

Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species



Chesapeake Bay Program

Chesapeake Bay Program

Publication

Chesapeake Bay Policy for the Introduction of Non-indigenous Aquatic Species

Published: December 01, 1993

This policy document considers only first time introductions of non-indigenous, non-naturalized aquatic species. Organisms, including marsh-dwellers, that live on land or in the soil are not included in the scope of this policy.

Originator: Chesapeake Bay Program

CBP Number: CBP/TRS 112/94

Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species



December 1993

ADOPTION STATEMENT

We, the undersigned, adopt the following policy statement regarding the Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species:

"It shall be the policy of the Jurisdictions in the Chesapeake Bay basin to oppose the first-time introduction of any non-indigenous aquatic species into the unconfined waters of the Chesapeake Bay and its tributaries for any reason unless environmental and economic evaluations are conducted and reviewed in order to ensure that risks associated with the first-time introduction are acceptably low. The signatories to the Adoption Statement are committed to sharing information and to carefully assessing through a joint review process all proposed first-time introductions of non-indigenous aquatic species in the Chesapeake Bay basin. The signatories to the Adoption Statement are also committed to working together to prevent unintentional introductions of non-indigenous aquatic species and to minimize the negative effects of undesired aquatic species within the Chesapeake Bay ecosystem."

We accept the Policy Statement as a guide to controlling first-time introductions of non-indigenous aquatic species, both intentional and unintentional, and to monitoring the aquatic habitats affected by the introductions, to protect the ecological integrity of the Chesapeake Bay, its tributaries and other surface waters in the Bay basin.

We recognize the need to commit long-term, stable financial support and human resources to the tasks associated with protecting the indigenous and naturalized aquatic species and their habitats in the Chesapeake region.

Date December 1993

For the Commonwealth of Virginia

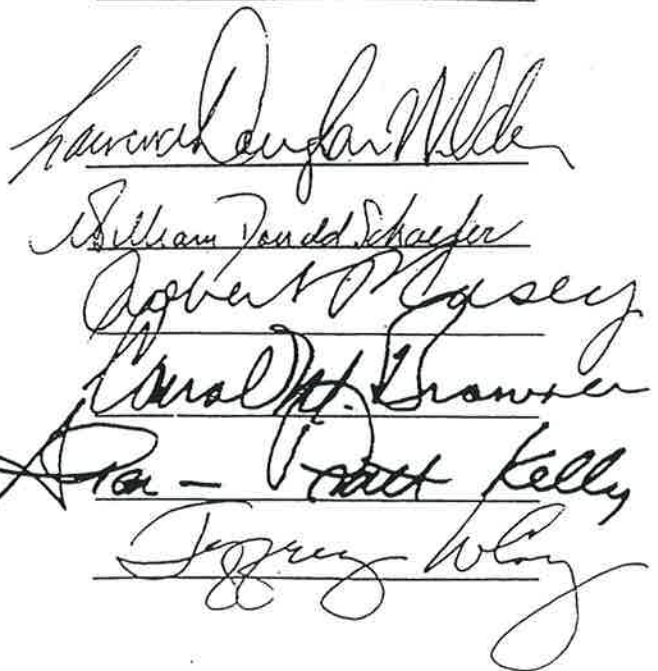
For the State of Maryland

For the Commonwealth of Pennsylvania

For the United States of America

For the District of Columbia

For the Chesapeake Bay Commission


The block contains five handwritten signatures, each written over a horizontal line. From top to bottom, the signatures are: 1. A cursive signature that appears to be 'Harold Edgar Miller'. 2. A cursive signature that appears to be 'William Donald Schaefer'. 3. A cursive signature that appears to be 'Robert P. Casey'. 4. A cursive signature that appears to be 'Carol M. Browner'. 5. A cursive signature that appears to be 'Pat Kelly'.

MQ
1.6.1
+
1.6.2

TABLE OF CONTENTS

Introduction.....	1
Definitions.....	1
Need for a Basin-Wide Policy.....	2
Scope of the Policy.....	3
Policy on Intentional First-Time Introductions.....	4
Review Process.....	4
Policy on Unintentional Introductions.....	8
Education and Information.....	8
Ballast Water.....	8
Monitoring.....	9
Control Methods.....	10
Appendix A.....	13
Appendix B.....	21
References.....	29

INTRODUCTION

DEFINITIONS

Aquatic Species

Aquatic organisms such as fish, shellfish, and aquatic plants. Birds, mammals and other organisms, including marsh-dwellers, that live in soil or otherwise on land are not considered to be aquatic species.

Historic Range

Geographic area inhabited by a species at the time of European Colonization of North America.

Indigenous Species

A species which evolved on the North American continent, was present at the time of European Colonization, and is resident within the Chesapeake Bay basin without human manipulation.

Non-indigenous Species

For the purpose of this document, any aquatic species, as defined herein, that enters a watershed, as defined herein, beyond that species' historic range.

Hatchery-produced hybrids and genetically engineered organisms are also defined as non-indigenous species, even if the parent species or source organisms are indigenous or naturalized.

Naturalized Species

A non-indigenous species, as defined herein, which has been introduced into the Chesapeake Bay or into a tributary watershed (as defined by the Chesapeake Bay Nutrient Strategy) and has established a self-sustaining population that has persisted for at least ten years.

Non-Indigenous, Non-Naturalized Species

Species not native to any of the Chesapeake Bay basin watersheds which have not established self-sustaining populations there. Some of the species in this group have never been introduced, while others may require continued introduction as part of stocking programs or appear incidentally having escaped from aquaria, private or public aquaculture, or research facilities.

Watershed

The area of drainage which feeds a river, or the bay. These areas, as originally mapped by the Chesapeake Bay Program for the Nutrient Reduction Strategy (see Figure 1), have ecosystem importance to aquatic species and are thus used in this policy.

Unconfined Waters

Any waters which could potentially flow directly into the Chesapeake Bay or have more than a minimal potential for escapement into the Bay watershed. This does not include confined (recirculation) units.

Pathogen

Any viable biological agent capable of producing disease.

Introductions

An introduction occurs when a non-indigenous, non-naturalized species is caused to enter a geographic area beyond its historic range or its present naturalized range. Introductions should not be confused with natural migrations or range extensions, or other changes in distribution not directly influenced by human activities.

First-time Introductions

Introductions of non-indigenous species which occur after the time this policy is

adopted by the signatory jurisdictions. An introduction may be considered "first time" if 1) the species is not indigenous or naturalized, or 2) the jurisdiction has not previously promulgated rules, regulations or otherwise issued a permit allowing the introduction of that aquatic species into an unconfined system, excluding permits issued for the purpose of research. The existence of a permit or approval for the purpose of research will not eliminate the need for the review process outlined in this policy for intentional introductions in a watershed (as defined by the Nutrient Reduction Strategy), for a purpose or in a manner not previously approved. First-time introductions specifically exclude non-indigenous, non-naturalized species which are part of ongoing stocking programs but which have not established self-sustaining populations and species previously approved for introduction (e.g. rainbow trout). First-time introduction includes allowing a species to be stocked or cultured in a manner not previously approved within a jurisdiction - e.g., while tilapia may be approved for confined system production, culture of tilapia in outdoor raceways would be considered a new introduction.

