would likely raise concerns with the additional release of chlorine-based disinfectants into the basin's waters.

In dealing with an environmental problem with catastrophic and irreversible impacts like ANS, the problem must be examined by taking an ecosystem approach and critically examining whether cultural, social or economic practices are unsustainable and need to be modified. Only through this approach can all alternatives for solving such a critical environmental problem be identified. The Great Lakes are fortunate to have many viable options for ballast water management that are not available to the rest of North America due to the unique constricted access to the basin.

The problem of ANS must also be addressed in an environmentally sound manner, in such a way that does not contradict or undermine ongoing efforts to protect and restore the biological, chemical and physical integrity of the environment. The statement has been made at this symposium that there will be greater increases of funding allocated to ANS prevention when we bring forth an obstacle-free approach. As we work collectively in the Great Lakes region to address the ANS issue, the members of Great Lakes United, which I represent, strongly state that the use of biocides, their release, and the release of their byproducts, into the environment is an obstacle.

Despite the current limited approach, a very encouraging point is that viable nonchemical ballast water technologies are currently being field-tested. Many more stand-alone technologies are waiting for ballast water standards to be set before they are modified for shipboard application. In fact, nonchemical technologies are arguably on comparable timelines with chemical control experimentation. Unlike chemical controls, the efficacy of these nonchemical technologies can be improved without increasing risk to the environment, or compromising worker safety from exposure to chemicals or their by-products.

I challenge the Great Lakes Panel on ANS to take an ecosystem approach consistent with the concepts and practices of soundness and pollution prevention -- both biological and chemical. Addressing ANS invasions in this manner will lead to effective and sustainable technologies, and programs in this region that will be compatible with other countries developing ballast water management strategies. By adopting an approach based on the principles of environmental soundness and pollution prevention, the Great Lakes region will continue to be a global leader in the fight to prevent the spread of ANS.

VII. Recommendations for the Reauthorization of the National Invasive Species Act of 1996

Workshop participants were divided into five breakout sessions to identify gaps and unmet needs in NISA. The themes for the breakout sessions followed the framework of the symposium: institutional framework and implementation, research and monitoring, ballast water and standards, information and education, and nonballast prevention and control. Following the workshop, the suggestions made by each breakout group were formalized into recommendations. A complete list of recommendations was then distributed to members of the Great Lakes Panel on ANS and symposium participants for consideration. During the review process, several revisions suggested by Panel members were incorporated into the document, allowing the Panel to reach consensus on the recommendations for reauthorization. As presented below, these recommendations reflect the consensus of the Great Lakes Panel on ANS.

Institutional Framework/Implementation

- Enhance binational cooperation between the United States and Canada to account for the interjurisdictional/ecosystem challenges posed by the ANS problem in the Great Lakes-St. Lawrence region.

- Use the existing expertise, leadership and the institutional platform of the Great Lakes-St. Lawrence region to advance action on ANS prevention and control on a global level.

- Empower regional, state and local entities with the authority and resources needed to implement the legislative goals/mandates established under NISA.

- Specify particular agency oversight of ANS tasks and activities, and empower the agency with the ability to ensure that these tasks are carried out within a reasonable time frame.

- Incorporate measurable goals, objectives and feasible timetables into NISA that will strengthen the effectiveness of the legislation.

- Clarify and identify the roles of the federal agencies, individually and as represented on the ANS Task Force, in their work on ANS issues. As part of this process, determine how federal entities can work most effectively with regional and state entities.

- Incorporate language from Executive Order 13112 (issued by President Clinton, 1999) into NISA, so that federal agencies are required to take proactive steps to minimize ANS introduction or spread.

Research and Monitoring

- Elevate research and monitoring priorities authorized through NISA.

- Require reporting by all ships entering U.S. waters, including coastwise and foreign arrivals, regarding the source and status of their ballast.

- Modify the funding mechanisms to facilitate the conduct of research required to predict and confront an ANS invasion within a reasonable time frame (e.g. zero to 12 months).

- Provide funding to develop, test and implement rapid response containment and eradication measures.

- Transform ecological surveys required by NISA from a status report to a trend analysis, and use these surveys as part of a monitoring program to better gauge prevention/control success. Focus survey efforts on selected sites based on biogeographic regions where there is a high potential for nonindigenous species introductions.

- Develop a technology feasibility study center able to assess technologies prior to demonstration on actual ships.

- Establish a challenge grant funding process for research on priority interjurisdictional issues concerning ANS control and prevention.

Ballast Water and Standards

- Establish rigorous, but dynamic performance-based ballast water standards (e.g., 95 percent reduction of zooplankton, including resting stages) that can be measured and enforced on a national level.

- Provide industry with incentives to adopt technology/management practices necessary to meet standards.

