Idaho Aquatic Nuisance Species Plan

A Supplement to Idaho's Strategic Action Plan
For Invasive Species

Prepared for
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And the
Idaho Invasive Species Council

By

The Idaho Invasive Species Council
Technical Committee

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Executive Summary

The Plan and why it is Necessary
In 2005, the Governor approved Idaho's "Strategic Action Plan for Invasive Species", prepared by the Idaho Invasive Species Council (IISC) as a statewide effort to limit the introduction and spread of invasive species. Invasive species are generally those plants and animals that are not native to an area, have the potential to spread uncontrollably, and when they do, cause significant economic or ecological harm. They include noxious weeds that invade all lands ranging from cultivated farms to vacant city blocks, as well as unwanted insects and some animals. Their economic impacts of these species nationwide in terms of the costs of treatment and prevention, in lost agricultural production and in restoring infested areas have been estimated in the billions of dollars.

A special class of invasive species that deserve particular attention are the "aquatic nuisance species" (ANS). ANS are those plants and animals that are dependent upon aquatic and riparian ecosystems. Here, as is the case with all other invasive species, introductions and uncontrollable spreads wreak havoc with native fish and ecological communities as well as the importance our streams, rivers and lakes have for recreation, irrigation and power generation.

By definition, ANS are those non-native plant and animal species that threaten the diversity or abundance of native species, the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters. While ANS are defined as non-native or nonindigenous, not all nonindigenous species are nuisance species since many alien species are non-invasive and support human livelihoods or a preferred quality of life.

Despite the fact that Idaho is a landlocked semi-arid state, there are factors that make it extremely vulnerable to the impacts of ANS. Indeed the scarcity of water in many parts of the state and the overall values associated with aquatic resources demand actions to protect this resource. Here is why Idaho must be particularly vigilant:

- Impacts to and from an agricultural economy that depends upon a complex irrigation system and which also has a flourishing aquaculture industry depending on quality supply waters

- Fishing and boating opportunities on Idaho's lakes, rivers and streams that attract enthusiasts from all parts of the United States

- A growing population of new and part time residents with second homes in Idaho that spend part of the year pursuing recreational interests on our waters

- Migratory steelhead and salmon runs in the Lower Snake, Salmon and Clearwater drainages that are vital to the recovery of these populations throughout the Northwest

- A seaport in Lewiston where barges and tugs are exposed to international ships and the species that live in their holds and ballast water.

Add to these factors the ease of buying and transporting plants for aquatic landscaping or exotic fish for ponds. In addition, there is a tendency for ANS to "hitchhike" on boats or fishing gear commonly moved between all states. For these reasons, the IISC believes that a separate set of actions and emphasis on ANS as a component of the state's Strategic Action Plan for Invasive Species is not only justified but also essential. In addition, development of this ANS plan fulfills the mandate of the federal "National Aquatic Nuisance Prevention and Control Act for individual state plans as part of the national strategy on ANS and qualifies Idaho for federal funding under this Act.

What is Idaho's ANS Plan?
Idaho's ANS plan has a clear goal:

"Minimize the harmful ecological, economic, and social impact of ANS through prevention of introduction. If ANS are established, manage population growth and prevent dispersal, within, and from Idaho."

The ANS plan complements the current Idaho Strategic Action Plan for Invasive Species and is intended to help the state coordinate efforts and secure cooperative funding to prevent, eradicate or control new introductions more effectively, before they cause major environmental and economic damage. An advisory committee consisting of state, federal, tribal, and private sector members, developed this plan with interagency and public support. This ANS plan, including its goals and objectives, is a dynamic document to be reviewed and revised as necessary and as situations change.

Like the Idaho Strategic Action Plan for Invasive Species, the ANS plan recognizes that prevention is, in the long term, easier and less expensive than eradication and restoration. It is also based upon a thorough understanding of the types of ANS we might expect and the invasion pathways that might facilitate their entry and spread. Idaho's ANS plan takes a streamlined view of categories of ANS and the threats that might be associated with each. There are two categories of ANS: those that are in the state now and further spread is undesirable, and those that are not here and which must be kept out. Granted, within those broad categories, there are individual species that pose greater risks than others. Therefore, assigning risks in each category for species helps guide rapid response actions, risks are based upon the following criteria:

- **High-Not Present**—Species which are not present in Idaho but which would likely have a high adverse impact if they were to arrive.

- **High-Present**— Those which are present in Idaho and likely to have a high adverse impact but are still in a potentially containable state, with areas of local eradication possible.

- **Medium-Present**—Established species which warrant long-term control actions to prevent further spread.

- **Low-Not Present**—Those species which may not be in Idaho but which present low risks of establishment or adverse impacts.

- **Low- Present**—Established species where control is unlikely or which present low risks to the state.

As noted in Idaho's Strategic Action Plan for Invasive Species, there is a myriad of existing programs and other efforts at the federal and regional level that are in place to control ANS. These range from the work of the national Aquatic Nuisance Species Task Force (Task Force) which is responsible for reviewing and approving state plans to the individual programs of agencies to manage such prominent invasion pathways as the discharge of ballast water. They also include regional efforts such as the 100th Meridian Initiative directed at zebra mussel or the "Stop Aquatic Hitchhikers" campaign, which empowers recreational users to become part of the solution in stopping the transport and spread of these harmful hitchhikers

There are state programs in Idaho, with the state departments of Agriculture, Environmental Quality, Fish and Game, Lands, Parks and Recreation, and Transportation all engaged through various initiatives of their own or through cooperative efforts at the state, regional or national levels. These fall into seven broad categories:

- Early Intervention – Prevention, Early Detection, and Rapid Response
- Containment, Control and Restoration
- Reaching Important Audiences through Education and Training
- Broadening Knowledge through Research and Technology Transfer
- Assuring Adequate Funding
- Creating an Adequate, Effective Legal Structure
- Coordination of Efforts

It is noteworthy that despite the development of the overall state strategic action plan and the ongoing actions of not only federal but state agencies, Idaho's ANS plan currently identifies 21 gaps in those programs which need to be filled by completing 43 separate tasks if we are to fully prevent and control ANS in the state. These actions are summarized in the "Implementation Table", which also includes the major resources needed, the lead entity and a timetable for completing the individual tasks.

One final component of the state's ANS plan is a plan for early detection and rapid response (EDRR) to a new or spreading invasion of an unwanted species. This EDRR plan mirrors a similar Columbia Basin rapid response plan that is being developed for the

control of zebra\quagga mussels, which have been recently detected in the nearby Colorado River system. This unfortunate event, underscores the importance of vigilance and the ability to respond. It also provides a model for rapid response and a test of that model upon which Idaho's rapid response plan is based.

Acknowledgements

The Idaho Invasive Species Council Technical Committee with support from Idaho state agencies and universities, federal land management agencies, tribes and numerous private parties, companies, and interested parties prepared this plan for Idaho.

We would like to thank Stephen Phillips and the Pacific States Marine Fish Commission for providing resources and encouragement to complete this plan.

We would like to thank the Northwest Natural Resource Group, LLC for their preparation of preliminary drafts.

List of Acronyms

ACOE	Army Corps of Engineers
ANS	Aquatic Nuisance Species
APHIS	Animal and Plant Health Inspection Service
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
CRANSI	Columbia River Aquatic Nonindigenous Species Initiative
CWMA	Cooperative Weed Management Area
IDEQ	Idaho Department of Environmental Quality
EDRR	Early Detection, Rapid Response
ELI	Environmental Law Institute
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
HACCP	Hazard Analysis and Critical Control Points
IDFG	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
IISC	Idaho Invasive Species Council
IPR	Idaho Department of Parks and Recreation
ISDA	Idaho State Department of Agriculture
ISSG	Invasive Species Specialist Group (Global Invasive Species Database)
ITD	Idaho Transportation Department
MOU	Memo of Understanding
NANPCA	Nonindigenous Aquatic Nuisance Prevention and Control Act
NEPA	National Environmental Policy Act
NISA	National Invasive Species Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resource Conservation Service
PSMFC	Pacific States Marine Fisheries Commission
PSU	Portland State University
Task Force	Aquatic Nuisance Species Task Force (national)
TNC	The Nature Conservancy
U of I	University of Idaho
USAID	United States Agency for International Development
USBLM	United States Bureau of Land Management
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WGA	Western Governors' Association

Introduction - Managing Aquatic Nuisance Species in Idaho

Invasive Species in Idaho

In 2003-2005, Idaho adopted both a comprehensive assessment in 2003 and the subsequent Idaho's Strategic Action Plan for Invasive Species in 2005 to limit the introduction and spread of invasive species within the state (IISC 2003 and 2005). Invasive species are generally those plants and animals that are not native to an area, have the potential to spread uncontrollably, and when they do, to cause significant economic or ecological harm (IISC 2005). Idaho's invasive species action plan recognized that these undesirable invaders occupy city lots and residential areas, farms and rangelands as well as aquatic environments, such as lakes, streams and riparian areas. While there have been many separate efforts to prevent and control these invasive species in the state, the assessment of current conditions and future efforts to manage or prevent their introduction to the state were based upon these premises:

- Invasive species management in Idaho is fragmented. Responsibilities and authorities for invasive species management are not clearly defined for most agencies. There is no clear relationship among budgets, needs, and results. There is a need to set priorities and measure results.

- Levels of education and awareness among landowners, policy-makers, and the public are not commensurate with the degree of the problem. Landowners need to understand their obligations to control invasive species and the costs associated with failure to manage them. Political leaders need to ensure adequate funding, appropriate legal authorities, and agency accountability. The public needs to understand invasive species so they become mindful of actions they can take, and help build broad public and political support for adequate programs.

- Idaho has expanded significant programs for managing noxious weeds, agricultural pests, forest insects, and invasive species that threaten human or animal health. Other invasive species, such as aquatic invaders, have received little attention to date.

- Resources are scarce so we must ensure that we expend them wisely. Applied science can help us set priorities and develop cost-effective methods for managing invasive species.

- There is a need for adequate resources to do the job, including funding. This was perceived as the greatest barrier to effective invasive species management in 2004, when Idaho's invasive species action plan was being considered.

- It is less expensive to prevent introductions of invasive species than to control them because of our limited ability to eradicate or control invasive species once they become established. Idaho's land managers place a high premium on

prevention i.e., actions to keep an invasive species from ever arriving here and on early detection and rapid response once an invasive species arrives.

Idaho's Invasive Species Council (IISC), the sponsor of the statewide assessment and strategic plan, anticipated subsequent detailed action strategies for invasive species by those entities responsible for various aspects of invasive species management and prevention. The specialized efforts of the "Cooperative Weed Management Areas" (CWMA) and the statewide coordination of this work by the Idaho State Department of Agriculture (ISDA) are an excellent example of an "on the ground" program. This aquatic nuisance species (ANS) plan is both a logical and a necessary refinement of the state's overall strategic action plan.

By definition, ANS are those non-native plant and animal species that threaten the diversity or abundance of native species, the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters. While ANS are defined as non-native or nonindigenous, not all nonindigenous species are nuisance species since many alien species are non-invasive and support human livelihoods or a preferred quality of life. ANS are the cause of significant ecological and socio-economic problems throughout North America. Populations of invasive species, such as zebra mussel *Dreissena polymorpha* , New Zealand mudsnail *Potamopyrgus antipodarum*, Eurasian watermilfoil *Myriophyllum spicatum*, and the parasites that cause whirling disease are increasing in prevalence nationwide. After introduction, these populations can expand and spread rapidly due to lack of natural controls and their ability to adapt to a variety of habitats. ANS can displace native species, clog waterways, impact municipal and industrial irrigation and power systems, degrade ecosystems, reduce or threaten recreational and commercial fishing opportunities, and can cause wildlife and public health problems.

Many governmental agencies have recognized the threat posed by ANS. In 1990, the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) was passed by Congress and enacted to address ANS problems in the United States. This legislation provided federal cost-share support for implementation of state ANS plans. While programs created by this national legislation initially were aimed at problems in the Great Lakes region, the reauthorization of NANPCA in 1996 as the National Invasive Species Act (NISA) established a national goal of preventing new ANS introductions and limiting the dispersal of existing ANS in all of the states. NISA specifies that state ANS plans identify feasible, cost-effective management practices and measures that can be implemented by the state to prevent and control ANS infestations in a manner that is environmentally sound.

The Aquatic Nuisance Species Plan for Idaho

Most of Idaho's eastern border is a mountainous wall through which only four major rivers flow from the east. Three of the rivers, the Kootenai, the Clark Fork, and the Snake, are major components of the Columbia River Basin. The fourth, the Bear River in southeast Idaho crosses the Utah, Wyoming and Idaho borders before returning to Utah

and ending in Great Salt Lake. Except for three smaller Snake River tributaries originating in Nevada, most of the other rivers in the state arise from within its borders, and virtually all of them flow into the Columbia River. These watercourses represent ready-made invasion pathways. The Pacific Ocean is 465 river miles away from the Port of Lewiston; commercial barges and tugs regularly travel the Snake and Columbia rivers to and from the Pacific Ocean. Recreational boating and fishing enthusiasts from across the country use the waterways of Idaho and neighboring states, increasing the potential for unwanted invasions or spread of ANS. There is a need to be doubly vigilant with respect to ANS in Idaho—the results of our efforts are reflected in what happens to the states downstream of our major rivers (Figure 1).

Idaho has temperate to alpine climates, ranging from warmer, usually snow free river canyons and lower valleys to high mountain ranges with much colder water and severe winter conditions. However, cold-water temperatures cannot always be counted upon to prevent exotic species that are intolerant of cold. The state has 2,614 documented geothermal sources of water, primarily springs or wells (IDWR //idahogeothermal.org/) (Figure 2). While these generally have a negligible effect on the ambient temperature of larger streams, they do represent small pockets of warm water where tropical species can and do survive. These geothermal waters contribute to a significant portion of Idaho's aquacultural economy.

Figure 1. Potential ANS Migration Routes between Idaho and Neighboring States.

The goal of the ANS plan and the actions outlined in it are:

"Minimize the harmful ecological, economic, and social impact of ANS through prevention of introduction. If ANS are established, manage population growth and prevent dispersal, within, and from Idaho."

The ANS plan is based on these assumptions:

- Prevention is the best course of action. Species management plans, education programs, and regulations are strategies that can help in the prevention and spread of ANS

- There are many pathways of introduction and spread for ANS, virtually all of which are related to human activities, both accidental and intentional

- New introductions and the spread of existing infestations have many associated costs. There are the economic impacts such as lost recreational opportunities or damage to water conveyance systems, as well as the ecological costs of the loss of desirable native species and the degradation of aquatic habitats

- Often there are few control methods available for use in water bodies once ANS become established.

- Once species become established and widespread, any control efforts will usually be very expensive and the potential for eradication becomes very unlikely.

The coordinated efforts contained within this ANS plan are designed to protect Idaho and its aquatic resources from the multitude of potential losses associated with ANS. It complements and adds to the current Idaho Strategic Action Plan for Invasive Species (IISC 2005). The ANS plan is intended to help the state coordinate efforts and secure long term cooperative funding to prevent, control, and hopefully, eradicate new introductions before they cause major environmental and economic damage. An advisory committee consisting of state, federal, tribal, and private sector members developed this plan with interagency and public support. This ANS plan, including its goals and objectives, will be reviewed and revised as necessary. Interested or impacted parties are welcome to participate in plan revisions and public comments will help provide guidance and support of the ANS plan's goals, objectives and implementation strategies.

The draft ANS plan was made available for public review from June 26 to July 27, 2007. Notices of its availability were provided to interested groups and published in local papers. Copies of the ANS plan were available in electronic or hard copy formats. Open houses were held in Boise, Coeur d'Alene, and Pocatello during July 2007. Public comments were limited and related to controlling Eurasian watermilfoil. Primary editorial comments were made from members of the national Task Force and IISC Technical Advisory Committee (Appendix A).

What is At Stake?

Despite the state, regional and federal responses to the growing challenge of invasive species, Idaho remains vulnerable to new introductions and unmanaged spread of existing ANS. Physical, social and economic factors within the state heighten the threat of unwanted species. Among these are:

- Impacts to and from an agricultural economy that depends upon a complex irrigation system, including numerous impoundments, canals and diversion structures

- Impacts to and from a flourishing aquaculture industry

- A growing population of new and part time residents with second homes in Idaho that spend part of the year pursuing recreational interests on our waters

- Fishing and boating opportunities on Idaho's lakes, rivers and streams that attract enthusiasts from all parts of the United States, who bring their own boats and fishing gear, which may have some unwanted ANS"hitchhikers"

- Access to maritime trade through the Port of Lewiston, via barges and tugs that come in contact with international ships and the species that arrive in their holds and ballast water

- Migratory steelhead and salmon runs in the Lower Snake, Salmon and Clearwater drainages that are vital to the recovery of these populations throughout the Northwest

- Impacts to ESA "threatened", "endangered" or "candidate" species that are either aquatic or partially dependent on riparian areas

- A wide variety of aquatic habitats, including mountain streams, natural lakes, reservoirs, and desert riparian areas, along with a large number of hot springs that provide unique warm water "micro-sites"

- Expansion of private ornamental ponds, waterscapes and other water features

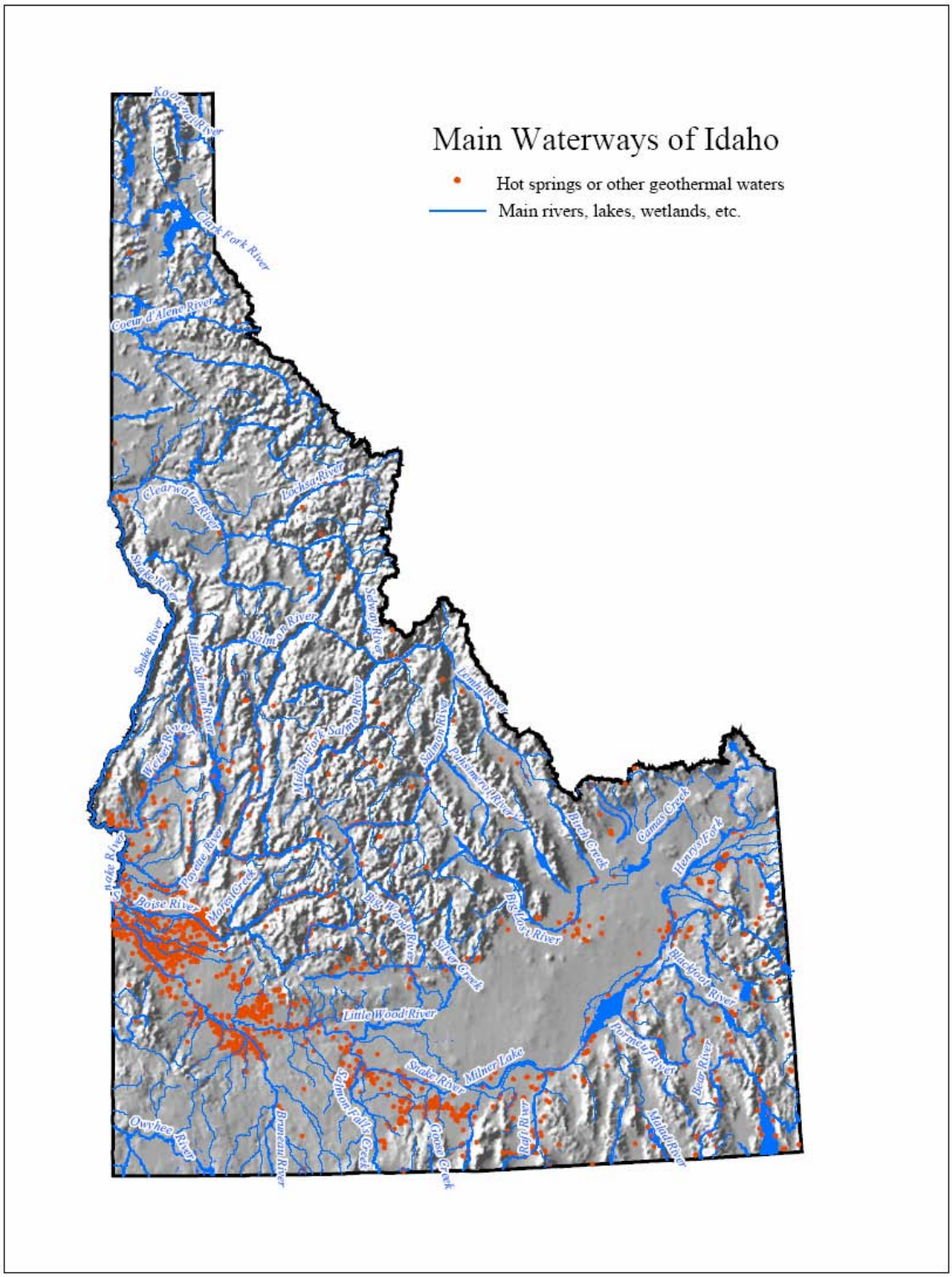
- Ease of sale and rapid shipping of live organisms from anywhere in the world to Idaho.

Figure 2 illustrates the important streams, lakes and other water bodies in Idaho. Their value for recreation, irrigation, wildlife, scenic beauty and aquaculture increases the potential for ANS to be a threat. An example is the undeniable value of springs in the Hagerman area for aquaculture, which by the nature of the industry makes the springs

potential waters where ANS cab become established. One of the ways ANS might arrive in Idaho and infect wild fish and their habitats is through the movement of fish eggs, live fish or their food. Similarly, boaters attracted to our magnificent rivers and lakes, can inadvertently introduce invasive invertebrates, parasites or plants that adhere to boats or trailers. One of the greatest potential losses to Idaho from ANS is the intangible but incalculable value of the complex aquatic and riparian ecosystems that characterize the state and upon which much of our economy and lifestyles depend.

The economic and environmental costs of harmful ANS in Idaho have not been adequately determined. Costs can be incurred through the loss of economic output, such as reductions in aquaculture, fisheries, or crop production, and also through the direct cost of combating and mitigating the impacts of the species (Mack et. al. 2000). Profitability in agriculture for example is reduced by the costs associated with controlling aquatic nuisance plants that clog irrigation canals. If zebra mussel or quagga mussel *Dreissena rostriformis bugensis* become established in Idaho, substantial expenses would be involved for the maintenance of industrial, hydropower, irrigation, and water supply systems. The impacts of the zebra mussel in the United States have been an estimated in the billions of dollars annually (Khalanski 2005).

Figure 2. Main waterways of Idaho.



Facing the Enemy—What is out there and how might it arrive in Idaho?

When species are introduced into a new environment, there is the potential for significant ecological, economic, and social effects. Non-native species may have few natural enemies, such as parasites or predators. Lack of natural enemies and the ability to adapt to new environments may allow a population to increase rapidly. Not all nonindigenous species pose an identified threat and some, such as warm water game fish can provide significant economic and recreational benefits in appropriate habitats.

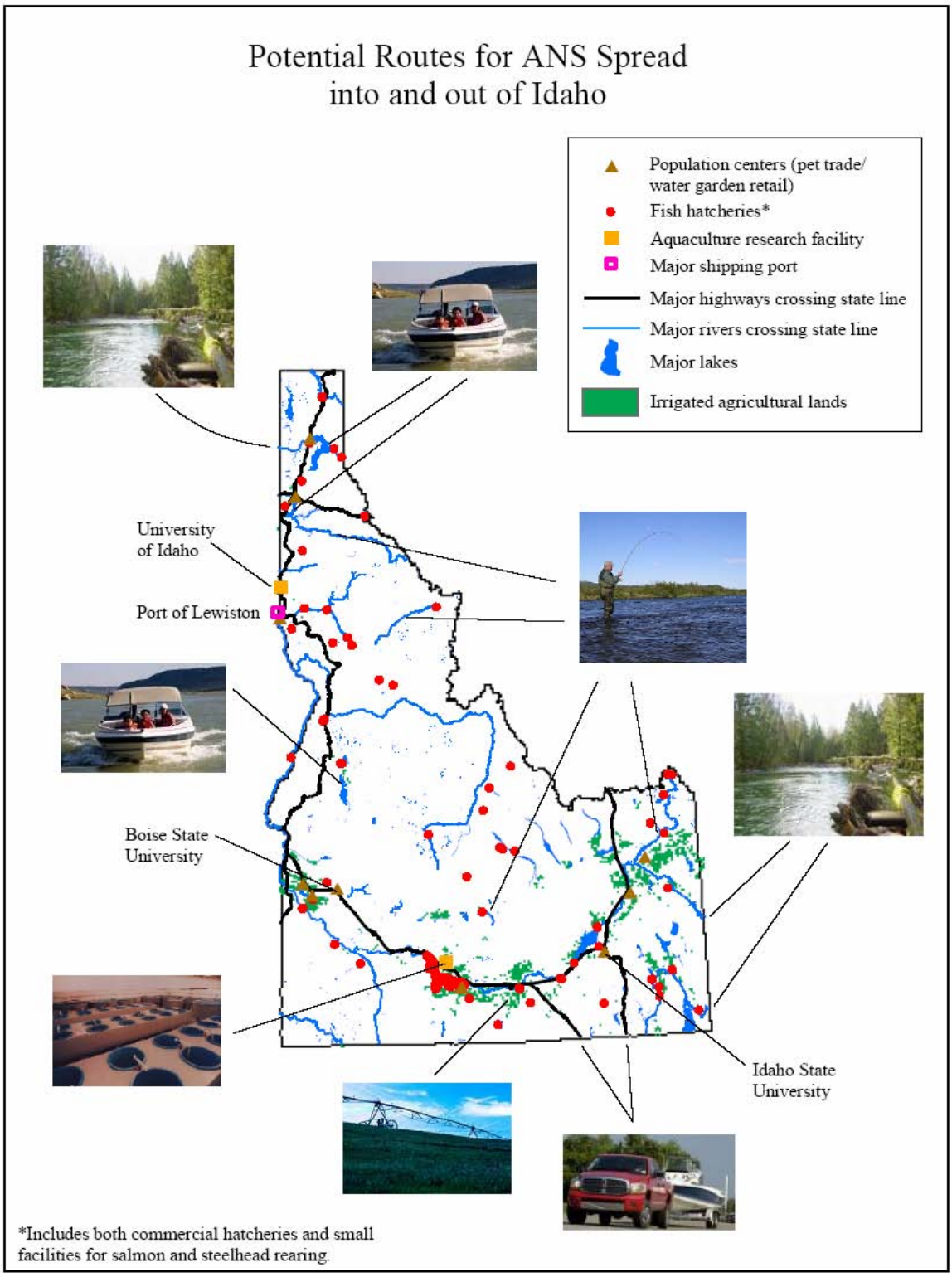
We cannot know what new and unanticipated ANS might surface in Idaho or surrounding states. Some threats are known given the impacts certain species have had in other states. We can anticipate their points of possible entry into Idaho, along with the areas of likely establishment (Figure 3).

Types of ANS

In general, there are three basic types of ANS: 1) harmful nonindigenous aquatic animals, 2) harmful nonindigenous aquatic plants, and, 3) harmful nonindigenous pathogens, diseases and micro parasites. These organisms have the potential for significant negative ecological, economic, and social effects. Once introduced, the lack of natural controls allow a population to increase at an exponential rate. Establishment of new species can cause the disruption of native species in the ecosystem as the introduced species may prey upon, out-compete, or transmit disease to the native species.

Animal ANS have arrived in Idaho from a variety of intentional or unintentional actions (Figure 3). ANS such as zebra and quagga mussels can attach to boats, fishing gear, be moved in the live wells, and\or bait buckets from one body of water to another. Water diversions allow fish or other ANS from different drainages to invade new habitats. Although not intentional, the ability of some ANS to "hitchhike" during importation of approve species can put bodies of water at risk for invasion. Although aquaculture is well regulated in Idaho, the out of state propagation of animals for commercial or recreational purposes provides a potential source for ANS. ANS may also be introduced through intentional, unpermitted releases of fish, baits or plants by anglers and aquarium owners.

Figure 3.


Potential Routes for ANS Spread
into and out of Idaho
Population centers (pet trade/ water garden retail)
Fish hatcheries*
Aquaculture research facility
Major shipping port
Major highways crossing state line
Major rivers crossing state line
Major lakes
Irrigated agricultural lands
University of Idaho
Port of Lewiston
Boise State University
Idaho State University
*Includes both commercial hatcheries and small facilities for salmon and steelhead rearing.

Nonindigenous aquatic plants cause significant economic and ecological problems throughout North America. Pathways for introduction of aquatic plant species include boats and trailers, the aquarium trade, nursery and garden centers, and mail order and internet suppliers. Many nonindigenous aquatic plant species have become established in the United States outside of their natural range. Vascular species such as hydrilla *Hydrilla verticillata* and Eurasian watermilfoil are examples well known for their ability to alter physical and biological functions of aquatic systems. They affect water quality, recreational uses of water, and fisheries in many states. A wide variety of pondweed *Potomogeton* spp. species clog irrigation and drainage ditches. Filamentous and planktonic algae can clog waterways, impact water quality, and produce toxic blooms in lakes and ponds. Emergent species such as purple loosestrife *Lythrum salicaria* and Japanese knotweed *Polygonum cuspidatum* reduce wildlife cover and habitat. Saltcedar or tamarisk *Tamarix* spp. seriously degrades wetlands, completely drying up some lakes, ponds, and river areas along with altering soil chemistry.

Microorganisms include pathogens, diseases, bacteria, viruses fungi and related microbes. They can enter Idaho on plants or animals imported into the state or through the water in which plants or animals are transported. When microorganisms are allowed into a new aquatic environment, they also have the ability of infecting native or existing plants or animals. Importation of pathogenic organisms must be regulated and the spread of these microorganisms must be controlled. Parasites, such as *Myxobolus cerebralis*, the cause of salmonid whirling disease, may affect wild trout fisheries in Idaho, resulting in serious loss of recreational activity and financial loss to Idaho. Other parasites and viral or bacterial pathogens like Viral Hemorrhagic Septicemia can cause heavy mortalities of trout and salmon, plus other fish species, both those in the wild or in Idaho's aquaculture industry. These viruses must be kept out of Idaho through comprehensive efforts to identify and control sources of their entry. Although included in this plan as ANS, many aquatic micro-organisms associated with fish and aquaculture are addressed through other state and regional programs such as the Model Comprehensive Fish Health Protection Program (PNFHPC 2007) and the policies of the Columbia Basin Integrated Hatchery Operations Team (Shelldrake et al. 1993).

The ability to prevent entry or manage the spread of each species varies and the resources available are limited. Management efforts must be focused on species for which actions can produce the greatest benefit. In recognition of the known threats, impacts, and potential problems of certain ANS and the state's current management capabilities, management actions should be directed toward species for which the threats are the highest. Idaho's ANS plan is based on the categories of threats and risks described in this section.

Although this plan is directed towards introduced ANS, information and actions in the plan and from future ANS work in Idaho can also be applicable for native species, which can become "nuisances" in our changing and altered environments. One such species that is native to Idaho is the stalked diatom, *Didymosphenia geminate*, more commonly known as "rock snot". This diatom can become abundant to the point of being a nuisance (resembling whitish-gray sewage fungus) in rivers and streams where it can form thick

gelatinous mats under certain environmental conditions (Stevenson et al. 1996 as cited by Holderman, et. al. 2004). Actions such as cleaning equipment, taken to prevent movement of new species into Idaho should also be taken to prevent the movement of native species out of the state or into other drainages within Idaho.

The Known Threats

It is possible to place too much emphasis on identifying the species most likely to arrive or spread in Idaho and calculating the relative risks of damage if they do. It is tempting to do so as the basis for formulating prevention strategies and control actions that are based upon threats and risks. However, some species may not be obvious threats. Consider the appearance of "sudden oak death syndrome" in Oregon and California. Before it appeared, the pathogenic cause for the disease was not on any list of potentially invasive species. In Washington, piranhas and a potentially invasive member of the "tunicate" family of marine organisms from the East Coast were recently found, neither of which would have appeared on a watch list for that state (Joan Cabreza, USEPA, personal communication). While existing authorization was apparently either sufficient to allow funds to be spent on control measures or was quickly amended to allow this, valuable time can be lost if there is a requirement to modify lists of species for which funds can be legally directed.

For these reasons, Idaho's ANS plan takes a streamlined view of categories of ANS and their associated threats. There are two basic categories of ANS: Those that are in the state now and where their spread is undesirable, and those that have not yet been introduced and must be kept out. Within these broad categories there are individual species that pose greater risks than others do. Therefore, assigning risks in each category for species helps guide rapid response actions, risks are based upon the following criteria:

- **"High-Not Present"**— Species which are not present in Idaho but which would likely have a high adverse impact if they were to arrive.

- **"High-Present"**— Those which are present in Idaho and likely to have a high adverse impact but are still in a potentially containable state, with areas of local eradication possible.

- **"Medium-Present"**— Established species which warrant long-term control actions to prevent further spread.

- **"Low-Not Present"**— Those species which may not be in Idaho but which present low risks of establishment or adverse impacts.

- **"Low- Present"** — Established species where control is unlikely or which present low risks to the state.

Appendix B includes detailed descriptions of high priority species currently established in Idaho, and those that are not currently present here but likely to have a high adverse impact. Those species are summarized in Tables 1 and 2.
Appendix C contains a list of all known aquatic nonindigenous species in Idaho. Species in this list include not only those that would rank in the high, medium and low criteria as ANS species, but also species that are currently considered beneficial in some waters of the state.

Table 1. High-Priority Aquatic Nuisance Species known to be in Idaho

These species are defined as present in Idaho, but still in a potentially containable state in known waters or with local eradication possible.

Scientific Name	Common Name
Animals	
Potamopyrgus antipodarum	New Zealand mudsnail
Corbicula fluminea	Asian clam
Myxobolus cerebralis	Whirling disease
Plants	
Myriophyllum spicatum	Eurasian watermilfoil
Myriophyllum aquaticum	Parrot feather milfoil
Iris pseudacorus	Yellow flag iris
Potamogeton crispus	Curly leaf pondweed
Lythrum salicaria	Purple loosestrife
Tamaricaceae spp.	Saltcedar

Table 2. High Priority Species Not Currently Found in Idaho

These species are defined as not currently present in Idaho, and likely to have a high adverse impact.

Scientific Name	Common Name
Animals	
Dreissena polymorpha / Dreissena rostriformis bugensis	Zebra mussel/Quagga mussel
Mylopharyngodon piceus, Hypophthalmichthys molitrix, H. nobilis, Ctenopharyngodon idella	Asian Carp (black, silver, bighead, grass (fertile variety))
Orconectes rusticus	Rusty crayfish
Neogobius melanostomus	Round goby
Gymnocephalus cernuus	Eurasian ruffe
Rhinogobius brunneus	Amur goby
Channa argus, C. maculata, C. marulius, C. micropeltes	Snakehead fish, sp.
Bythotrephes cederstroemii / Bythotrephes longimanus	Spiney/fishhook water flea
Myocastor coypus	Nutria
	Viral hemorrhagic septicemia
Plants	
Eichhornia sp.	Water hyacinth
Hydrilla verticillata	Hydrilla
Egeria sp.	Brazilian elodea
Hydrocharis morsus-ranae	Frog's bit / European frogbit
Trapa natans	Water-chestnut
Cabomba sp.	Carolina fanwort

The Framework for Aquatic Nuisance Species Management in Idaho

Federal Policies and Efforts

Generally, federal programs have sought to either coordinate or encourage the roles and activities of the individual states, although federal programs are responsible for interstate commerce and other related potential invasion pathways that transcend state borders. For example, the regulation of ballast water discharges in the Great Lakes or in coastal ports is a responsibility of the USGC. The growing challenge posed by ANS and the role of the federal government in coordination and regulation of activities that cross state or international borders, Congress has authorized a number of specific actions. While no single federal agency has clear authority over all aspects of ANS management, many agencies have programs and responsibilities that address aspects of the problem, such as importation, interstate transport, exclusion, control, and eradication.

Nonindigenous Aquatic Nuisance Prevention and Control Act and the National Aquatic Nuisance Species Task Force

The Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990 established a federal program to prevent or control introduced ANS and the brown tree snake. The mandate is prevention, monitoring, and control with these activities supported by research and education. Under NANPCA, state governors are authorized to submit comprehensive ANS management plans to the national Aquatic Nuisance Species Task Force (Task Force) for approval. The plans identify areas or activities for which technical and financial assistance is needed. Grants are authorized to states for implementing approved ANS management plans. The federal share cannot exceed 75% of cost incurred by the State and the non-federal share must come from non-federal sources (www.anstaskforce.gov).

Federal activities on ANS management are coordinated through the Task Force as authorized by the NANPCA. The Task Force is an intergovernmental organization dedicated to prevention and control of ANS, and implementing the NANPCA. The various NANPCA mandates were expanded later with the passage of the National Invasive Species Act NISA, (see below) in 1996. The Task Force consists of 10 Federal agency representatives and 12 Ex-officio members, and is co-chaired by the USFWS and NOAA. The Task Force coordinates federal governmental efforts dealing with ANS with those of the private sector and other North American interests via regional panels and issue-specific committees and work groups (www.anstaskforce.gov). When appropriate, the Task Force develops national species specific management and control plans. The current plans can be found at http://anstaskforce.gov/control.php.

National Invasive Species Act

In 1996, National Invasive Species Act (NISA) amended NANPCA to mandate regulations to prevent the introduction and spread of ANS into the Great Lakes through

ballast water and other vessel operations. This Act required a USCG study and report to Congress on the effectiveness of existing near-shore ballast water facilities used by crude oil tankers. It also authorized funding for research on ANS prevention and control in the Chesapeake Bay, the Gulf of Mexico, the Pacific Coast, the Atlantic Coast, and the San Francisco Bay-Delta Estuary. In addition, NISA required a ballast water management program to demonstrate technologies and practices to prevent aquatic nonindigenous species from being introduced into and spread through ballast water in United States waters. The Act also modified: 1) the composition and research priorities of the Task Force; and 2) zebra mussel demonstration program requirements (www.invasivespecies.gov).

Invasive Species Executive Order

In addition to these authorities, in February 1999, President Clinton signed Executive Order 13112, which requires all federal agencies to collaborate in developing a national invasive species management plan that will include terrestrial and aquatic species. This seeks to prevent the introduction of invasive species, provide for their control, and minimize their impacts through better coordination of federal agency efforts under a National Invasive Species Management Plan to be developed by a national interagency Invasive Species Council. The Order directs all federal agencies to address invasive species concerns as well as refrain from actions likely to increase invasive species problems (Federal Register 1999). The National Invasive Species Management Plan was finalized on January 18, 2001 and is on the national Invasive Species Council website at www.invasivespecies.gov.