NEED FOR A BASIN-WIDE POLICY

The introduction of non-indigenous species into an ecosystem has been known to create problems for existing species in that ecosystem. Further, in jurisdictions that share an ecosystem, the decision of one jurisdiction to permit the introduction of a species can affect the ecosystem shared with the other jurisdictions. The states of Maryland, Pennsylvania and Virginia, and the District of Columbia, which share the Chesapeake Bay basin and are signatories to the 1987 Chesapeake Bay Agreement, seek to institute a process by which they can

cooperate with one another in making decisions regarding the introduction of non-indigenous species. The goals for such a process are that it would:

(a) provide objective technical reviews of proposed non-indigenous species introductions to identify potential nuisance species,

(b) provide the permitting decision-makers with the best available information and assessment regarding a non-indigenous species' potential for becoming a nuisance in the ecosystem or to human activities,

(c) create a mechanism for sharing information among all Bay jurisdictions, including Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia and West Virginia, regarding species being considered by other Bay jurisdictions, and

(d) not unduly lengthen or burden the existing permitting processes within the signatory jurisdictions.

Therefore a regional policy on non-indigenous species that is embraced by all Bay basin jurisdictions is preferable to an array of individual jurisdictional policies or regulatory philosophies that may vary significantly. Existing policies, including federal, regional and state ones, are briefly summarized in Appendix A.

Formulation and adoption of a regional strategy and suggested protocol for dealing with non-indigenous species should be the major review and control components of a new policy established by jurisdictional and federal agencies in the Chesapeake Bay watershed. This policy is based on the real

concern that introduced species may carry a lasting and adverse legacy if they become established as reproducing populations, expand their ranges, and affect native species.

This policy is cautious with intentional introductions and proactive with the threats of unintentional introductions.

Concern over the environmental and ecological consequences of non-indigenous species was heightened by the disruption caused by zebra mussels and resulted in passage of the federal Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990 which mandates development and implementation of a comprehensive program of prevention and remediation of problems resulting from non-indigenous introductions. Information on current control programs for zebra mussel in the Chesapeake watershed are contained in Appendix B.

The Living Resources Subcommittee (LRSC) of the Chesapeake Bay Program was charged by the Implementation Committee with developing a policy to provide guidance to the Chesapeake Bay Agreement signatories on the intentional (e.g., rainbow trout) and unintentional (e.g., zebra mussel) introduction of non-indigenous aquatic species in the Chesapeake basin.

In early 1992, the Living Resources Subcommittee of the Chesapeake Bay Program established the Exotic Species Workgroup. The mission of this workgroup is to coordinate regional information and develop a strategy for dealing with the introduction of non-indigenous aquatic species into the Chesapeake Bay basin. A major goal of the Exotic Species Workgroup

is to assist the signatories to the 1987 Chesapeake Bay Agreement and other Bay basin jurisdictions in identifying activities that promote the prudent control of non-indigenous aquatic species introductions. This goal is consistent with the goal of the 1987 Chesapeake Bay Agreement: "provide for the restoration and protection of the living resources, their habitats and ecological relationships," and the letter from the Chesapeake Bay Commission to the resource management agencies of the signatory jurisdictions in 1992 which stated that management of non-native species anywhere within the Chesapeake Bay watershed should be pursued on a regional rather than a state-by-state or species-by-species basis. The complete policy statement of the Chesapeake Bay Commission can be found in Appendix A.

SCOPE OF THE POLICY

This policy document considers only first time introductions of non-indigenous, non-naturalized aquatic species. Birds, mammals and other organisms, including marsh-dwellers, that live on land or in the soil are not included in the scope of this policy.

I. POLICY ON INTENTIONAL FIRST-TIME INTRODUCTIONS

This policy is intended to be consistent with the federal Non-Indigenous Aquatic Nuisance Prevention and Control Act of 1990. Intentional introductions are made for the purposes of aquaculture, recreational fishing, biological controls, and research. Background information on these pathways of introduction can be found in Appendix B.

To provide guidance to the signatory jurisdictions in how certain objectives might best be reached, the Exotic Species Workgroup will develop an Implementation Plan to this policy which will contain an overview of existing jurisdictional approaches and a schedule for the development of suggested protocols. The Implementation Plan will be prepared and submitted for review by the Exotic Species Workgroup to the Living Resources Subcommittee of the Chesapeake Bay Program by September 30, 1994.

Aquatic species have extensive histories of being translocated from one ecosystem to another for a variety of purposes. Those species which have colonized successfully in the new ecosystem have proven both beneficial and detrimental to the social and economic sectors of our society and to that ecosystem. Undesirable introduced species have been a major factor in the loss of biological integrity. With some introductions come the concomitant introduction of parasites, pests, predators, and other biological entities which have forever changed the local environments in which they were introduced.

It is therefore the purpose of this policy to reduce the risk of adverse consequences to

the environment and the associated biota in a manner consistent with the federal act and to do so in a spirit of cooperation for the benefit of all.

REVIEW PROCESS:

To reduce the risks associated with introducing undesirable non-indigenous organisms, particularly those which have the potential to harm the environment or become a nuisance, the signatory jurisdictions will implement the following procedure for making decisions about the intentional first-time introduction of non-indigenous, non-naturalized aquatic species:

- Proposals for all intentional first-time introductions of non-indigenous, non-naturalized aquatic species into the unconfined waters of the Chesapeake Bay watershed must be submitted for review and approval by the appropriate agency of the jurisdiction prior to the introduction taking place. The process for review and approval is outlined under "Actions."
- All species currently approved for aquaculture or stocking and the conditions under which each may be cultured or stocked at the present time in each jurisdiction will be considered as approved under this policy for that jurisdiction.

ACTIONS

- To the degree possible, each jurisdiction will provide a list of aquatic species which they know to be indigenous or naturalized to the Chesapeake Bay watershed in accordance with the definitions provided herein so that a master list may be developed. A copy of

this list shall be supplied to the Living Resources Subcommittee.

- Each jurisdiction shall compile a list of species currently approved for culture or stocking/maintenance stocking within its jurisdiction and the conditions and methods by which such species is allowed to be cultured or stocked. A copy of this list shall be supplied to the Living Resources Subcommittee.
- All proposals for a first-time intentional introduction shall be made to the appropriate jurisdictional agency.

1) The agency will review a request for an intentional introduction, evaluating the relative risks and benefits of the first-time introduction.

As part of the review process for a first-time introduction, there will be an evaluation to determine whether monitoring the surrounding habitats for occurrence of the species to be introduced may be necessary, and, if so, what means might be appropriate.