- Articulate and work towards the long-term goal of zero ANS introductions from ballast water and sediment.

- Develop and implement ballast water exchange verification requirements that are as inclusive as possible, including NOBOB vessels.

- Develop and implement enhanced ballast management plans for vessels (e.g., regular flushing of tanks and exchange practices).

Information/Education/Outreach

- Increase incorporation of information/education (I/E) efforts into all aspects of NISA implementation, particularly voluntary guidelines and the ballast water technology demonstration program.

- Elevate wide-scale I/E programs supporting ANS prevention and control efforts by adding specific language to Section 1202 of NISA defining the role and objectives of I/E activities.

- Develop and implement specific methods for the evaluation of I/E efforts under NISA. Provide tools to allow for the adaptability of programs in areas identified as needing improvement.

- Clarify the role of I/E activities in targeting specific vectors contributing to ANS introduction and spread, including ballast water and other commercial and recreational transport mechanisms. Provide for program evaluation to assess if I/E activities are instigating change among target audiences, and provide tools for adaptability of program areas identified as needing improvement.

- Increase I/E efforts to state/tribal authorities on the importance and benefits of ANS state/interstate management plans to advance ANS prevention and control efforts.

- Designate a lead federal agency to coordinate I/E efforts on a national level.

Nonballast Prevention and Control

- Create a national rapid response protocol to serve as guidance for states and/or watersheds to use in mobilizing an emergency network equipped to contain new introductions. Authorize and appropriate funding to institutionalize/implement rapid response efforts when need arises.

- Provide for an enforcement mechanism to limit the overland sale and transport of known ANS.

- Identify and recognize the importance of commercial and recreational vectors, other than ballast water, (e.g. aquaculture, recreational boating, bait fish industry) and their role in providing pathways for ANS introductions and spread. Develop best management practices to target these vectors.

- Amend Section 1208 to include all injurious ANS species, not limited to zebra mussels, in the Lacey Act.

- Provide funding to states for ANS management plan development as well as implementation. Encourage the ANS Task Force, in cooperation with the regional panels, to take the lead in providing guidance to states developing plans. The state management plans should be in compliance with regulatory laws and compatible with approved environmental and species restoration plans.

- Authorize and appropriate funding for research focused on biological, chemical and physical control options for ANS that are environmentally sound while protecting non target species, especially those listed as threatened or endangered. This research effort should be based on interagency cooperation between U.S. EPA, USFWS, U.S. Army Corps of Engineers and other federal agencies.

- Expand the language in Section 1202(i)(1)(C) from "zebra mussel" demonstration project to "ANS" demonstration project. Also expand the language to include developing and implementing voluntary guidelines for controlling the spread of ANS through commercial and industrial activities.

- Accelerate the process to identify new injurious species, which will expedite the process of establishing and implementing species-specific control plans.

- Continue operation and upgrading of the electrical dispersal barrier in the Chicago Sanitary and Ship Canal as a demonstration project to prevent the further spread of ANS in the short term, while developing for implementation a long-term strategy to control and prevent the exchange of all organisms between the Great Lakes and the Mississippi River basins.

- Develop a feasibility report on measures that can be taken to protect the economic future and the biological integrity of the entire mid continent of North America by preventing the introduction and spread of aquatic invasive species.

General Recommendations

- Provide for a comprehensive review of existing legislation to update authorization levels and remove dormant provisions and outmoded language. In addition, remove specific species names from the legislation and replace them with the more general term "aquatic nuisance species."

- Appropriate the necessary funding to conduct research as delineated in NISA on the environmental and economic risks and impacts associated with the introduction of ANS into the waters of the United States.

- Define historic/intentional versus modern/unintentional ANS and clarify the policy implications in the use of these terms.

VII. Appendices

Appendix A: Acronyms

ANS	Aquatic Nuisance Species
CEO	Communication, Education and Outreach (a committee of the National ANS Task Force)
EEZ	Exclusive Economic Zone
EPA	U.S. Environmental Protection Agency
I/E	Information and Education
IMO	International Maritime Organization
NANPCA	National Aquatic Nuisance Prevention and Control Act of 1990
NBIC	National Ballast Information Clearinghouse
NISA	National Invasive Species Act of 1996
NISC	National Invasive Species Council
NOAA	National Oceanic and Atmospheric Administration
NOBOB	"No Ballast on Board"
NRC	National Research Council
SERC	Smithsonian Environmental Research Center
THMs	Trihalomethanes
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington State Department of Fish and Wildlife

Appendix B

Holiday Inn – North Campus
3600 Plymouth Road
Ann Arbor, Michigan
(734) 769-9800
May 16-17, 2001