The response of the federal government toward the increasing threat of invasive species and the mandates of Congress has been to create a wide variety of federal programs. While not all of these directly relate to aquatic species, more than 20 federal agencies in 10 cabinet level Departments have some responsibility for some aspect of invasive species management, including responsibilities for ANS (General Accounting Office 2002). These range from the regulation of ballast water of ships coming to United States ports to customs inspections to the interstate shipments of animals and plants. The State Department even negotiates provisions aimed at preventing the movement of invasive species in various trade and other agreements with foreign governments.

Individual Federal Agency Programs

One of the lead federal agencies battling the spread of ANS is the USFWS. This agency, as co-chair of the ANS Task Force, provides federal funding for implementation of state and regional ANS management plans and maintains a number of “hands on” efforts for controlling ANS through training of field managers and research. Other agencies that maintain or support ANS programs include: NOAA, ACOE, Customs Bureau, USCG, plus agencies of the Departments of Energy and Agriculture (General Accounting Office 2001).

Table 3 summarizes the various roles of many federal agencies and the authorities provided to carry out these efforts (but are not exhaustive).

Table 3. Examples of Federal Roles in Invasive Species Management

Invasive Species Function	Authorities	Agencies	Key Responsibilities
Prevention	Plant Protection Act; Animal quarantine laws; Lacey Act; Federal Seed Act; Nonindigenous Aquatic Nuisance Prevention and Control Act; National Invasive Species Act	APHIS; USFWS; NOAA, USEPA, USCG, Depts. of Defense, State and Transportation (for aquatic noxious weeds)	Prohibit or restrict imports or movements of plant pests, including noxious weeds; Control interstate movement of invasive animals and those with communicable diseases; Control weed infested seeds; Regulate the movement of injurious animals; Prevent and control noxious aquatic weeds
Early Detection and Rapid Response	Plant Protection Act; Animal quarantine laws; NUSEPA;	Various agencies have the emergency authority to deal with incipient invasions	Seize, hold, quarantine and treat prohibited species imported into the United States or transported between states
Control, Management and Restoration	Such acts and NFMA, FLPMA and those that guide the management of lands or waters under various agency jurisdiction; the Nonindigenous Aquatic Nuisance Prevention and Control Act; Clean Water Act; FIFRA; NUSEPA; Plant Protection Act; Emergency Watershed Program	Forest Service, NOAA, USEPA, BOR, ACOE, NRCS; No single agency has overall responsibility	Control and manage invasive species and restore affected areas on federal lands and waters
Research and Monitoring	Cooperative Agriculture Pest Survey; Nonindigenous Aquatic Nuisance Prevention and Control Act, various organic acts	Various USDA, Interior agencies, NOAA, USEPA	Develop databases on various invasives, research invasive species and micro-organisms of concern to forests, agricultural lands, rangelands and wetlands. Research risks associated with invasive species
Information Management	International Plant Protection Convention; NAFTA; Convention on International Trade in End. Species of Wild Fauna and Flora; Convention on Biological Diversity; N. American Agreement for Environmental Cooperation	USDA agencies, Office of the U.S. Trade Representative, World Trade Organization, Depts. of Interior, Transportation, State; International Maritime Organization, USEPA, U.S. AID	Develop strategies for international control of invasive species and share information; Capacity building in other countries; treaty and trade negotiations; ballast water management;
Public Outreach and Partnership Efforts	Various statutory authorities	USDA, Dept. of Interior, NOAA	Dissemination of public information; Cooperate with state, local and tribal governments
Interagency Efforts	Various statutory authorities	Task Force, National Invasive Species Council, Federal Interagency Committee on the Management of Noxious and Exotic Weeds, Committee on Environment and Natural Resources of the National Science and Technology Council	Problem specific cooperative efforts and the coordination of control and research efforts

Regional Organization and Efforts

The Western Regional Panel on Aquatic Nuisance Species

The Western Regional Panel (WRP) on Aquatic Nuisance Species was formed under a provision of the NISA in 1997 to help limit the introduction, spread, and impacts of ANS into western North America. The panel includes representatives from federal, state and local agencies and private environmental and commercial interests. The purposes of the WRP, as described in NISA, are to:

- Identify regional priorities for responding to ANS;
- Make recommendations to the Task Force, including an education, monitoring (including inspection), prevention, and control program to prevent the spread of the zebra mussel west of the l00th Meridian;
- Coordinate, where possible, other ANS program activities in the West not conducted pursuant to the Act;
- Develop an emergency response strategy for federal, state, and local entities to stem new invasions of ANS in the region;
- Provide advice to public and private individuals and entities concerning methods of preventing and controlling ANS infestations; and
- Submit an annual report to the Task Force describing activities within the western region related to aquatic nuisance species prevention, research and control.

Idaho IDFG staff have attended the annual WRP meetings and provided reports on state activities since the formation of the panel. Currently the state Invasive Species Coordinator is the official Idaho representative.

Western Governors Association

The Western Governors' Association (WGA) is involved with programs to address undesirable aquatic and terrestrial invasive species in the West. In 1998, the WGA passed Resolution 98-018, "Undesirable Aquatic and Terrestrial Species"; which in part directs states to develop and coordinate Western strategies and to support management actions to control and prevent the spread and introduction of undesirable species. In 2005, Resolution 05-11, "Undesirable, Invasive Aquatic and Riparian Species" recognizes the importance of, and need for, a coordinated Western regional approach to all invasive species. It also directed the WGA to convene an Aquatic Invasive Species Working Group to develop, fund, and implement a comprehensive program to prevent the spread of aquatic invasive species in the water resources of the Western states. The Working Group shall partner with the WRP and other western groups to coordinate invasive species lists and efforts across the regions, establish model legislation to prevent the transport, sale, and dispersal of undesirable species, and develop the needed public

outreach and education tools as identified by the regional working groups. (Western Governor's Association, www.westgov.org).

Pacific States Marine Fisheries Commission/Bonneville Power Administration Aquatic Nuisance Species Program for the Columbia River Basin

In 1999, the Bonneville Power Administration (BPA), recognizing the potential impact to its operations, funded the Pacific States Marine Fisheries Commission (PSMFC) to carry out an ANS prevention program for the Columbia River Basin. The USFWS and NOAA Fisheries also provide program support. In addition to species-specific projects, the PSMFC coordinate regional ANS activities and some support funding to regional states in conjunction with the 100th Meridian Initiative and the Columbia River Basin ANS Coordinating Group. A primary emphasis is to assist states in the development of state ANS plans. An additional goal of this regional program is to include ANS public outreach in Montana, Washington, Idaho, and Wyoming in the prevention of zebra mussel movement.

100th Meridian Initiative

One major regional ANS partnership is the 100th Meridian Initiative, a cooperative effort among federal, state, provincial and tribal entities, potentially affected industries, and other interested parties to begin addressing the threat of the spread of zebra mussels and other ANS in the western United States. The goals of the Initiative are to be attained through the implementation of the following six components: 1) information and education, 2) voluntary boat inspections and boater surveys, 3) involvement of those who haul boats for commercial purposes, 4) monitoring, 5) rapid response, and 6) evaluation. The 100th Meridian Initiative has three subgroups or "Teams" for the Colorado, Columbia and Missouri Basins. Idaho participates in the Columbia River basin team, which is administered by the PSMFC with funding support from the USFWS and Bonneville Power Administration. The Columbia River ANS Team includes representation from the IDFG, PSMFC, Portland State University (PSU), tribal agencies, and state and federal entities in Oregon, Washington, Idaho and Montana. This team has developed a working draft rapid response plan for zebra and quagga mussels in the Columbia River Basin (www.100thmeridian.org/ColumbiaRT). Idaho is a participant in the Initiative and has conducted surveys of boater movement, developed a statewide cooperative sign program for marinas and is conducting early detection monitoring for zebra and quagga mussel on lakes and reservoirs throughout the state.

"Stop Aquatic Hitchhikers!"

The USFWS leads the Task Force national campaign known as Stop Aquatic Hitchhikers!^{TM}. Using strategic communications, social marketing and branding processes, the intent of the campaign is to unify the entire conservation community to provide consistent messaging about this complex issue. The campaign can empower all recreational users to adopt environmentally responsible behaviors to prevent the spread of harmful species. By targeting aquatic recreation users, Stop Aquatic Hitchhikers!^{TM} strives to make stewardship inherent in all recreational experiences.

A part of the Stop Aquatic Hitchhikers program has focused on the Greater Yellowstone Area. The focus is on attracting public-sector groups to join federal, state and county agencies to promote the conservation message. This public-sector momentum has attracted numerous nonprofit organizations like local lake homeowner associations, Trout Unlimited and BASS chapters, statewide marine trade associations, and local, regional and national environmental and conservation organizations. All of these organizations are complemented by diverse private sector interests including fishing tackle and boat manufacturers, consumer travel product companies, recreational and multi-media companies, regional internet publishers, hotel chains, chambers of commerce, lodges and full-service resorts, fly and tackle shops, marinas, dive shops and resource restoration businesses. Over forty businesses and nonprofits from Jackson Hole, Cody, Livingston, Bozeman, Ennis, West Yellowstone, Island Park and other communities of the Greater Yellowstone area have joined the campaign (www.protectyourwaters.net/).

Current State Programs

Idaho is a leader in managing invasive species, with a number of programs, task forces, studies, organizations and partnerships designed to identify, prevent, eradicate or manage various harmful species. A model for cooperation in dealing with invasive species is the Cooperative Weed Management Area (CWMA) which originated in Idaho. The CWMA concept focuses on involving all landowners in a watershed or region, developing integrated management plans, and defining roles and partnerships that allow for the blurring of jurisdictional lines of ownership. CWMA now cover more than 82 percent of the state. Due to the success achieved in Idaho, CWMA have become a national model for successful weed management across the country.

State and local programs often work in concert with the implementation of federal programs, frequently sharing funding and expertise. Idaho's current laws and programs address both established and potential invasive species, and combine education, regulation, prevention, detection and control actions as the needed basis for managing all invasive species, including those associated with aquatic or riparian habitats.

A variety of Idaho laws has been passed and programs established to address each of these classes of invasive species (IISC 2003). They include:

- Idaho's Noxious Weed Law that addresses weed control on public and private lands and is administered by the ISDA and individual counties

- IDFG authorities to govern the importation, release, sale, possession and transportation of any species of wildlife, which by definition includes non domestic fish species

- ISDA authorities that require weed free seeds, straw for revegetation projects, and livestock feed, and regulate the propagation of species not classed as "wildlife"

- Idaho's Plant Pest Act, with its broad authorities to inspect nursery and horticultural operations and to quarantine areas or articles that may spread plant pests or plant diseases

- IDL authorities to manage and control forest pests

- The ability of the state or individual counties to take steps on private or state lands to suppress insect outbreaks or weeds or control unwanted animals

- Broad county authority to quarantine or undertake other control mechanisms for a variety of invasive species.

In 2002, the Environmental Law Institute (ELI) published "Halting the Invasion: State Tools for Invasive Species Management", a comprehensive review of the laws, policies and programs related to invasive species management in each state. Their work considered state efforts to identify, prevent or control invasive species, as well as state level mechanisms to coordinate efforts and enforce existing laws. Among their findings for Idaho, ELI noted several shortcomings in Idaho's statutory framework for invasive species management, including a lack of specific authority to identify future threats and the absence of a comprehensive statewide invasive species management plan. However, since ELI's report, the state has enacted the Plant Protection Act (2002) and a new law addressing "deleterious animals" passed in 2003. Perhaps equally importantly, Idaho has attempted to address all invasive species issues in a comprehensive fashion by the creation of a statewide Idaho Invasive Species Council (IISC) created by Executive Order No. 2001-11 in 2001 (Office of the Governor 2001) and reauthorized in 2006 by Executive Order No. 2006-28 (Office of the Governor 2006).

This IISC includes representatives of state, local, federal and tribal governments as well as private entities who "provide policy level direction and planning for combating harmful invasive species infestations throughout the state and for preventing the introduction of others that may be potentially harmful" IISC (2005). The overall goals of the IISC include using the existing authorities to minimize the effects of harmful non-native species, to serve as a non-partisan forum to build understanding of invasive species, to encourage control and prevention, to organize and streamline the process for identifying and controlling invasive species, and to find ways to bring current problems under control (IISC 2005). The role of the IISC is to coordinate among the various

public agencies and tribes toward achieving the goals outlined above, and active participation in the IISC is largely voluntary, except for state agencies. It operates without a dedicated budget, but leadership is provided by a full time statewide "invasive species coordinator", established in 2004 and housed in ISDA.

The IISC addresses all categories of invasive species, both terrestrial and aquatic. The purpose of the IISC is to provide policy level direction and planning for combating harmful invasive species infestations throughout the state and for preventing the introduction of others that may be potentially harmful. The IISC is charged to:

- Minimize the effects of harmful non-native species on Idaho citizens and to ensure the economic and environmental well being of the State of Idaho;
- Serve as a nonpartisan forum for identifying and understanding invasive species issues from all perspectives;
- Take measures that will encourage control and prevention of harmful non-native species;
- Organize and streamline the process for identifying and controlling invasive species; and consider ways to halt the spread of invasive species as well as finding possible ways to bring current problems under control.

Table 4 summarizes the existing statutory authorities for state agencies related to invasive species management in Idaho (highlighted in blue) and the actions of the agencies charged with administering the law, including efforts directed at ANS. It should be noted that several other agencies have responsibilities for either assisting in the implementation of existing laws or for cooperating with overall efforts. For example, the IDEQ does not have specific statutory authority for managing invasive species even though the agency does monitor and report infestations of aquatic weeds or animals as part of its responsibilities to protect water quality within the state.

Table 4. Summary of Idaho's Invasive Species Regulatory Authorities

Import/Introduction/Release: *What are the general requirements for the import, introduction or release of non-native or imported species?*				***Non-Native Species:***	
	Authority	***Statute***	***Import***	***Introduction***	***Release***
	IDFG	36-104 Fish and Game Authorities	Permits for allowable species. Prohibitions against specific species	Permits for allowable species based upon American Fisheries Society protocols.	All releases or abandonment of domestic or exotic animals are prohibited
	ISDA	22-2016, Plant Pest Act	Permits for allowable species	Permits for allowable species	Prohibited except by permit
	ISDA	25-3900, Deleterious Animals	Prohibitions and permits	Prohibitions and permits	Prohibited
Quarantines: *Is there authority for quarantines of potentially invasive species, either for an area or for transportation through the state?*	***Authority***	***Statute***	***Quarantine Regulations***		
	ISDA	22-2012, Plant Pest Act	Broad authority, but specific to "plant pests". Authorizes cooperation with federally imposed quarantines		
	ISDA, except for domestic sheep	25-218, Animal management	Broad authority for control of livestock diseases		
	IDL, in cooperation with ISDA	36-106, Forest pests	IDL, through the Forest Pest Act and ISDA, through the Plant Pest Act, can survey for forest pests and have broad authorities for control and prevention.		
	ISDA, Counties	22-2404, Noxious Weed Law	Broad authority in the case of actual or potential noxious weed emergencies		
Interstate Transportation and Shipping: *Are there requirements for shipping or transportation of invasive species through the state?*	***Authority***	***Statute***	***Shipping/Transportation Regulations***		
	ISDA	25-214	It is unlawful to transport animals infected with communicable diseases into or through the state. The law gives the Ports of Entry and the ITD authority to inspect for compliance with rules. Federal laws govern most aspects of interstate commerce.		
	IDFG, in cooperation with ISDA	36-106	Wildlife that is transported is generally subject to the same rules that govern livestock for transport or importation.		

Table 4. Continued.

Management of Biological Control Agents: *Are there requirements for approval, permit or a license to use biological control agents and standards for using them?*			***Biological Control Agents:***		
	Authority	***Statute***	***Import***	***Introduction***	***Release***
	IDFG	36-104 Fish and Game Authorities	Permits for allowable species. Prohibitions against specific species	Permits for allowable species based upon American Fisheries Society protocols	All releases or abandonment of domestic or exotic animals are prohibited.
	ISDA	22-2016, Plant Pest Act	Permits for allowable species	Permits for allowable species	Prohibited except by permit
	ISDA	25-3900, Deleterious Animals	Prohibitions and permits	Prohibitions and permits	Prohibited
Emergency Powers: *Is there authorization of emergency powers to address invasive species outbreaks?*	***Authority***	***Statute***	***Emergency Powers***		
	ISDA	22-2404, Noxious Weed Law	The Noxious Weed Law and the Plant Pest Act contain specific references to the ability of any state agency to take emergency actions. This authority may be implied in other statutes regulating public health, animal health, or agricultural pests.		
	ISDA	22-2009, Plant Pest Act			
Enforcement Mechanisms: *What authorities help assure the enforcement of various laws that regulate invasive species?*	***Authority***	***Statute***	***Enforcement Mechanisms***		
	ISDA	22-2009, Plant Pest Act	The Plant Pest Act allows the ISDA to stop sales of infectious materials and take other emergency actions. If landowners refuse to control pests on their lands, the ISDA may take control actions and impose liens on the property in the amount of the control costs. Violations of the Plant Pest Act or misdemeanors are punishable by fines, civil penalties or imprisonment.		
	ISDA	22-2409, Noxious Weed Law	Violations of the Noxious Weed Law are misdemeanors punishable by fines or imprisonment. Counties may impose liens and collect control costs, if they must take actions to control weeds on private lands.		
	ISDA	25-3905, Animals	Violations of the Deleterious Animal Act can result in the assessment and collection of civil penalties		
	ISDA	25-219, Animals	Failure to control animal diseases as specified in 25-200 are misdemeanor violations, punishable by fines or imprisonment.		

Blue highlights are authorities related to invasive species management.

Current Efforts and How We Can Be More Effective

Idaho has a comprehensive program to prevent new introductions and spread of unwanted invasive species, as described in the Idaho Strategic Action Plan for Invasive Species (IISC 2005). Virtually all of them are relevant for the management of ANS and many are already being implemented by various agencies. In addition, the state's efforts on invasive species management are coordinated through the IISC and the work of a full-time invasive species coordinator.

The responsibilities for invasive species management, including those for ANS, are seldom the domain of a single agency and there are overlaps and potential duplications. For example, new additions to the state code that address deleterious exotic species specifically calls for cooperation between the departments of Agriculture and Fish and Game in implementing the sections of the new law concerning threats to fish, wildlife or the environment. While many agencies have some authority to regulate ANS, no centralized authority or management structure exists to coordinate ANS activities in Idaho. In Idaho, there are a number of programs dedicated solely to the prevention of new introductions and spread of ANS. Some of these programs reside exclusively with state agencies. Others, like the state's participation in the previously mentioned "100th Meridian Initiative", take the form of regional programs conducted in cooperation with other states or with various federal agencies. This section describes the existing programs in Idaho for managing ANS, including both those that are specific to individual state agencies along with those that cross agency boundaries and are administered through cooperative actions.

1. Early Intervention – Prevention, Early Detection, & Rapid Response

One point of consensus from the "Invasive Species Summit", held at the request of Governor Kempthorne in 2004, is that it is more desirable and cost effective to prevent new invasions of unwanted species than to attempt to eradicate or control them once they become established. Prevention is a multi-faceted task that includes actions ranging from education of those who might inadvertently introduce unwanted species to enforcement of laws for inspections and quarantines.

By far, the most effective method to control ANS and their impacts is to prevent their introduction in the first place. New species can arrive in Idaho by many different pathways. Species that provide sport fishing opportunities, erosion control, food, fur, and aesthetic enjoyment have been intentionally brought to Idaho and released into the wild or escaped from private ponds or holding facilities. Common carp *Cyprinus carpio*, goldfish *Carassius auratus*, nutria *Myocastor coypus* , Eurasian watermilfoil, and parrot feather milfoil *Myriophyllum aquaticum* can and some have become established through these pathways. Humans, through recreational, development, and management activities can unintentionally introduce ANS. ANS introduced and established in neighboring states and Canada may be dispersed into and throughout Idaho by natural means such as "hitchhiking" on domestic or wild birds and animals. Even firefighting efforts can spread

ANS, when equipment used to move water to fires is not cleaned between drainages. Understanding how various pathways function as conduits for ANS into Idaho is critical for intercepting species and preventing introductions.

Once ANS have arrived, there is usually a window of opportunity to eradicate small pioneering populations before they become wide spread, however species are not often detected until large populations are formed. Usually, it is too late or too expensive to eradicate a species once it has reached these levels, and when management is conducted after a population is well-established, long-term routine activities will often be required to control the population and reduce environmental impacts. By initiating an early detection, rapid response and monitoring program, hopefully the state will be able to discover and manage pioneering infestations at a point when the species can be eradicated in a cost effective manner. This has been successful is several recent terrestrial instances such as gypsy moth *Lymantria dispar* in north Idaho and the potato cyst nematode *Globodera pallida* in eastern Idaho.

Some examples of early detection and rapid response to ANS or undesired fish species introductions into Idaho include such actions as IDFG's efforts to: 1) Aggressively pursuing eradication of undesirable and non-native species of fish in select locations or as a result of illegal introductions, 2) Modifying fish stocking from state and federal hatcheries to prevent releasing fish from hatcheries with New Zealand mudsnail into waters where the snail is not present, and, 3) Establishing a whirling disease research and management program. As a partner in the 100th Meridian Initiative, IDFG made a special effort to communicate with boat owners and anglers in the state by providing informational articles to the media and in Department rule booklets.

Responsible agencies: ISDA, IDFG, IDEQ, USFWS, PSMFC, U of I

Major current initiatives:

- Major initiatives coordinated at the regional level to survey for the spread of quagga mussel in the Columbia Basin and to educate boaters on this new threat;
- Along with the Task Force, develop and maintain a list of taxonomic experts for ANS identification;
- In 2001, with PSMFC, USFWS, and BPA funding, PSU began to recruit and enlist volunteers to deploy zebra mussel colonization substrates. By 2002, about 200 substrates had been distributed in Oregon, Washington, Idaho, Wyoming, Montana, Arizona, Utah and other states. The PSU program also now has the capability to process zebra mussel veliger (larvae) samples (Stephen Phillips, PSMFC, personal communication).
- Further development of the "*Columbia River Basin Rapid Response Plan for Zebra Mussels and other Dreissena species."*

Gaps:

- New aquatic species may not be reviewed before importation;
- Limited inspection programs;

- No agency is actively, routinely and systematically monitoring or surveying for new or spreading ANS;
- Response time to an invasion is slow due to a lack of contingency plans, advance environmental compliance arrangements, and funding.

Tasks

1A). Identify high-risk invasion pathways and water bodies. With this information, create early intervention strategies that reflect the risk and values of each. For example, where the risk of zebra mussel is high, develop an inspection and control program for trailered boats and water-based equipment, which includes appropriate wash stations for boats and equipment;

1B). Conduct an annual survey of high-risk waters, utilizing both existing state and federal field personnel and crews specifically targeting ANS;

1C). Work with agencies and industries to develop protocols to guide the importation and transport of non-native species;

1D). Develop a "watch list" of all species where introduction or spread is unwanted, along with management strategies for dealing with them according to their priority class;

1E). Refine and implement the Rapid Response Plan as outlined in Appendix D

1F). Encourage and train volunteer groups to work in cooperation with state agencies to monitor for new invasions or spreads by such methods as distributing zebra mussel substrates;

1G). Develop a response program that can be quickly invoked for various species when there is imminent threat of their introduction;

1H). Develop, maintain and implement Hazard Analysis and Critical Control Points (HACCP) plans for hatcheries, field, and survey crews.

…And Now There Is Another One

Ironically, during the development of this plan, a new aquatic species that promises to truly be a nuisance found its way into waters in the Southwest, with the discovery of invasive quagga mussel in Lake Mead in January 2007. Like its better known cousin the zebra mussel, the freshwater quagga mussel can grow on many surfaces and form dense colonies that clog water pipes, foul irrigation screens and fish ladders, restrict water recreation, harm native aquatic life, and result in costly maintenance. In the event of a quagga or zebra mussel invasion, estimated maintenance and control costs to the Federal Columbia River Power System could run into the hundreds of millions of dollars, which would pass down to Pacific Northwest consumers. After the initial discovery of quagga mussel in Lake Mead, biologists found the invasive shellfish growing in the Lake Mead Fish Hatchery. Although that hatchery normally releases fish within the Lake Mead region, it did transport fish into Northeast Nevada's Wild Horse Reservoir in April and May 2006. Wild Horse Reservoir drains into the Owhyee River, which flows into the Snake River. So far, surveys conducted in 2007 in Wild Horse Reservoir have not found any quagga mussel; however, a small number of zebra or quagga mussel veligers were detected in Lake Powell, Utah in July 2007.

Cross-country transport from the Great Lakes on a recreational boat is the likely route that recently brought quagga mussel to the Colorado River drainage. "Stopping the quagga mussel from entering the waters of Columbia River Basin will require the cooperation and vigilance of the general public," says Randy Fisher of the Pacific States Marine Fisheries Commission. "Anglers, people at gas stations, and people using lakes, marinas, and beaches can all help by being lookouts for this invasive mussel."

Below is a list of actions boaters including personal watercraft, canoe, and kayak) and anglers can take to ensure that their boats, vehicles, trailers and other equipment do not become the means of infecting other waters:

- Drain the water from your motor, live well, and bilge on land *before* leaving the immediate area of the lake.

- Wash the hull, live well, equipment, and any other exposed surface, and flush the motor and bilges, using hot over 140 degrees F) soapy water or use a solution of 1 part household bleach to 19 parts water.

- Completely inspect your vessel and trailer, removing any visible mussels, but also feel for any rough or gritty spots on the hull. These may be young mussels that can be hard to see.

- Clean and wash your trailer, truck or any other equipment that comes in contact with water. Mussels can live in small pockets anywhere water collects.

- Air-dry the boat and other equipment for at least five days before launching in any other waterway.

2. Containment, Control and Restoration

Some unwanted species are already here and have proven to be truly invasive. Others will arrive despite our efforts to prevent them. It is important to control ANS by eradicating small, incipient populations and by preventing the spread of larger populations where eradication will no longer be possible. This might be viewed as the in-state version of prevention, early detection and rapid response, where the object is not to keep the unwanted species from our state but rather to keep those that are already here from spreading into other drainages.

Aquatic Weed Efforts
An important outgrowth of the successful approach of the CWMA has been the development of a parallel effort to address aquatic weeds, particularly Eurasian watermilfoil. Between 2003 and 2005, the Idaho Eurasian Watermilfoil Task Force (a subcommittee of the IISC) used almost $30,000 of ISDA CWMA funding to survey 107 sites on 75 water bodies to provide the much needed basis for a statewide Eurasian watermilfoil control program (Idaho Milfoil Task Force 2006). In addition, the Idaho Milfoil Task Force developed educational materials and began a database of Idaho's waters to help guide future survey and control efforts. Finally, the Idaho Milfoil Task Force is sponsoring research by the University of Idaho on control methods in small impoundments. There are also cooperative agreements between the Department of Fish and Game and the counties for controlling purple loosestrife.

In 2006, the Legislature appropriated four million dollars for the 2006-07 treatment seasons to control Eurasian watermilfoil in Idaho. As directed by the Legislature, ISDA is using the appropriated funds to support on-the-ground eradication and control efforts. This included approval of 13 locally developed projects totaling $2.5 million. Over 5,000 acres were treated, mostly with herbicides specifically approved for aquatic use. In 2007, the Idaho Legislature approved another $4 million for additional survey and control work.

An additional program of cooperative agreements between the IDFG and CWMA is in place for controlling purple loosestrife along the Snake River in southern Idaho. With funding from CWMA, the IDFG provides boats and staff to chemically treat or to release and monitor biological control agents in areas infested with purple loosestrife. The biocontrol agents are significantly reducing large stands of this plant. In conjunction with this program IDL has provided funding to IDFG to help contain other noxious weeds on inaccessible IDL managed islands along the Snake River.

Responsible Agencies: CWMA, IDFG, ISDA, IDL

Major Current Initiatives:

- Idaho agencies are using two biocontrol agents to control purple loosestrife;
- IDFG is pursuing the eradication of undesirable and non-native species of fish in select locations or as a result of illegal introductions
- IDFG has established a whirling disease research and management program;

- ISDA is leading a statewide effort to control or, where possible, eradicate Eurasian watermilfoil from Idaho's waters.
- University of Idaho, USGS, and USFWS are collaborating on research and development of New Zealand mudsnail treatment systems for fish hatcheries.

Gaps:

- Current efforts are directed at individual populations and not at controlling species in their entirety.
- Restoration techniques and\or acceptable vegetation are lacking for artificial habitats such as ponds established in gravel quarries.

Tasks:

2A). Continue surveys and control actions associated with Eurasian watermilfoil, including grants for local actions;

2B). Continue current management programs for New Zealand mudsnail and whirling disease. Develop and implement an eradication and management program for saltcedar and other unfunded ANS.

New Plant, Bigger Headache

If ever an individual aquatic nuisance species illustrates both the problems it causes if left unchecked and the costs of control, it is Eurasian watermilfoil. Eurasian watermilfoil is an attractive plant with feathery underwater foliage. It was once commonly sold as an aquarium plant, introduced to North America many years ago and is now found over much of the United States.

The spread of this plant can drastically alter a water body's ecology. Eurasian watermilfoil forms very dense mats of vegetation on the surface of the water. These mats interfere with recreational activities such as swimming, fishing, water skiing, and boating. In eastern Washington, it interferes with power generation and irrigation by clogging water intakes. The sheer mass of plants can cause flooding and the stagnant mats can create good habitat for mosquitoes. Eurasian watermilfoil mats can rob oxygen from the water by preventing the wind from mixing the oxygenated surface waters to deeper water.

Eurasian watermilfoil reproduces extremely rapidly and can infest an entire lake within two years of introduction to the system. Break a plant and the portion remaining in the lakebed continues to grow, while the piece that was broken off will sprout roots and grow equally well, whether in the original water body or a new one, transported there by the boat trailer that broke the piece off in the first place. This is why Eurasian watermilfoil can so easily be transported from lake to lake on boat trailers or fishing gear. Once established in its new home, water currents may carry Eurasian watermilfoil fragments and start new colonies within the same water body.

Eurasian watermilfoil is gaining a foothold in Idaho's lakes, ponds, rivers and other waterways, with infestations in Idaho's Panhandle, Payette Lake and other lakes in Ada, Canyon and Payette Counties. There has been approximately 4,000 surface acres of the plant identified through surveys that have been conducted in the state. In 2006, the Idaho State Legislature passed a bill that allows for $4 million in funding to control Eurasian watermilfoil in Idaho. An additional $4 million was approved by the Legislature for more control measures in 2007 and beyond.

How do we control Eurasian watermilfoil once it has become established? Only with great difficulty and at great expense. The list of options narrows, ranging from using herbicides to installing plastic sheets on the lakebed and employing divers to hand pull the plants or dredge them so they can be brought to the surface and removed. IISC is currently developing a statewide management strategy for Eurasian watermilfoil in Idaho.

3. Reaching Important Audiences through Education and Training

There is a consensus that education lies at the heart of most successful efforts to prevent and control unwanted invasive species. The resources and the political will necessary to inspect, regulate and mandate control actions for all potential invasive species and all invasion pathways do not exist now and likely will not exist in the future. People will only change their behavior because they understand the risks and they want to do their part. Creating that climate is a function of education.

ANS information

IDFG has included information on ANS in the state fishing regulations, posting of signs, purchase and distribution of videos, video segments in IDFG "Idaho Outdoors", and conducted direct mailings to permit holders. U of I provides research-based invasive species information, including aquatic species, and informal education programs to individuals, businesses, and communities. Some of the work of the U of I is disseminated through individual agencies, including an array of pamphlets, papers and other various print materials that help inform various audiences about invasive species and why they need to be addressed. One example of an ongoing educational effort involves the cooperative program to help make boaters aware of harmful aquatic invasive species like Eurasian watermilfoil, parrot feather milfoil, and New Zealand mudsnails that have already spread to many parts of Idaho.

Marina Signage Project

In 2004, a number of partners joined together to prevent the spread of aquatic invaders by posting signs at boat access sites around the state. The eye-catching signs provide information on the threat of ANS and ask boaters to clean their vessels before entering and after leaving any water body. Participants include the ISDA, IDFG and IDPR. Federal partners include the ACOE, USBLM, USFS and the USFWS. Private and local participants include Ada County, the Idaho Weed Awareness Campaign, The Nature Conservancy (TNC), PSMFC, and the Western Whitewater Association, together with the USEPA, which provided funding for the signs and accompanying brochures. Together, the partners have raised approximately $27,000 to distribute and erect 1,500 aluminum signs and 2,000 laminated posters (Andy Brunelle USFS and Bas Hargrove TNC, personal communication).

Responsible agencies: IDFG; ISDA; IDPR, USFS, USBLM, USDA; U of I; ACOE; USFWS; PSMFC

Major current initiatives:

- IDFG has included information on ANS in the state fishing regulations, posted informational signs, purchased and distributed videos, published articles in "Idaho Outdoors" and conducted direct mailings;
- U of I through the statewide Cooperative Extension Service provides research-based weed information and informal education programs to individuals, businesses, and communities. A variety of extension programs include invasive species issues including ANS;

- USFWS provides training, signs, and informational brochures;
- The PSMFC is completing an ANS boater survey and has been conducting outreach and education efforts of marinas in the state of Idaho and other states for the past four years. With partners such as the USFWS and BPA, PSMFC has been conducting watercraft inspection training for boating law enforcement/safety staff professionals. A watercraft inspection training video has also been developed. The PSMFC also prints and distributes ANS educational materials (brochures, cards, key chains) to recreational boaters in the Columbia River basin at sport and outdoor shows. The PSMFC also supports Portland States University's zebra mussel monitoring program activities (Stephen Phillips, PSMFC, personal communication).

Gaps:

- There is no systematic effort to identify all audiences with a stake in ANS prevention and control and then to develop a comprehensive strategy across state and federal agencies to reach those audiences;
- Little training is provided to agency and private personnel to identify ANS and to provide avenues to report new sightings.

Tasks:

3A). Develop a comprehensive education program to raise the awareness of ANS introduction and spread for such businesses as nurseries, aquatic pet stores, bait dealers, private pond management firms, fish hatcheries, irrigation managers and entities with watershed management responsibilities;

3B). Develop a comprehensive education program to raise the awareness of ANS introduction and spread for county, state and federal agency field staffs;

3C). Provide information on ANS to managers of fishing tournament and various sportsmen or recreational groups;

3D). Build and maintain a comprehensive website on ANS in Idaho highlighting high risk water bodies, high risk species and high risk actions that might lead to introduction or spread. Incorporate ways to report new sightings of ANS through this website;

3E). Train enforcement personnel on ANS regulations and the field workers of all county, state and federal agencies to better equip them to identify new or spreading ANS; Use IDPR boat safety education training program as a foundation,

3F). Develop an annual report focused on ANS in Idaho and use it as an opportunity to reach decision makers and opinion leaders on the need for proper policies and funding for ANS efforts;

3G). Develop and maintain statewide advertisements, PSAs, signing programs and other methods of communication with the public to remind them of ANS threats and the need for such personal actions as cleaning fishing or boating equipment;

3H). Create an ANS component to the established Project Wild and Project Wet curricula for students;

3I). Assign state employees to public education and outreach activities;

3J). Increase the capabilities of those who interact with invasion pathways (aquatic pet dealers, live plant distributors, irrigation districts, others) to understand the potential harm from the introduction and spread of ANS into uncontrolled environments.

4. Broadening Knowledge through Research and Technology Transfer

Little is known about the extent and magnitude of the ANS problem in Idaho. In fact many more nonindigenous species may occur in Idaho than are recognized (Appendix C). Of these nonindigenous species, we still do not know which have the potential to become ANS. Information and research is needed to quantify and clarify the effects that nonindigenous species are having on native species and habitat. Research can identify the threat posed by ANS and the mechanism responsible for their movement. By compiling available information and by providing quick access to information on taxonomy, management methods, and experts to contact; the response to new ANS can be quick, and existing ANS can be readily recognized and managed.

It is not enough, however, to simply compile data and conduct research. The lack of awareness concerning ANS impacts is one of the largest obstacles to preventing the introduction and spread of unwanted species. Few people understand the threat ANS pose and how their actions might introduce them. Uninformed people, through the dumping of an aquarium or a bait bucket, launching of a contaminated boat, or stocking of a private pond have introduced many species. The improper importation and holding of plants and animals have allowed species to escape, or caused the receipt of unwanted species mixed in with intentionally imported ones. In the past, many policy makers, natural resource administrators, and private interest groups have facilitated the intentional introductions of species for economic or recreational purposes without fully understanding the effects these species would have on native species. Currently, IDFG requires a review of new species using the American Fisheries Society's introduction policy (IDFG 2007). These intentional and unintentional methods of introduction can be eliminated or curtailed by educating people about their potential to transfer ANS into Idaho.

There is much to be learned about invasive species. Legitimate areas of inquiry include their biological parameters, how they can best be controlled and the assessment of the risks of their arrival, spread and potential damage. We must also increase our ability to predict their occurrence, detect, map and monitor their presence. It is equally important that the results of research and the practical experience of others be synthesized and made available to Idahoans. There are excellent models for research and technology transfer in the agricultural research and extension programs carried out by land grant universities across the country. Many of these programs are directly applicable or could be easily expanded to include invasive species.

Responsible Agencies: IISC, U of I, IDFG research, federal agency research programs

Major Current Initiatives:

- The U of I, has two graduate students working on New Zealand mudsnails research, including testing a device to rid hatcheries of New Zealand mudsnails;
- U of I is involved in the development of biological control agents for Common Reed and potentially Eurasian watermilfoil
- U of I researchers are exploring development of a risk assessment model for ANS;
- The IISC has requested that U of I conduct a review of invasive species research in Idaho;

Gaps:

- There are no risk analysis protocols for aquatic species;
- There is limited understanding of the impacts of ANS.