At a minimum, evaluations should include analyses of:

- (i) the purpose and usage of the proposed introduction;
- (ii) long-term potential effects on native species and ecosystems;
- (iii) alternatives to the proposed action including the potential for using indigenous or naturalized species;
- (iv) proposed culture or stocking method for introduction if approved;
- (v) means of monitoring, if necessary;
- (vi) review of information on known pathogens of proposed introduction and its source; and

(vii) economic consideration.

2) Where the introduction involves non-indigenous, non-naturalized species, and the submittal is adequate to be considered for future agency action, the jurisdiction will notify the Living Resources Subcommittee, sending copies of the application and supporting documentation from the agency's review process. The Living Resources Subcommittee will then coordinate an independent review and evaluation of the proposed intentional introduction.

a) Reviews should include appropriate environmental and economic evaluation.

b) Jurisdictions will notify the Living Resources Subcommittee of first-time introductions into jurisdictionally-approved closed systems in the Chesapeake Bay watershed in accordance with procedures to be established in the Implementation Plan. This notification does not require review by an ad hoc panel, but it will include a description of the closed system involved.

c) The Living Resources Subcommittee will work to share information regarding system types and to develop guidelines with respect thereto.

3) An ad hoc panel shall be formed by the Living Resources Subcommittee upon receipt of copies of the permit application and supporting documentation from the jurisdictional agency.

Each such panel shall be comprised of one representative each from Virginia, Maryland, the District of Columbia, and Pennsylvania, named by those jurisdictions, whose backgrounds shall be of a technical or

scientific nature appropriate to review the species in question. The Living Resources Subcommittee, after consultation with STAC (the Scientific and Technical Advisory Committee) shall invite at least two other scientists or technicians having expertise on the species in question or with similar species to serve on each such panel. An economist or other specialist may also be required. The goal here is to enhance information available to the permitting agencies. The ad hoc panels should be kept as small as possible so that they remain workable.

4) Each ad hoc panel shall complete its review of a proposed introduction within 45 to 60 days from the date that the Living Resources Subcommittee receives copies of the permit application and supporting documentation. In cases in which review is required in shorter periods of time, the ad hoc panel will do its best to comply with the compressed deadline.

The signatory jurisdictions are committed to reviewing their permitting processes to determine whether their processes are compatible with the ad hoc panel review procedure.

5) Each ad hoc panel shall provide advice to the jurisdiction permitting authority regarding the potential of the species in question to harm the ecosystem or to become a nuisance to human activities, in accordance with the following:

a) It is recognized that the task of the ad hoc panel is advisory. The authority of issuing a permit lies within each Bay jurisdiction.

b) The majority opinion and the dissenting opinion (if any) will both be given.

c) The Living Resources Subcommittee will use the information obtained from the various ad hoc panels to provide an information exchange network including: species specific protocols, notification of escapes, unexpected dispersals, or illegal introductions that may affect other member jurisdictions.

6) After receiving the advice of the ad hoc panel, the jurisdictional permitting authority will decide to approve or decline the proposed introduction.

7) The jurisdiction will give notification of that decision to the Living Resources Subcommittee.

8) An agency may petition another agency to modify or reverse its position regarding the permitting of future introductions if:

a) additional information becomes available to demonstrate substantial harmful consequences to the ecosystem; or

b) the scopes or conditions of future introductions substantially expand upon those approved previously by rules, regulations or permits and increase substantially the risk of harm to the ecosystem.

When the decision has been in favor of any intentional first-time introduction, the Subcommittee will circulate this information to all jurisdictions in the Bay basin.

If a decision is made by the permitting agency in favor of the introduction **contrary to the majority opinion of the panel**, the jurisdiction will 1) provide a written document to the Living Resources Subcommittee, explaining the reasons for that decision, particularly in relation to potential threats to adjoining jurisdictions, and 2) defer implementation for a 3 week period to allow other Bay jurisdictions the opportunity to notify affected parties in their own jurisdictions of the decision.

If an agency acts to permit an introduction against the views of another agency or the ad hoc panel, adoption of this policy does not imply the concurrence of the other agency or the ad hoc panel.

- Each jurisdiction will develop or establish lists of pathogens: one list for those to be avoided, and one list for which little concern is felt.

For the pathogens on both lists, appropriate screening methods using pre-existing guidelines, such as the American Fisheries Bluebook, will be established. Each jurisdiction will identify the responsible agency for developing the lists of pathogens and identify the screening method to be used. The lists of pathogens will be modified, or updated, at the jurisdiction's discretion.

- Recognizing the diversity of viewpoint for specific intentional introductions, e.g. research, ornamentals and aquaculture, efforts will be made to develop collaborative programs such as the "Critical Issue Forum" Special Symposium with different governmental agencies and user groups.

APPENDIX A

SUMMARY OF EXISTING REGULATIONS GOVERNING THE INTRODUCTION OF NON-INDIGENOUS SPECIES IN THE CHESAPEAKE BAY BASIN

The Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species is intended to be consistent with the federal Non-Indigenous Aquatic Nuisance Prevention and Control Act of 1990. Many of the definitions are taken from the federal documents.

Federal Policy

The Non-Indigenous Aquatic Nuisance Prevention and Control Act of 1990 established an Aquatic Nuisance Species Task Force with the responsibility to prevent introduction and dispersal of aquatic nuisance species, to monitor, control and study such species, and to disseminate related information.

This act also provides an intergovernmental mechanism for the development of a cooperative national program to reduce the risks of or prevent the unintentional introduction and dispersal of non-indigenous aquatic species that may be nuisances; ensure prompt detection of the presence of and monitor changes in the distribution of non-indigenous aquatic species; and control established aquatic nuisance species in a cost-effective, environmentally sound manner.

Regional Policy

The only regional policy for non-indigenous species that has been developed in the Chesapeake Bay basin was issued by the Chesapeake Bay Commission.

- On May 8, 1992, the Chesapeake Bay Commission unanimously adopted the following policy statement:

It is the policy of the Chesapeake Bay Commission to oppose the introduction of non-native species into the Chesapeake Bay watershed for any reason unless comprehensive environmental and economic impact studies are conducted and thoroughly evaluated in order to ensure that risks associated with the introduction are minimized. Proposals for the introduction of non-native species should be subjected to an extensive review process that provides for ample peer review by the Exotic Species Workgroup and others prior to the final decision-making process.

- In a May 20, 1992 letter sent to the resource management agencies in Pennsylvania, Maryland, the District of Columbia and Virginia, the Chesapeake Bay Commission stated that the management of non-native species anywhere within the Chesapeake Bay watershed should be pursued on a regional rather than a state-by-state or species-by-species basis and urged each state agency to "weigh the position of the Chesapeake Bay Commission in any pertinent policy decision or action."

State Policies

Individual Bay basin jurisdictions have regulations pertaining to the introduction of non-indigenous or non-native species.