Looking Forward, Looking Back:
Assessing Aquatic Nuisance Species Prevention and Control

Final Program

Wednesday, May 16, 2001

12:00 p.m.	**Meeting Registration**	
1:00 p.m.	**Welcome, Introductions**	**Nathaniel E. Robinson** Chair, Great Lakes Commission Wisconsin Technical College System Board **Ron Martin** Chair, Great Lakes Panel on Aquatic Nuisance Species Wisconsin Department of Natural Resources
1:15 p.m.	**Symposium Objectives**	**Dr. Michael J. Donahue** President/CEO, Great Lakes Commission **Katherine Glassner-Shwayder** Project Manager, Great Lakes Commission
1:30 p.m.	**Opening Keynote Address** "10 Years Under the National Invasive Species Act (NISA): What's Worked, What Hasn't, and Where Should We Go From Here?"	**Allegra Cangelosi** Senior Policy Analyst, Northeast-Midwest Institute
2:00 p.m.	**Assessment of NISA Implementation**	**Ron Martin** **Gary Isbell,** Executive Administrator, Fish Mgmt. and Research, Ohio Dept. of Natural Resources
2:30 p.m.	**Break**	
2:45 p.m.	**NISA Elements and Implementation**	
	1. Institutional Framework/ Implementation	**Sharon Gross**, Executive Secretary, ANS Task Force, U.S. Fish and Wildlife Service
	2. *Research and Monitoring*	**Dr. David Reid** Senior Physical Scientist, NOAA, Great Lakes Environmental Research Laboratory
3:45 p.m.	**NISA Elements and Implementation (continued)**	
	3. Ballast Water and Standards	**Dr. Richard Everett**, Research Coodinator, ANS Program, U.S. Coast Guard
	4. Information and Education	**Joe Starinchak**, Outreach Coordinator, ANS Task Force, U.S. Fish and Wildlife Service
	5. Non-Ballast Prevention and Control	**Pam Thiel**, Project Leader, Wisconsin Fishery Resource Office, U.S. Fish and Wildlife Service
5:00 p.m.	**Adjourn for the Day**	**Reception hosted by the Great Lakes Commission, 5 - 7 p.m.**

This workshop is sponsored by the Great Lakes Commission, in cooperation with the Great Lakes Panel on Aquatic Nuisance Species. Funding is provided by the U.S. EPA Great Lakes National Program Office.

THURSDAY, MAY 17, 2001

8:30 a.m.	**Welcome/ Day 2 Objectives**	**Dr. Phil Moy** Chair, Research Committee, Great Lakes Panel on Aquatic Nuisance Species University of Wisconsin Sea Grant
8:40 a.m.	**The Emerging Management Challenge: Ballast Water and NOBOBs**	**Captain Phil Jenkins** President, Philip T. Jenkins & Associates Ltd.
9:00 a.m.	**Ballast Water and NOBOBS - Panel Session I: Research Initiatives and Future Directions**	**Moderator:** **Marc Tuchman**, Environmental Scientist, U.S. EPA, Great Lakes National Program Office **David Reid** **Dr. Greg Ruiz**, Estuarine Ecologist, Smithsonian Environmental Research Center
10:30 a.m.	**Break**	
10:45 a.m.	**Ballast Water and NOBOBs - Panel Session II: Management Options and Unmet Needs**	**Moderator:** **Marc Tuchman** **Georges Robichon,** Senior Vice President, FEDNAV Limited **George Ryan,** President, Lake Carriers' Association **Scott Smith,** Washington Department of Fish and Wildlife **Jennifer Nalbone**, Habitat and Biodiversity Coordinator, Great Lakes United
12:15 p.m.	**Lunch: "One State's Perspective: A Ballast/NOBOB Management Strategy for the Great Lakes"**	**Tracy Mehan**, Director, Office of the Great Lakes, Michigan Dept. of Environmental Quality
1:30 p.m.	**Charge to break out groups**	**Michael J. Donahue**
1:45 p.m.	**Break Out Sessions**	
	Institutional Framework/ Implementation	**Facilitator: Michael J. Donahue Resource Person: Sharon Gross**
	Research and Monitoring	**Facilitator: Dr. Don Schloesser Resource Person: David Reid**
	Ballast Water and Standards	**Facilitator: Phil Moy Resource Person: Richard Everett**
	Information and Education	**Facilitator: Doug Jensen Resource Person: Katherine Glassner-Shwayder**
	Non-Ballast Prevention and Control	**Facilitator: Jay Rendall Resource Person: Pam Thiel**
3:45 p.m.	**Break**	
4:00 p.m.	**Reports from break out sessions**	
5:00 p.m.	**Concluding remarks, next steps**	**Michael J. Donahue** **Ron Martin**