Tasks:

4A). Using nationally developed risk assessments and research as a basis, focus necessary additional research efforts on the potential harm and control methods for specific ANS for Idaho,

4B). Evaluate the potential for aquarium and live food fish to serve as vectors of disease and parasites to native fish populations;

4C). Continue investigation on the effects of such established ANS as the New Zealand mudsnails or whirling disease on native species;

4D). Research the impacts management alternatives have on ANS and native species;

4E). Investigate and develop new and innovative methods of managing ANS, including the efficiency of herbicides and various other management practices in aquatic and riparian habitats;

4F). Facilitate the collection and dispersal of information, research, and data on ANS in Idaho through a central source for reference information and data;

4G). Using nationally developed risk assessments as a basis, develop ANS risk assessment guidelines that will help local government and other managers understand the potential impacts and the need to manage ANS;

4H). Develop a set of uniform definitions and terms to describe ANS.

5. Assuring Adequate Funding

There are three certainties. First, most ANS efforts are public sector programs and these must have sufficient dollars to support them. Second, the costs of preventing and controlling ANS will increase as commerce and travel increase. Mounting an adequate defense against ANS will require more funds and most of those will come from either federal or state sources. Third, it is far less expensive to prevent rather than control, and dollars can be saved in the long term through adequately funded prevention measures.

Responsible Agencies: The Idaho Legislature and the United States Congress provide funding for state and federal agency efforts. Other funds are available through grant programs and the collection of user fees.

Major Current Initiatives:

- The Idaho Legislature provided funding for Eurasian watermilfoil control;
- Legislation to increase boater registration fees has been approved. A portion of those fees could go to ANS efforts.

Gaps:

- Limited funding to implement laws relating to ANS, particularly the lack of a dedicated fund that is stable and continually available for ANS efforts.

Tasks:

5A). Identify possible funding sources for implementing Rapid Response Plan actions;

5B). Increase existing funding and resources for ANS management and explore new funding possibly through permit fees or other sources;

5C). Create stable funding sources for ANS management in Idaho by seeking federal funding from the NANPCA and other potential funding sources

6. Creating an Adequate, Effective Legal Structure

Laws are needed to address management efforts to prevent the introduction and spread of ANS. Those laws fall into two categories—those that seek to shape behavior and those that spell out the role and functions of government for ANS. In Idaho, there is a strong existing legal framework but there is perhaps a need for some adjustments that would markedly increase our effectiveness, as summarized in Table 4.

At least five separate statutes provide some authority for state departments, primarily Fish and Game and Agriculture, to take actions to prevent the introduction or spread of aquatic nuisance species (IISC 2005).

They are:

- 36-100, Fish and Game authorities;
- 25-3900, Deleterious Animals;
- 25-2600, Extermination of Wild Animals and Pests;
- 22-2400, Noxious Weed Act;
- 22-2001, Plant Pest Act.

These authorities provide most regulatory powers that might be necessary to detect, prevent or control most ANS. There are some gaps in needed authorities and questions to be answered. For example, it is not clear whether any agency has the authority to

impound or order the cleanup of a boat entering the state with zebra mussel or other ANS attached to it. There are also some apparent overlapping authorities. IDFG's general authorities to control imports of various wildlife species would seem to overlap the authorities given the ISDA under the "Deleterious Animals" statute.

Granted, much of what can be accomplished is a function of education and coordination among the various agencies. A first step in detecting an undesirable species or pathway that might harbor ANS is to make sure those who encounter them know how to recognize them. This requires that those in the IDFG, IDPR, IDT or other agencies help train port of entry personnel, conservation officers or law enforcement officials on what to look for and what actions to take. However, the regulatory authorities are important as well, for if someone is trained to recognize a dangerous situation from an ANS standpoint but cannot take the necessary control actions, the detection holds little value.

Responsible agencies: IDFG; ISDA, IDPR, IDT

Current initiatives:

- Implementation of Plant Pest Act and Deleterious Animal Act, as they apply to ANS.

Gaps:

- Limited authority and funding to quarantine species and infested waters;
- Limited ability to monitor direct mail shipments or internet sales that might introduce or spread ANS;
- Limited authority to inspect, regulate or control ANS in private ponds;
- Agencies lack the authority to inspect and quarantine a specific water body once an ANS is detected;
- Vague authority for search, detention and seizure for suspected carriers of ANS.

Tasks:

6A). Promote legislation and regulatory rules that establish or increase the state's authority to control the introduction of new species, including such authorities for detaining and require cleaning of any vehicle, vessel or water based equipment containing or infested with ANS that is traveling in Idaho;

6B). Increase the ability of the State to regulate the importation of aquatic organisms, including requirements that imported aquatic organisms are disease and parasite free;

6C). Establish the authority to quarantine water bodies to prevent ANS from spreading and to contain ANS for future eradication;

6D). Develop policies, rules and if needed legislation to prevent the introduction of ANS into private ponds, including increased authority to inspect ponds, remove ANS species and provide penalties for illegal introductions of ANS into private ponds;

6E). Assure that existing laws controlling the transport, propagation, sale, collection, possession, importation, purchase, cultivation, distribution, and introduction of ANS are enforced;

6F). Establish and administer a program for ANS management efforts that allow state agencies to quickly respond to new detections of ANS in Idaho.

7. Coordination of efforts

The proposals in this ANS plan envision additional efforts that must be efficient and coordinated, which poses a significant challenge. While more work is clearly needed, it is difficult for those who currently have invasive species responsibilities to find time to assume new duties. In addition, each of those managers works within an existing program such as weed management, plant or forest pests or fisheries management. Therefore, it is impossible for any one of them to assume a statewide role for the management of all invasive species. Finally, a myriad of federal actions also affects state efforts. An ANS coordinator would help unify Idaho's efforts and add to them.

The IISC developed the previously mentioned statewide assessment and a Strategic Action Plan for Invasive Species and, in 2007, hired an Idaho Invasive Species Coordinator to improve the coordination of invasive species activities within the State of Idaho. Staff works to coordinate efforts throughout Idaho by working with state agencies, federal agencies, local governments and non-governmental organizations to address the IISC's recommendation to ensure that a comprehensive invasive species program in Idaho is not diluted by competing efforts among various agencies.

Responsible agencies: IISC, ISDA

Current initiatives:

- An implementation plan for Idaho's Action Plan for Invasive Species has been developed to set program priorities for developing work plans, assign accountability, prepare budgets, and report activities;

- The IISC is working with the U of I to conduct a Research Review for invasive species in Idaho;

- The IISC is developing a list of unwanted and high risk species that should trigger rapid responses in Idaho;

- The IISC is developing a system to display location data on invasive species in Idaho:

- The IISC is identifying key audiences and educational efforts needed to reach them;

- The IISC is establishing a single statewide point of contact and clearinghouse for reporting new or spreading invasive species and for disseminating information about them;

- The IISC is coordinating USEPA Wetlands Grant efforts with the Idaho Milfoil Task Force and the development of the ANS Management Plan.

Gaps:

- There is no clear authority or agency charged with limiting and managing ANS;
- Most management activities are focused on isolated problems or are species-specific and do not address the issue of ANS strategically;
- ANS activities are currently uncoordinated in Idaho and the region;
- The lack of a strategic plan to deal with some ANS has allowed some species to become established in Idaho, and new introductions are not being monitored, prevented or eradicated;
- No single state agency has a clear program directed at controlling or eradicating ANS across taxa.

Tasks:

7A). Develop cooperative agreements and or MOUs with states and provinces that share common waters;

7B). Participate in monitoring and/or rapid response efforts for high priority ANS in Idaho;

7C). Develop partnerships with private groups to fund prevention and eradication efforts;

7D). Coordinate all ANS management programs and activities within Idaho through the IISC;

7E). Create and fund a state ANS coordinator position using Task Force monies and matching funds;

7F). Continue participation in the Task Force's Western Regional Panel and support for such regional or national efforts as the 100th Meridian Project or the Columbia River Aquatic Nonindigenous Species Initiative (CRANSI).

Closing the Net on ANS—Idaho's Plan

The purpose of this plan for ANS is to create a clear focus on those species and to spell out additional actions needed within the state to effectively prevent new or spreading invasions. It is meant to supplement the overall invasive species strategy for the state. In order to do this, it is necessary to focus attention on those existing ANS efforts as well as to review the progress toward implementing relevant actions that were adopted through the statewide invasive species strategy. Thus, the ANS plan can serve as both a review of progress to date and an identification of any shortcomings in current or proposed efforts, which, if corrected, would strengthen Idaho's ANS programs.

The advisory group charged with the developing Idaho's plan for ANS has identified changes, which need to take place if we are to have an effective program of managing these unwanted species. The elements of this ANS plan, together with the agency or other entity responsible for initiating the action items and what will be necessary for them

to meet those responsibilities are summarized in Table 5. In addition to funding, there is a primary need for prioritization of staff time by agencies to meet the ANS challenge. With finite resources available to agencies, a greater prioritization will be dependent on increased education and awareness of ANS issues.

What Does it Take to Close the Net?

It might be easy to assume that preventing the entry and spread of aquatic nuisance species is something a "government agency" does. Federal and state agencies do have a clear role, whether is it inspecting interstate shipments of plants or animals, surveys of streams or control of species that have escaped to areas where they are not wanted. However, there is an equally important role that individuals not only can play, but must, if we are to achieve the goals of this plan. Often the actions that individuals take tell the tale of whether aquatic nuisance species are not introduced or their spread prevented. Here are a few simple steps that sportsmen, homeowners and farmers can take in order to do their part in controlling aquatic nuisance species.

- Use only bait that is approved by the Idaho Department of Fish and Game and never dump unused bait or live fish, crawfish or insect larvae into a lake or stream,

- Always check your boat and trailer for strings of aquatic weeds or strange mollusks that might adhere to fenders or transoms, when leaving an area or before moving to a new stream or lake. Remove those you find.

- Watch for strange or new mollusks or weeds in irrigation ditches, storage ponds or on headgates. Call a representative of Idaho Department of Fish and Game or the Idaho Department of Agriculture if something seems out of the ordinary.

- Clean the mud off the soles of your waders after you leave a stream, particularly if you are going to a new area. Wash and if possible, complete dry equipment between waters.

- Never dump aquarium plants or fish in an area where they might enter a stream or pond. Never use live tropical fish like goldfish as bait.

- Be cautious when planning for an ornamental outdoor pond or fountain to make sure the plants and fish you want in it cannot follow a downstream flow into a neighboring stream.

- Coordinate with neighboring states and provinces on the permitted introduction of any new species and species which are on the ANS watch lists.

Table 5. Summary of Needed Implementation Actions

Category	Task Number	Recommendation	Lead Entity	Major Resource Needs	Start Date	Completion Target
1. Early Intervention – Prevention, Early Detection, & Rapid Response	**1A**	Identify high-risk invasion pathways and water bodies. With this information, create early intervention strategies that reflect the risk and values of each. For example, where the risk of zebra mussel is high, develop an inspection and control program for trailered boats and water-based equipment	IISC	Agency commitments for staff and funding	Fall 07	Summer 09
	1B	Conduct an annual survey of high-risk waters, utilizing both existing state and federal field personnel and crews specifically targeting ANS	ISDA, IDFG, IDEQ	ANS Coordinator, .66 FTE, $100,000 annually, training and coordination	Spring, 08	Ongoing
	1C	Work with agencies, industries to develop protocols to guide the importation and transport of non-native species that might become nuisances if they spread to uncontrolled environments	ISDA, IDFG			
	1D	Develop a "watch list" of all species where introduction or spread are unwanted, along with management strategies for dealing with them according to their priority class	ISDA, IDFG			
	1E	Refine and implement the Rapid Response Plan as outlined in Appendix D	IDFG, IPR, ISDA			Ongoing
	1F	Encourage and train volunteer groups to work in cooperation with state agencies to monitor for new invasions or spreads by such methods as distributing zebra mussel substrates	ISDA, IDPR, IDFGI			

Table 5. Continued.

Category	Task Number	Recommendation	Lead Entity	Major Resource Needs	Start Date	Completion Target
	1G	Develop a system that can be quickly invoked for various species when there is imminent threat of their introduction	IDFG, IDEQ	Training	Fall, 07	Ongoing
	IH	Develop, maintain and implement Hazard Analysis and Critical Control Points (HACCP) plans for hatcheries, field, and survey crews	IDFG, ISDA, IDEQ	Training	Ongoing	Ongoing
2. Containment, Control and Restoration	**2A**	Continue surveys and control actions associated with Eurasian watermilfoil, including grants for local actions	ISDA, IISC	Funding	Ongoing	Ongoing
	2B	Continue current management programs for New Zealand mudsnail and whirling disease. Develop and implement an eradication and management program for saltcedar and other unfunded ANS	IDFG, ISDA, IDEQ, IDPR	Funding	Spring, 08	Ongoing
3. Reaching Important Audiences through Education and Training	**3A**	Develop a comprehensive education program to raise the awareness of ANS introduction and spread for such businesses as nurseries, aquatic pet stores, bait dealers, private pond management firms, fish hatcheries, irrigation managers and entities with watershed management responsibilities	IISC	Funding	Fall, 07	Ongoing
	3B	Develop a comprehensive education program to raise the awareness of ANS introduction and spread for county, state and federal agency field staffs	IISC	Funding	Fall, 07	Ongoing
	3C	Provide information on ANS to managers of fishing tournament and various sportsmen or recreational groups	IDFG	Funds for brochures	Fall, 07	Ongoing

Table 5. Continued.

Category	Task Number	Recommendation	Lead Entity	Major Resource Needs	Start Date	Completion Target
	3D	Build and maintain a comprehensive website on ANS in Idaho, highlighting high risk water bodies, high risk species and high risk actions that might lead to introduction or spread. Incorporate ways to report new sightings of ANS through this website	IISC			
	3E	Train enforcement personnel on ANS regulations and the field workers of all county, state and federal agencies to better equip them to identify new or spreading ANS. Use the IDPR Boat Safety Education training program.	IDPR, IDFG, ISDA,		Winter 07, 08	
	3F	Develop an annual report focused on ANS in Idaho and use it as an opportunity to reach decision makers and opinion leaders on the need for proper policies and funding for ANS efforts.	IISC, IDFG, ISDA		Fall	Ongoing
	3G	Develop and maintain statewide advertisements, PSAs, signing programs and other methods of communication with the public to remind them of ANS threats and the need for such personal actions as cleaning fishing or boating equipment	IISC, IDFG, IDPR			
	3H	Create an ANS component to the established Project Wild and Project Wet curricula for students.	IDFG		Summer 08	
	3I	Assign state employees to public education and outreach activities.	IDPR, IDFG, U of I			
	3J	Increase the capabilities of those who interact with invasion pathways (aquatic pet dealers, live plant distributors, irrigation districts, others) to understand the potential harm from the introduction and spread of ANS into uncontrolled environments	ISDA			

Table 5. Continued.

Category	Task Number	Recommendation	Lead Entity	Major Resource Needs	Start Date	Completion Target
4. Broadening Knowledge through Research and Technology Transfer	**4A**	Using nationally developed risk assessments and research as a basis, focus necessary additional research efforts on the potential harm and control methods for specific ANS for Idaho	U of I			
	4B	Evaluate the potential for aquarium and live food fish to serve as vectors of disease and parasites to native fish populations	U of I, IDFG, ISDA	Funding	Fall, 07	Summer, 08
	4C	Continue investigation on the effects of such established ANS as New Zealand mudsnails or whirling disease on native species.	U of I	Funding	Fall, 07	Ongoing
	4D	Research the impacts management alternatives have on ANS and native species.	U of I			
	4E	Investigate and develop new and innovative methods of managing ANS, including the efficiency of herbicides and various other management practices in aquatic and riparian habitats.	U of I			
	4F	Facilitate the collection and dispersal of information, research, and data on ANS in Idaho through a central source for reference information and data.	IDFG, ISDA			
	4G	Using nationally developed risk assessments as a basis, develop ANS risk assessment guidelines that will help local government and other managers understand the potential impacts and the need to manage ANS	IISC			
	4H	Develop a set of uniform definitions and terms to describe ANS	IDFG, IISC		Ongoing	Spring, 08
5. Assuring Adequate Funding	**5A**	Identify possible funding sources for implementing Rapid Response Plan actions.	IISC		Fall, 07	

Table 5. Continued.

Category	Task Number	Recommendation	Lead Entity	Major Resource Needs	Start Date	Completion Target
	5B	Increase existing funding and resources for ANS management and explore new funding possibly through permit fees or other sources.	IDFG, IDPR, IISC		Fall, 07	Winter, 08
	5C	Create stable funding sources for ANS management in Idaho by seeking federal funding from the NANPCA Act and other potential funding sources.	IDFG, IISC		Fall, 07	Winter, 08
6. Creating an Adequate, Effective Legal Structure	**6A**	Promote legislation and regulatory rules that establish or increase the state's authority to control the introduction of new species, including such authorities for detaining and require cleaning of any vehicle, vessel or water based equipment containing or infested with ANS that is traveling in Idaho.	ISDA, IDFG, ITD, IDPR		Fall, 07	Ongoing
	6B	Increase the ability of the State to regulate the importation of aquatic organisms, including requirements that imported aquatic organisms are disease or parasite free.	IDFG, ISDA			
	6C	Establish the authority to quarantine water bodies to prevent ANS from spreading and to contain ANS for future eradication.	IISC			
	6D	Develop policies, rules and if needed legislation to prevent the introduction of ANS into private ponds, including increased authority to inspect ponds, remove ANS species and provide penalties for illegal introductions of ANS into private ponds.	IDFG		Fall, 07	

Table 5. Continued.

Category	Task Number	Recommendation	Lead Entity	Major Resource Needs	Start Date	Completion Target
	6E	Assure that existing laws controlling the transport, propagation, sale, collection, possession, importation, purchase, cultivation, distribution, and introduction of ANS are enforced	IDFG, ITD, ISP			
	6F	Establish and administer a program for ANS management efforts that allow state agencies to quickly respond to new detections of ANS in Idaho	IISC			
7. Coordination of efforts	**7A**	Develop cooperative agreements and or MOUs with states and provinces that share common waters.	IISC			
	7B	Participate in monitoring and/or rapid response efforts for high priority aquatic nuisance species in Idaho	IDFG, ISDA, IDEQ, IDPR			
	7C	Develop partnerships with private groups to fund prevention and eradication efforts	IISC			
	7D	Coordinate all ANS management programs and activities within Idaho through the IISC	IISC			
	7E	Create and fund a state ANS coordinator position using Task Force monies and matching funds	IDFG, IISC		Fall, 07	
	7F	Continue participation in the Task Force's Western Regional Panel and support for such regional or national efforts as the 100th Meridian Project or the Columbia River Aquatic Nonindigenous Species Initiative (CRANSI)	IDFG, IISC		Fall, 07	Ongoing

Glossary

Accidental introduction: an introduction of nonindigenous aquatic species that occurs as the result of activities other than the purposeful or intentional introduction of the species involved, such as the transport of nonindigenous species in ballast water or in water used to transport fish, mollusks, or crustaceans for aquaculture or other purposes.

Aquatic nuisance species: a plant or animal species that threatens the diversity or abundance of native species, the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters. (Note: for the purposes of the State management plans, reference to an aquatic nuisance species will imply that the species is nonindigenous.)

Biocontrol: The use of living organisms, such as predators, parasites, and pathogens, to control pest insects, weeds, or diseases.

Control: eradicating, suppressing, reducing, or managing nuisance species populations, preventing spread of nuisance species from areas where they are present, and taking steps such as restoration of native species and habitats to reduce the effects of nuisance species and to prevent further invasions.

Ecological integrity: the extent to which an ecosystem has been altered by human behavior; an ecosystem with minimal impact from human activity has a high level of integrity; an ecosystem that has been substantially altered by human activity has a low level of integrity.

Eradicate: the act or process of eliminating an aquatic nuisance species.

Established: An introduced organism with a permanent population(s), i.e., one that has the ability to reproduce and is not likely to be eliminated by humans or natural causes.

Exotic: (same as nonindigenous and non-native) any species or other variable biological material that enters an ecosystem beyond its historic range, including such organisms transferred from one country to another. Species may or may not be classified as a nuisance species.

Fouling: entanglement, clogging, or obstruction by an undesired organism often resulting in diminished functioning of ships, intake pipes, and other submerged equipment or machinery.

High Risk species: an ANS that is considered to be a significant threat to Montana waters and is recommended for immediate or continued management action to minimize or eliminate their impact.

Intentional introduction: all or part of the process by which a nonindigenous species is purposefully introduced into a new area.

Introduction: The intentional or unintentional escape, release, dissemination, or placement of a species into a Idaho ecosystem as a result of human activity.

Invasive: (same as nuisance) a species that takes over a new habitat where it was not previously found, often to the detriment of species which were there before.

Native species: A species within its natural range or natural zone of dispersal, i.e., within the range it would or could occupy without direct or indirect introduction and/or care by humans. Existing within a historical ecological range, usually within a balanced system of coevolved organisms.

Nonindigenous species: any species or other variable biological material that enters an ecosystem beyond its historic range, including such organisms transferred from one country to another. Species may or may not be classified as a nuisance species.

Pathogen: a microbe or other organism that causes disease.

Pioneer infestation: a small ANS colony that has spread to a new area from an established colony.

Watershed: an entire drainage basin including all living and nonliving components.

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Whirling Disease: whirlingdisease.montana.edu/default.asp

Zebra and quagga mussels: www.100thmeridian.org/zebras.asp

Appendix A. Idaho's ANS Technical Advisory Committee

Department\Agency	Appointee	Address	Phone	Email
IDFG	Fred Partridge	PO Box 25, 600 South Walnut Boise, ID 83707	208-334-3791	fpartridge@idfg.idaho.gov
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IDEQ	Mark Shumar	1410 North Hilton Boise, ID 83706-0417	208-373-0132	Mark.Shumar@deq.idaho.gov
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UI	Christine Moffitt		208-885-7047	cmoffitt@uidaho.edu
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IPR	David Dahms			ddahms@idpr.state.id.us
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Idaho Association of Counties	Tom Kerr			twkfrk@ctcweb.net
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USEPA	Joan Cabreza			Cabreza.joan@epa.gov
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USFS	Jim Olivarez			jolivarez@fs.fed.us
University of Florida Center for Aquatic and Invasive Plants	Bill Haller	7922 NW 71st St. Gainesville, FL. 32653	352-392-9615	whaler@ufl.edu
USACE – Waterways Experiment Station	Kurt Getsinger	3909 Halls Ferry Road Vicksburg, MS 39180-6199	601-634-2498	getsink@wes.army.mil
Office of Species Conservation	Nate Fisher			nfisher@osc.state.id.us
Portland State University	Mark Sytsma			systsmam@pdx.edu

Appendix B. Species and Categories

HIGH-PRIORITY
AQUATIC NUISANCE SPECIES
CURRENTLY FOUND IN IDAHO

These species are defined as present in Idaho, but still in a potentially containable state, with local eradication possible.

New Zealand mudsnail *Potamopyrgus antipodarum*

Ecology: This very small snail (average size 5 mm) can be found in all types of aquatic habitats from eutrophic mud bottom ponds to clear rocky streams. It can tolerate a wide range of water temperatures (except freezing), salinity, and turbidity in clean as well as degraded waters. It feeds on dead and dying plant and animal material, algae, and bacteria. Its tolerance of a broad range of ecological factors makes the possibility of further spread likely.

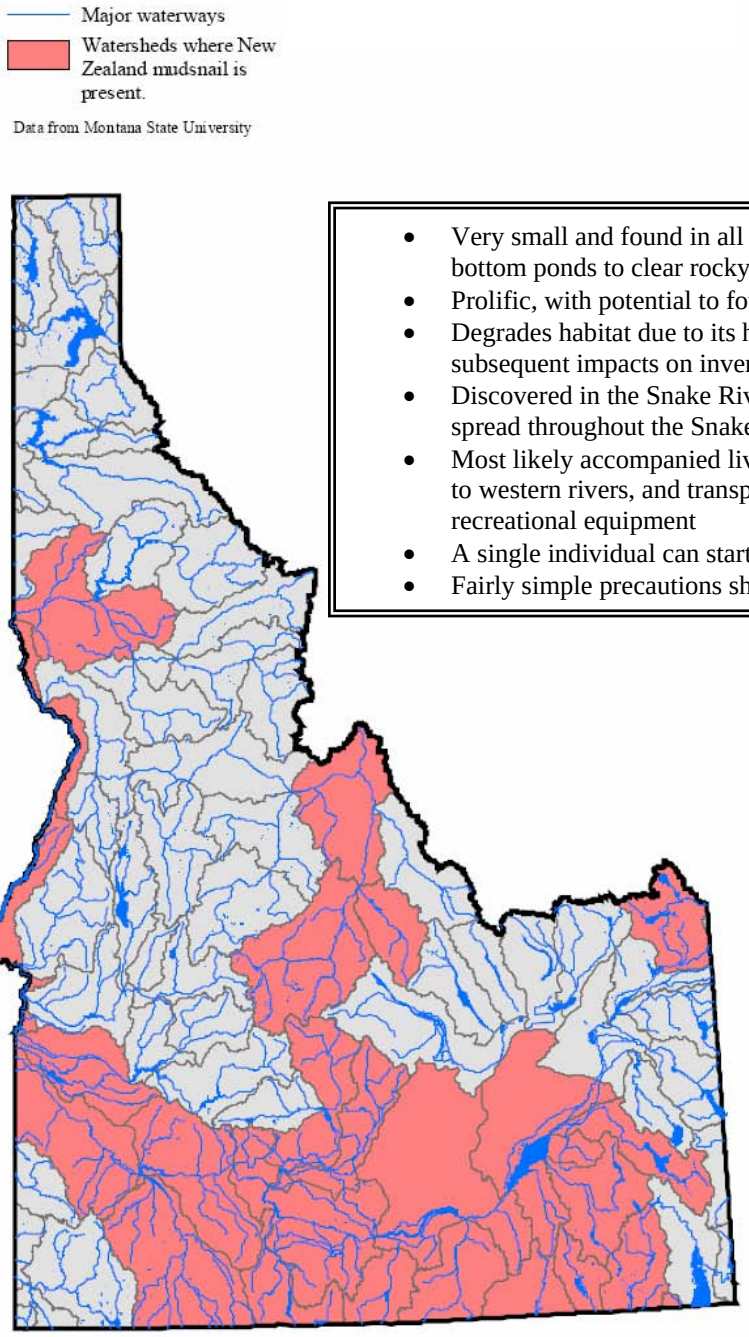
Densities have been known to reach over 300,000 individuals per square meter. A species as prolific as this has potential to be a biofouler at facilities drawing from infested waters. It also may compete for food and space occupied by native snails. The species degrades habitat due to its high reproductive capacity and the subsequent impacts on invertebrate food sources. Fish receive little, if any, nutritive value from eating the New Zealand mudsnail. The snail has an operculum that it closes when threatened, which prevents digestive juices from reaching the soft tissue of the snail's body when ingested by fish.

Distribution: New Zealand mudsnail have become established in all major river drainages in Yellowstone National Park, in the Madison River Drainage in Montana, at several other locations in the western United States, and in Lake Ontario, New York. Native to New Zealand but long established in Australia and Europe, this species was discovered in North America in 1987 in the Snake River in south-central Idaho, and has now spread throughout the Snake River Basin and elsewhere in the state.

Pathways of Introduction: This aquatic snail most likely accompanied live game fish shipped from their native waters to western rivers in the United States. Other modes of transportation may include hitchhiking on recreational equipment and other equipment used in water, in the guts of harvested or transported fish, or via transport on waterfowl and other aquatic birds.

Management considerations: Their large populations at many sites, small body size and broad environmental tolerance, make the New Zealand mudsnail well adapted to accidental transport by humans. As an asexual live-bearer, a single individual can start a new population. However, there is no resistance stage, nor is there any attachment mechanism, so fairly simple precautions should prevent accidental transport. While these snails can live for weeks if wet and cold, they are quickly killed by heat or thorough drying.

New Zealand mudsnail



- Very small and found in all types of aquatic habitats from mud bottom ponds to clear rocky streams
- Prolific, with potential to foul facilities drawing from infested waters
- Degrades habitat due to its high reproductive capacity and subsequent impacts on invertebrate food sources
- Discovered in the Snake River in south-central Idaho, and has now spread throughout the Snake River Basin
- Most likely accompanied live game fish shipped from infested waters to western rivers, and transportation may include hitchhiking on recreational equipment
- A single individual can start a new population
- Fairly simple precautions should prevent accidental transport

Potamopyrgus antipodarum
(New Zealand mudsnail)

Asian clam *Corbicula fluminea*

Ecology: A bivalve native to tropical and subtropical waters, the Asian clam is a filter feeder that removes particles from the water column. It can be found at the sediment surface or slightly buried. Its ability to reproduce rapidly, coupled with low tolerance of cold temperatures, can produce wild swings in population sizes from year to year in northern water bodies. Factors that may affect population density and distribution of Asian clams include excessively high or low temperatures, salinity, drying, low pH, silt, hypoxia, pollution, bacterial, viral and parasitic infections, inter- and intraspecific competition, predators, and genetic changes.

The most prominent effect of the introduction of the Asian clam into the United States has been biofouling, especially of complex power plant and industrial water systems. It has also been documented to cause problems in irrigation canals and pipes and drinking water supplies. It alters benthic substrate and competes with native species for limited resources.

Distribution: The Asian clam was introduced to the eastern United States in the early 20th century. It has since spread to most of the waterways in the east, and somewhat less widely in the west. In Idaho it is currently found in the lower Boise River in Ada and Canyon Counties, and in the Snake River from C.J. Strike Reservoir in Elmore County downstream.

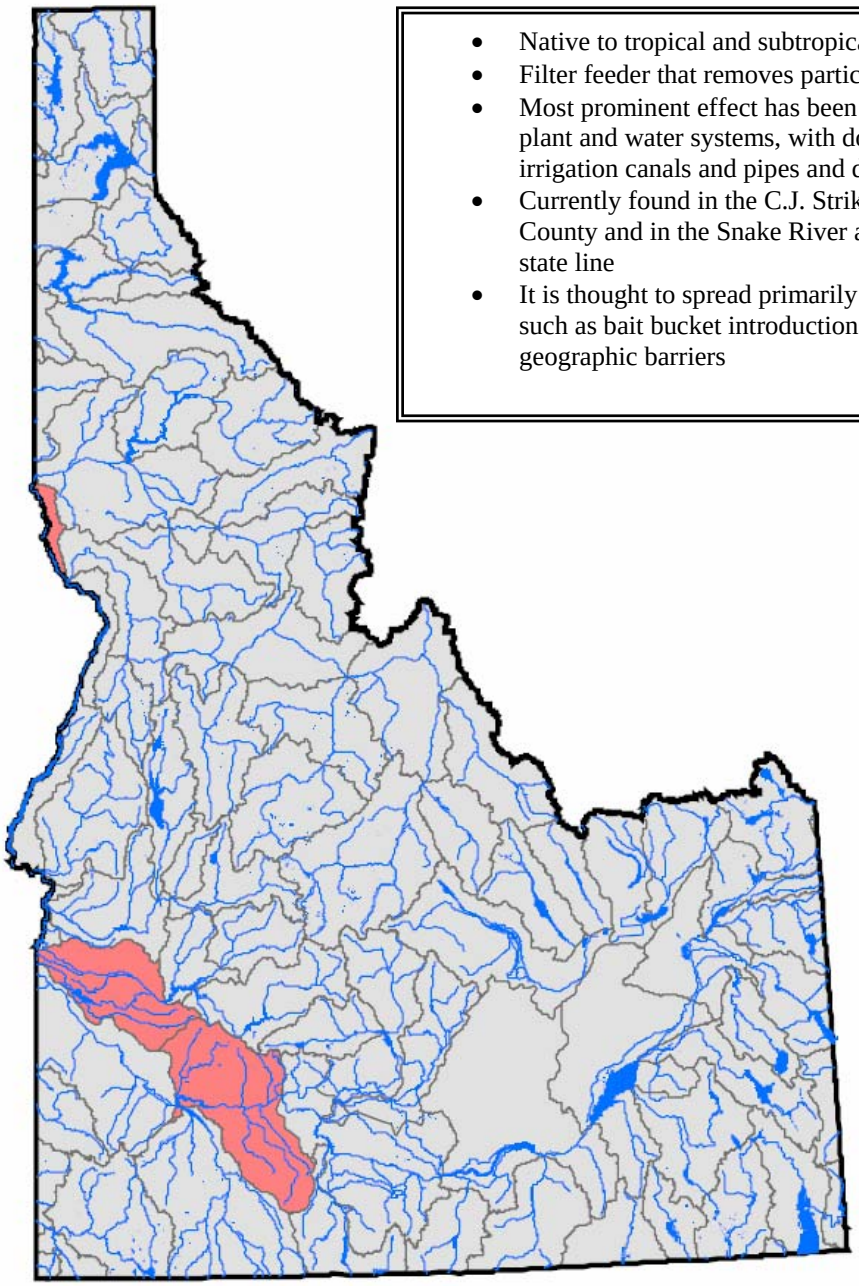
Pathways of Introduction: *Corbicula fluminea* was thought to have first entered the United States as a food item. With man shown to be the primary agent of dispersal, no large-scale geographic features function as dispersal barriers. It is thought to spread primarily through human activity such as bait bucket introductions, accidental introductions associated with imported aquaculture species, and intentional introductions by people who buy them as a food item in markets. The only other significant dispersal agents are water currents or flooding events. Fish and birds are not thought to be dispersal vectors.

Asian clam

Major waterways

Watersheds where Asian clams are present.

Data from DEQ and USGS



- Native to tropical and subtropical waters
- Filter feeder that removes particles from the water column
- Most prominent effect has been fouling of complex power plant and water systems, with documented problems in irrigation canals and pipes and drinking water supplies
- Currently found in the C.J. Strike Reservoir in Elmore County and in the Snake River at the Idaho-Washington state line
- It is thought to spread primarily through human activity such as bait bucket introductions; there are no large-scale geographic barriers

Corbicula fluminea
(Asian clam)

Whirling Disease *Myxobolus cerebralis*

Ecology: Whirling disease is caused by a metazoan parasite that can infect most wild or farm-raised salmonid species, although rainbow trout and cutthroat trout appear to be more susceptible than other trout species. This parasite has a two-host life cycle which includes both the primary salmonid host and a common aquatic worm *Tubifex tubifex*. When an infected fish dies and decays, spores are released and ingested by tubifex worms. The spores undergo development in the worm's intestine and multiply rapidly. When released by the worm, the water-borne spores infect susceptible fish by attaching to the fish's body. The parasite then migrates through the skin to the central nervous system and the cartilage of the fish. The spores are believed to be capable of remaining dormant in mud for thirty years.

Whirling disease afflicts juvenile fish (fingerlings and fry) and causes skeletal deformation and neurological damage. Fish "whirl" rather than swim forward, find feeding difficult, and are more vulnerable to predators. The mortality rate is high for fingerlings, up to 90% of infected populations, and those that do survive are deformed by the parasite residing in their cartilage and bone. They act as a reservoir for the parasite, which is released into water following the fish's death.

Distribution: *M. cerebralis* was first recorded in North America in 1956 in Pennsylvania, having been introduced via infected trout imported from Europe, and has spread steadily south and westwards. Until the 1990s, whirling disease was considered a manageable problem affecting rainbow trout in hatcheries. However, it has recently become established in natural waters of the Rocky Mountain states including Idaho in 1987, where it can cause heavy mortalities in trout populations. Some streams in the western United States have lost 90% of their trout.

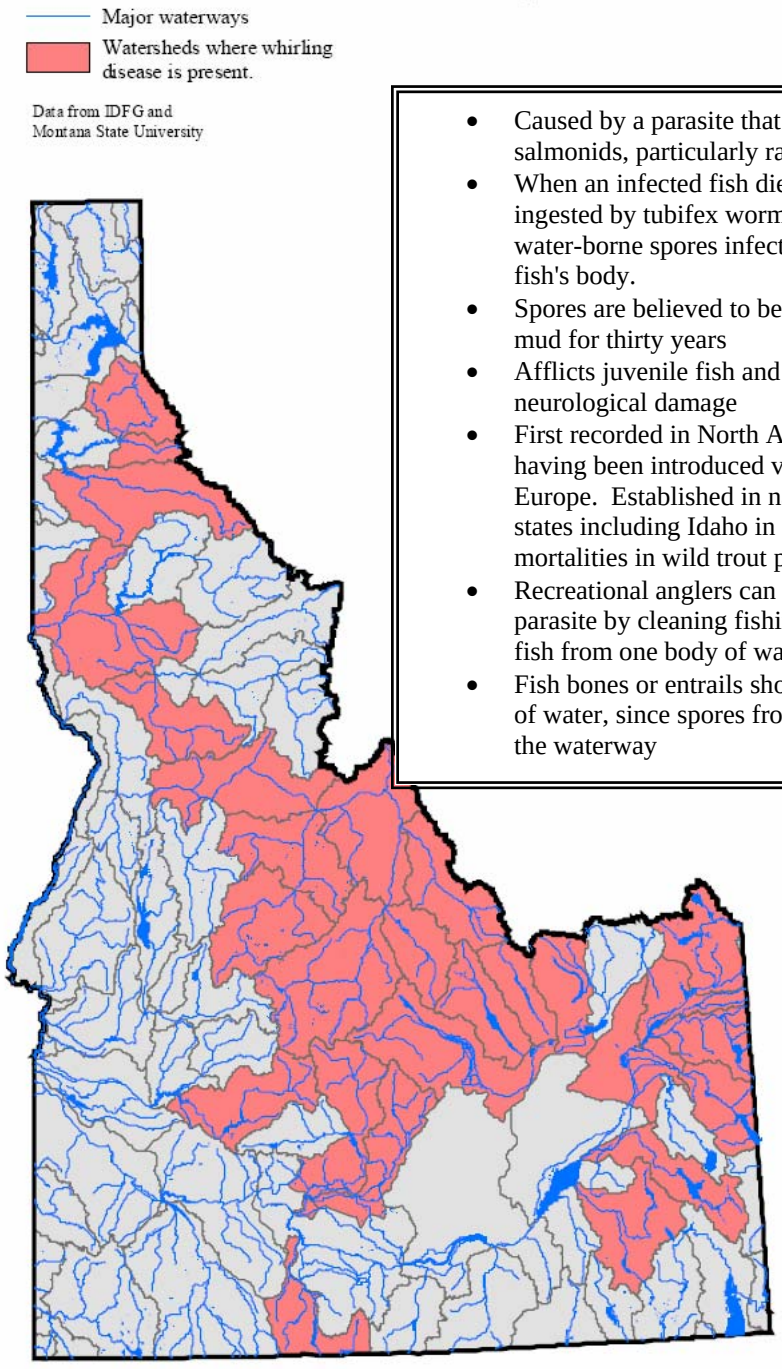
Pathways of Introduction: The manner in which whirling disease was spread to Idaho is not known, but may have been a result of aquaculture release. Other avenues for spread of this disease include landscape/fauna "improvement", live food trade, transportation of domesticated animals, transportation of habitat material, and water currents. Wild salmonid populations may have been infected through the alimentary tracts of fish-eating migratory birds.