SIGNATORY STATES

District of Columbia

The District of Columbia has rules that establish guidelines for the management of fisheries and wildlife resources. These guidelines and procedures provide for implementation of the Water Pollution Act of 1984, which mandates protection of aquatic animals and plants and the restoration and preservation of aquatic life in the District's waters for aesthetic enjoyment, recreation and industry. The purpose of these rules is to ensure that the District's fisheries and wildlife resources are properly managed and protected.

With regard to the introduction of non-indigenous species, the guidelines are simple and clear.

Section 1503.1, Prohibited Activities:

It shall be unlawful to do any of the following:

- a) Introduce any species of fish or other aquatic organism not indigenous to the District of Columbia into the waters of the District of Columbia.

Maryland

In Maryland, the Tidewater and Fish, Heritage and Wildlife Administrations of the Department of Natural Resources (DNR) regulate the introduction of non-indigenous aquatic species (Code of Maryland Regulations). With regard to one non-indigenous mollusk species, the zebra mussel (*Dreissena polymorpha*), a section of the regulations pertaining to shellfish, (COMAR 08.02.08.02) states: "Except as permitted by the Secretary of Natural Resources, a person may not import into the state or possess any living life stage or reproductive products of mussels of the genus *Dreissena*." For other species of shellfish taken from waters outside the waters of the state, a person may not import or possess any of these species within Maryland, unless they first obtain a permit from DNR. This section of the regulation goes on to say that "the Department shall issue a permit if presented with proof satisfactory to the Department that the shellfish will not be harmful to Maryland shellfish." For these regulations, the term shellfish includes live oysters, seed oysters, oyster shells, live hard-shell clams, live soft-shell clams, and clam shells.

In COMAR 08.02.11.05K, the term "indigenous fish species" is defined by Maryland as "any fish species that naturally occurs in, or has been artificially introduced into, the waters of the state, and has established self-sustaining populations for at least ten years." To protect fish populations in the non-tidal waters of the state, a person may not introduce into the non-tidal waters, or import or possess for introduction, any live fish not indigenous to the non-tidal waters of the state without first obtaining a permit. A permit will not be granted until satisfactory proof is provided by the applicant that the specific fish intended to be imported will be free of any

communicable disease at the time of importation and will not be harmful to the native flora and fauna in the non-tidal waters.

The provisions of the Maryland regulations in COMAR 08.02.11.05K that deal with importation and possession do not apply to fish for use in laboratories and exhibitions, or for use as pets. Any fish not indigenous to the waters of the State shall be held only in aquaria and other indoor facilities from which escape into the waters of the state is impossible. Hence, except for the specific provision directed at zebra mussels, Maryland does not prohibit nor is a permit required for the importation of non-indigenous species for research purposes, provided the species are confined indoors and cannot escape into state waters.

Maryland also has regulations (COMAR 08.02.14) pertaining to non-native fish and aquatic plant species related to aquaculture. The stated purpose of these regulations is "to encourage the orderly development of an aquaculture industry in Maryland, while ensuring that aquaculture operations do not adversely impact upon the state's wild stocks of fish." In this section of the regulations, the phrase "non-native" species means "a species of fish that is not native or naturalized...". A native species means "any species of fish which historically has lived, grown, and reproduced in Maryland's waters." A naturalized species means "any species of fish which, though not indigenous to Maryland, has acclimated, or adapted to life in Maryland's waters so that the species has been documented as having lived, grown, and reproduced in Maryland for more than ten years."

Any person who wishes to engage in aquaculture in Maryland (the commercial rearing of fish or aquatic plant species listed in COMAR 08.02.12.07) must first obtain a permit from DNR. A permit will not be issued if the proposed aquaculture activity will adversely affect wild stocks of fish; result in the release of non-native species into Maryland waters, except in confined water such as ponds where there are safeguards to prevent escape; or result in the contamination of native or naturalized species of fish or their ecosystem. A facility that is permitted to culture non-native and hybrid finfish in non-tidal waters may not discharge its effluent directly or indirectly into Maryland without approved treatment. Maryland also requires that imported hybrid or non-native finfish shall be certified by an authority acceptable to DNR to be free of known, infectious disease that have the potential to contaminate native or naturalized fish or aquatic plants.

Anyone wishing further information on Maryland regulations is referred to the Code of Maryland: Title 08, Subtitle 02, Chapters 08, 11 and 14; and the Natural Resources Articles, Sections 4 and 10, Annotated Code of Maryland.

Pennsylvania

Pennsylvania Department of Agriculture: Under Act 66 of 1993, the Pennsylvania Department of Agriculture has the authority to regulate the health of all domestic animals, including those wild or semi-wild animals held in captivity. The Commonwealth interprets "animal" to include all fish, invertebrates, and other members of the taxonomic Animal Kingdom. The Department of Agriculture is seeking a consolidation of all Pennsylvania animal health statutes into a new

"Domestic Animal Act." Once this legislation is enacted, the Department will work with the Pennsylvania Fish and Boat Commission to draft and promulgate any necessary fish health regulations.

Pennsylvania Fish and Boat Commission: The Pennsylvania Fish and Boat Code of 1980 (Act 1980-175, Title 30, Pennsylvania Consolidated Statutes, 30 Pa.C.S. §§ *et seq.*) provides authority for the Pennsylvania Fish and Boat Commission to promulgate general and specific regulations about fish and fishing in Pennsylvania. The following provisions apply:

30 Pa. C.S. § 102 defines shows "fish," when used as a noun, to include all game fish, fish bait, bait fish, amphibians, reptiles and aquatic organisms.

30 Pa. C.S. § 2102(a) authorizes the Fish and Boat Commission to make such general and special regulations as it deems necessary and appropriate concerning fish and fishing in the waters of Pennsylvania, the protection, preservation and management of fish and related matters.

30 Pa. C.S. § 2102(c) authorizes the Commission to make regulations concerning the transportation or introduction of, or importation into or within this Commonwealth or exporting of fish, the selling, offering for sale or purchase of fish or the disturbing of fish in their natural habitat.

30 Pa. C.S. § 2904 authorizes the Executive Director, with the approval of the Commission, to require permits for the taking, catching, killing, possession, introduction, removal, importing, transporting, exporting or disturbing any fish in Pennsylvania waters. The Commission may set fees for the permits and make rules and regulations concerning the issuance and provisions of the permits.

30 Pa. C.S. Chapter 33 contains requirements for artificial propagation licenses and provides that no person may artificially propagate any fish in Pennsylvania without a license issued by the Fish and Boat Commission (30 Pa. C.S. § 3312). In addition, this chapter requires licenses or permits for live fish dealers and for transportation of live fish in Pennsylvania.

Title 58. Pennsylvania Code contains regulations promulgated by the Pennsylvania Fish and Boat Commission.

Chapter 71, "INTRODUCTION OF FISH INTO COMMONWEALTH WATERS" subsection 71.3 (b), provides for the issuing of limited propagation license subject to additional restrictions. These are used to permit non-indigenous fish species to closed system aquaculture.