Management considerations: As young fish are the most susceptible, management techniques have traditionally focused on controlling exposure of fry to the infectious stage of *M. cerebralis*, which are microscopic spores called triactinomyxons. Hatcheries have previously done this in two ways: 1) rear the young fish in well water to prevent exposure until they are older and more resistant, or 2) use pond designs that reduce potential habitat for oligochaetes. New research suggests that exposing water to unltraviolet light can inactivate triactinomyxons. A dose of 1300 mWs cm-2 ultraviolet light can inactivate 100% of the triactinomyxons.

For reasons that are poorly understood, but probably have to do with environmental conditions, the impact on infected fish has been greatest in Colorado and Montana and least in California, Michigan, and New York.

Recreational anglers can help to prevent the spread of the parasite in a number of ways. Cleaning fishing equipment between fishing trips and never transporting fish from one body of water to another should protect against cross contamination of waterways. Spores are particularly persistent in felt soled wading shoes, which can be treated with 10% chlorine bleach and water for at least 15 minutes and then rinsed thoroughly. Fish bones or entrails should never be disposed of in any body of water, since spores from the carcass will be released into the waterway. Salmon and trout should not be used as bait.

Whirling Disease



- Caused by a parasite that can infect most wild or farm-raised salmonids, particularly rainbow trout and cutthroat trout
- When an infected fish dies and decays, spores are released and ingested by tubifex worms. When released by the worm, the water-borne spores infect susceptible fish by attaching to the fish's body.
- Spores are believed to be capable of remaining dormant in mud for thirty years
- Afflicts juvenile fish and causes skeletal deformation and neurological damage
- First recorded in North America in 1956 in Pennsylvania, having been introduced via infected trout imported from Europe. Established in natural waters of the Rocky Mountain states including Idaho in 1987), where it may causing heavy mortalities in wild trout populations
- Recreational anglers can help to prevent the spread of the parasite by cleaning fishing equipment and never transporting fish from one body of water to another
- Fish bones or entrails should never be disposed of in any body of water, since spores from the carcass will be released into the waterway

Eurasian watermilfoil *Myriophyllum spicatum*

Ecology: This is a submersed, rooted, perennial vascular plant consisting of long underwater stems that branch and produce whorled, finely divided leaves near the water surface. It colonizes lakes, ponds, shallow reservoirs, low energy areas of rivers and streams, and the brackish water of protected tidal creeks and bays. Key factors in the plant's success is its ability to reproduce through stem fragmentation and seeds. A single segment of stem can take root and form a new colony.

Eurasian watermilfoil competes aggressively to displace and reduce the diversity of native aquatic plants. It survives and photosynthesizes under the ice in winter and begins spring growth earlier than most native aquatic plants. Tolerant of low water temperatures, it quickly grows to the surface, forming dense canopies that overtop and shade the surrounding vegetation. Canopy formation and light reduction are significant factors in the decline of native plant abundance and diversity observed when Eurasian watermilfoil invades plant communities. Typical dense beds restrict swimming, fishing and boating, clog water intakes and result in decaying mats that foul lakeside beaches.

Eurasian watermilfoil has less value as a food source for waterfowl than the native plants it replaces. Although fish may initially experience a favorable edge effect, the characteristics of Eurasian watermilfoil's overabundant growth negate any short-term benefits it may provide fish in healthy waters. At high densities, its foliage supports a lower abundance and diversity of invertebrates and other organisms that serve as fish food.

Distribution: First documented in 1942 in a pond in Washington D.C., Eurasian watermilfoil probably was intentionally introduced to the United States from Europe, possibly for aquarium use. Spread westward into inland lakes primarily by boats and water birds, it reached the Midwestern states between the 1950s and 1980s. It is now one of the most widely distributed of all nonindigenous aquatic plants, having been confirmed in 45 United States and in the Canadian provinces of British Columbia, Ontario and Quebec. In Idaho it is abundant throughout the northern and southwestern portions of the state.

Pathways of Introduction: It is not known exactly how Eurasian watermilfoil was introduced into Idaho, but it was likely carried by boats and/or water birds. Fragments clinging to boats and trailers can spread the plant from lake to lake. Once the plant is established it is almost impossible to eradicate.

Management considerations: The occurrence of sixteen species of including *Potamogeton illinoensis* and *Potamogeton pectinatus* may be indicators of conditions suitable for Eurasian watermilfoil invasion. Searching areas colonized by these species may provide early detection, the best method for preventing new infestations.

Several aquatic herbicides are available for control of Eurasian watermilfoil, including fluridone, 2,4-D, diquat, endothall, copper and confentrazone. Mechanical harvesting has also been widely used in the Midwest and the northeast.

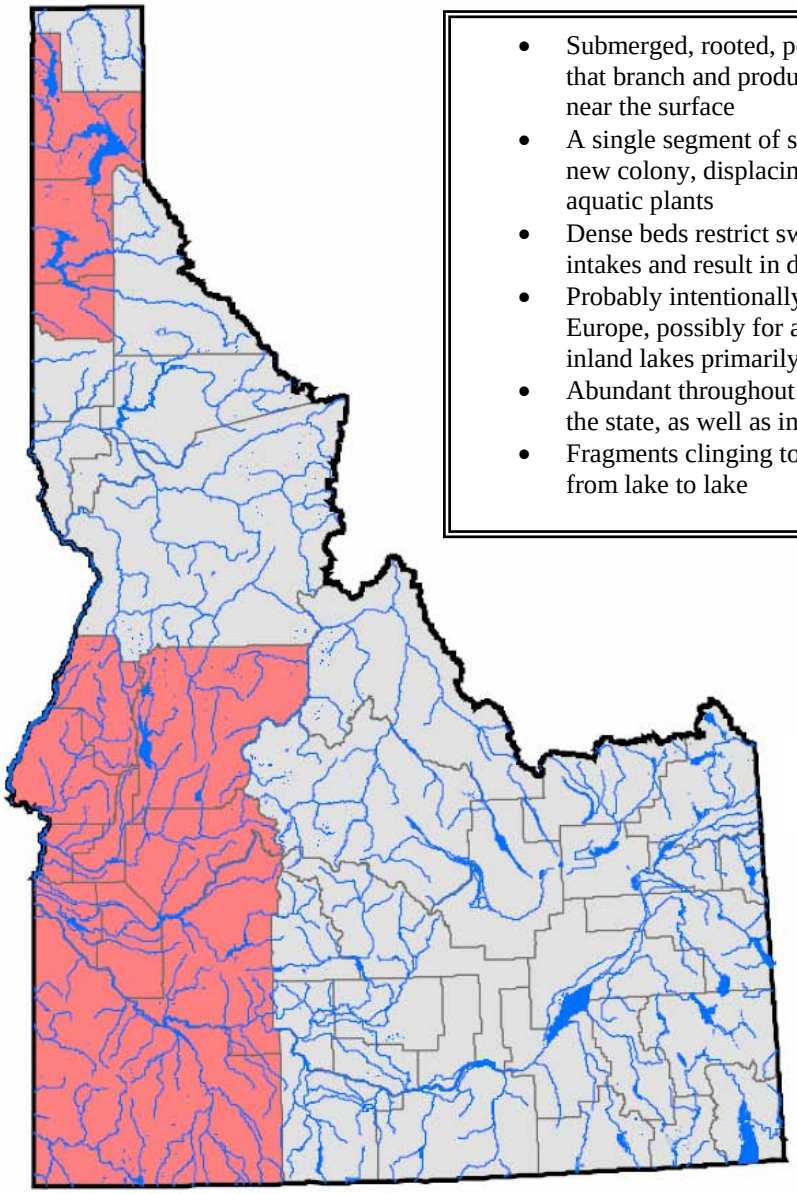
A North American weevil, *Euhrychiopsis lecontie*, is widely associated with Eurasian watermilfoil and may be linked with natural declines at northern lakes. Studies have found the herbivorous weevil occasionally causes significant damage to Eurasian watermilfoil while having no impact on native species. However, extensive testing over the past decade has shown its effects are unpredictable and research on this agent is ongoing.

Eurasian watermilfoil

Major waterways

Counties where Eurasian Water-milfoil is present.

Data from NRCS



- Submerged, rooted, perennial herb with long underwater stems that branch and produce many whorled, finely divided leaves near the surface
- A single segment of stem and leaves can take root and form a new colony, displacing and reducing the diversity of native aquatic plants
- Dense beds restrict swimming, fishing and boating, clog water intakes and result in decaying mats that foul lakeside beaches.
- Probably intentionally introduced to the United States from Europe, possibly for aquarium use, spread westward into inland lakes primarily by boats and water birds
- Abundant throughout the western and southwestern portions of the state, as well as in numerous watersheds in the north
- Fragments clinging to boats and trailers can spread the plant from lake to lake

Myriophyllum spicatum
(Eurasian watermilfoil)

Parrot feather milfoil *Myriophyllum aquaticum*

Ecology: Parrot feather milfoil exhibits two different leaf forms depending on whether it is growing as a submersed plant or as an emergent shoot extending above the water surface. The submersed leaves are 1.5 to 3.5 centimeters long and have 20 to 30 divisions per leaf while the emergent leaves are 2 to 5 centimeters long and have 6 to 18 divisions per leaf. The bright green emergent leaves are stiffer and a darker green than the submersed leaves.

Parrot feather milfoil grows in sluggish waters, edges of streams, lakes, ponds, drainage and irrigation ditches, and canals, backwaters, sloughs and lagoons. It appears to be adapted to high nutrient environments, and does well in good light and a slightly alkaline environment.

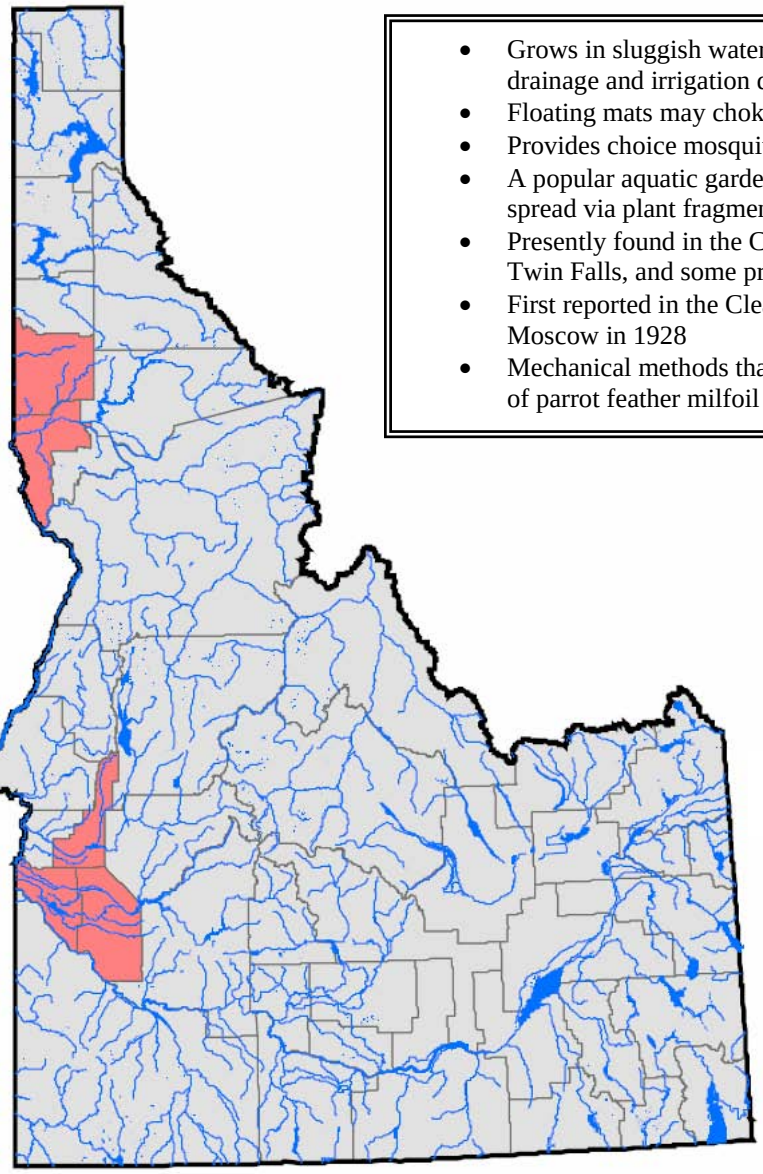
Populations often become dense and sometime occur as floating mats that have been uprooted, often choking waterways and impeding navigation. While parrot feather milfoil may provide cover for some aquatic organisms, it can seriously change the physical and chemical characteristics of lakes and streams. Infestations can alter aquatic ecosystems by shading out the algae in the water column that serve as the basis of the aquatic food web. In addition, the plant severely restricts water flow in both natural and artificial channels, providing choice mosquito larvae habitat. The plant can restrict water flow in canals and recreational opportunities.

Distribution: Parrot feather milfoil is a popular aquatic garden plant offered for sale by retailers throughout the United States. However, it has escaped cultivation and spread via plant fragments and intentional plantings. Parrot feather milfoil is also spread by floods, animals, boating and other recreational activities. In Idaho it is presently found in the Clearwater subbasin and in the lower Payette and Boise basins.

Pathways of Introduction: Parrot feather milfoil's route into Idaho is not known, but may have been via waterfowl or boats. It was first reported in the Clearwater drainage about 50 miles east of Moscow in 1928. It is currently still offered to sale for water gardens throughout the United States.

Management considerations: Mechanical control of parrot feather milfoil usually provides only temporary reduction of biomass and can spread plant fragments downstream or to other locations where they can start new growth. There are no known bio-control agents that are in widespread use and grass carp do not eat a significant amount of any of the milfoil families. Several contact and systemic herbicides offer temporary reduction in plant biomass. The most effective, long term control might be achieved by treating plants that are exposed by drawdown of water levels so that a greater portion of the vegetation comes into contact with the herbicide.

Parrot feather milfoil



- Grows in sluggish waters, edges of streams, lakes, ponds, drainage and irrigation ditches
- Floating mats may choke waterways and impede navigation
- Provides choice mosquito larvae habitat
- A popular aquatic garden plant that escaped cultivation and spread via plant fragments and intentional plantings
- Presently found in the Clearwater subbasin and in Emmett, Twin Falls, and some private ponds in Ada County
- First reported in the Clearwater about 50 miles east of Moscow in 1928
- Mechanical methods that cut up stems will increase the spread of parrot feather milfoil

Myriophyllum aquaticum
Parrot feather milfoil

Yellow iris *Iris pseudacorus*

Ecology: Yellow iris is a perennial monocot plant that forms dense stands along the margins of water bodies. It thrives in temperate climates, and can grow in water up to 25 cm deep. It is a fast-growing and fast-spreading invasive plant that dominates other wetland plants, forming almost impenetrable thickets. All parts of the plant are poisonous, especially the rhizomes, and caution should be used when hand-pulling this plant because it causes skin irritations.

Once established, yellow iris thick tuberous rhizomes can tolerate both prolonged anoxic and/or drought conditions, and its rhizomes and seeds can be transported downstream for further spread. The rhizome mat can prevent the germination and seedling growth of native plant species. The mat also creates improved habitat for yellow iris by compacting soil and elevating the topography, thereby creating a drier habitat with an increased rate of sediment and organic matter accumulation.

Distribution: Yellow iris is not equally distributed or problematic throughout the 40 states in which it is reported. It is relatively new to the western United States, where early records from California and western Montana date to the 1950s. Yellow iris is widespread in the northeastern United States, where it has been found in the wild for close to 140 years. In Idaho, it is found in streams and irrigation canals in Latah, Benewah, Ada, Canyon, Boise, Jerome, and Twin Falls counties.

Pathways of Introduction: It has typically been introduced as an ornamental, but has also been used in erosion control and for making dyes and fibers. It remains a horticultural favorite and often escapes cultivation to spread along shorelines, stream flats, and into fresh and brackish marshes.

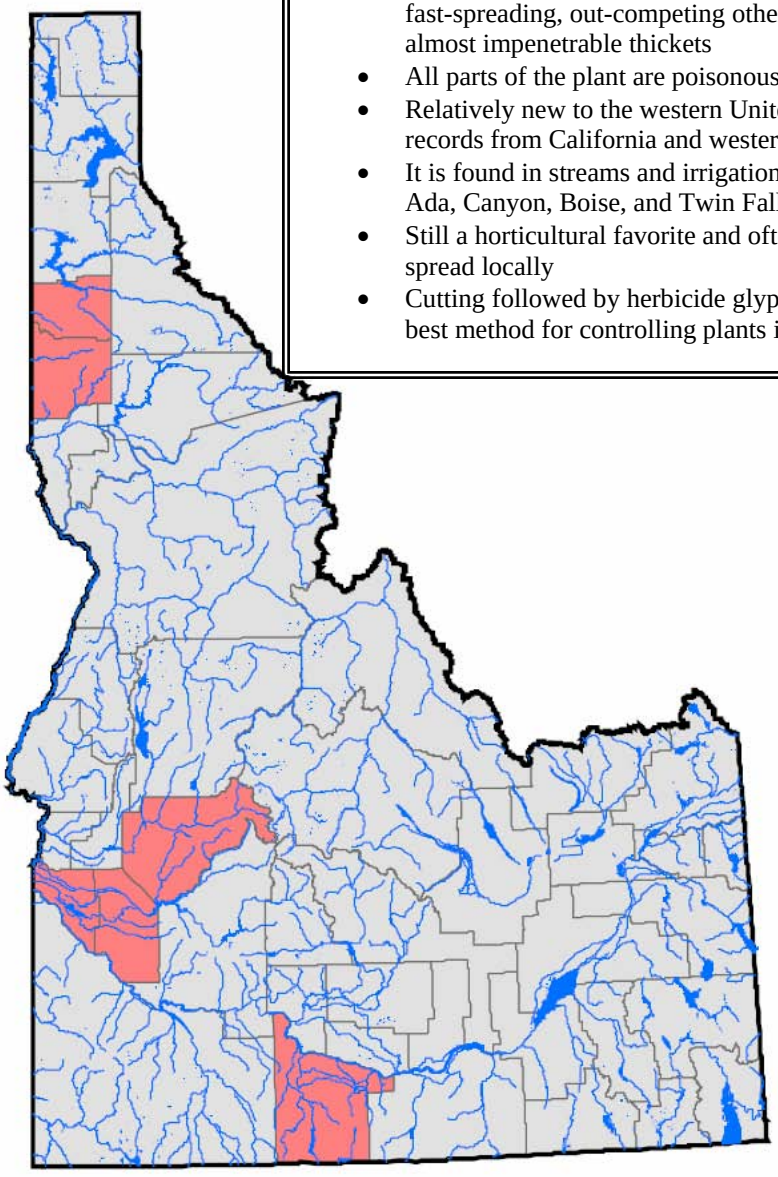
Management considerations: Because of its strong tendency to resprout from rhizomes, burning is not recommended for control. Similarly, fire in late summer was not found to suppress seedling recruitment the following spring. Yellow iris is susceptible to many registered herbicides. It can be controlled either by directly applying herbicides to foliage, or by immediately applying herbicide to freshly cut leaf and stem surfaces.

Yellow Iris

Major waterways

Counties where Yellow Iris is present.

Data from NRCS



- Forms dense stands of robust plants that are fast-growing and fast-spreading, out-competing other wetland plants, forming almost impenetrable thickets
- All parts of the plant are poisonous
- Relatively new to the western United States, where notable early records from California and western Montana date to the 1950s
- It is found in streams and irrigation canals in Latah, Benewah, Ada, Canyon, Boise, and Twin Falls Counties
- Still a horticultural favorite and often escapes cultivation to spread locally
- Cutting followed by herbicide glyphosate) treatment may be the best method for controlling plants in sensitive sites

Iris pseudacorus
(Yellow iris)

Curly-leaf pondweed *Potamogeton crispus*

Ecology: Curly-leaf pondweed is a perennial, rooted, submersed aquatic vascular plant native to Eurasia, Africa, and Australia. It is found in freshwater lakes, ponds, rivers and streams, and in slightly brackish waters. This pondweed shelters small fish and aquatic insects that provide food for larger fish and amphibians but becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to preempt native plants in the early spring.

By late spring it forms dense mats which may interfere with recreation and limit the growth of native aquatic plants. By July, this plant senesces and forms vegetative propagules called turions which are dispersed by water movement throughout a water body.

In some lakes, it coexists with native plants and does not cause significant problems. In other lakes, it becomes the dominant plant and interferes with late spring and early summer recreation due to the formation of dense mats. Its mid-summer senescence triggers an increase in phosphorus concentrations sometimes causing algae blooms, and dying plants pile up along the shore.

Distribution: This species is widespread throughout the northern United States. Although its first arrival in Idaho is not known, it has been reported since at least 1973, and is currently found in several counties in southeastern, western, and northern Idaho.

Pathways of Introduction: Curly-leaf pondweed can spread by plant fragments attached to boats and equipment. Its turions may also be transferred to uninfested lakes through human or animal transport or by water currents.

Management considerations: Curly-leaf pondweed has a unique lifecycle, which influences management options for its control. It is the first pondweed to resume growth in spring and dies back during mid-summer. Before it dies, it forms vegetative propagules called turions (hardened stem tips) that disperse by water movement. Turions lie dormant during summer when native plants are growing, and germinate in late fall or early spring when most native vegetation has died back. Long-term management of curly-leaf will require the reduction or elimination of turions to interrupt its life cycle. Management activities should be undertaken in spring or very early summer to have the maximum benefit. Mechanical control includes raking, cutting or harvesting vegetation. Raking and hand cutting generally remove the plants at the sediment surface while harvesting removes the top 5 ft of the plant. Mechanical methods control plants in the specific areas where they are causing a nuisance, and there is immediate relief from the nuisance. There is some evidence that early season cutting of pondweed at the sediment surface can prevent turion production.

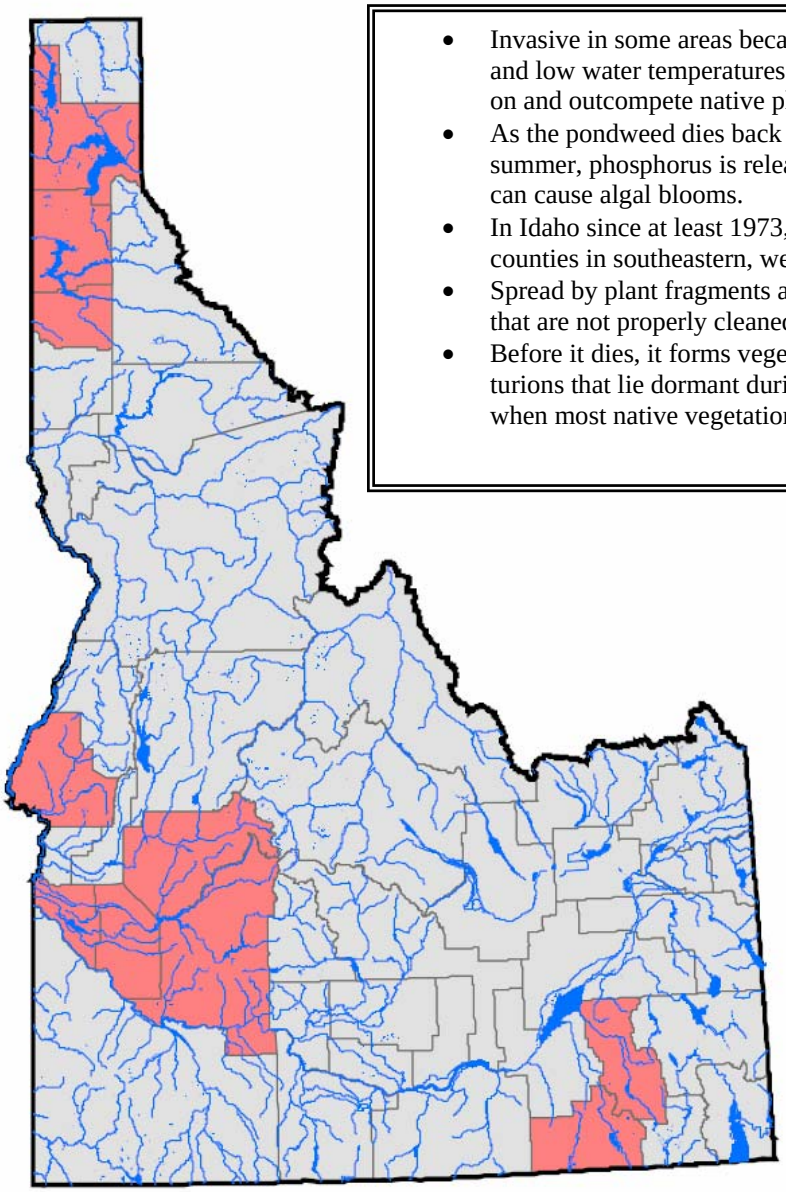
There are no known biocontrol agents. Early spring herbicide treatments, repeated over a 2-3 year period, have been shown to reduce the density of this species significantly. It is susceptible to several herbicides, but both herbicides and mechanical control are expensive.

Curly-leaf pondweed

Major waterways

Counties where Curly-leaf Pondweed is present.

Data from NRCS



- Invasive in some areas because of its tolerance for low light and low water temperatures, which allow it to get a head start on and outcompete native plants in the spring
- As the pondweed dies back and decomposes in the mid-summer, phosphorus is released into the water column which can cause algal blooms.
- In Idaho since at least 1973, and currently found in several counties in southeastern, western, and northern Idaho
- Spread by plant fragments attached to boats and equipment that are not properly cleaned
- Before it dies, it forms vegetative reproductive buds called turions that lie dormant during the summer and germinate when most native vegetation has died back

Potamogeton crispus
(Curly-leaf pondweed)

Purple loosestrife *Lythrum salicaria*

Ecology: Purple loosestrife is an emergent, perennial plant with a woody stem and whirled leaves. It has the ability to reproduce prolifically by both seed dispersal and vegetative propagation. It is capable of invading a variety of wetland habitats, including marshes, river and stream banks, pond edges, lakes, road site ditches, and reservoirs. The plant prefers moist soil with neutral to slightly acidic pH. Once established, however, purple loosestrife can exist in a wide range of soil types. Disturbed areas are more prone to invasion because exposed soil is ideal for seed germination.

As purple loosestrife establishes itself, it outcompetes and replaces native grasses, sedges, and other plants that provide a higher quality food source and habitat for wildlife. It can deleteriously impact wildlife habitat used by birds and furbearers. Purple loosestrife forms dense homogeneous stands that restrict native wetland plant species, including some endangered plants. Purple loosestrife dominates wetlands and almost entirely eliminates shallow open water habitat if left uncontrolled. The recreational and aesthetic value of wetlands and waterways is diminished as dense stands of purple loosestrife choke waterways and decrease biodiversity. Its vegetative dominance may increase the likelihood of listing additional native species as “threatened” or “endangered” under the ESA.

Distribution: It is currently found in the wild in 42 of the 48 contiguous states and is widespread in Idaho’s wetlands.

Pathways of Introduction: Purple loosestrife can spread via floating vegetation/debris, landscape/fauna "improvement", garden escape or garden waste, and water currents. Purple loosestrife is also widely sold as an ornamental in states where regulations do not prohibit its sale and distribution. In Idaho, it is listed as a noxious weed and its sale is prohibited.

Management considerations: Herbicides are most commonly used for quick, effective control of purple loosestrife. They may be most effectively applied when plants are preparing for dormancy; however, mid-summer and late season treatments may be needed to reduce the amount of seed produced. Multiple chemical treatments are usually required as new seedlings emerge annually from the seed bank.

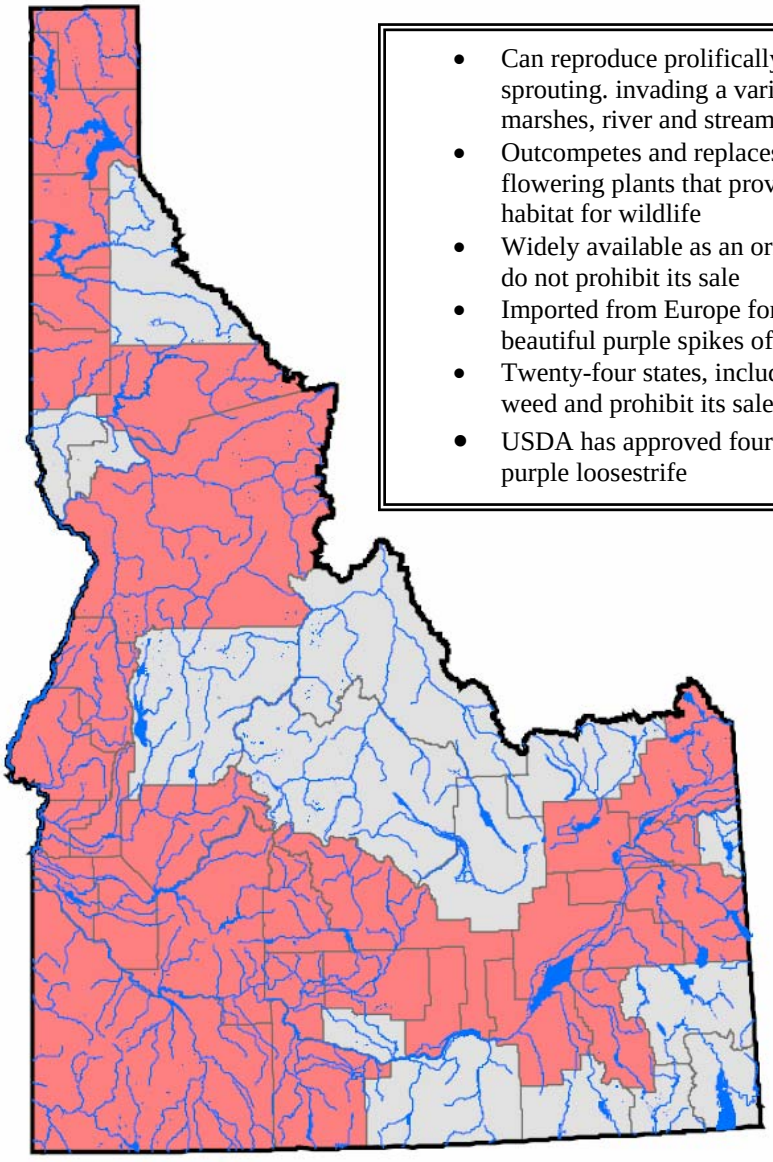
Although chemical control measures are effective, they are usually costly. In the United States, four insects from Europe have been approved by the APHIS for use as biological control agents: The root-mining weevil *Hylobius transversovittatus*, two leaf-feeding beetles *Galerucella calmariensis* and *G. pusilla,* and *Nanophyes marmoratus,* an herbivorous weevil. *G. calmariensis*, *G. pusilla* and *H. transversovittatus* have been released across the United States and Canada. In many release sites *G. calmariensis* has provided successful control of the target weed in as little as 3 years by reducing plant populations as much as 100%. The two leaf beetles have been successful in Idaho, with little to no impact on native, non-target species.

Purple loosestrife

Major waterways

Counties where Purple Loosestrife is present.

Data from NRCS



- Can reproduce prolifically by both seed dispersal and sprouting. invading a variety of wetland habitats, including marshes, river and stream banks, ponds and lakes
- Outcompetes and replaces native grasses, sedges, and other flowering plants that provide a higher quality food source and habitat for wildlife
- Widely available as an ornamental in states where regulations do not prohibit its sale
- Imported from Europe for its medicinal value and for the beautiful purple spikes of the blooming plant
- Twenty-four states, including Idaho, have listed it as a noxious weed and prohibit its sale
- USDA has approved four insects for biological control of purple loosestrife

Lythrum salicaria
(Purple loosestrife)

Saltcedar *Tamarix ramosissima*

Ecology: Saltcedar is a deciduous shrub that can appear as a small tree. It can be found where its roots reach the water table, such as floodplains, along irrigation ditches and on lake shores and it can tolerate a wide range of saline or alkaline soils. Periods without access to the water table are also well tolerated, which contributes to its becoming an invasive species in Idaho.

Saltcedar benefits from altered hydrology, especially where natural flooding is attenuated by water regulation. Alteration of natural flooding regimes through dam construction has resulted in saltcedar replacing many native tree species in riparian areas, such as cottonwood *Populus deltoides* and willows *Salix* spp.. The invasion of saltcedar along streams is likely to have altered the food webs in these aquatic ecosystems. The roots of saltcedar bind together gravel and cobble riverbeds, resulting in enlarged bars and narrowed channels, which contribute to flooding, accelerated erosion, and undercutting of the stream banks.

The leaf litter and foliage produced by saltcedar is flammable and encourages the spread of wildfires. Native vegetation and wildlife are destroyed in these fires, saltcedar seedlings are fire tolerant and can re-sprout more successfully than native plants following fire. Moreover, enormous numbers of seeds—up to half a million per year from a mature shrub—are spread by wind or fire.

Saltcedar is also known to transpire large amounts of groundwater, which desiccates soils and lowers the water table. Its transpiration rate is similar to native plants on a per-leaf basis but it maintains a larger leaf area per ground area, and therefore uses more water. Because saltcedar can take up water from non-saturated soils, it has an added advantage in out competing native vegetation.

Saltcedar supports few native insects and is considered poor habitat for birds. It is able to dominate floodplain communities in desert environments due to its ability to tolerate water stress for extended periods.

Distribution: This species is found in nearly all of the 48 contiguous states of the United States including Idaho, where it is found in several locations throughout the Snake River Basin.

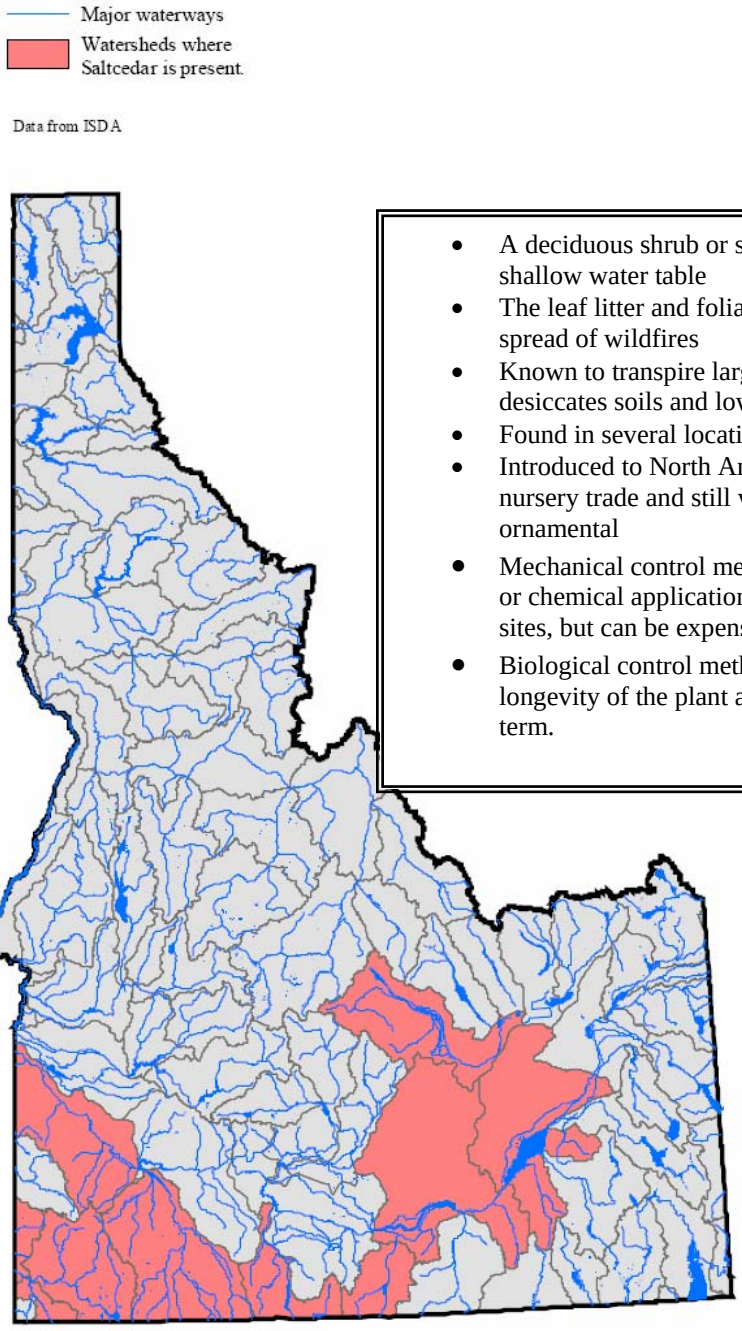
Pathways of Introduction: Saltcedar is thought to have been introduced to North America from its native Eurasia in the 19th century by the nursery trade. It is widely available for sale as an ornamental, due to its feathery foliage and its profusion of white or pink flowers. It has also been use as windbreaks. In coastal environments it has been used for sand-binding and has become naturalized in many coastal areas. In addition to deliberate spread by humans, it can also spread easily by its abundant wind-borne seeds.

Management considerations: An integrated management approach that incorporates multiple control techniques is most widely used in the western United States. Mechanical control methods (hand-pulling, cutting, bulldozing) or chemical applications are effective

but can be expensive and/or labor intensive. Cattle and goats will eat saltcedar, but grazing alone is not a feasible control method in many locations. However, goats might be able to control dense stands of saltcedar where little native vegetation is present, particularly if the stands are cut or burned first, allowing goats to eat the regrowth.

A biocontrol agent, the saltcedar leaf beetle *Diorhabda elongata*, has been released in certain areas in nine western states. It is anticipated that control by the leaf beetle will occur gradually because three years of defoliation are required for major dieback, with very little mortality of host plants. A mealy bug *Trabutina mannipara* and a weevil *Coniatus tamarisci* have also been approved for re-introduction by APHIS, but not yet released pending results from beetle introductions. Several other specialist herbivores are being studied for their biocontrol potential.

Saltcedar



- A deciduous shrub or small tree usually found in areas with a shallow water table
- The leaf litter and foliage are flammable and encourage the spread of wildfires
- Known to transpire large amounts of groundwater, which desiccates soils and lowers the water table
- Found in several locations throughout the Snake River Basin
- Introduced to North America from its native Eurasia by the nursery trade and still widely available for sale as an ornamental
- Mechanical control methods hand-pulling, cutting, bulldozing) or chemical applications are effective in controlling smaller sites, but can be expensive and/or labor intensive
- Biological control methods are being developed but due to the longevity of the plant are likely to only be useful in the long term.

Tamarix ramosissima
(Saltcedar)

HIGH-PRIORITY
AQUATIC NUISANCE SPECIES
NOT YET IN IDAHO

These species are defined as not currently present in Idaho, and likely to have a high adverse impact.

Zebra mussel *Dreissena polymorpha*

Ecology: Zebra mussel are freshwater, bivalve mollusk that typically have a dark and white (zebra-like) pattern on their shells. However, color patterns can vary to the point of having only dark or light colored shells and no stripes. They are usually about an inch long or less, and attach to hard substrates much like marine mussels but unlike any native freshwater bivalve. They are prolific, often found in colonies with some colonies reported to be over 700,000 individuals per square meter in some locations in the Great Lakes. They produce microscopic larvae (veligers) that float freely in the water column, passing through screens installed to exclude them. Females generally reproduce in their second year by expelling eggs, which are fertilized outside the body by the males; this process usually occurs in the spring or summer, depending on water temperature. Optimal temperature for spawning is 14-16° C. Over 40,000 eggs can be laid in a reproductive cycle and up to one million in a spawning season. In thermally polluted areas, reproduction can occur continually through the year. After the eggs are fertilized, the veligers emerge within 3 to 5 days and are free-swimming for up to a month. Optimal temperature for larval development is 20-22° C. Dispersal of larvae is normally passive with the flow. The larvae begin their juvenile stage by settling to the bottom where they crawl about by means of a foot, searching for suitable substrate. They then attach themselves by means of a byssus, an organ outside the body near the foot consisting of many threads. The vast majority of veliger mortality (99%) occurs at this stage due to settlement onto unsuitable substrates. Sensitivity to changes in temperature and oxygen are also greatest at this stage. Once attached, the life span of zebra mussel ranges from 3-9 years. Maximum growth rates can reach 1.5-2.0 cm/year. Adults are sexually mature at 8-9 mm in shell length i.e. within one year.

Zebra mussel have some well-defined but broad environmental limitations. The optimal temperature range for adults extends to 20-25° C, but they can persist for a short term in temperatures up to 35° C. Zebra mussel are described as poor oxygen regulators, possibly explaining their low success rate in colonizing eutrophic lakes. They can tolerate slight salinity (up to 4 ‰). They require calcium concentrations of 10 mg Ca/l to initiate shell growth and 25 mg Ca/l to maintain it. Optimal larval survival occurs at a pH of 8.4, and optimal adult growth occurs at pH 7.4-8.0.

They adhere to almost any surface, including the shells of native mussels and turtles, rocks, macrophytes, artificial surfaces (cement, steel, rope, pilings, etc.), crayfish, unionid clams, and each other. Factors exist, however, that cause the substrate to be unsuitable for both initial and long term colonization, including extensive siltation, some sessile benthic macroinvertebrates, macroalgae, and fluctuating water levels. Spatial patterns of pelagic veliger density and benthic adult dispersion within a lake are

controlled by physical conditions including wind strength, lake/shore morphometry, and current patterns.

Monitoring and control of zebra mussel costs millions of dollars annually. Zebra mussel are known for their biofouling capabilities by colonizing water supply pipes of hydroelectric and nuclear power plants, public water supply plants, and industrial facilities. They typically constrict flow in pipes by two-thirds or more and reduce the intake in heat exchangers, condensers, fire fighting equipment, and air conditioning and cooling systems. Although there is little information on zebra mussel affecting irrigation, farms and golf courses could be likely candidates for infestations. Navigational and recreational boating can be affected by increased drag due to attached mussels and fouling of cooling systems. Navigational buoys have been sunk under the weight of attached zebra mussel. Deterioration of dock pilings has increased when they are encrusted with zebra mussel which corrode steel and concrete, affecting its structural integrity.

Zebra mussel negatively impact aquatic ecosystems, harming native organisms including already imperiled indigenous mussels. In huge numbers, they out-compete other filter feeders. Lakes infested with zebra mussel have experienced decreases in phytoplankton and zooplankton biomass of 70-90%, leading to increased water clarity and greater penetration of sunlight, altering water temperature and thermoclines. As phytoplankton are consumed, levels of dissolved organic carbon decrease. Increased light penetration may promote macrophyte populations. As macrophytes can be colonized by veligers, the macrophyte community may be altered if such colonization proves detrimental. Moreover, there is some evidence that pollutants are concentrated in zebra mussel feces, possibly affecting other trophic levels.

Effects may continue through the food web. Reduction in zooplankton biomass may cause increased competition, decreased survival and decreased biomass of planktivorous fish. Alternatively, because microzooplankton are more heavily impacted by zebra mussel, the larval fish population may be more greatly affected than later life stages. In addition, proliferation of macrophytes may alter fish habitat. Other effects include the extirpation of native unionid clams through crowding. Many species of birds are known to be predators of zebra mussel, and while a new food source may benefit such predators, biomagnification of toxins into both fish and birds is another potential risk.

Distribution: Zebra mussel are native to the Black, Caspian, and Azov seas. By the late 18th and early 19th centuries, zebra mussel had spread to most major drainages of Europe through widespread construction of canal systems. Zebra mussel were first discovered in North America in 1988 in the Great Lakes. It is suspected that zebra mussel were transported in ballast water tanks of commercial ships.

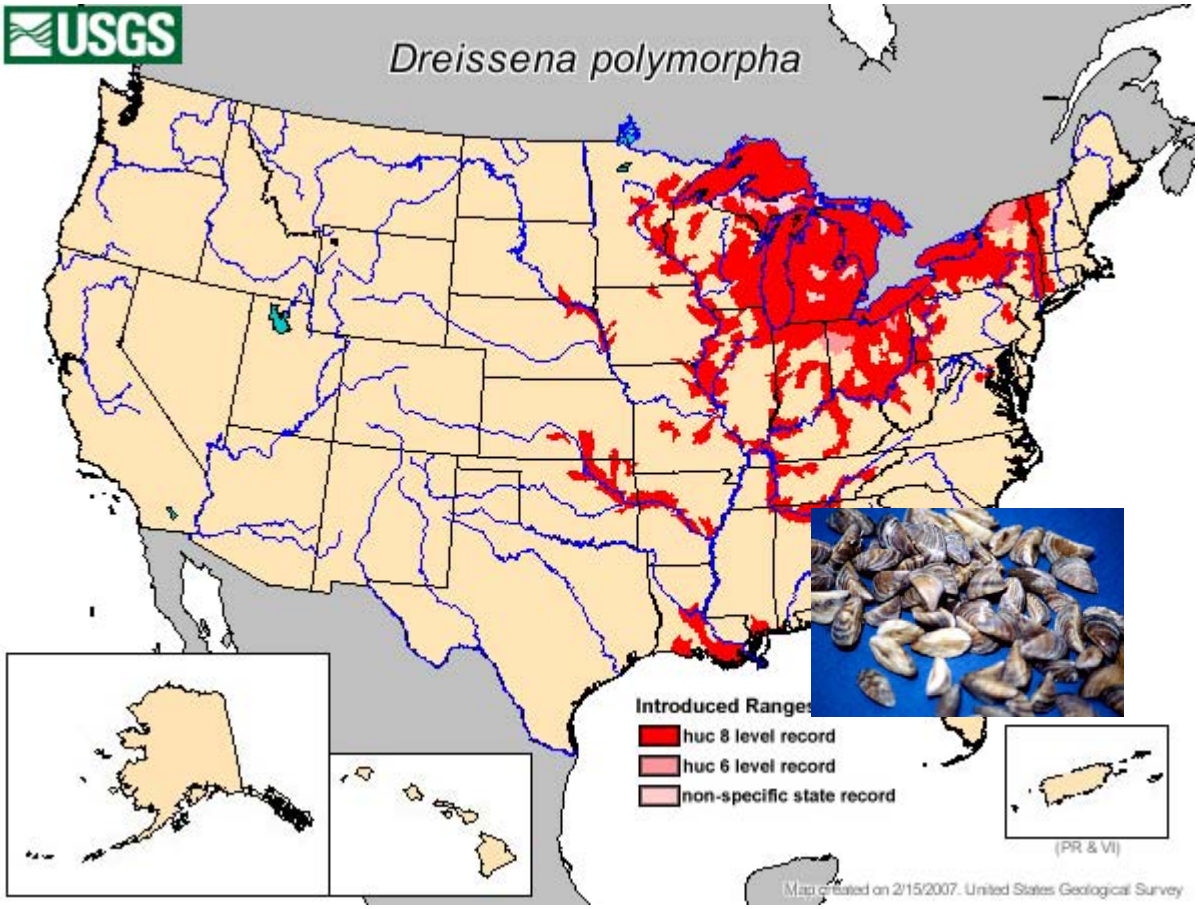
By 1990, zebra mussel had been found in all the Great Lakes. By the following year, they had spread throughout the Illinois and Hudson rivers and the Mississippi River drainage. By 1994, 19 states east of the Rockies had reported records of zebra mussel within their borders or in water bodies adjacent to their borders. During the summer of

2003, zebra mussel veligers were collected in the Missouri River where it borders Nebraska and South Dakota.

Pathways of Introduction: The rapid invasion of North American waterways has been facilitated by the zebra mussel's ability to disperse during all life stages. Passive drift of large numbers of pelagic larval veligers allows invasion downstream. Yearlings are able to detach and drift for short distances. Both veligers and yearlings can be carried in ballast water, bait buckets, or any other water reservoir. Adults routinely attach to boat and floating objects and are transported to new locations. Under cool, humid conditions, zebra mussel can stay alive for several days out of water. At one time, they were being promoted as biofilters for aquariums. In addition, speculation exists that waterfowl can disperse zebra mussel, but this has yet to be proven.

Management considerations: A number of approaches have been taken to controlling zebra mussel infestations, with varying success. With the exception of molluscicides, most are mitigation methods that do not eliminate infestations. Of course, not all of them are suitable or practical for all situations:

- Chemical molluscicides: oxidizing (chlorine, chlorine dioxide) and non-oxidizing
- Manual removal (pigging, high pressure wash)
- Dewatering/desiccation (freezing, heated air)
- Thermal (steam injection, hot water)
- Acoustical vibration
- Electrical current
- Filters, screens
- Coatings: toxic (copper, zinc) and non-toxic (silicone-based)
- Toxic constructed piping (copper, brass, galvanized metals)
- CO2 injection
- Ultraviolet light
- Anoxia/hypoxia
- Flushing
- Biological (predators, parasites, diseases)


USGS
Dreissena polymorpha
Introduced Ranges
huc 8 level record
huc 6 level record
non-specific state record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey

Quagga mussel *Dreissena bugensis*

Ecology: The quagga mussel is a freshwater bivalve mollusk up to 1.5 inches in size, slightly larger than a zebra mussel. Color patterns in the quagga mussel vary widely with black, cream, or white bands, ranging to a nearly uniform whitish coloration. The quagga mussel has a rounded angle, or carina, between the ventral and dorsal surfaces. It also has a convex ventral side that can be distinguished from a zebra mussel by placing shells on their ventral side; a quagga mussel will topple over, whereas a zebra mussel will not. If quagga mussel are viewed from the front or from the ventral side, the valves are clearly asymmetrical.

Quagga mussel are prodigious water filterers, removing substantial amounts of phytoplankton and suspended particulate from the water. As such, their impacts are similar to those of the zebra mussel. By removing the phytoplankton, they decrease the food source for zooplankton, therefore altering the food web. Impacts associated with the filtration of water include increases in water transparency, decreases in mean chlorophyll a concentrations, and accumulation of feces. Water clarity increases light penetration, sometimes causing an increase in aquatic plants that can change species dominance and alter the ecosystem. The feces that are produced from filtering the water accumulate and create a foul environment. As the waste particles decompose, oxygen deficits occur, the pH becomes very acidic, and toxic byproducts are produced. In addition, quagga mussel accumulate organic pollutants within their tissues to levels more than 300,000 times greater than concentrations in the environment and these pollutants are found in their feces, which can be passed up the food chain, therefore increasing wildlife exposure to organic pollutants.

Like zebra mussel, quagga mussel will clog water intake structures and reduce pumping capabilities for power and water treatment plants, costing industries, companies, and communities millions of dollars in treatment costs. Quagga mussel have a greater tolerance for cooler water temperatures than zebra mussel, and have been found to colonize substrates at greater water depths. Recreation-based industries and activities have also been impacted. Docks, break walls, buoys, boats, and beaches have all been heavily colonized on both hard and soft substrates. It is clear that the genus *Dreissena* is highly polymorphic and has a high potential for rapid adaptation to extreme environmental conditions, possibly leading to significant long-term impacts on North American waters.

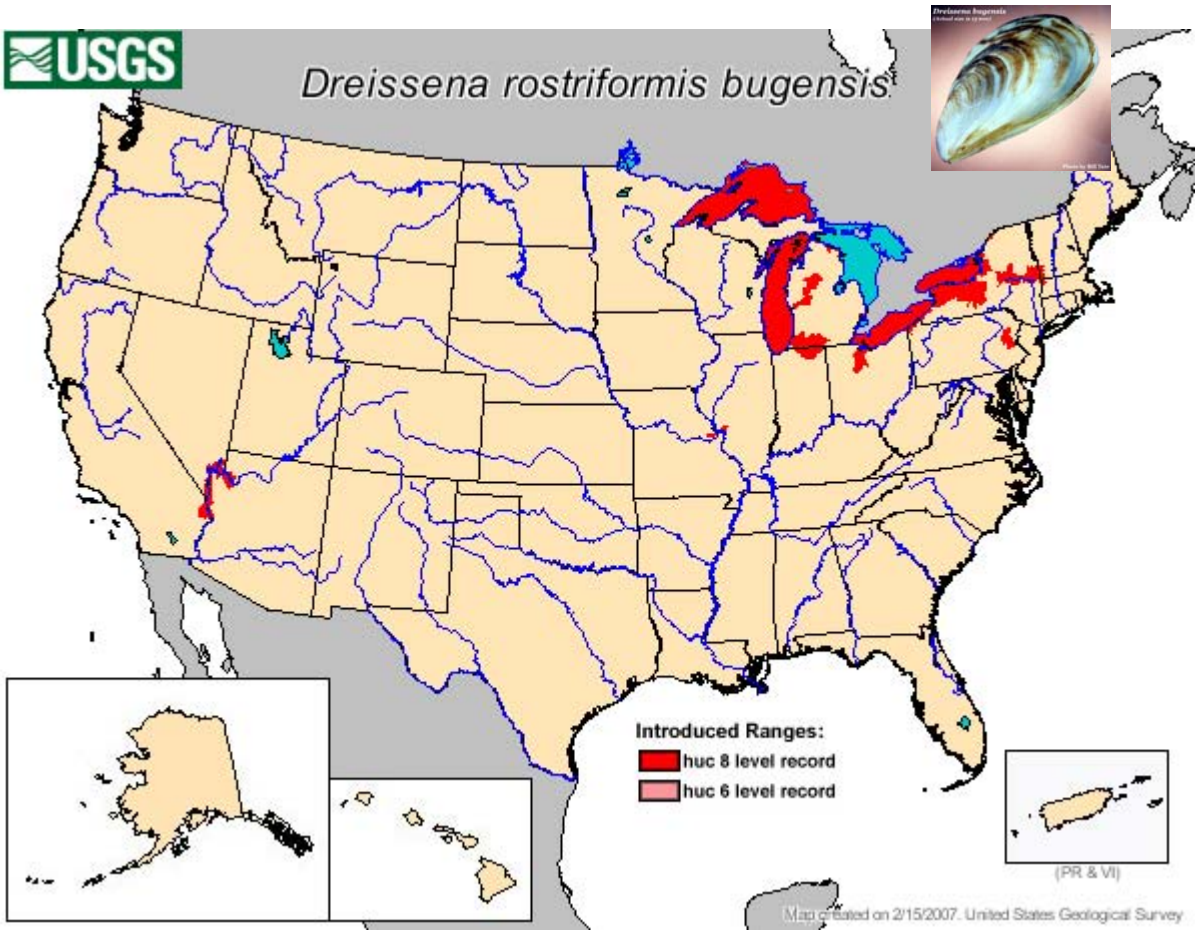
In the 1990's, the absence of quagga mussel from areas where zebra mussel were present may have been related to the later timing and location of introduction, rather than physiological tolerances. If the native habitat of quagga mussel provides any sort of indicator, the quagga mussel will most likely colonize areas where the zebra mussel is now established to become the dominant dreissenid of the Great Lakes. Indeed, this trend does appear to be occurring in the lower Great Lakes. Mean shell size and biomass increased for both dreissenid species from 1992 to 1995 in southern Lake Ontario, but the increase was sharper in quagga mussel, and they now dominate in southern Lake Ontario instead of zebra mussel.

Distribution: Quagga mussel are indigenous to the Dneiper River drainage of Ukraine. It was first documented in the Great Lakes in September 1989, and after confirmation that this mussel was not a variety of zebra mussel, the new species was named "quagga mussel" after the quagga, an extinct African relative of the zebra.

Quagga mussel are currently distributed throughout most of the Great Lakes – Saint Lawrence system, and there are also a few inland occurrences in New York, Ohio, Michigan, and Pennsylvania. They were reported in Missouri and Illinois in 1995. More recently, in January 2007, populations of quagga mussel were discovered in Lake Mead on the lower Colorado River and may possibly be in Lake Powell in Utah.

Pathways of Introduction: The introduction of quagga mussel into the Great Lakes appears to be the result of ballast water discharge from transoceanic ships that were carrying veligers, juveniles, or adult mussels.. Like zebra mussel, there are other factors that can also aid in the spread of quagga across North American waters, such as larval drift in river systems, and fishing and boating activities that allow for overland transport or movement between water basins.

Management considerations: Chlorination has been the most common treatment for control. Another alternative has been potassium permanganate, especially for drinking water sources. Other methods of control include: oxygen deprivation, thermal treatment, exposure and desiccation, radiation, manual scraping, high-pressure wash, mechanical filtration, removable substrates, molluscicides, ozone, antifouling coatings, electric currents, and sonic vibration. Some industries even built their intake structures and piping at depths too low for zebra mussel colonization; however, when the quagga mussel were discovered at lower water depths these new structures became vulnerable to quagga colonization. Biological control so far has proven to be ineffective in controlling *Dreissena* species. Predation by migrating diving ducks, fish species, and crayfish may reduce mussel abundance, though the effects appear to be short-lived. A proposed approach to controlling *Dreissena* populations may be to disrupt the reproductive process, by interfering with the synchronization of spawning by males and females in their release of gametes. Another approach would be to inhibit the planktonic veliger from settling, since this is the most vulnerable stage in the life cycle.


USGS
Dreissena rostriformis bugensis
Introduced Ranges:
huc 8 level record
huc 6 level record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey

Asian carp, Including:

Black carp *Mylopharyngodon piceus*
Silver carp *Hypophthalmichthys molitrix*
Bighead carp *Hypophthalmichthys nobilis*
Grass carp *Ctenopharyngodon idella*
Asian carp hybrids *H. molitrix x nobilis, C. idella x H. idella x nobilis*

Ecology: Typical habitat for these carp species includes quiet waters, such as lakes, ponds, pools, and backwaters of large rivers, and a range of water depths. They are generally considered a nuisance because they prey on native species and/or compete with them for food and habitat. In addition, carp may carry several parasites and diseases known to be transmissible or potentially transmissible to native fishes.

The black carp is a bottom-dwelling molluscivore that has been used by fish farmers in the South to prey on and control disease-carrying snails in their farm ponds. Black carp are superficially very similar in appearance to grass carp, leading to a risk that the species be misidentified and unintentionally introduced as "grass carp" to some areas. There is high potential that the black carp would negatively impact native aquatic communities by feeding on, and reducing, populations of native mussels and snails, many of which are considered endangered or threatened.

The silver carp is a filter-feeder capable of consuming large amounts of phytoplankton. Its diet also includes zooplankton, bacteria, and detritus. It has the potential to cause enormous damage to native species because it feeds on plankton required by larval fish and native mussels. This species would also be a potential competitor with adults of some native fishes that also rely on plankton for food.

Similar to the closely-related silver carp, the bighead carp is a filter feeder that prefers large river habitats. Because bighead carp are planktivorous and attain a large size, they have the potential to deplete zooplankton populations, leading to reductions in populations of native species that rely on plankton for food including all larval fishes, some adult fishes, and native mussels.

Grass carp, which are herbivores, seem to affect other animal species by modifying preferred habitat; however, they may directly influence other animals through either predation or competition when plant food is scarce. These influences include interspecific competition for food with invertebrates and other fishes, significant changes in the composition of macrophyte, phytoplankton, and invertebrate communities, interference with the reproduction of other fishes, and decreases in refugia for other fishes. Increased phytoplankton populations are often a secondary effect of grass carp presence: a grass carp can digest only about half of the plant material that it consumes each day, expelling the rest into the water where it promotes algal blooms. These blooms can reduce water clarity and decrease oxygen levels. A sterile variety (triploid) of grass carp is approved

for use in Idaho in isolated ponds. All such fish imported into Idaho must be certified as triploid and be free of specific diseases.

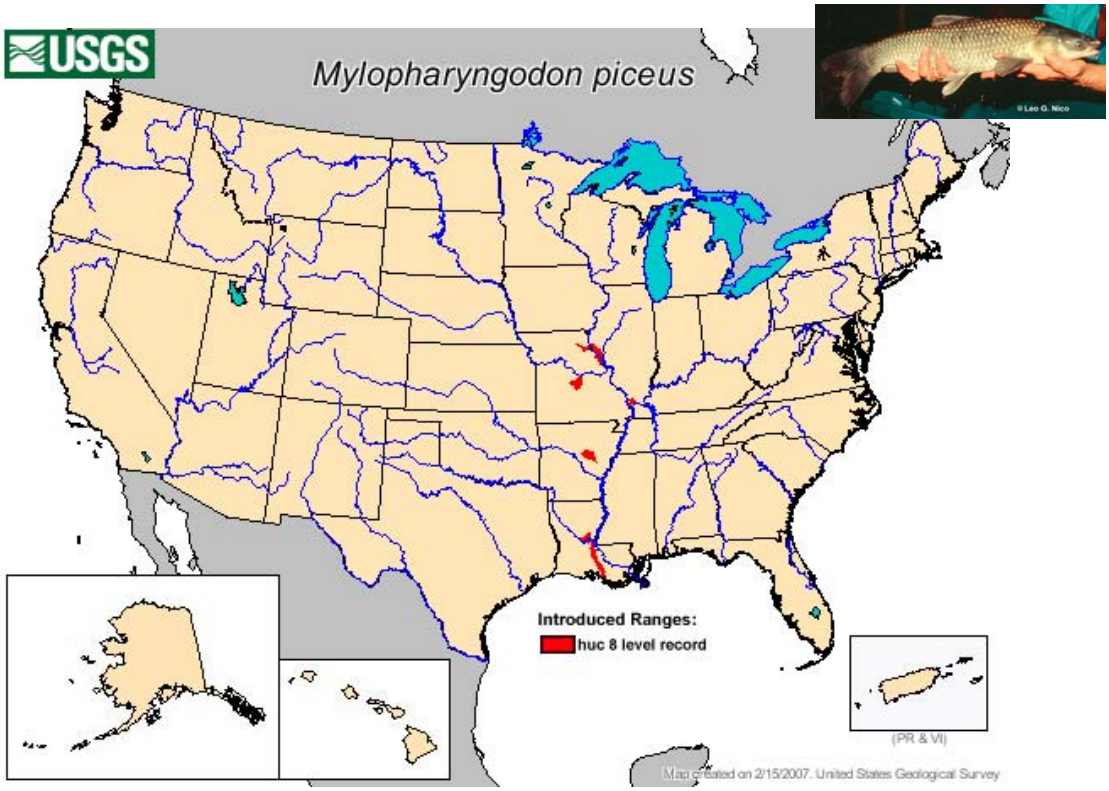
Silver/bighead carp hybrids have been reported in a number of locations in the United States. The hybrid fish can be intermediate or externally indistinguishable from either parent species and are documented to be fertile. Grass/bighead carp hybrids have been reported in Florida, Texas, California and Arizona, where it was intentionally stocked. It is believed to be sterile. Both of these hybrids exhibit similar behavior and impact their habitat in similar ways to their parent species.

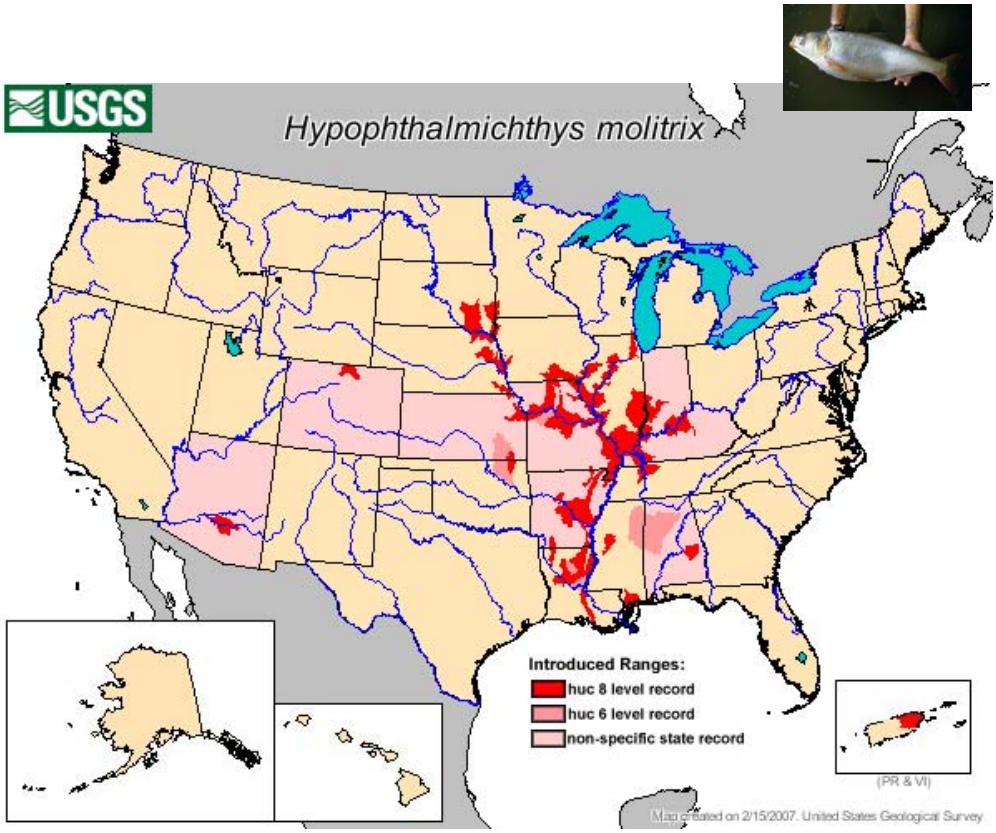
Distribution: : Fertile grass carp have been documented in Idaho in only a limited area, in the Snake River between King Hill and Shoshone Falls in the early 1980s. These fish were escapes from unscreened waters where they introduced to control vegetation. With the establishment of restrictions on their importation and use in Idaho in the mid 1980s, they have disappeared from the Snake River and currently there are no known reproducing populations in Idaho. However, the species has a tolerance for a wide range of temperatures, which makes it a likely candidate to establish in some water bodies in the state if illegally released. The other three species of Asian carp and the known hybrids have not been reported in Idaho to date, but are reported to be established in many other areas of the United States, particularly the Mississippi River drainage and in the South.

Pathways of Introduction: These four carp species were introduced in the United States in the 1970s as food fish and/or as biological control agents in aquaculture ponds or eutrophic water bodies. Some were illegally stocked in ponds or commercial fish farms. In many cases, they made their initial escape during episodes of flooding or through accidental release from a farm or aquaculture facility.

The possibility of deliberate transportation and release of these species is a likely occurrence. Asian carp have been discovered in public ponds and lagoons in the Great Lakes region, and media stories indicate that these fish are being intentionally released as part of religious ceremonies. .

Management considerations: Asian carp species are so widely established in the United States that eradication is impossible and control is unlikely. A regulatory approach of identifying legal responsibility and developing consistent regulations will be needed on a regional basis to prevent intentional or unintentional release of invasive species including Asian carp. Several of the Asian carp species have or are being added to the USFWS injurious species list.


USGS
Mylopharyngodon piceus
Introduced Ranges:
huc 8 level record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey


USGS
Hypophthalmichthys molitrix
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huc 6 level record
non-specific state record
(PR & VI)
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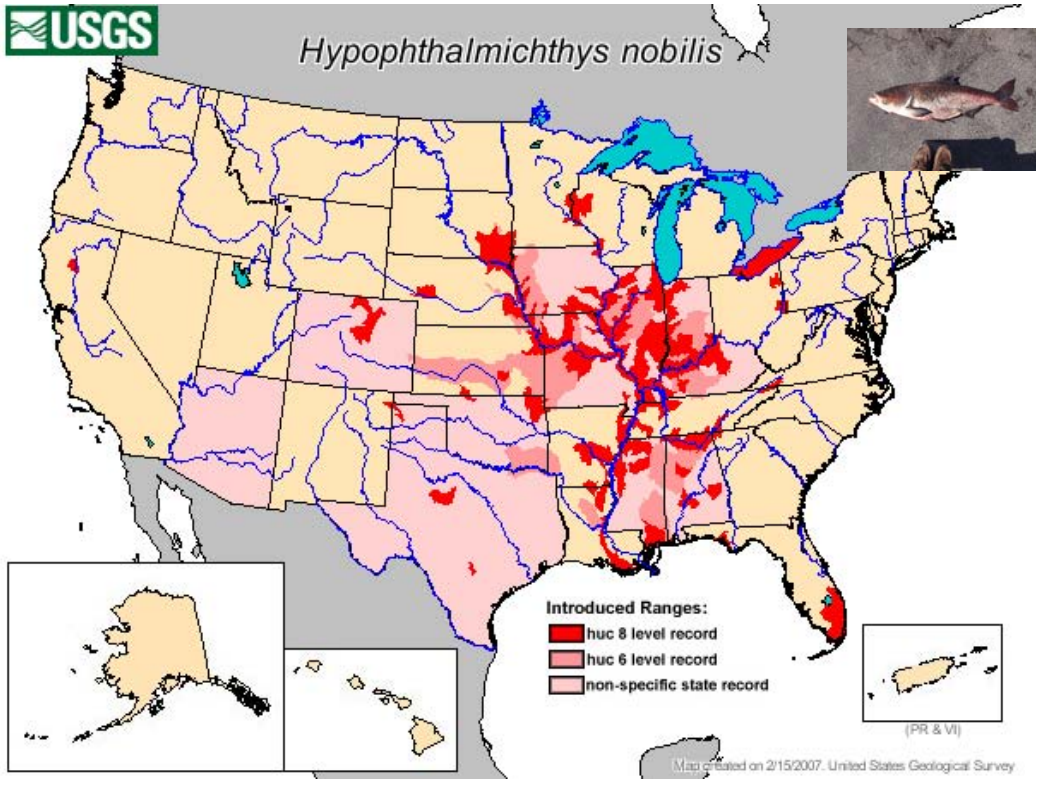
USGS
Hypophthalmichthys nobilis
Introduced Ranges:
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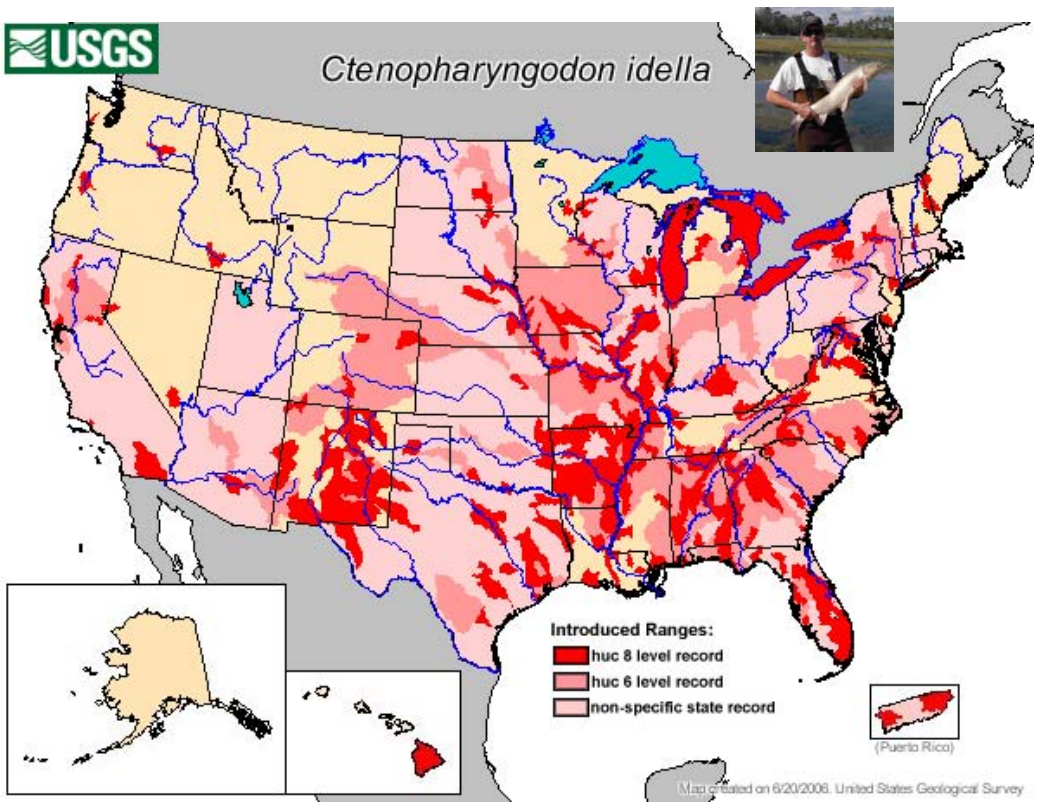
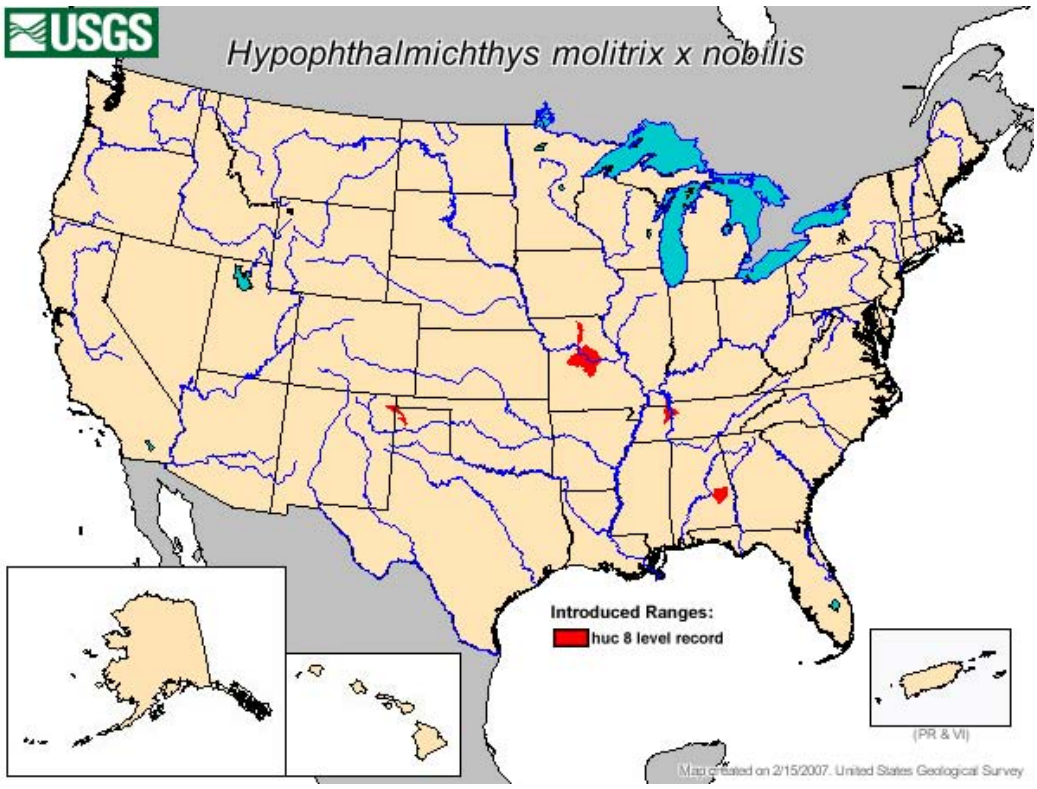
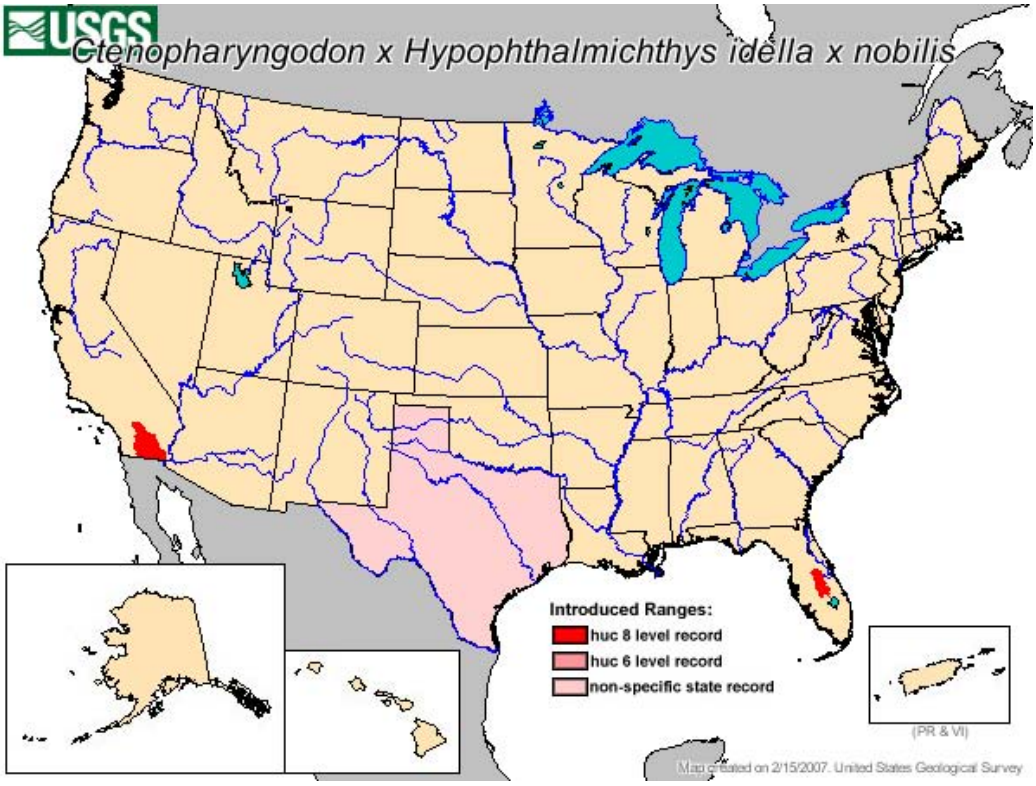
non-specific state record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey


USGS
Ctenopharyngodon idella
Introduced Ranges:
huc 8 level record
huc 6 level record
non-specific state record
(Puerto Rico)
Map created on 6/20/2006. United States Geological Survey


USGS
Hypophthalmichthys molitrix x nobilis
Introduced Ranges:
huc 8 level record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey


USGS
Ctenopharyngodon x Hypophthalmichthys idella x nobilis
Introduced Ranges:
huc 8 level record
huc 6 level record
non-specific state record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey

Rusty crayfish *Orconectes rusticus*

Ecology: The rusty crayfish is a dark-colored crustacean reaching about 4 inches in length, with large, robust claws and sometimes with "rusty" spots on the sides of its carapace. It is native to the Ohio, Tennessee, and Cumberland drainages. Rusty crayfish inhabit lakes, ponds, and streams. They prefer areas that offer rocks, logs, or other debris as cover. Bottom types may be clay, silt, sand, gravel, or rock. Rusty crayfish inhabit both pools and fast water areas of streams. They generally do not dig burrows other than small pockets under rocks and other debris, although there have been reports of more substantial burrows. Rusty crayfish need permanent lakes or streams that provide suitable water quality year-round.