Chapter 73, "TRANSPORTATION OF LIVE FISH INTO THE COMMONWEALTH" subsection 73.1 (a) states "No species of fish may be transported into this Commonwealth from another state, province, or country and liberated in any watershed of the

Commonwealth without previous written permission for the Fish and Boat Commission. Nor may any species of fish be transferred from any water within the Commonwealth into any other drainage of the Commonwealth where this particular species is not always present without prior written consent from the Fish and Boat Commission. Inspection for species composition or presence of disease, or both, will be required at the discretion of the Fish and Boat Commission on all lots of fish transported into the Commonwealth."

References to grass carp in Chapters 71 and 73 have been changed by Fish and Boat Commission action which provided for the issuing of permits for the use of triploid grass carp in Pennsylvania beginning January 1, 1994.

Virginia

In Virginia, regulations pertaining to non-indigenous species are administered by the Department of Game and Inland Fisheries (freshwater species) and under the Virginia Marine Resources Commission (saltwater species). Under regulation VR325-01-2 (Virginia Department of Game and Inland Fisheries), Section 4, it is unlawful to import, cause to be imported, buy, sell or offer for sale or liberate within the state several species unless a permit is obtained. These species are: rudd (genus *Scardinius*), tilapia (any of the genera *Sarotherodon* and *Oreochromis*), piranha (any of the genera *Serrasalmus*, *Rooseveltiella*, *Pygocentrus*, or *Tadyyella*), walking catfish (genus *Clarias*), grass carp (genus *Ctenopharynogodon*), African clawed frog (*Xenopus* spp.), and zebra mussel (*Dreissena polymorpha*). It is also unlawful in Virginia to stock any species of fish into any public inland waters without first obtaining a permit from the Department of Game and Inland Fisheries. Under regulation 28.2-825 (Virginia Marine Resources Commission), it is unlawful to import any fish, shellfish or crustacea with the intent of placing such organisms into the waters of the Commonwealth unless the organism is coming from an approved list of states and waters, and unless it is on an approved species list. If the species or source is not on the approved lists, the person desiring to import may notify the Commissioner of Marine Resources and receive written permission.

Anyone wishing further information on Virginia regulations is referred to the Virginia Department of Game and Inland Fisheries regulation VR325-01-2, and the Virginia Marine Resources Commission regulation 28.2-825.

NON-SIGNATORY STATES

New York

In New York, importation and stocking of triploid (sterile) grass carp became legal for the purpose of pond vegetation control in 1990. Requirements for the pond into which the triploid grass carp were to be introduced were very strict: 5 acres or less in size, having no inlets or outlets to or from other waters, lying wholly within the boundaries of lands privately owned or leased by the individual authorizing the treatment, harboring no species of wildlife, fish,

shellfish, crustacea or plants of special concern, threatened or endangered, not contiguous to a New York State regulated freshwater wetland. Effective March 12, 1993, New York is allowing the stocking of triploid grass carp in ponds with inlets or outlets to other waters, provided that the ponds are not impoundments or natural ponds on a permanent stream or a source of a permanent stream as designated by the most recent U.S. Geological Survey or New York State Department of Transportation quadrangle covering the permit application site.

In May, 1991, New York added section 11-0507-4 to the environmental conservation law. It now reads: No person shall intentionally liberate zebra mussels (*Dreissena polymorpha*) into any waters of the state. No person shall buy, sell, or offer to buy or sell, or intentionally possess or transport zebra mussels except under a license or permit. Zebra mussels, except those lawfully held pursuant to a license or permit, may be destroyed by any person at any time.

The regulations about wildlife and fish require permits for placing fish or fish eggs in the waters of the state, or for willfully liberating wildlife. Permits are also required to possess, transport, import or export species of live native or non-native wildlife or fish where such actions would present a danger to the health or welfare of people in the state, and individual or indigenous fish or wildlife populations. Licenses are required to collect, possess or sell fish, wildlife, shellfish, crustacea and aquatic insects, and the Department has the power to make regulations to protect the animals from cruelty, disease or undue discomfort and to protect the public from attack or contamination. Fish or shellfish which hinder the propagation of food fish or shellfish may be removed by the state, or by an individual permitted by the state, in any manner the state may prescribe from public or private waters.

Anyone wishing further information on New York regulations is referred to the environmental conservation law 11-0507, 11-0511, 11-0515, and 11-0517, and the 1991 amendment regarding zebra mussels. Also see the New York State Department of Environmental Conservation, Division of Fish and Wildlife Policy on triploid grass carp use (revised 3/12/93).

Delaware

In Delaware, triploid grass carp became a legal method of aquatic weed control beginning January 1, 1990. Permits are issued to private pond owners meeting a set of criteria, including escape prevention, demonstrated need for aquatic plant control, the aquatic plants in question are known targets of the grass carp, the carp must be triploid and stocked at a controlled rate, the state must have access to the pond for evaluation, the pond must not contain rare, threatened or endangered plants or animals, and must not be in any designated natural area or a freshwater marsh wetland. The grass carp must be certified as triploid by the USFWS or by another agency approved by the Delaware Division of Fish and Wildlife.

Other laws governing the introduction of aquatic species exist for oysters and aquaculture. Written permission from the state agency is needed to bring live oysters or seed oysters into the state and place them in Delaware waters. Permits are needed for aquaculture of any species. A facility to be used for restricted species (black bass, grass carp, hybrid striped bass, and all non-

native species of finfish and shellfish) must have Delaware Department of Natural Resources and Environmental Control approval. The walking catfish is prohibited.

Anyone wishing further information on Delaware regulations is referred to regulation 2112 for material on oysters, the memorandum of understanding between the Department of Natural Resources and Environmental Control and the Department of Agriculture (May, 1992), and the grass carp policy (January, 1990; revised 1993).

West Virginia

In West Virginia, a fish importation permit allows an individual to import and haul native game, food, and sport fishes. However, the introduction of exotic fishes or those not native to this state is strictly prohibited. All persons must be legally licensed to propagate or sell fish, amphibians or other forms of aquatic life. Those persons legally entitled to propagate and sell fish, amphibians and other forms of aquatic life are also allowed to transport such beyond the limits of the state. All imported wildlife shall be subject to inspection by authorized agents of the department and such inspections may include biological examinations and the removal of a reasonable sample of fish or eggs for such purposes.

Permits to import triploid grass carp may be obtained if a pond owner has the pond inspected by proper state personnel, follows the required application process and orders the fish from an approved producer of certified triploid grass carp. Only triploid grass carp may be imported under any circumstances. A certificate issued by the USFWS is required from their authorized point of origin.

Anyone wishing further information on West Virginia regulations is referred to Chapter 20 of the Code of West Virginia and the annual fishing regulations.

APPENDIX B

This appendix contains background information including a general overview of the problem of non-indigenous species introductions, pathways of introduction, and the model monitoring program developed in the Chesapeake Basin for zebra mussels.