Mature rusty crayfish mate in late summer, early fall, or early spring. The male transfers sperm to the female, which she then stores until her eggs are ready to fertilize, typically when water temperatures begin to increase. The stored sperm are released as the eggs are expelled, and external fertilization occurs. The eggs are then attached to the swimmerets on the underside of the crayfish's abdomen. Rusty crayfish females lay from 80 to 575 eggs. The eggs hatch in three to six weeks, depending on water temperature. Once hatched, young crayfish cling to the female's swimmerets for three to four molts, usually a period of several weeks. The young undergo eight to ten molts before they mature, which may occur during the first year, but more likely the following year. Rusty crayfish reach maturity at a total length of one and three-eighths inches and reach a maximum length of about four inches (not including claws). A typical rusty crayfish lives three to four years.

Invading rusty crayfish frequently displace native crayfish, reduce the amount and kinds of aquatic plants and invertebrates, and reduce some fish populations. Perhaps the most serious impact is the destruction of aquatic plant beds that rusty crayfish causes. These aquatic plants are important for habitat for invertebrates, food for fish and ducks, shelter for young game fish or forage species of fish, nesting substrate for fish, and erosion control (by minimizing waves). Although other crayfish eat aquatic plants, rusty crayfish eat about twice as much because they have a higher metabolic rate. Rusty crayfish, especially juveniles, also feed heavily on benthic invertebrates such as mayflies, stoneflies, midges, and side-swimmers. Thus they are more likely to compete with juvenile game fish and forage species for invertebrates than are native crayfish species.

Distribution: In the 1990s rusty crayfish were spread, probably through bait bucket transfers, to several states in northeastern and north-central US and to New Mexico. To date, they have not been reported in Idaho waters.

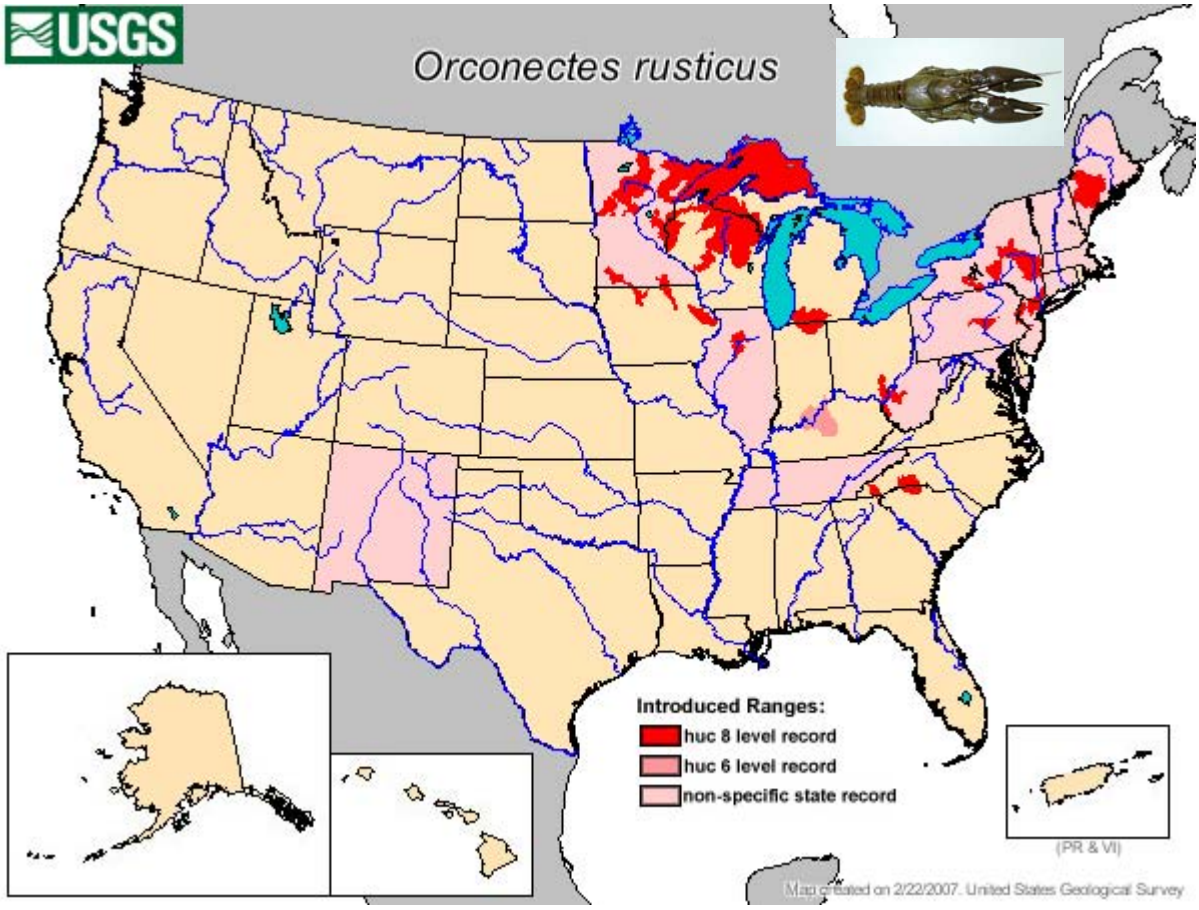
Pathways of Introduction: Anglers using crayfish as bait are thought to be the primary cause of introduction. Developing a viable commercial harvest of rusty crayfish from natural lakes could be an incentive for unscrupulous trappers to plant them in other waters.

Rusty crayfish are also sold to schools by biological supply houses. Even though a warning not to release them into the wild accompanies crayfish sold to schools, such

warnings may not be effective, as live crayfish may be given away to students and may eventually be released into the wild.

Management considerations: It is important to note that it is not necessary to have both a male and a female crayfish to begin a new infestation. One female carrying viable sperm could begin a new population if released into a suitable environment. Rusty crayfish readily mate in captivity so it is reasonable to expect that mature females, whether used as fishing bait or as science class study specimens, could produce offspring.

Currently the only method of control is to prevent their introduction. Educating anglers, crayfish trappers, bait dealers, and teachers about the threats posed by rusty crayfish will help reduce the risk of spreading it to new areas. Environmentally-sound ways to eradicate or control introduced populations of rusty crayfish have not been developed.



Round goby *Neogobius melanostomus*

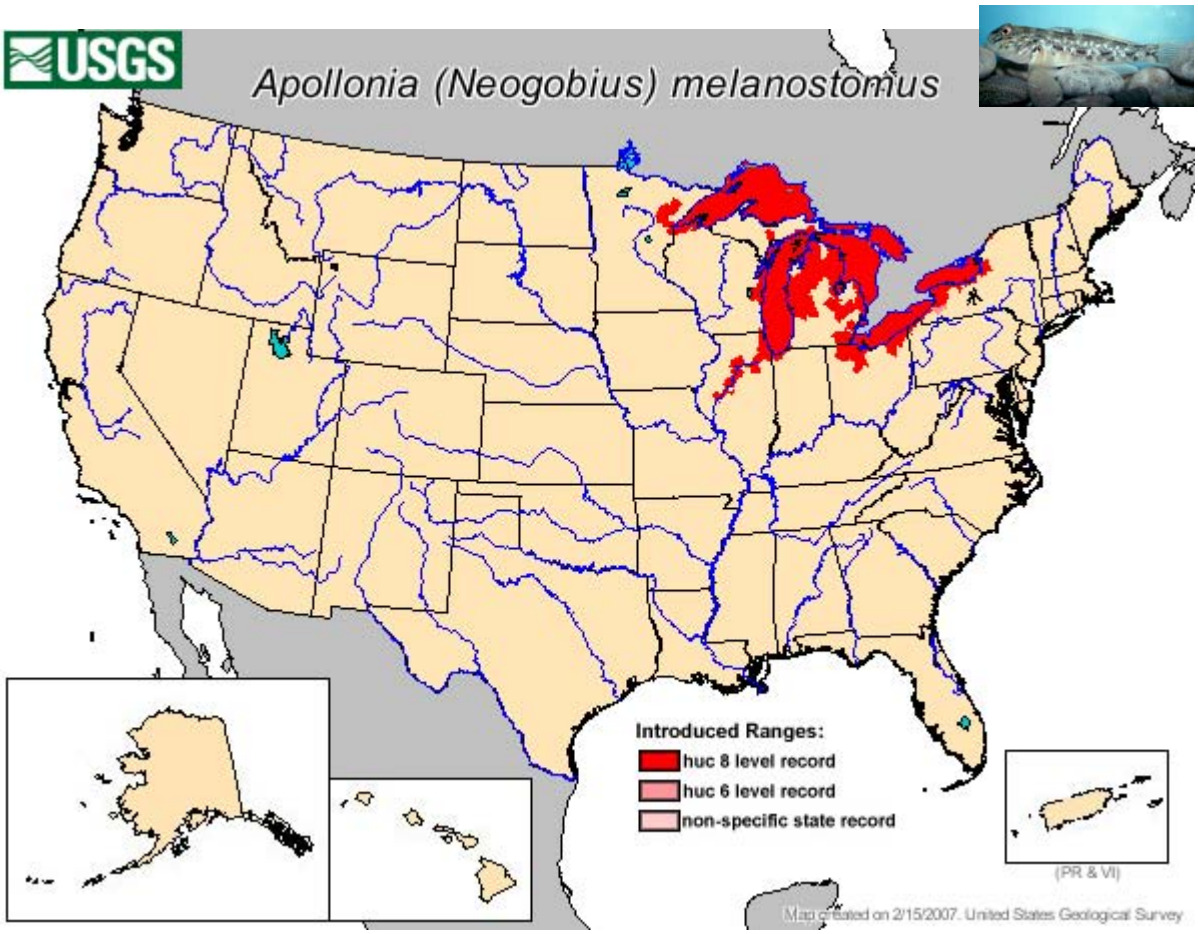
Ecology: Native to the Black Sea, Caspian Sea, and Sea of Azov, this small (about 7 in max) fish has prominent eyes and a grey body with black and brown blotches. They can become established in lakes, ponds, rivers, creeks, and canals. The diet of round gobies collected in the United States consists of aquatic insects, zebra mussel, and some native snails. Studies have shown a single goby can eat as many as 78 zebra mussels per day. Given the proliferation of zebra mussel in the Great Lakes system, and the fact that no other fish species feeds on the zebra mussel as heavily, the goby population is apparently undergoing a population explosion in that area. Trawls in the Great Lakes in the mid-90s collected thousands of gobies, and densities in one location exceeded 20 individuals per square meter. They have been found in a range of habitats, from near-shore rocky or weedy areas to about 20m water depth.

Round gobies are aggressive feeders and will eat other small fish or each other, as well as the eggs and fry of many larger species including several popular game fish. Native fish species have declined in locations where round gobies have become abundant. They are also aggressive about seizing and defending optimal spawning sites and daytime refugia from native fishes, driving them out to where they can be preyed upon. Round gobies undergo a long spawning period during which individuals can spawn every 20 days, while they aggressively defend their nests. Moreover, round goby fry compete with the fry of some native species for food, due to the overlap of an arthropod diet at this age.

Distribution: Since 1990, round gobies have become established in many locations in the Great Lakes and in parts of the Saint Lawrence River system.

Pathways of Introduction: The round goby was introduced into the Great Lakes about 1990 by freighter ballast from Eurasia, and has been spread throughout the Great Lakes system by boats and freighter ballast. The potential for spread to Idaho is primarily in illegal shipments of live fish.

Management considerations: No biological control agents are known at this time and chemical control would be economically restricted to smaller waters; the best management policy is to prevent the spread of this species.


USGS
Apollonia (Neogobius) melanostomus
Introduced Ranges:
huc 8 level record
huc 6 level record
non-specific state record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey

Ruffe *Gymnocephalus cernuus*

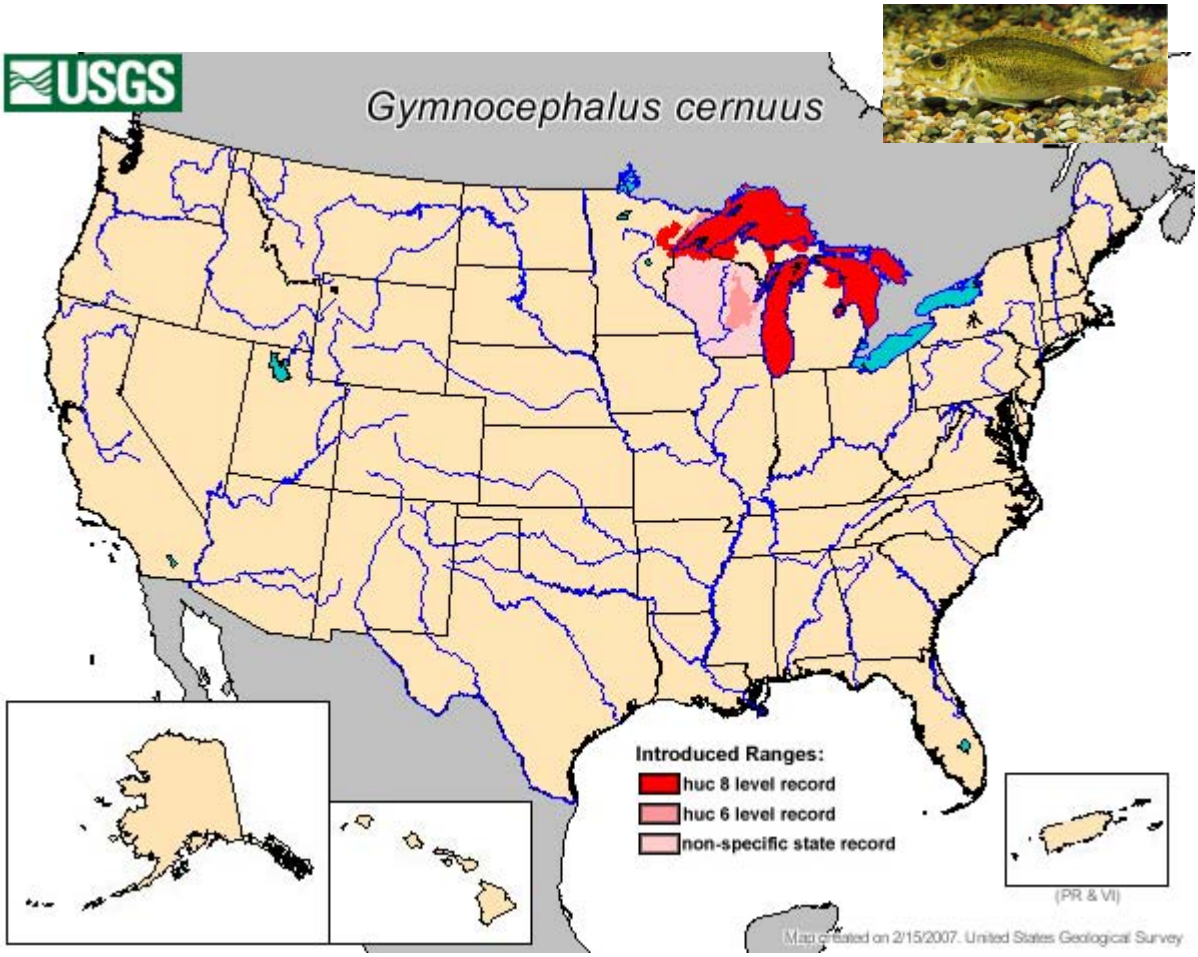
Ecology: The ruffe is a small (4 to 6 inch) freshwater fish, olive-brown to golden-brown on its back, with yellowish-white undersides. It is native to northern Europe and Asia and lives in lakes, rivers, streams and ponds. Spawning takes place in the spring. The diet of ruffe changes throughout the course of development, becoming more benthic with increasing size. Copepods, typify the diet of larval ruffe. The bottom-dwelling larvae of other insects, mainly mayflies and stoneflies, become increasingly important in the diet of ruffe as they grow.

Ruffe exhibit rapid growth and high reproductive rates and are able to adapt to a wide range of habitat types, posing a threat to native North American fish. In the Great Lakes system, there is concern that ruffe may have a detrimental effect on more desirable species such as yellow perch and walleye, by feeding on the young of these species and/or by competing for food. Ruffe prey heavily on benthic insects, the primary food source for native benthic-feeding fishes. In the Great Lakes, ruffe hold an advantage over native yellow perch in their greater ability to select moving objects under relatively dim light conditions or in high turbidity. Further, it has been found that native pike, bass, bullhead, walleye and perch prefer feeding upon native fish species rather than ruffe.

Distribution: Eurasian ruffe has been established in the western Great Lakes since about 1988 and has become the dominant species in some areas. It has been reported in Wisconsin, Michigan, and Minnesota, and Ontario, Canada, and continues to spread eastward. Its potential habitat would include the lakes and rivers of Idaho.

Pathways of Introduction: The ruffe was probably introduced via ship ballast water discharged from a vessel arriving from a Eurasian port, possibly as early as 1982-1983. Within the Great Lakes, the species spread may have been augmented by intra-lake shipping transport. The potential for spread to Idaho is primarily in illegal shipments of live fish.

Management considerations: No biological control agents are known at this time and chemical control would be economically restricted to smaller waters; the best management policy is to prevent the spread of this species. Some native fishes feed on ruffe but they are not preferred, and populations control by native fishes is unlikely.


USGS
Gymnocephalus cernuus
Introduced Ranges:
huc 8 level record
huc 6 level record
non-specific state record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey

Amur goby *Rhinogobius brunneus*

Ecology: The Amur goby is a small (4 in) fish native to Japan, the Russian Far East, Taiwan, Korea, China and the Philippines. They have fused pelvic fins, which form a suction-cup structure on the chest of the fish; a red or dark line running from the front edge of the eye to the tip of its snout; and breeding males are red or blue with colorful fins.

Many goby species are distinguished primarily by body coloration, but they also often occupy different habitat types within the same stream, and are collectively referred to as the Amur goby species complex. Species in this complex have different life histories and egg sizes. At this time, the taxonomy of this species complex is not resolved. Therefore, it is not clear whether the type(s) introduced to the US constitute one or more species of *Rhinogobius*, so it is prudent that all species of goby be prohibited in Idaho.

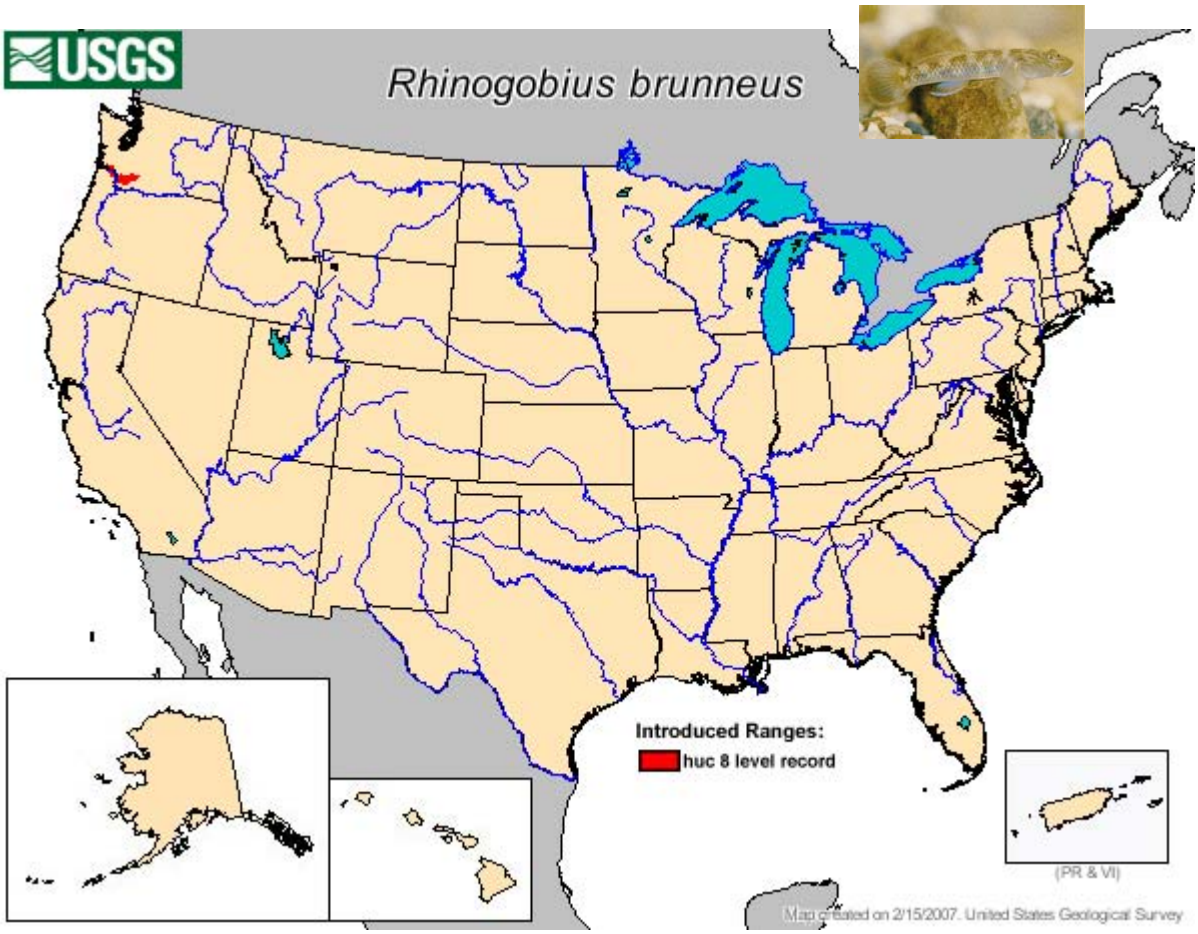
While some species in the *Rhinogobius* species complex are landlocked, others have an amphidromous life history, spending portions of their lives in both fresh and saline waters. In the spring, males construct nests under stones and entice females to spawn. After spawning, males defend and care for the eggs. Larvae hatch and drift downstream to the sea where they feed and grow. Larval drift occurs nocturnally, and the larvae halt their migration in pools with low flow rates during the day. After a few months in marine waters, juveniles migrate upstream into freshwater for further growth and reproduction.

At this time, the impact of this fish on native species is not known, but it is likely that it will compete for resources with native fishes.

Distribution: This species has spread from its native Asia elsewhere in the world via shipping. Amur goby was discovered in the Lewis River in western Washington in 2004, and is reported to be spawning there. Since that time, another specimen was collected from the Columbia River (River Mile 54) at Crims Island.

Pathways of Introduction: Its initial introduction into North America was probably in ballast water, though it may have been the aquarium trade. It could be transported elsewhere in the US by similar means.

Management considerations: No biological control agents are known at this time and chemical control would be economically restricted to smaller waters; the best management policy is to prevent the spread of this species.


USGS
Rhinogobius brunneus
Introduced Ranges:
huc 8 level record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey

Spiny water flea *Bythotrephes longimanus, formerly B. cederstroemii*

Ecology: *Bythotrephes longimanus* is a large (15 mm) cladoceran distinguished by a long straight tail spine that is twice as long as its body and has one to three pairs of barbs. Parthenogenically produced animals have a kink in middle of their spine and sexually produced animals lack the kink. The spiny water flea is native to Northern Europe and Asia.

Bythotrephes are found among the zooplankton in the upper water column of temperate lakes, can tolerate brackish water, and are most abundant in late summer and autumn. Occurrence and density of *Bythotrephes* populations are apparently determined mainly by water temperature and salinity. Within both its native and its introduced range, it appears to prefer large, deep, clear lakes with relatively low summer bottom temperatures, which is characteristic of many Idaho lakes. *Bythotrephes* is limited to regions where water temperature ranges between 4 and 30°C and salinity values up to 8.0‰, but prefers temperatures between 10 and 24°C and salinity values between 0.04 and 0.4‰. Temperature appears to be the major factor in determining the abundance and location of *Bythotrephes* in the Great Lakes. *Bythotrephes* can reproduce asexually as well as sexually; unfertilized eggs are carried in a brood pouch, and fertilized eggs are cast in the fall, hatching the following spring.

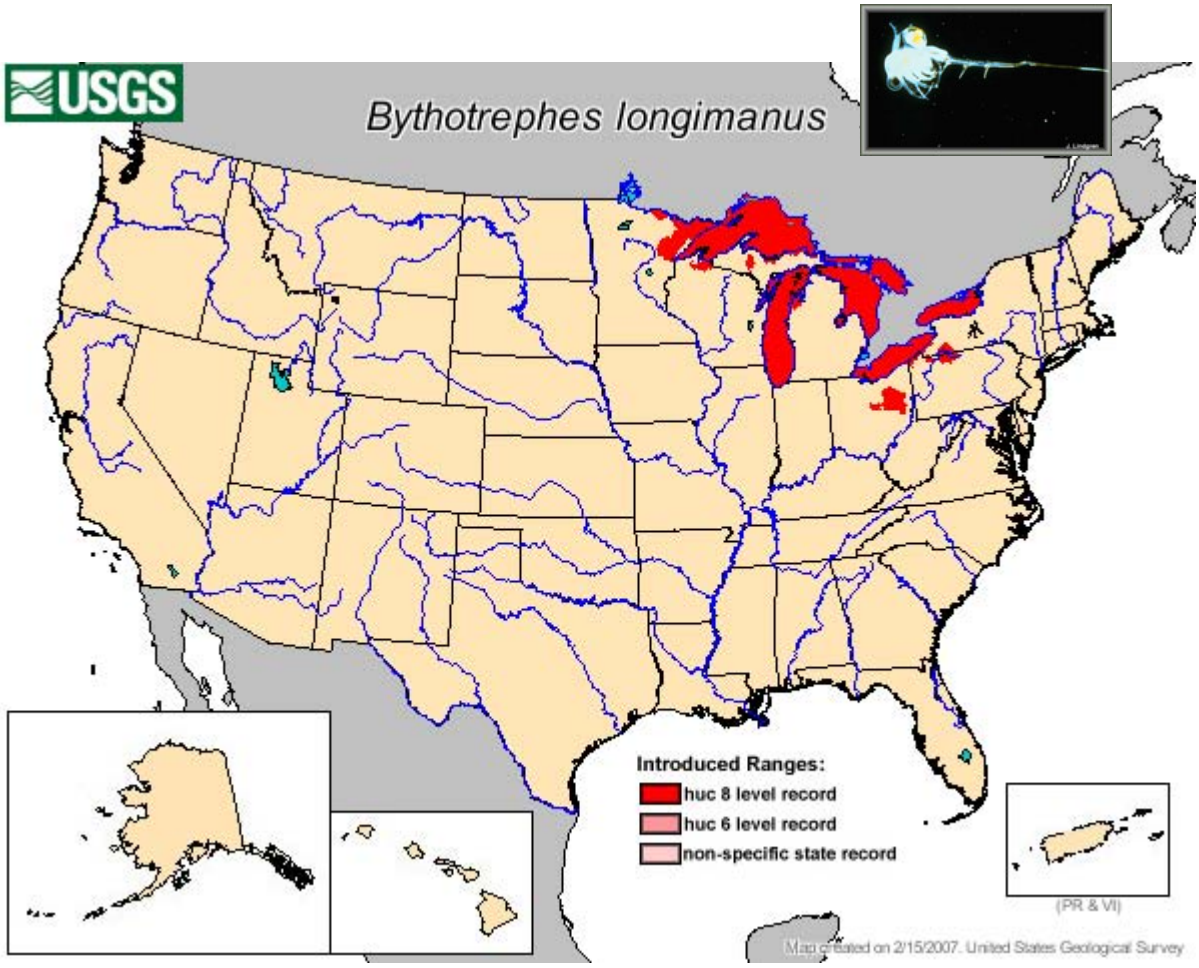
The first noticeable impact of *Bythotrephes* was on anglers. The tail spines of *Bythotrephes* hook on fishing lines, fouling fishing gear. The invasion of *B. longimanus* into the Great Lakes has resulted in substantial and sustained decreases in the populations of a number of native zooplankton species. *Bythotrephes* consume small cladocerans, copepods, and rotifers, thus competing directly with planktivorous larval fish for food. They have been implicated as a factor in the decline of alewife *Alosa pseudoharengus*. *Bythotrephes* are used as a food source by some fish species.

Distribution: *Bythotrephes* was first reported in December 1984 in Lake Huron, and had spread to the other four Great Lakes by August 1987. They are now established throughout the Great Lakes and many inland lakes in the region, although their densities vary widely by location. More recently they have been collected from lakes and reservoirs in Minnesota, Michigan, and New York.

Pathways of Introduction: *Bythotrephes* were probably first introduced from ships ballast water. Spiny water flea eggs and adults spread unseen in bilge water, bait buckets, and livewells. In addition, boat hulls, fishing gear, fishing lines and downriggers will often be coated with both eggs and adults.

Management considerations: As anglers and recreational boaters are a primary means of transport for the spiny water flea, public education should form a central part of control efforts. Personal management practices for boaters and anglers include cleaning of boating equipment with high-pressure water or heated water at temperatures of 104ºF or higher. Bait buckets should not be emptied into natural waters; they should be emptied on land. Visual inspection of rigging, fishing, and anchor lines as well as the props and hulls of boats can help limit the spread of *B. longimanus*. Boats should be allowed to dry

for at least 5 days before transport between lakes, but because of *B. longimanus* resting eggs, longer periods are recommended. Boats and trailers should be towed through carwashes if exposed to infected waters for long time periods.



Snakehead fish, including:

Northern snakehead *Channa argus*
Bullseye snakehead *Channa marulius*

Ecology: The snakehead group of species originates in eastern and southeastern Asia where they are valued as food for human consumption. They inhabit freshwater lakes, watercourses, or wetlands, mostly preferring deep, slow-moving or standing water with rocky or sandy substrates. They are all voracious predators with no natural enemies, and would severely impact native fishes, crustaceans, insects, amphibians, birds and small mammals living near the water's edge. Snakeheads are obligate air breathers and can survive out of water for up to four days. They range from less than 1 ft. to 3.5 ft. long and weigh up to 45 lbs, although the bullseye snakehead can reach 6 ft. in length and about 65 lbs.

Snakeheads spawn from 1 to 5 times during the warmest months of the year, the brood size consisting of anywhere from several hundred to several thousand pale yellow-red eggs. These eggs may float in a nest of weeds and leaves, or simply float in the water column, for one or two days until the yolks are absorbed and the eggs hatch. The number of broods per year and the rate at which they hatch depends on water temperature. The eggs are ferociously guarded by the parents who will attack anyone or anything approaching the nest, including humans.

The fry feed initially on zooplankton, and later on insect and fish larvae and small crustaceans. Adults prefer fish but will eat frogs, crustaceans, small reptiles, birds, and mammals. They remain close to shore, typically under aquatic vegetation, and are most active at dusk and dawn, feeding very near the shore.

The northern snakehead prefers stagnant shallow ponds, swamps and slow streams with mud or vegetated substrate, with temperatures ranging from 0 to >30^{o}C. It has a wider latitudinal range and temperature tolerance than other snakehead species. It also seems to be adaptable to a wide range of aquatic environments, indicating that it has the potential to invade many water bodies in Idaho and elsewhere in the US.

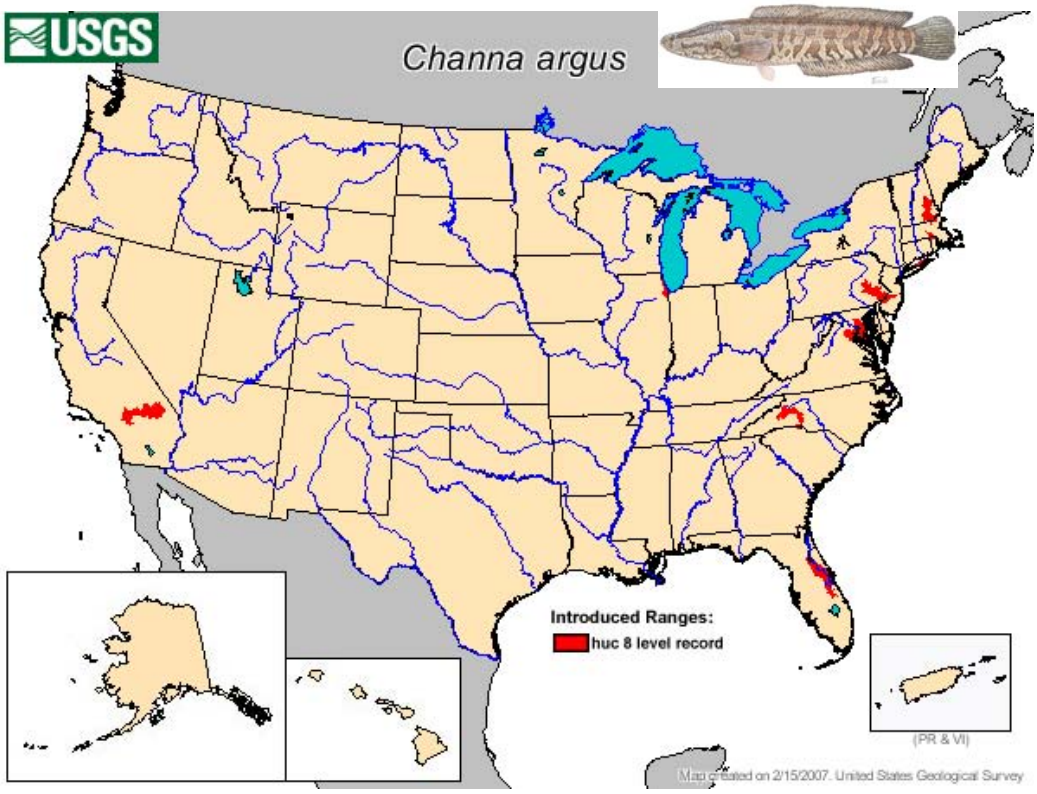
Two additional species of snakehead, the blotched *C. maculate* and giant *C micropeltes* are tropical species and unlikely to establish in Idaho except in a few larger geothermal waters.

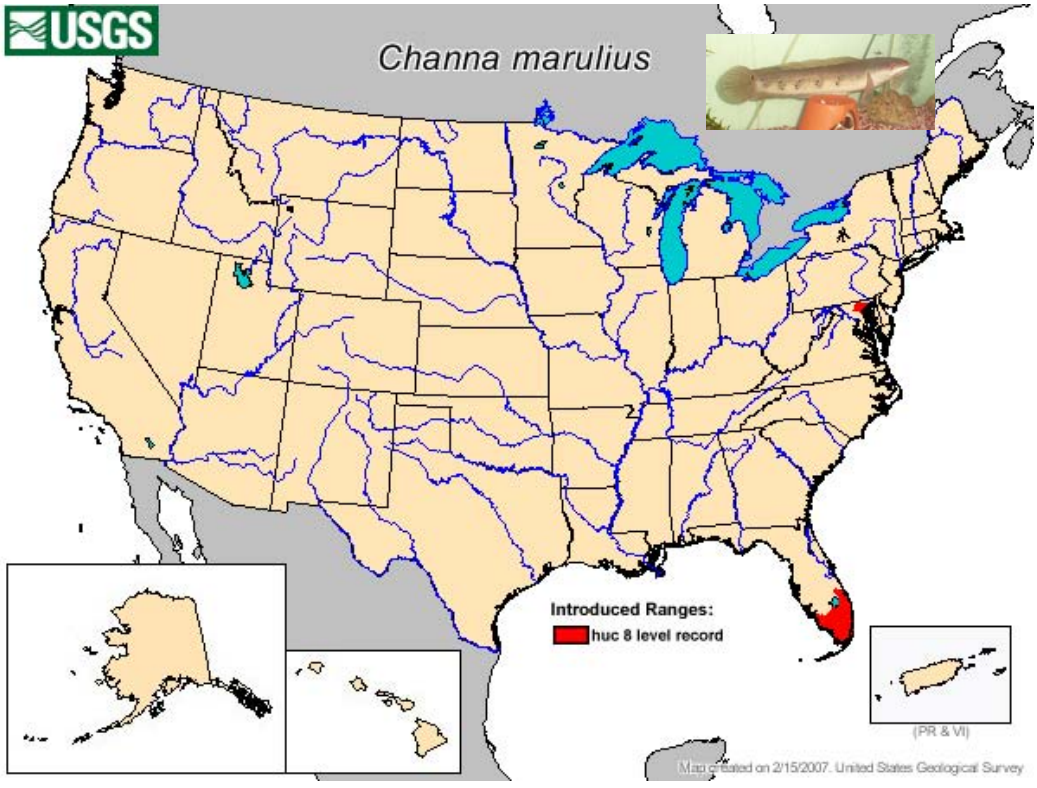
Distribution:
Northern snakehead: Collected in California and Massachusetts. Reported in Florida but status uncertain. Eradicated where it was established in a pond in Maryland. Believed to be established in the Potomac River. Status of a Philadelphia location is uncertain, although officials believe the fish may have gotten into the lower Schuylkill and Delaware Rivers and see no practical means to eradicate them.
Bullseye snakehead: Locally established in Florida; reported in Maryland.

Pathways of Introduction: Probably originally introduced to the United States in the Asian food trade at various times in the 19th and 20th centuries, and deliberately stocked

in local ponds. These fish are available, though rare, in the aquarium trade, and isolated reports of individual specimens are likely deliberate aquarium releases. Human transportation is the most likely means of introduction to new areas. They can also spread by moving through river and stream networks.

Management considerations: The ability to eradicate or control snakehead populations depends on where they are found, but in most cases, the prevention of introduction is the only effective means of control. If established in large lakes or river systems, eradication and/or control are virtually impossible. Control in smaller water bodies depends upon the amount of vegetation and the accessibility of the water body. Moreover, there is some disagreement about the effectiveness of piscicides on air-breathing snakeheads.


USGS
Channa argus
Introduced Ranges:
huc 8 level record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey


USGS
Channa marulius
Introduced Ranges:
huc 8 level record
(PR & VI)
Map created on 2/15/2007. United States Geological Survey

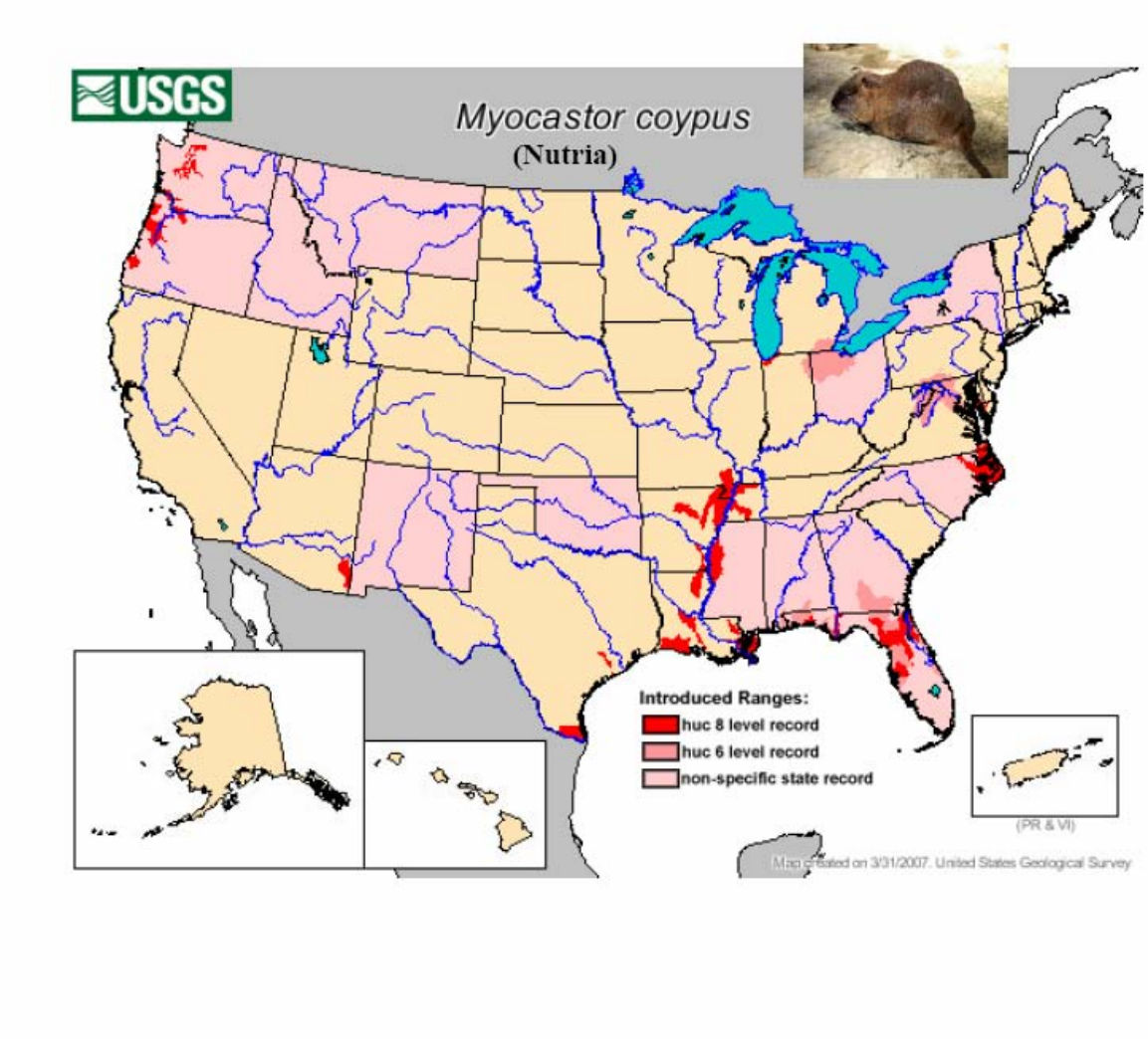
Nutria *Myocastor coypus*

Ecology: The nutria is a large semi-aquatic rodent native to South America. The only known mammalian ANS, nutria are found in and around fresh and saltwater ponds, streams, and swamps, and are rarely observed over 100 m away from water. Presently, they are considered to be a pest species, disrupting irrigation systems, destroying native aquatic vegetation, and crops. Additionally, by disturbing the balance of the native biota they provide an advantage for non-native plant species to become established. Their burrows undermine and damage river banks, dikes and irrigation facilities. By eating the young shoots of reeds and their rhizomes, the nutria can completely clear marshland communities, converting them into open water areas. It threatens the habitat and survival of rare marsh birds, such as bitterns and marsh harriers. Infestation by this animal would have very serious consequences for riparian communities statewide.

Distribution: Since their introduction to North America, some animals have escaped and established localized breeding populations from Texas to Virginia, Washington and Oregon, and in the Great Lakes area. There has been only one report to date of nutria in Idaho, in an unspecified location, in 1991. Populations in western Oregon and Washington have been increasing resulting in negative impacts to wetlands.

Pathways of Introduction: Nutrias were initially introduced into North America and farmed for their fur. However, due to escapes from fur farms there are now large feral populations in North America, Europe and Asia.

Management considerations: Management of nutria includes shooting and trapping. There is a significant relationship between winter severity and female reproduction in the following spring, with prenatal embryo losses common during cold winter and in females in poor health condition. Likelihood of establishment in Idaho is low due to cold winters but in some lower elevations in the Snake drainage it is feasible.


USGS
Myocastor coypus
(Nutria)
Introduced Ranges:
huc 8 level record
huc 6 level record
non-specific state record
(PR & VI)
Map created on 3/31/2007. United States Geological Survey

Viral hemorrhagic septicemia

Ecology: Viral hemorrhagic septicemia (VHS) is a viral fish disease affecting most salmonid and a few non-salmonid species. It has caused large scale mortalities in rainbow trout and turbot aquaculture operations in Europe and in Pacific herring and pilchard populations along the Pacific Coast of North America. The disease is caused by a rhabdovirus known as Viral Hemorrhagic Septicemia Virus. There are currently five known strains of VHS in Europe, Japan, and North America. The virus infection occurs in fishes of any age and may result in significant cumulative mortality. Fish that survive may become carriers. The strain in the Great Lakes is a more virulent strain than the one on the Pacific Coast.

A variety of clinical signs and histopathologic changes may be apparent in fish infected with VHS virus. Not all fish show clear clinical manifestations of disease. Historically, clinical and pathologic signs of VHS have been catalogued into acute, chronic, and latent forms. Acute signs are typically accompanied by a rapid onset of heavy mortality. In the acute form of the disease, fish become lethargic, dark and anemic, with bulging eyes, congested kidneys, and mottled liver. Hemorrhages are evident in the eyes, skin, and gills and at the bases of the fins. In the chronic form of the disease, mortality is low and all the symptoms are similar to the acute form, except that hemorrhaging is not common; instead, the liver, spleen and kidneys experience an accumulation of fluid such that the body becomes bloated and the liver and kidneys become very light in color. In the latent manifestation of the disease, some mortality may occur and fish become hyperactive, sometimes displaying nervous symptoms such as twisting of the body and behavior that involves swimming erratically in circles or in a corkscrew pattern. Conversely, some carriers of the virus may show no symptoms at all.

VHSv can be transmitted by fish urine, feces and sexual fluids. The virus can be found on the surface of salmonid eggs during spawning of infected female broodstock (sometimes at very high levels) and is capable of persisting for a sufficient time to result in egg-associated transmission between generations (adult to progeny). It is also likely to enter the body through the gills or through wounds. Experiments showed that blood sucking parasitic arthropods and leeches can transmit the infection physically. In the western United States, salmon eggs are routinely surface disinfected with an iodine compound at or after water hardening to eliminate vertical (parent to egg) VHSv transmission.

VHSv is not a human pathogen. There are no concerns with respect to human health with this pathogen and it can not infect humans if they eat fish with the pathogen. However, it is a reportable animal disease that requires notification of APHIS, the Canadian Food Inspection Agency, and the International Organization for Animal Health.

APHIS issued a Federal Order on 24 October 2006, amended on 14 November 2006, to take emergency action to prevent the spread of VHS. According to this Federal Order, VHS-susceptible species are prohibited from moving out of the states and Canadian provinces bordering the Great Lakes except for:

- Movement to slaughter with adequate disinfection

- Movement to a research or diagnostic lab with adequate disinfection
- Movement of live fish testing negative for VHS virus by laboratory assays
- Movement of salmonids from Canada that meet Title 50 requirements

Distribution: VHS has been reported in the northeastern Pacific Ocean, the northern Atlantic, and the Baltic Sea. In North America, outbreaks have occurred in lakes Ontario, Erie, and Huron, the Saint Lawrence River, and along the western coast from Alaska to San Francisco. It has affected the Columbia River system as far inland as the Sandy River in Oregon, and has occurred in at least one of the Finger Lakes in upstate New York.

Pathways of Introduction: VHS was first isolated in Denmark in 1963. The earliest confirmed report in the US was in 2003 in a Great Lakes muskellunge from Lake St. Clair, so it is likely to have been introduced here in 2002 or 2003. It is not known exactly how this virus arrived in the Great Lakes, but ballast water discharge is considered as a likely vector given its pattern of distribution in the lakes.

Live, water-borne virus can move downstream 10-20 km. Fish-eating birds (especially herons) can act as mechanical vectors from one aquaculture facility to another. Transfer of infected fish in the incubation phase (before onset of visible signs) or of infected transport water is another well-known route of infection. Import or interstate transfer of potentially infected fish is also a possible avenue for the spread of VHS.

Management considerations: There is currently no effective treatment for VHS, so prevention is paramount. APHIS must develop a rule to replace the temporary Federal Order that will provide for specific testing requirements and develop criteria for United States import and interstate transfer of fish.

All of the recommended ways to prevent the movement of ANS i.e. zebra mussel, will help prevent the spread of this pathogen. The use of a bleach solution (1 cup bleach to 10 gallons water) to disinfect and clean boats, bilges and gear is very effective in killing VHSv, as is completely drying items in the sunlight for 4-6 hours. It is also critical not to move live fish or water between water bodies, in particular baitfish. These measures will help control the spread of this pathogen along with many other ANS.

Viral hemorrhagic septicemia

Water hyacinth *Eichhornia sp.*

Ecology: *Eichhornia sp.* is a free-floating aquatic macrophyte growing to 0.5 m in height and often forming dense floating mats. Foliage leaves are petiolate with a glossy sheen, and are arranged spirally, appearing to be in a rosette. Flowers are borne terminally on a lavender spike on an elongated peduncle and are subtended by two bracts. As much as 50% of a single water hyacinth's biomass can be roots. Roots are adventitious and fibrous, 10-300 cm in length. As many as 70 lateral roots per cm give the roots a feathery appearance. They are dark violet to bluish or pinkish violet (though whitish if grown in total darkness) and contain soluble pigments, including anthocyanins that may protect the root from herbivory. There are approximately a half-dozen species of *Eichhornia* including *E. azurea*, known as the rooted water hyacinth, which is listed on the Federal Noxious Weed List.

Eichhornia sp. grows in shallow ponds, wetlands and marshes, sluggish flowing waters, lakes, reservoirs and rivers. Disruptions of wetland ecosystems involving irrigation canals, hydroelectric projects and construction of artificial lakes have created areas particularly susceptible to invasion by water hyacinth. Growth of water hyacinth is largely facilitated by nutrient rich waters, particularly those rich in nitrogen, phosphorus and potassium. It grows particularly well in waters in which fish production is also very good. Originating from the tropical regions of South America, this plant exhibits frost sensitivity and does not tolerate brackish water.

Eichhornia sp. has been spread by humans to all tropical and subtropical regions in the world where it forms thick mats that cover rice paddies, clog irrigation channels, impede navigation, halt fishing, sweep away buildings during floods and foster breeding of disease-transmitting mosquitoes. Doubling in biomass every 6 to 18 days, the exact time being dependent on location and time of year, this weed rapidly invades waterways and is listed as the most serious aquatic weed in the world.

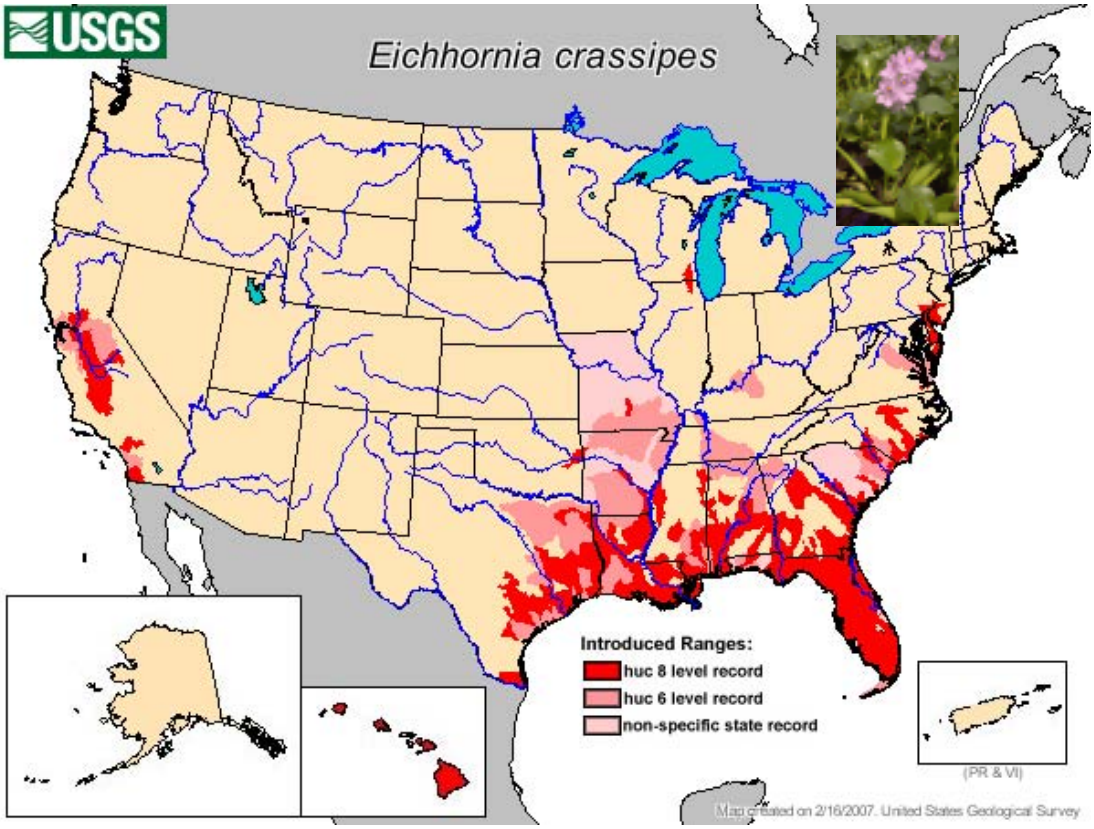
Environmental problems associated with the water hyacinth are exacerbated in warm areas, where the weed flourishes. It reduces dissolved oxygen levels and light, significantly altering ecosystems and plant and animal communities. Low oxygen levels kill native fish populations and fish spawning areas may be reduced, as well as critical waterfowl habitat degraded. Mats of water hyacinth also deposit large amounts of organic matter which increase the organic content of sediments and greatly accelerate succession patterns, allowing emergent and riparian vegetation to colonize.

Eichhornia sp. has a detrimental impact on water use by humans. In drainage and irrigation canals it reduces the flow, which can result in flooding and damage to canal banks and structures, and clogs intakes of pumps used for irrigation. Water flow patterns have been disrupted in utility cooling reservoirs. Water hyacinth interferes with navigation of both recreational and commercial craft, negatively impacting anglers, water-skiers and swimmers in recreational waters. It also impedes subsistence fishing and transportation in developing countries in Africa and Asia.

Distribution: Water hyacinth originated in the Amazon basin and the extensive lakes and marshes of the Pantanal region of western Brazil. *Eichhornia sp.* now has a worldwide distribution throughout the tropics and occurs on every continent except Europe, where it is inhibited by climate. In the United States, water hyacinth is widespread throughout the southeastern and south-central portions of the country, in California, and in Hawaii. It has not been reported in Idaho, but may exist in thermal waters and is likely sold in the aquarium trade.

Pathways of Introduction: Water hyacinth has an attractive purple flower which has made it a favorite amongst ornamental pond and botanical garden enthusiasts. Most spread can be attributed to deliberate planting of water hyacinth in ponds or dams as an ornamental, or use in aquariums. Unwanted plant material discarded into creeks, rivers and dams is a major mode of dispersal. Water hyacinth can be spread, though rarely, by contaminated boating and waterway equipment. Stolons, solitary plants and drifting mats are readily distributed by water currents, winds and boat traffic. High water flows and floods can move infestations to new locations. Additionally, seeds may be carried by machinery, on boots, in water flow, mud, and by birds.

Management considerations: Small scale mechanical or hand removal of water hyacinth is widely practiced around the world because of the ease of collecting these floating plants. Large scale mechanical harvesting requires expensive equipment, and water hyacinths have not been efficiently utilized for cattle feed, energy or other use due to the high water content of the plants. Biocontrol agents have been introduced into the United States from the native range of water hyacinth (South America) which slow the growth of the plant and reduce flowering. The introduced insects are widely distributed over the range, but do not usually destroy existing populations. Management of water hyacinth in the United States is largely accomplished with herbicides.


USGS
Eichhornia crassipes
Introduced Ranges:
huc 8 level record
huc 6 level record
non-specific state record
(PR & VI)
Map created on 2/16/2007. United States Geological Survey

Hydrilla *Hydrilla verticillata*

Ecology: Hydrilla is a submersed aquatic perennial with heavily branched stems towards the water surface. Stems are slender and can grow up to 9 m long depending upon water clarity. Leaves are 6 to 20 mm long and 2 to 4 mm wide. The leaves are strap-shaped with pointed tips and saw-tooth edges, and grow in whorls of 4 to 8 around the stem. Leaf color can vary from green, translucent, yellowish, to brown. Hydrilla produces turions (over-wintering dense vegetative buds) in the axils of leaves and tubers within the sediment. Small white flowers on long slender stems near the water's surface are female, and small, green, free-floating, inverted bell-shaped flowers are male. The plant is usually rooted to the substrate but sometimes grows as floating mats at the water's surface.

Hydrilla reproduces mostly by asexual vegetative fragmentation (from stem fragments), but it also grows new plants from turions and underground tubers, as well as seeds in locations where they are produced. One hydrilla tuber can lead to the production of 5,000 new tubers per square meter. Tubers and turions can survive ice cover, drying, ingestion and regurgitation by waterfowl, and may remain viable in the sediment for several years.

Hydrilla is found in freshwater but can tolerate salinities of up to 7‰. It has been found in springs, lakes, marshes, ditches, rivers, and tidal zones. It can grow in relatively low light and CO2 conditions. Hydrilla prefers temperatures between 20 and 27 degrees C, but tolerates and survives for long periods at 4-5 degrees C.

Hydrilla competes with native plants by growing to the water surface and forming dense surface mats that totally exclude sunlight from other plants, which in turn can significantly reduce aquatic plant and animal biodiversity. Large populations hydrilla may affect fish size and population levels where predatory fish cannot hunt effectively within the thick mats. The dense mats also negatively affect recreational activities. Apart from interfering with fishing, boat motors can become tangled with them and swimming areas choked. Children have become entangled in hydrilla and drowned. Hydrilla often slows or clogs rivers, irrigation ditches, and flood control canals, creating stagnant water that is prime mosquito breeding habitat. Dense stands can even cause flooding, alter water quality by decreasing oxygen levels and increasing pH and water temperature.

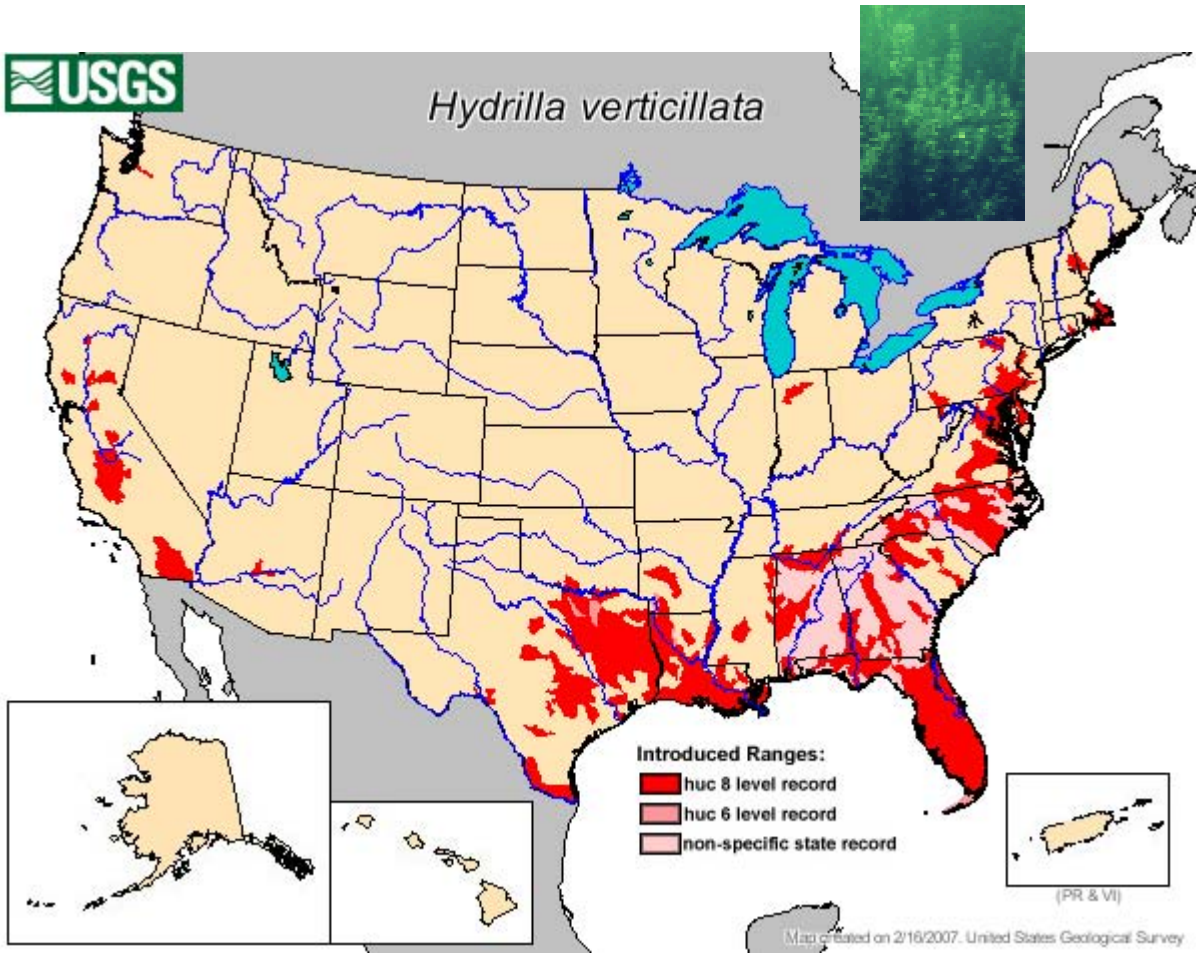
Distribution: Hydrilla is thought to be native to Asia, Africa, and northern Australia. The dioecious plant is native to southern India and the monoecious plant is probably native to Korea. The dioecious and the monoecious plants are now found on every continent except Antarctica. In the US, it is widespread in states along the Gulf coast and the eastern seaboard, as well as in numerous locations in California and an isolated outbreak in a lake east of Puget Sound. Some of these occurrences have been successfully eradicated. Hydrilla populations north of South Carolina are mainly monoecious, while southern populations are primarily dioecious females. Early biomass measurements of the Washington State occurrence reflect high growth potential in the northwest.

Pathways of Introduction: The dioecious strain was imported to the United States in the early 1950s for use in aquariums. It entered Florida's inland water system after plants were discarded or planted into canals. The monoecious strain was a separate introduction, first found decades later in the Chesapeake Basin. Hydrilla is mainly introduced to new waters as castaway fragments on recreational boats, motors, trailers and live wells. Stem pieces root in the substrate and develop into new colonies, which are commonly found near boat ramps. Once established, boat traffic continues to shatter and spread hydrilla throughout the waterbody. Both types propagate primarily by stem fragmentation, although axillary buds (turions) and subterranean tubers are also important. Tubers are resistant to most control techniques and may be viable as a source of reinfestation for many years. Hydrilla may be unknowingly transplanted into private ponds as a contaminant on water garden plants.

Management considerations: Potential biological controls include grass carp *Ctenopharyngodon idella* and leaf-feeding flies. Grass carp are effective but are vegetative generalists, so they should be used with care so as not to destroy native aquatic vegetation. Leaf-eating flies are still under evaluation for their effectiveness. They are species specific but do not appear to reduce hydrilla biomass significantly. Grass carp, themselves are regulated species in Idaho with only certified sterile (triploid) fish being permitted.

Harvesting and use of motorized boats is not recommended in partially infested lakes or where uncontaminated water bodies occur nearby, because this can chop the plants and facilitate spread of shoot fragments. In ponds and small lakes, water draw-downs, which expose and kill the plants, have been found to be temporarily effective. Weed mats in public access sites to contain spread and signage to increase public awareness are some of the containment methods adopted.

Aquatic herbicides are effective at temporarily controlling the weed but do not kill the tubers, turions, and seeds.


USGS
Hydrilla verticillata
Introduced Ranges:
huc 8 level record
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non-specific state record
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Map created on 2/16/2007. United States Geological Survey

Brazilian elodea *Egeria sp.*

Ecology: *Egeria sp.* is a submersed, freshwater perennial herb that grows on the bottom in depths of up to 20 feet depending on water clarity. It is found in both still and flowing waters, in lakes, ponds, pools, ditches, and quiet streams. Stems are erect, cylindrical, simple or branched, and grow until they reach the surface of the water where they form dense surface mats. This plant is easily and regularly confused with hydrilla.

Egeria sp. initiates growth when water temperatures reach 10 C. Two major growth flushes occur, in spring and fall. Each of these flushes is followed by a period of senescence, with a loss of biomass through sloughing and decay of tips and branches. Flowers (18-25mm) are produced on the water's surface in late spring and again in the fall. The intensity of flowering varies from year to year. *Egeria* is not known to produce viable seeds in the United States. During the summer, profuse branching forms a canopy. The branches form dense, tangled mats on the water's surface.

The absence of sexual reproduction in introduced populations of *Egeria sp.* emphasizes the importance of the vegetative growth phase of the plant. Specialized nodal regions described as double nodes occur at intervals of 6 to 12 nodes along a shoot. A double node consists of 2 single nodes separated by a greatly shortened internode. Double nodes produce lateral buds, branches, and adventitious roots. Only shoot fragments of *Egeria sp.* which contain double node regions can develop into new plants. *Egeria sp.* lacks specialized storage organs such as rhizomes or tubers and stores carbohydrates in stem tissues.

Egeria sp. forms dense mono-specific stands that restrict water movement, trap sediment, and cause fluctuations in water quality. Dense beds interfere with recreational uses of a water body by interfering with navigation, fishing, swimming, and water skiing. It has exhibited the ability to rapidly recolonize de-vegetated areas following.

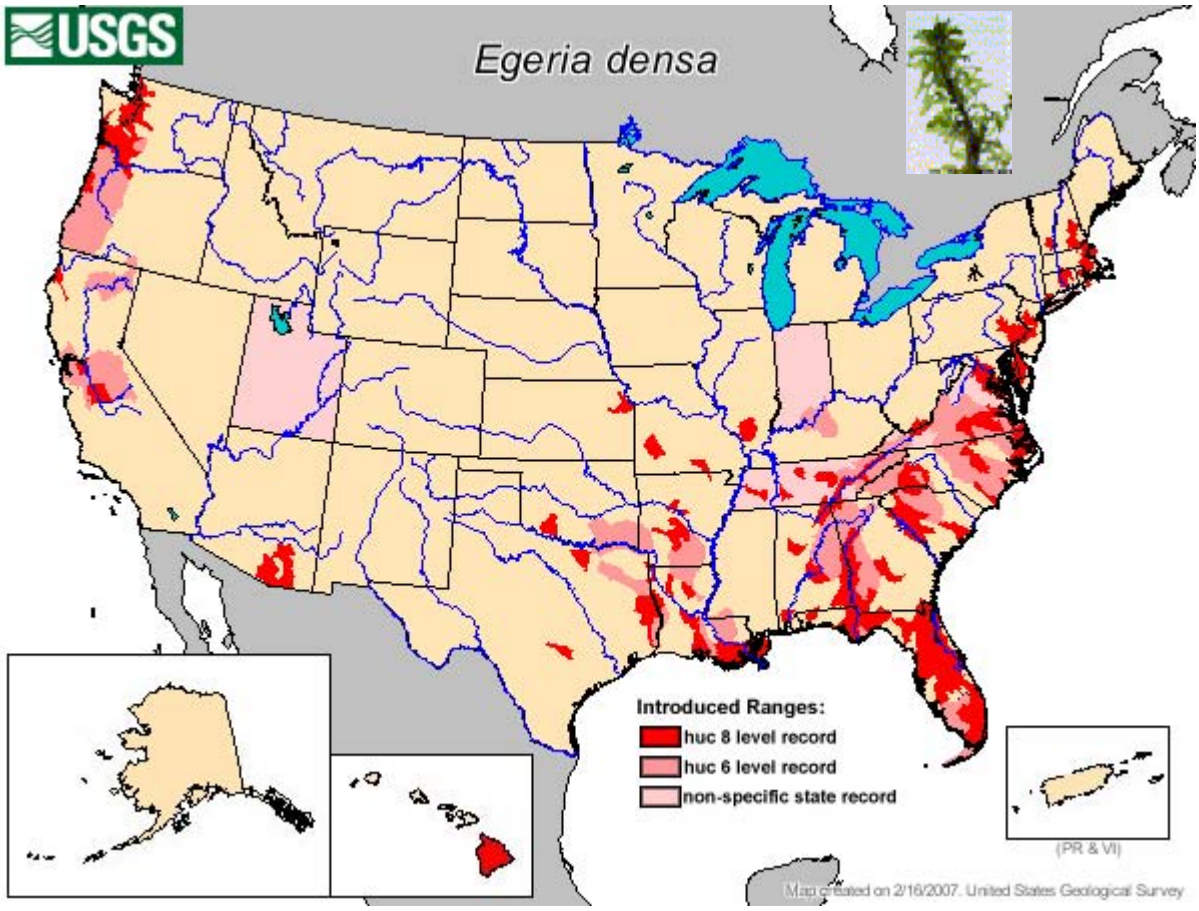
Distribution: Native to South America, this species has been introduced to Asia, Australia, Europe, New Zealand, and North America. In the United States, it is widespread along the eastern seaboard, the Gulf coast, and in California. It has been reported in Washington, Oregon, and Utah. It is not yet naturalized in Idaho but is sold here as an aquarium plant.

Pathways of Introduction: *E. densa* was first reportedly offered for sale in the United States in 1915, where it was recommended as a good "oxygenator" plant. It is a popular aquarium plant and can be found for sale in most pet shops, usually under the name anacharis. It is one of several invasive aquatic plants sold in aquarium or water garden dealerships, advertised on commercial websites, or occurring as contaminants among plants that are offered for sale.

Management considerations: Grass carp find *Egeria sp.* highly palatable (when older than fingerlings) and have been successfully employed as a management tool elsewhere in the US, though it is important to note only sterile (triploid) grass carp are legal in

Idaho. Where they have been employed, they have been observed to remove the entire submersed aquatic community, and thus represent an equivalent ANS.

Localized control (in swimming areas and around docks) can be achieved by covering the sediment with an opaque fabric which blocks light from the plants. Managers of reservoirs and some lake systems may have the ability to lower the water level as a method of managing *Egeria*. Producing no seeds or perennial rhizomes or tubers, *Egeria* can be effectively controlled for a few years by drawdown, desiccation and freezing. Because this plant spreads readily through fragmentation, mechanical controls (such as cutting, harvesting, and rotovation underwater rototilling) should be used with care. In some locations, appropriate herbicides can be used successfully.



European frog-bit *Hydrocharis morsus-ranae*

Ecology: European frog-bit is an herbaceous, annual freshwater species that can reach 20 cm in length. It does well in quiet open water and can be found in marshes, ditches and swamps. It grows well in sheltered coves and along the still water shorelines of rivers, lakes and streams. The leaves of this plant are usually floating, but if the vegetation is dense enough, they can be emergent. Each plant has numerous, fibrous, free floating roots which can attain a maximum length of 30cm. In early summer, the plants produce small, white, three petaled, unisexual flowers. Despite profuse flowering during the summer, European frog-bit rarely produces seeds and instead relies on vegetative reproduction for survival and spread. Multiple plantlets develop along the stolons, or runners, of each plant during the growing season. In the fall, European frog-bit produces buds, called turions, which sink to the substrate where they remain dormant until the springtime, at which time the developing buds floats to the surface and mature. One plant is capable of producing about one hundred of theses turions each year. In spring European frog-bit develops free-floating mats comprised of interlocking plants that have recently developed from overwintering turions. These mats stabilize in position as water levels drop and roots elongate.

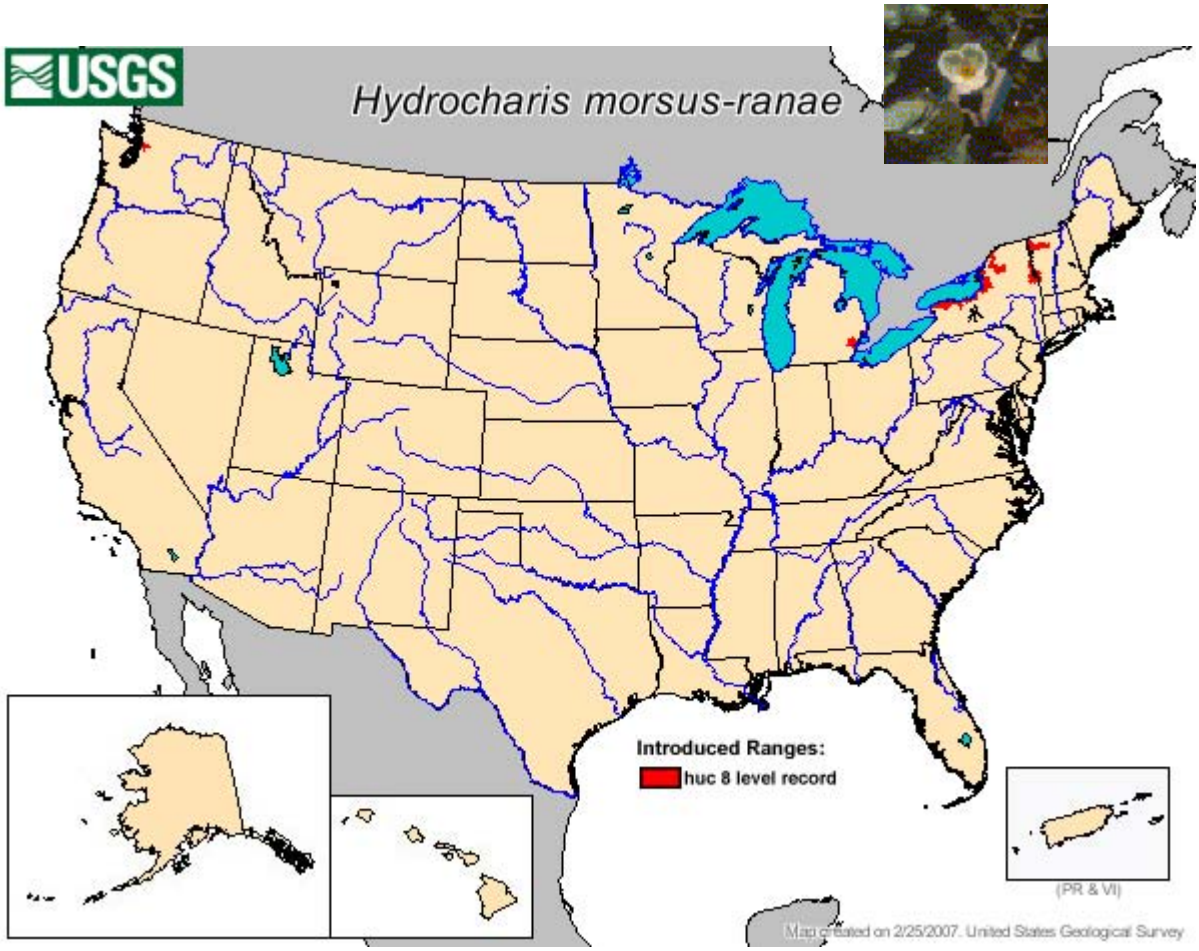
Because of the dense floating mat of vegetation produced by European frog-bit, available light, dissolved gases, and nutrients were reduced to submersed aquatic plants attempting to grow beneath this mat. The plant is often a dominant species in the wetlands within which it occurs. By dominating wetlands with its thick mats, European frog-bit displaces native flora and is perhaps affecting the fauna. European frog-bit is also implicated in limiting water flow in irrigation systems and restricting water traffic, thereby hindering recreational activity. On the other hand, European frog-bit is a food plant for several water birds, rodents, fish and insects.