History

Aquatic species have been translocated from one ecosystem to another throughout history. These introductions have affected the social and economic sectors of our society and the ecosystems into which they were introduced. Some of our most familiar species are both non-indigenous and beneficial, many of them being important in agriculture. Apples, oats, wheat, cattle and chickens are just a few examples. Others have had negative impacts, both economically and ecologically. Examples are the array of now-familiar species such as common carp, starling, gypsy moth and Japanese beetle. Non-indigenous aquatic species are introduced intentionally, such as for aquaculture, or unintentionally, such as in the release of ballast water from trans-oceanic ships.

The rate of introduction of non-indigenous species has increased with human population growth, construction of canals, and transportation throughout the world. This is particularly threatening in aquatic environments because non-indigenous species are more likely to succeed there than in terrestrial conditions due to the greater uniformity of aquatic habitats.

The introduction of a non-indigenous species can appear, initially, to be beneficial from an economic or environmental perspective. However, there are numerous examples of introductions that have resulted in serious environmental impact. The Chesapeake region has been adversely impacted by past introductions including the aquatic plant *Hydrilla verticillata* (hydrilla), the bivalve *Corbicula fluminea* (Asian clam), and the oyster disease organism, *Haplosporidium nelsoni* (MSX). More recent invaders include a Japanese crab (*Hemigrapsis sanguineus*) that threatens marsh areas of the mid-Atlantic region. There is also concern that phytoplankton species capable of causing toxic blooms are being introduced into the Chesapeake Bay via ship ballast discharges.

The Chesapeake basin is preparing for the arrival of the zebra mussel, a prolific freshwater fouling agent, that may become established in low salinity regions of tributaries and the important nursery areas of the northern Chesapeake. In the short interval since its introduction, the zebra mussel has proliferated throughout the Mississippi River, extended into the lower Hudson River and is approaching the Chesapeake basin via the Susquehanna River. The rapid dispersal of zebra mussels through the eastern United States has increased awareness of the risks associated with introductions.

The Chesapeake region has already experienced the ecological and economic consequences of non-indigenous species. The oyster parasite MSX has been introduced into oyster populations via shipment of infected oyster stock into Massachusetts and perhaps Delaware and Chesapeake Bays. This parasite is a factor in devastating mortalities in oyster populations and the associated

decline of the Chesapeake oyster industry. Other non-indigenous species are now naturalized in the region as a result of both intentional and unintentional introduction. For example, *Littorina littorea* is a European native that is now widely distributed throughout marshes of the mid-Atlantic, the Asian clam is distributed throughout the Chesapeake Bay and its tributaries, and the Japanese crab *Hemigrapsis sanguineus* is well established in the coastal areas surrounding the Chesapeake Bay.

Currently there are no real predictive capabilities with regard to environmental risk and the frequency of non-indigenous species invasions of a region, but it is clear that the Chesapeake region could ill afford, ecologically or economically, the costs associated with an introduction like the Great Lakes have experienced with the zebra mussel. While the zebra mussel does filter excess phytoplankton in the Great Lakes, the costs associated with its ability to clog industrial pipes have been immense. In the Great Lakes region alone, clean-up, repair, and control costs are expected to run into billions of dollars over the next decade. Increased public awareness through education will be required to prepare residents for the consequences of introductions and to help prevent further dispersal of non-indigenous species once they arrive.

A recent example of public awareness leading to preventive actions was the decision by the Department of Public Works of the City of Baltimore to close its reservoirs temporarily to boating to prevent introduction of zebra mussels. This closure was designed to enable the city to determine and implement appropriate treatment methods. This ban was lifted in 1993 and replaced by a ban on the use of aquatic baits in the reservoir since it was felt that water from bait suppliers might be a mechanism of zebra mussel introduction. It is anticipated that this second ban will be lifted when a State-developed certification program is enacted to ensure that suppliers of aquatic bait are free of zebra mussel contamination.

Pathways of Introduction

The framework of a non-indigenous species introduction policy for the Chesapeake Bay basin should be linked to potential introduction pathways, both intentional and non-intentional. Most intentional introductions of non-indigenous aquatic species are made for aquacultural or recreational fishing purposes. The introductions of *Tilapia* species and striped bass x white bass hybrids are examples of these kinds of non-indigenous species introductions. The aquarium trade is another important introduction pathway. Hydrilla blooms in Chesapeake tributaries can be traced to plants introduced to Florida via the aquarium trade. Asian clams were being sold in aquarium shops in Pennsylvania before they were found in the Susquehanna River drainage.

Non-indigenous aquatic species are also being intentionally introduced as biological control agents for various pest species, many of which are also non-indigenous. For example, over 30 states permit the introduction of grass carp for control of aquatic vegetation in ponds.

Transoceanic ship ballast water is another pathway by which non-indigenous aquatic species can be unintentionally introduced. One aquatic species that has been inadvertently introduced with detrimental consequences via ship ballast water is the zebra mussel.

Research projects can also inadvertently release non-indigenous test organisms from laboratory facilities to the environment.

Aquaculture, Stock Enhancement and Restoration Introductions

Although shipping has been the primary dispersal agent for freshwater and marine non-indigenous species, the intentional introductions of the aquaculture industry and related fishery activities such as stocking by public agencies have also played an important role. Probably the most notorious example of a fish introduction leading to environmental problems was the introduction of the common carp from Europe into the United States in the 1800's. Although highly regarded as an aquaculture and recreational species in Europe, the carp was not readily accepted into the U.S. diet. Its feeding behavior coupled with its high reproductive rate has created habitat disruption leading to changes in gamefish populations.

Other fish introductions have had less clear consequences. The brown trout was introduced into Michigan in 1883 and is regarded by many as an example of a successful introduction. However, others object to the introduction of brown trout in other places due to the impacts on existing rainbow trout and brook trout fisheries. In the Kern River of California, the native golden trout was displaced by brown trout. Thus, even those intentional introductions that are successful in some situations are not as successful in others, resulting in some environmental cost. Most often this cost is loss of biodiversity.

Stock enhancement and restoration programs have been a traditional and important activity used by natural resource agencies and public groups to increase the availability of aquatic species, including plants, fish, mollusks and crustaceans, for ecological, recreational and commercial benefit. Stock enhancement programs for salmon, trout, American shad, striped bass, oysters, and other species have been conducted in the Chesapeake Bay watershed using sources of these species from other watersheds throughout the United States and Canada. American shad from the Susquehanna River basin were used to stock Pacific Northwest waters years ago.

While the value of such activities is recognized, it is also recognized that some control over these introductions is required to ensure that inadvertent escape of non-indigenous organisms into the environment or into wild populations of plants, fish, mollusks or crustaceans. Furthermore, such activities have long been recognized as risks to the receiving waters from the introduction of non-indigenous pathogens and opportunistic free-living organisms which are carried in the transport water. While such introductions of pathogens are unintentional, they are closely associated with intentional introductions and therefore must be considered together. Salmon and trout have been introduced to the northeastern US via the Pacific Northwest and with them came bacterial kidney disease, and enteric redmouth disease-causing pathogens.