Distribution: European frog-bit is native to Eurasia but has been present in North America since at least 1932, when it was intentionally introduced for horticultural purposes in an arboretum in Ottawa. By 1955 its North American distribution extended from Ottawa to Montreal. By 1980 it had extended southwest to Lake Ontario and northeast to Quebec City. Recently it has spread throughout much of the central and southwestern parts of southern Ontario, and further into northern New York, Vermont, and eastern Michigan. By 2002 it was found to be established in a lake in Snohomish County, Washington.

Pathways of Introduction: Self-propelled spread takes place primarily vegetatively by means of strong cord-like stolons and the production of winter turions. Boats and waterfowl can transport both turions and plantlets, expediting the expansion from one region to another. Water currents in connected waterways, canals, and watersheds can also facilitate its dispersal.

Management considerations: The best management policy is to prevent the spread of this species. Plants can be harvested by mechanical means or by hand depending upon the extent of the infestation and the water depth. There are no known biocontrol agents

that have been introduced into the US. Herbicide research has been limited, but the broad spectrum herbicides may be effective.



Water chestnut *Trapa natans*

Ecology: Water chestnut is an annual aquatic plant with a submerged flexuous stem that is anchored in the mud and extends upward to the surface of the water, much like a water lily. Water chestnut features a rosette of floating, fan-shaped leaves, each leaf having a slightly inflated petiole (stem); the roots are fine, long and profuse. The small, 4-petalled flower is white and the fruit is a large nut with four sharp spines. Water chestnut grows best in shallow, nutrient-rich lakes, ponds, canals, and rivers and is generally found in waters with a pH range of 6.7 to 8.2 and alkalinity of 12 to 128 mg/L of calcium carbonate.

Flowers are produced singly on stalks arising from the center of the floating rosette of leaves. Four triangular sepals surround the flower and develop into barbed spines in the mature fruit. Once the ovules of the insect pollinated flowers are fertilized, the flower stalks curve downward, allowing the fruit to develop under water into a nut-like, barbed, spiny seed. The single-seeded woody fruits produced from the previous year germinate in early spring. A single seed may give rise to 10 to 15 plant rosettes, and each rosette can produce up to 15 to 20 seeds. Ungerminated seeds may remain viable for many years, but most seeds probably germinate in the first two years following their formation.

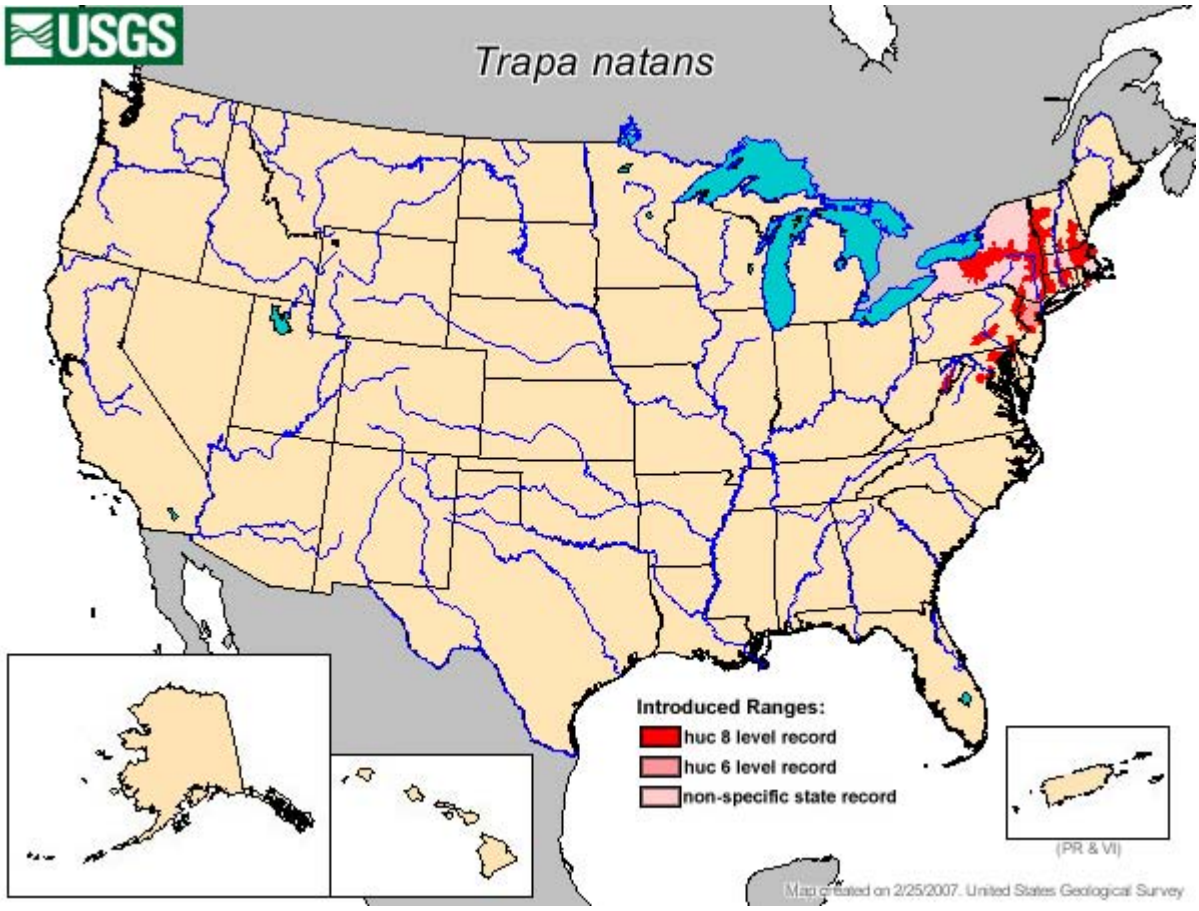
Water chestnut is a fierce competitor in shallow waters with soft, muddy bottoms. Uncontrolled, it creates nearly impenetrable mats across wide areas of water. In Vermont, many previously fished bays of southern Lake Champlain are now inaccessible, and floating mats can create a hazard for boaters. It is also a human nuisance because mature Water chestnut nuts drift to shore where their sharp spines injure bare feet. This noxious plant also severely limits the passage of light into the water, a critical element of a well-functioning aquatic ecosystem. It reduces oxygen levels, which may increase the potential for fish kills. Water chestnut out competes native vegetation and is of little value to wildfowl.

Distribution: While established in the northeastern United States since the late 1800s, this Asian native continues to advance into new areas in New England and the Mid-Atlantic states. In the past two years, New Hampshire and Connecticut have experienced first occurrences of this robust floating aquatic plant. Water chestnut has reappeared in tributaries of the Chesapeake Bay where plants were first experienced in the 1920s.

Pathways of Introduction: The plant spreads when rosettes detach from the stems and float to another area. Currents or waves carry nuts to other parts of water bodies. Dispersal of rosettes by boats or waterfowl is possible, though probably not a primary method of spread. Some infestations may be a result of water garden escapes.

Management considerations: Hand harvesting is an effective means for eradication of smaller populations because water chestnut roots are easily uplifted. Their removal is imperative because floating, uprooted plants can survive and disperse downstream. The potential of water chestnut seeds to lie dormant for many years makes total eradication difficult. Raking and hand harvesting from canoes have been effective and are a means to promote community awareness and involvement.

Herbicides and mechanical harvesting can both be effective for large-scale control of water chestnut populations. Aquatic plant harvesting boats are often employed in instances where waterways are blocked and the herbicide 2,4-D has been tested and found effective.



Fanwort *Cabomba sp*

Ecology: Fanwort is a submersed perennial aquarium plant that grows in stagnant to slow flowing freshwater. It grows from short rhizomes with fibrous roots on the bottom of water bodies and the stems reach the surface, growing up to 10m long. Parts of the plant can survive free-floating for six to eight weeks.

Fanwort is sensitive to dessication, but survives wide fluctuations in water depths and grows well in silty substrate. It exhibits reduced vigor in hard substrates. It may be found in stagnant or slow-flowing water in streams, small rivers, ponds, lakes, reservoirs, sloughs, ditches and canals. Growth of 50 mm a day has been reported in Lake Macdonald in Australia. It grows well in high nutrient environments with low pH, but in more alkaline waters it tends to lose its leaves. High calcium levels inhibit growth, but unlike other aquatic weeds, fanwort can grow well in turbid water. It prefers a warm, humid climate with a temperature range of 13-27ºC but can survive when the surface of the water body is frozen.

Fanwort spreads primarily by stem fragments or rhizomes. The erect shoots are simply upturned extensions of horizontal rhizomes. The species forms large clones as new rhizomes and floating shoots arise as axillary branches. The rhizomes are fragile and easily broken, facilitating vegetative spread and transport to new areas.

Fanwort is an extremely persistent and competitive plant. Under suitable environmental conditions it forms dense stands and crowds out native plants. Once established, this plant can clog drainage canals and freshwater streams, interfering with recreational, agricultural, and aesthetic uses. Fanwort 's dense mass of underwater stems and leaves provide a hazard for recreational water users. When this vegetation dies off, decomposition can cause dramatic oxygen reductions and foul smelling water.

Cabomba sp. is commonly used as an aquarium plant because of its delicate appearance. Large numbers of plants are sent from Florida to the rest of the United States for commercial use. It is also grown commercially in Asia for export to Europe and other parts of the world. In its native habitat *Cabomba sp.* is eaten by waterfowl and some fish and provides cover for some small fish and plankton.

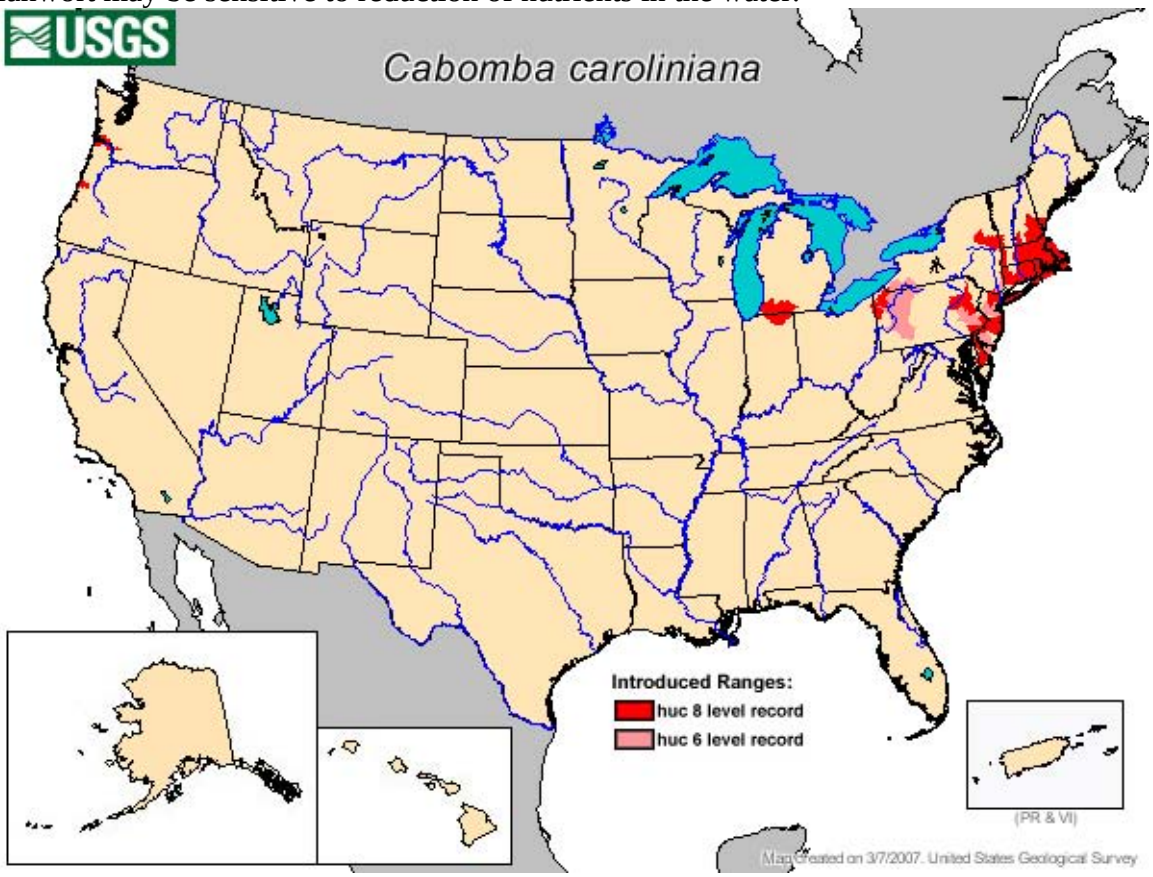
Distribution: *Cabomba sp.* is native to southern Brazil, Paraguay, Uruguay and northeast Argentina, and the southeastern US. It has been dispersed throughout the world by the aquarium trade and is naturalized in Peru, China, India, Japan, Malaysia, parts of Australia, and Canada. In the United States it is naturalized in the northeast from Maryland to Maine, in western New York and Pennsylvania, in Michigan and Indiana, and in Oregon and Washington.

Pathways of Introduction: *Cabomba sp.* is commonly used as an aquarium plant because of its delicate appearance, and is spread through aquarium release. Like many problem aquatic plants, fanwort can reproduce from small fragments. Fanwort stems become brittle in late summer, which causes the plant to break apart, facilitating its distribution and invasion of new water bodies.

Management considerations: Fanwort is sensitive to dessication and requires permanent shallow water; therefore, drawdown can provide temporary control. The root ball must dry out thoroughly or the plant will quickly return. Preventing new outbreaks is the most effective control method. As the plant is submerged and not easily visible, education and public awareness are needed to prevent the spread of fanwort. People also need to be educated to buy other species of aquarium plants.

In a recreational water body or river, hygiene protocols are needed to ensure wash down of boats, trailers and fishing equipment. Habitat modification via re-vegetation is also recommended and may offer some control if it produces a shading effect. Because fanwort requires direct sunlight, shading has been used to kill it in small areas; however the cost is prohibitive for large-scale programs. In a closed water body with a heavy infestation, it is recommended to use strict hygiene regulations and mechanical control (involving cutting and removing plants and ensuring fragments are not spread). In the case of isolated plants and in small areas physical control (hand pulling by divers) and the use of herbicides may offer suitable control.

Herbicide treatments have been used for fanwort control. Grass carp are known to eat fanwort, but they do not prefer it. Unlike most other rooted aquatic plants, fanwort may get most of its important nutrients from the water rather than the sediment. Therefore, fanwort may be sensitive to reduction of nutrients in the water.



Appendix C. List of Known Nonindigenous Aquatic Species in Idaho.

The following is a list of nonindigenous species known to be likely present in Idaho. It includes species that have been classified as High priority ANS along with others that would fall into medium or low categories after complete classification. **Not all species in this list are ANS**. It also contains species that the state would not currently classify as ANS species due to their beneficial nature in selected waters, such as introduced game fish species.

Scientific Name	Common Name
Plants	
"Aquatic" Group	
Alopecurus geniculatus	water foxtail, meadow foxtail
Bassia hirsuta	hairy smotherweed
Butomus umbellatus	flowering rush
Callitriche stagnalis	pond water-starwort
Crypsis alopecuroides	foxtail pricklegrass, fox-tail timothy
Glyceria fluitans	water mannagrass
Iris pseudacorus	yellow iris, paleyellow iris
Lythrum salicaria	purple loosestrife
Lythrum tribracteatum	threebract loosestrife
Mentha spicata	spearmint
Myriophyllum aquaticum	parrot-feather milfoil
Myriophyllum spicatum	Eurasian watermilfoil
Nasturtium officinale Syn. *Rorippa nasturtium-aquaticum*	water-cress, watercress
Nymphaea odorata	white water-lily
Polygonum hydropiper	marshpepper knotweed, marshpepper smartweed
Potamogeton crispus	curly pondweed
Rorippa sylvestris	creeping yellowcress
Sparganium emersum	European bur-reed
Typha angustifolia	narrowleaf cattail
Vaccinium macrocarpon	cranberry
Vallisneria americana	eel-grass
Zizania palustris var. *palustris*	northern wildrice
"Terrestrial Wetland" Group	
Acer negundo var. *violaceum*	box elder
Acer saccharinum	silver maple
Aegopodium podagraria	bishop's goutweed
Allium schoenoprasum	wild chives
Alopecurus pratensis	meadow foxtail, field meadow foxtail
Amaranthus blitoides	mat amaranth
Amorpha fruticosa	desert false indigo
Apium graveolens	wild celery
Arctium minus	lesser burdock
Artemisia biennis	biennial wormwood

Barbarea vulgaris	garden yellowrocket
Bassia hyssopifolia	fivehorn smotherweed
Briza minor	little quakinggrass
Calystegia sepium	hedge false bindweed
Cardaria draba	whitetop, hoary cress
Carduus acanthoides	plumeless thistle
Carduus nutans	musk thistle
Cirsium arvense	canada thistle, creeping thistle
Cirsium vulgare	bull thistle
Conium maculatum	poison-hemlock
Cynoglossum officinale	common hound's-tongue, houndstongue
Cyperus esculentus	yellow nutsedge, chufa flatsedge
Echinochloa crus-galli	barnyard grass
Echinochloa muricata	rough barnyardgrass
Elaeagnus angustifolia	Russian olive
Elymus repens Syn. *Agropyron repens, Elytrigia repens*	quackgrass, creeping wild rye
Fraxinus pennsylvanica	green ash
Galega officinalis	common milkpea, goatsrue
Holcus lanatus	common velvetgrass
Impatiens glandulifera	ornamental jewelweed, policeman’s helmet
Juglans regia	English walnut
Lactuca tatarica var. pulchella Syn. *Lactuca pulchella*	blue lettuce
Lepidium latifolium	perennial pepperweed
Linaria vulgaris	butter-and-eggs, yellow toadflax
Lythrum hyssopifolium Syn. *L. hyssopfolia*	hyssop loosestrife
Mentha ×piperita	peppermint
Morus alba	white mulberry
Myosotis scorpioides	true forget-me-not
Nepeta cataria	catnip
Phalaris arundinacea	reed canary grass
Phragmites australis	common reed
Plantago major	common plantain
Poa annua	annual bluegrass
Poa trivialis	rough bluegrass, Scribner bluegrass
Polygonum argyrocoleon	silversheath knotweed
Polygonum bohemicum	Bohemian knotweed
Polygonum cuspidatum	Japanese knotweed
Polygonum persicaria	spotted ladysthumb
Polypogon monspeliensis	annual rabbitsfoot grass
Populus deltoides	eastern cottonwood
Populus fremontii	Fremont's cottonwood
Prunus avium	bird cherry
Prunus cerasifera	cherry plum
Puccinellia distans	weeping alkaligrass, spreading alkali grass
Ranunculus acris	tall buttercup
Ranunculus repens	creeping buttercup
Rorippa austriaca	Austrian yellowcress, Austrian fieldcress

Rosa eglanteria	sweetbriar rose
Rumex crispus	curly dock
Rumex obtusifolius	bitter dock
Sagina procumbens	birdeye pearlwort
Salix alba	white willow
Sonchus arvensis	perennial sowthistle, moist sowthistle
Sonchus asper	spiny sowthistle
Spergularia diandra	diandra sandspurry, Mediterranean sandspurry
Tamarix spp.	saltcedar

Fish

Ameiurus melas	black bullhead
Ameiurus natalis	yellow bullhead
Ameiurus nebulosus	brown bullhead
Carassius auratus	goldfish
Characidae	pacu sp.
Coregonus clupeaformis	lake whitefish
Ctenopharyngodon idella	grass carp
Cyprinus carpio	common carp
Esox lucius	northern pike
Esox masquinongy x lucius	tiger musky
Fundulus diaphanus	banded killifish
Gambusia affinis	western mosquitofish
Gila bicolor	tui chub
Ictalurus furcatus	blue catfish
Ictalurus punctatus	channel catfish
Lepomis cyanellus	green sunfish
Lepomis gibbosus	pumpkinseed
Lepomis gulosus	warmouth
Lepomis macrochirus	bluegill
Micropterus dolomieu	smallmouth bass
Micropterus salmoides	largemouth bass
Misgurnus anguillicaudatus	oriental weatherfish
Notemigonus crysoleucas	golden shiner
Notropis hudsonius	spottail shiner
Noturus gyrinus	tadpole madtom
Oncorhynchus clarki henshawi	Lahontan cutthroat trout
Oncorhynchus mykiss aguabonita	golden trout
Perca flavescens	yellow perch
Pimephales promelas	fathead minnow
Pomoxis annularis	white crappie
Pomoxis nigromaculatus	black crappie
Pygocentrus or Serrasalmus sp.	piranna sp.
Pylodictis olivaris	flathead catfish
Salmo salar	Atlantic salmon
Salmo trutta	brown trout
Salvelinus alpinus	Arctic char
Salvelinus fontinalis	brook trout
Salvelinus namaycush	lake trout

Salvelinus namaycush x fontinalis	splake
Stizostedion vitreum	walleye
Thymallus arcticus	Arctic grayling
Tilapia aurea	blue tilapia
Tilapia mossambica	Mozambique tilapia
Tinca tinca	tench
Xiphophorus helleri	green swordtail

Amphibians

Rana catesbeiana	bullfrog
Taricha granulosa	rough-skinned newt

Invertebrates

Corbicula fluminea	Asian clam
Mysis oculata relicta	Opossum shrimp
Orconectes virilis	virile crayfish, northern crayfish
Potamopyrgus antipodarum	New Zealand mudsnail
Radix auricularia	big-ear radix

Appendix D. Idaho's Rapid Response Strategy[1]

Much of this ANS plan is dedicated to either preventing new unwanted species from arriving and becoming established in Idaho, or to control the spread of those that are already established. However, another important function of this ANS plan is to be the basis for a coordinated early detection and rapid response to newly discovered species or to the recent spread to previously uninfested waters. This might be viewed as the response to an emergency situation, no less important or demanding of proper planning before the event than if a truck of toxic chemicals overturned near a stream.

Currently, Idaho's response to a new or spreading invasion of an ANS is likely dependent upon chance—a concerned informed sportsman or the employee of any number of agencies might see something out of the ordinary and reports it to a supervisor or someone they think might be "in charge". Whether this happens in a timely fashion with the report made to a responsible official who will take responsibility for appropriate responses is more a matter of luck than thoughtful planning before the fact. As such, this portion of this ANS plan is dedicated to outlining a series of rapid response actions protocols that, if followed, will provide for an adequate and timely response. It is patterned after the recently completed rapid response plan for zebra and quagga mussel, necessitated by the discovery of this particular ANS in the Colorado River. It is also based upon ten objectives to be achieved through a rapid response plan, including:

- Verify reported detection
- Make initial notifications to all relevant managers
- Define extent of colonization
- Set up an interagency response management team
- Establish external communications system
- Organize resources (personnel, equipment, funds, etc.)
- Prevent further spread via quarantine and pathway management
- Launch available/relevant control actions
- Institute long-term monitoring
- Evaluate the response and the Rapid Response Plan

Rapid Response Objective 1: Verify Reported Detection

Purpose: Confirm the veracity of the report, determine the condition (age, maturity, spawning status, etc.) of the species, and ensure that everyone is handling reports consistently and judiciously across a broad geographic area.

Lead entity: The agency that receives and accepts responsibility for handling the initial report in coordination with the state, tribal, provincial, and/or federal agency where the initial sighting of species occurs.

[1] Adapted from the "*Columbia River Basin Rapid Response Plan for Zebra Mussels and other Dreissena species.*"

Tasks:

1. Interview the reporter(s) to validate detection by:
    - Recording details of the location such as name of the water body, landmarks, highway mile, and other (GPS if possible) where the suspect species were found.
    - Collecting contact information from the reporter(s).
    - Securing an estimate of the number, density, extent of the species colonies found.
    - Obtaining a digital or other photograph (with scale indicator), if possible.
    - Securing a sample of the species, if possible.
    - Documenting the date and time of sighting(s).
    - Noting other relevant conditions (access limitations, etc.)

2. Validate identification as soon as possible via examination of a physical sample.
    - When feasible, arrange for a site visit by at least one recognized expert (preferably a small team).
    - If recognized experts cannot feasibly reach the site within 24 hours, arrange to have samples and other evidence (e.g., photographs) sent via Express Mail Service or email to the most accessible recognized expert.
    - Prior to shipping samples, obtain guidelines from recognized experts and use any existing protocols regarding handling of the sample, desired quantity, where and how to deliver the sample, etc.

Rapid Response Objective 2: Make Initial Notifications

Purpose: Ensure that all parties that have jurisdiction in response decisions or can provide technical support are quickly engaged and to also rapidly inform all other interested parties.

Lead entity: The agency that initially receives confirmation of the species identification

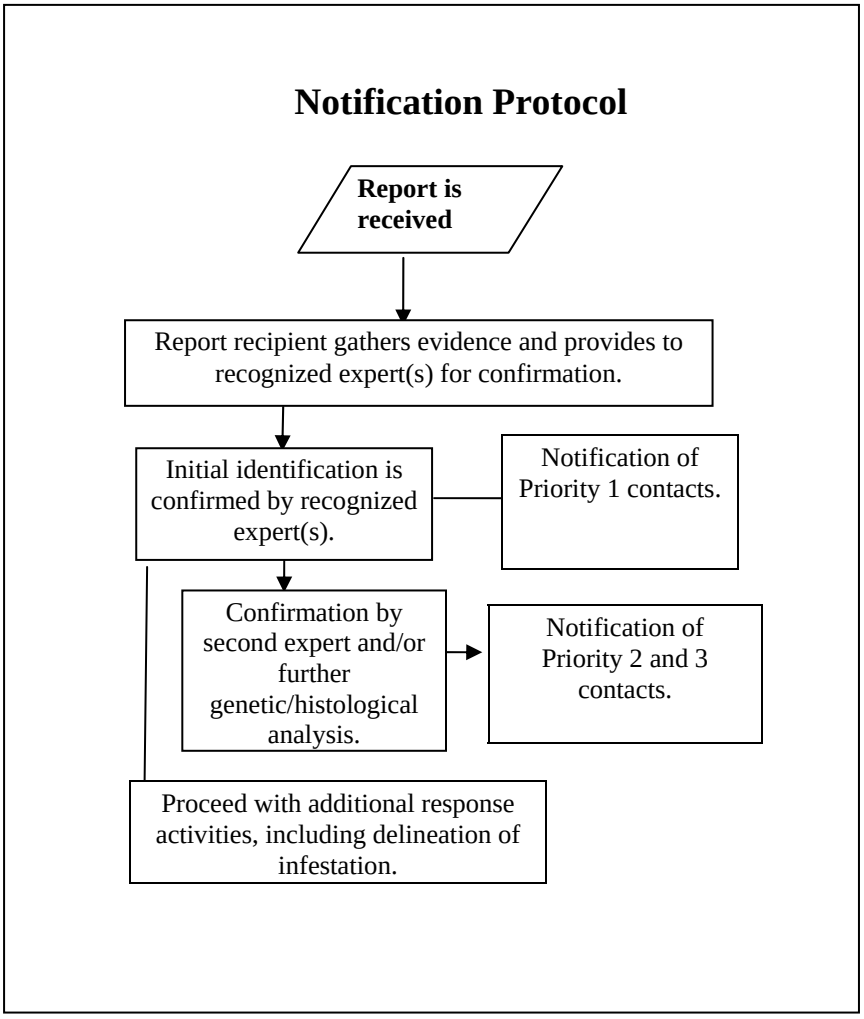
Tasks:

1. Within the first 24 hours or as soon as practical after a physical sample is visually confirmed to be an ANS by a recognized expert, the agency receiving such confirmation (with assistance from agencies in relevant jurisdictions) will notify all primary management contacts. It is critical that this notification list be updated, and preferably tested, at least annually.

2. Secure verification of notifications to confirm that parties on the contact list did, in fact, receive notification (e.g., Internet list server response confirmation requirement, phone list call-backs, etc.).

3. While proceeding with subsequent response activities described below, obtain secondary visual confirmation of species identification via a different expert. Also submit a sample to an expert who can provide definitive confirmation based on genetic or histological analysis.

This process is summarized in the following figure.



Rapid Response Objective 3: Define Extent of Colonization

Purpose: Rapidly provide information on location of introduced species to guide subsequent management decisions, including survey design.

Lead entity: The appropriate state or federal agency where the initial sighting(s) of species occurs in partnership with other agencies and organizations.

Tasks:

1. Determine geographic extent and demography of infestation, including upstream and downstream areas and connected water bodies. Also survey nearby water bodies with vulnerability to the same vectors.

2. Identify a lead monitoring coordinator who can maximize the effectiveness of survey efforts by individual agencies.

3. Identify any potential facilities (e.g., hydropower, fish hatcheries, irrigation systems, etc.) that could be affected.

4. Ensure that surveys are completed and that results are reported through responsible tracking organizations.

Rapid Response Objective 4: Set Up an Interagency Response Management Team

Purpose: Activate a predetermined response management system that expedites decision-making, information sharing, avoids duplication, and minimizes authority conflicts while preserving flexibility for adaptive management. Use the Incident Command System as a foundation for the response organization and decision-making processes. Any existing agreement documents developed in association with this rapid response plan should be consulted to guide the steps below.

Lead entity: Incident Commander(s), as defined below, in collaboration with overall response team.

Tasks:
As soon as possible, the appropriate state agency associated with the initial sighting of ANS convenes a meeting and/or conference call involving all relevant managers and these cooperators. During this initial meeting, a response organization should be established using the Incident Command System (ICS) as a foundation. Where multiple agencies have lead jurisdiction, a unified command structure should be used. The incident commander(s) will serve as the focal point for coordinating implementation of the rapid response plan, and in cooperation with the overall responses team, will establish other components of an ICS organization as needed (e.g., Operations Branch). Where time allows, the incident commander(s) will seek collaborative decision-making by the entire team of involved response agencies. For a multi-state infestation where there is no initial consensus on the incident commander role, this default role will fall to the appropriate USFWS Regional ANS Coordinator until the relevant authorities reach agreement on an alternative.

The incident commander(s) will:

- Coordinate Interagency Team notification operations
- Facilitate creation of an ICS organization involving lead representatives of each local, tribal, state, provincial, and/or federal government that has legal authority over the response, and comprised as appropriate by specific ICS staff positions (e.g., safety officer) and divisions (e.g., Operations).
- Represent (i.e., be the spokesperson for) the management team.
- Facilitate a decision-making process that considers consensus processes and cascading levels of authority within individual agencies
- Facilitate development of response priorities
- Establish planning horizons for the response (e.g., 2 weeks vs. 2 months vs. 2 years)

3. These above actions should take into account roles/relationships/inter-agency agreements among:

- All affected states: e.g., Governor, state agencies, ANS Coordinator and Canadian provinces.
- Federal agencies: USFWS, ACOE, USEPA, NOAA, etc.
- Tribes.
- Local governments.
- Other interested parties, such as irrigation districts, marinas, etc.

4. The incident commanders should develop a technical advisory team that includes experts from outside the region to help advise response activities.

Rapid Response Objective 5: Establish External Communications System

Purpose: Develop an information center to ensure consistent and effective communication to interested external stakeholders, including the media and public.

Lead Entity: Incident Commander(s) identified in Objective 4 above.

Tasks:
1. Notify and educate affected landowners, and where appropriate, gain their written permission to access property for response activities.

2. Notify and educate potentially affected water users and water-rights holders.

3. Develop public information strategy, press packets, press release process, and press conferences.

4. Develop and implement general public education and outreach. Since there are a variety of educational materials between regions and states, assure coordination and perhaps agreement on materials that can be used region-wide.

Rapid Response Objective 6: Organize Resources

Purpose: Provide sufficient resources to initiate control actions and associated activities (including acquisition of required permits).

Lead Entity: The Incident Commander(s) identified in Objective 4 above in partnership with all other organizations involved in the response.

Tasks:
1. Develop estimates for staffing needs, facilities and equipment, and funding.

2. Identify potential sources for staffing, facilities, equipment, and funds.

3. Secure commitments for needed staff, facilities and equipment, and funds.

4. Ensure mechanism for dispersal of funds is in place, and when the funds are needed, flow of dollars occurs expeditiously. For applicable jurisdictions, this includes pursuing declarations of emergency by elected officials.

Rapid Response Objective 7: Prevent Further Spread Via Quarantine and Pathway Management

Purpose: Minimize all vectors that might further spread the original infestation.

Lead Entity: Incident Commander(s) and agencies with regulatory jurisdiction

Tasks:

1. Evaluate risks, dispersal vectors (including movement by humans, fish and wildlife, water traffic, water flow, and other physical processes).

2. Restrict dispersal pathways, where feasible, including the following or similar measures that are suitable for individual species:

    - Quarantine any hatcheries or aquaculture operations that are likely to spread the species or their larvae via transfers outside the affected watershed(s).
    - Quarantine infested water bodies as needed to prevent spread by watercraft or other vectors following any existing protocols.
    - Assess the likely movement of boats that recently used the infested water body to identify inspection needs in other water bodies.
    - Establish wash and inspection requirements on boats and equipment, and provide for associated logistical support (e.g., disinfection kits).
    - Ensure that species "alert" signs are adequately deployed.
    - Develop and implement Hazard Analysis and Critical Control Point (HACCP) plans to ensure that local, state, tribal or federal government response personnel do not further spread the original infestation.
    - Work with the information center to design and implement educational outreach programs using print, electronic media and other avenues, with an emphasis on water users.
    - Stop or slow water release to potentially uninfested sites.
    - Draw water from below thermocline.
    - Install physical barriers.

Rapid Response Objective 8: Initiate Available/Relevant Control Measures

Purpose: Evaluate management options, and then proceed with either eradication efforts or containment/mitigation activities.

Lead Entity: Incident Commanders in collaboration with overall response team

Tasks:

1. Decide if eradication is possible based on rapid analysis of population dynamics and pathways of spread. Consider the following:

    - Anticipated cost of eradication effort relative to available funding
    - Type of water body – contained lake, mainstem reservoir, tributary reservoir, small stream, large river, estuary, or water diversion facility.
    - Type of substrate – e.g., rocks that allow species attachment on their undersides where chemicals may not reach them.
    - Extent of population distribution – isolated vs. widespread coupled with *a priori* assumptions about the spread of species before detection.
    - Life stage(s).
    - Amount of water in reservoir or waterway.
    - Does the reservoir need to be drawn down before treatment?
    - How far can the reservoir be drawn down?
    - Is river flow low enough for effective treatment?
    - Circulation patterns in water body.
    - Spreading pattern of population within the water body.
    - Inflow rates and sources.
    - Presence of state or federally listed threatened or endangered species.
    - Special status of water body, including:
        1. Water use designation e.g., drinking water.
        2. 'Wild and scenic' designation.
        3. Wilderness area.
        4. Potential impact to cultural resources.
        5. Department of Defense or other restricted access areas
        6. Tribal lands
        7. Endangered Species Act critical habitat
        8. Clean Water Act 303(d) listing
        9. Beneficial Uses of water bodies

2. If eradication is attempted, select appropriate methods.

3. If eradication is not possible, develop control objectives and select/design appropriate control measures.

4. Obtain relevant permits and regulatory agency concurrence
    - Determine the permits and other regulatory reviews required for chosen eradication methods, including any applicable emergency provisions.
    - Begin with any existing permits and/or templates for required permits.
    - Assign lead person from each regulatory agency to facilitate permit approval in a timely manner within their respective agency.
    - Obtain a FIFRA Federal Crisis Exemption e.g., 40 C.F.R. PART 166 if the known or accepted methods of eradication are not currently permitted.

- Determine if an environmental impact statement or environmental assessment is required and if so, begin that work.
- NPDES (Section 402)
- NEPA (using template for environmental assessments where available)
- Initiate Endangered Species Act Section 7 consultations if needed by contacting appropriate USFWS and NOAA field offices.

5. Implement eradication or control strategies

- Lead coordinator facilitates implementation of operations plan developed by management team
- Agencies collaborate to coordinate and deploy field resources
- Establish schedule for frequent management team meetings to resolve operational issues that cross jurisdictional interests.

Rapid Response Objective 9: Institute Long-Term Monitoring

Purpose: Provide for data for adaptive management and long-term evaluation efforts.

Lead Entity: Incident Commander(s) in collaboration with overall response team

Tasks:

1. Design a monitoring program to evaluate the status of the species. Monitoring activities should be carried out in coordination with other field operations, such as environmental monitoring to meet permit and other regulatory compliance requirements (e.g. National Pollution Discharge Elimination System (NPDES)).

2. Disseminate findings through an easily accessible, consolidated, coordinated real-time database and list serve (e.g., via 100th Meridian Initiative website)

Rapid Response Objective 10: Evaluate the Response and the Rapid Response Plan

Purpose: Allow for adaptive management by ensuring feedback on the efficacy of response actions and the effectiveness of the Rapid Response Plan; enhance long-term Preparedness for response to other aquatic invasive species introductions.

Lead Entity: Responsible state and federal agencies

Tasks:

1. Conduct a follow-up evaluation of response organizations and other interest groups to identify opportunities for improving rapid response capacity. Disseminate "lessons learned" to other interested organizations e.g., regional ANS panels.

2. Revise the Rapid Response Plan and associated documents/guidelines based on evaluation and long-term monitoring results.

3. As resources allow, develop and implement a research plan that evaluates the associated ecological and economic impacts of the invasion, the effectiveness of management interventions, and negative consequences of management interventions beyond that required by permits.

4. Determine the need for long-term funding for the current management effort and seek this funding as warranted.

- Meet with state and federal legislators to map out a regionally coordinated long term funding strategy