Aquaculture benefits the region through economic development, and support of recreational fisheries. The aquaculture industry of the Chesapeake region is highly diverse including a variety of freshwater (catfish, trout, hybrid striped bass, Tilapia) and marine species (oysters, striped bass, clams and scallops) in a variety of culture systems including open ponds, raceways and recirculation systems. Carlton (1992a) recently presented a summary of mechanisms of

introduction via aquaculture based on deliberate release including grow-out, experimental systems, and biocontrol. All of these potential introduction mechanisms are part of the developing aquaculture industry of the Chesapeake basin.

With increased development of the aquaculture industry there is increased risk. Welcome (1988) noted "species originally introduced for aquaculture eventually escape from the confinement of their ponds, but not always to colonize natural waters". Shelton and Smitherman (1984) stated "For whatever purpose an exotic fish is used, escape is virtually inevitable; thus, this eventuality should be considered". Thoughtful development of aquaculture in the Chesapeake region should proceed with awareness of the risks that the inevitable releases of non-indigenous species from an active aquaculture industry entail. Further development of this industry in the Chesapeake region will proceed in parallel with development worldwide but should be based on policies that provide adequate protection without being simply prohibitive.

Biological Control Introductions

A variety of plant and animal species have been proposed for use as biological control agents in aquatic systems, including insects, snails, fish, marine mammals, plants and plant pathogens. Such introductions carry inherent risks, and therefore should be regulated or prohibited.

Aquatic vegetation control is an important issue region-wide due to the importance of fresh water impoundments for recreational fishing, municipality reservoirs and as sources of water for agriculture including: livestock watering, crop irrigation and aquaculture. Current management practices for control of excess vegetation include prevention through water quality management, chemical treatment, mechanical removal and biological control. All methods of control carry questions about the ecological safety and effectiveness of the control relative to the risk of introduction (Courtenay and Williams, 1992).

Research Introductions

The research introduction pathway for non-indigenous aquatic species may occur less frequently than other pathways discussed in this policy document, but the consequences may be very high. However, it is a pathway that can be more easily controlled than many others.

One effective way to control the research introduction pathway is through the development and adoption of stringent protocols (or guidelines) for handling and containing non-indigenous aquatic species and any associated diseases and parasites. Use of these protocols will allow important research to be conducted, and yet minimize the chances that test organisms, or associated diseases and parasites, will escape or be accidentally released into the environment.

The first set of handling and containment protocols developed by the Exotic Species Workgroup provide detailed guidelines for laboratory (i.e. closed-system) research on zebra mussels and other members of the genus *Dreissena*. The June 1993 draft document titled *Protocols for Conducting Research on Nonindigenous Mussels of the Genus Dreissena in the Chesapeake Bay Basin* will be available for Bay Program use upon the adoption of this Policy. These protocols describe a process that state agencies in the basin could adopt and use to evaluate permit

applications from scientific institutions who want to conduct laboratory research on *Dreissena* mussels. Maryland's Department of Natural Resources has recently used them in a permitting process that allowed two University of Maryland researchers to import live adult zebra mussels into Maryland to conduct research projects in closed and recirculating facilities. This document also offers one example of the kind of research protocols that could be developed by the Exotic Species Workgroup for other non-indigenous species as the need arises.

Allowing research to be conducted on non-indigenous aquatic species *in situ* while reducing the elements of risk to acceptably low levels, will require the preparation and adoption of protocols different from those referred to above for laboratory research on *Dreissena* mussels. These protocols must address concerns about inadvertent disease or parasite transfers, and survival, reproduction and proliferation of the test organisms in the environment. By definition, *in situ* tests with non-indigenous aquatic species cannot achieve the level of control possible in a closed-system, laboratory research situation. Therefore, as the need arises in the Chesapeake Bay basin, different protocols must be developed and followed for *in situ* research projects with non-indigenous aquatic species.

Guidelines for minimizing the risks associated with the introduction of non-indigenous aquatic species have been established by the International Council for the Exploration of the Seas (ICES). These guidelines should be considered in the development of research protocols for *in situ* testing on non-indigenous aquatic species in Bay basin state waters to minimize the risk of disease organism and parasite introductions. ICES guidelines require that broodstocks are held under quarantine conditions and only disease- and parasite-free progeny from the imports are used for the *in situ* tests.

With regard to concern about test organism reproduction and establishment of self-sustaining populations in the environment, induced triploidy is a genetic manipulation that reduces the risk of successful reproduction. These precautionary measures (use of disease- and parasite-free progeny of quarantined broodstock and induced reproductive impairment) offer two approaches to minimizing the environmental and economic risks associated with *in situ* testing of non-indigenous aquatic species in the Chesapeake Bay basin.

Ballast Water/Ship Transport Introductions

Ballast-water transport is the movement of living organisms contained in the water ballast tanks (not bilge water) of ships. Commercial shipping activity transports vast volumes of ballast-water and associated organisms around the world daily. This mechanism can move marine and estuarine organisms along and between coasts, and move freshwater organisms along waterways and between continents.

Water for ballast is pumped in bulk into the ballast tanks of vessels, either at dockside or as the vessel moves through coastal waters. Consequently, any organisms present in the water column may be pumped on board at the same time. While many of these organisms spend their lives in the plankton, organisms which are benthic as adults are also transported in ballast-water as planktonic larvae and during juvenile stages.

Several lines of evidence indicate that many organisms released with ballast water are viable and can successfully invade new ecosystems. The surveys in Oregon and Australia reported successful laboratory culture of many non-indigenous taxa collected from ballast tanks, including toxic dinoflagellates in Australia. Ballast-water transport has been proposed as the most probable mechanism of introduction for more than 40 recently identified non-indigenous species worldwide, including zebra mussels and European ruffe in the North American Great Lakes, saltwater Asian clams (*Potamocorbula amurensis*) in San Francisco Bay, and ctenophores in the Black Sea.

Recently there has been concern about the significance of ballast water discharge by ships in the introduction of non-indigenous species. Regulations mandated by the Aquatic Nuisance and Control Act of 1990 relating to ballast water discharge in the Great Lakes Region became effective on May 8, 1993. They require that all ships originating outside of the Economic Exclusion Zone (EEZ) of the United States and Canada (i.e., 200 mile limit) exchange their ballast water on the high seas before entering the EEZ. The salinity of ballast water must be 30 parts per thousand or greater upon entering the Great Lakes, and ballast water will be monitored by the U.S. Coast Guard. In the Chesapeake Bay watershed the major ports of concern are Hampton Roads, Virginia and Baltimore Harbor, Maryland. Preliminary studies by Carlton (pers. comm.) have detected crabs and fish in ballast water of ships in Baltimore Harbor.

The U.S. Coast Guard-sponsored National Biological Invasions Shipping Study (NABISS) has identified the ports of Baltimore and Norfolk in Chesapeake Bay as Atlantic coast "hot spots" for ballast-water discharge (J.T. Carlton, pers. comm.). Together, these two ports alone received in excess of 3 billion gallons of foreign water and associated organisms in 1992. This constitutes a regular and substantial inoculation with non-indigenous biota that are not well characterized. Today, the single largest source of non-indigenous aquatic species is the worldwide movement of ballast-water (Carlton, 1985).

The Chesapeake Bay Program, through the Living Resources Subcommittee, will support the National Biological Introductions Shipping Study currently being conducted in the Chesapeake Bay. This is the federal program initiated by the Aquatic Nuisance Species Task Force. This effort is identifying amounts and sources of ballast water delivered to the Bay, and sampling representative vessels for non-indigenous species in their ballast water.

Non-ballast water ship transport of non-indigenous species primarily involves fouling organisms which live on or in the hulls of vessels. Such passive transport of fouling organisms undoubtedly dates from the human species earliest attempts at boating. Although transport of fouling communities among ports and coastal regions was probably greatest in the days of sail, this mechanism continues to move species among geographic regions in modern times. Carlton (1985, 1989, 1992b) has recently reviewed the probable importance of shipping in transporting fouling communities around oceans of the world.

The Zebra Mussel and Its Monitoring Program

The zebra mussel, *Dreissena polymorpha*, is an aquatic nuisance species which has expanded its range rapidly in the Eastern and Central United States since it was first discovered in Lake St. Clair in 1988. In the Chesapeake Bay drainage, it has only been found in the upper reaches of the Susquehanna River, at Johnson City, New York. Although its distribution appears to be currently limited to this portion of the Chesapeake Bay drainage, its range is expected to rapidly expand, as it has in other watersheds, and zebra mussels may soon be unintentionally introduced into other tributaries of the Chesapeake Bay.

Monitoring programs underway in Delaware, Maryland, Pennsylvania, and Virginia are unique, being in place before the known presence of the target species. Effective monitoring methods have been developed for larvae, settled juveniles, and adults.

In the development of monitoring plans for aquatic nuisance species, such as the zebra mussel, a common protocol must be used. One example of such a network is the Susquehanna River Basin Zebra Mussel Monitoring Protocol, conceptualized in 1992 by the Chesapeake Bay Program's Exotic Species Workgroup, and implemented in March 1992, with the Pennsylvania Department of Environmental Resources (PADER) serving as the clearinghouse. After a series of meetings, a common monitoring protocol was agreed upon by participants, incorporating standard methodologies for sampling larvae, settled juveniles, and adults (McMahon 1990; Marsden 1992; Mussalli 1992). The actual monitoring was not initiated until several training sessions were held, with uniform artificial substrate sampler devices provided by PADER. Currently, 76 stations in the Susquehanna River - from New York to Maryland - are monitored biweekly for zebra mussels by 18 different groups, including federal, state and municipal governments as well as private industry and academic institutions. The use of a common protocol allows for the quantification and comparability of results within this watershed, as zebra mussels expand their range.

In Virginia, volunteer water quality monitors coordinated by the Alliance for the Chesapeake Bay are monitoring for zebra mussels at sites on the James, York, Elizabeth, Potomac and Piankatank Rivers. Volunteers check weekly for the presence of zebra mussels on provided plates. Sites have been chosen by the Virginia Department of Game and Inland Fisheries. Potential exists for expanding the involvement of volunteer citizen monitors.

While the current level of monitoring for zebra mussels seems adequate, it is important to note that the public has been alerted as to the general appearance of the zebra mussel and who to contact should they find what appears to be one. This is essential to obtain needed presence or absence data, as there are only a limited number of monitoring stations covering an extensive area. There are many more bank fishermen and recreational boaters than there are monitoring sites, and it is likely that the public will first encounter a zebra mussel - knowingly or unknowingly - before one is collected at one of the monitoring sites (Kraft 1993).

This approach, cooperative between states and regions and with active public participation, will serve as a model for monitoring other non-indigenous species recognized as nuisance organisms.

REFERENCES

- Carlton, J.T. 1985. Transoceanic and interoceanic dispersal of coastal marine organisms: the biology of ballast water. *Oceanographical and Marine Biology: an Annual Review* 23: 313-374.
- Carlton, J.T. 1989. Man's role in changing the face of the ocean: biological invasions and implications for conservation of near-shore environments. *Conservation Biology* 3: 265-273.
- Carlton, J.T. 1992a. Dispersal of Living Organisms into Aquatic Ecosystems as Mediated by Aquaculture and Fisheries Activities. In: *Dispersal of Living Organisms into Aquatic Ecosystems*. Aaron Rosenfield and Roger Mann (eds). pp. 13-46.
- Carlton, J.T. 1992b. Introduced marine and estuarine mollusks of North America: an end-of-the-20th-century perspective. *Journal of Shellfish Research* 11: 489-505.
- Courtenay, W.R. and J.D. Williams 1992. Dispersal of Exotic Species from Aquaculture Sources, with Emphasis on Freshwater Fishes. In: *Dispersal of Living Organisms into Aquatic Ecosystems*. Aaron Rosenfield and Roger Mann (eds.) pp. 49-81.
- Jones, M.M. 1991. Marine organisms transported in ballast water: a review of the Australian scientific position. Department of Primary Industries and Energy, Bureau of Rural Resources. Commonwealth of Australia. Bulletin No. 11. 48 pp.
- Kraft, C. 1993. Early detection of the zebra mussel, *Dreissena polymorpha*. In: *Zebra Mussels: Biology, impacts, and control*. T.F. Nalepa and D.W. Schloesser (eds.). Lewis Publishers, Ann Arbor, pp. 705-714.
- McMahon, R.F. 1990. The zebra mussel: U.S. utility implications. Macrofouling Consultants, Arlington, Texas. Research Project 1689-24. Prepared for Electric Power Research Institute, Palo Alto, California.
- Marsden, J.E. 1992. Standard protocols for monitoring and sampling zebra mussels. Illinois Natural History Survey. Biological Notes 138, 40 pp.
- Mussalli, Y.G. 1992. Zebra mussel monitoring and control guide. Stone and Webster Environmental Services, Boston, Massachusetts. Research Project 3052-03. Prepared for Electric Power Research Institute, Palo Alto, California.
- Reimer, D.N. 1984. Introduction to Freshwater Vegetation. Van Nostrand Reinhold Company, New York. 207 pp.
- Shelton, W.L. and Smitherman, R.O. 1984. Exotic Fishes in Warm Water Aquaculture, p. 262-301. In Courtenay, Jr., W.R. and Stauffer, Jr., J.R. (eds.), *Distribution, Biology, and Management of Freshwater Fishes*. Johns Hopkins University Press, Baltimore, Maryland.
- Welcome, R.L. 1986. International Measures for the Control of Introduction of Aquatic Organisms. *Fisheries* 11(2):4-9.

