

Idaho's Dreissenid Mussel Prevention Program: Implementing Policy Directives to Protect the State's Resources

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CONTENTS

Background.....	333
The State of Idaho: What Is at Risk?	335
Idaho's Policy.....	337
State Response	339
What If Prevention Fails in Idaho?	342
Additional AERF Panel Recommendations.....	344
Discussion and Future Needs.....	344
References.....	345

ABSTRACT Quagga mussels (*Dreissena rostriformis bugensis*) and zebra mussels (*Dreissena polymorpha*) are dreissenid species native to eastern Europe and western Russia. First discovered in the Great Lakes in the late 1980s, they are now considered invasive species throughout North America. Dreissenid mussels use byssal threads to attach and hitchhike between unconnected waterbodies. Resource managers began to recognize the significance of the eastern North American invasion in the early 1990s. It is widely accepted that trailered boats introduced the mussels to western United States waters, where they were first reported in the Lake Mead National Recreation Area in January 2007. The invasive mussels are now found in all western states except Idaho, Oregon, Washington, Montana, Wyoming, Alaska, and Hawaii. The mussels would have a significant economic impact if they are introduced to Idaho's waters and infrastructure systems. In response to this threat, the Idaho Legislature enacted progressive Invasive Species Laws in 2008 to establish state agency authorities and prevent the mussels from being introduced to the state. Through these policies, the state operates highway-based stations to inspect boats that are entering the state. More than 100 mussel-fouled boats have been intercepted by Idaho's program to date. The chances of eradicating a new population of zebra or quagga mussels in an Idaho waterbody will depend directly on the ability of the state to respond quickly. Idaho has developed an exclusion strategy and contingency plan in the event prevention fails.

Background

Quagga mussels (*Dreissena rostriformis bugensis*) and zebra mussels (*Dreissena polymorpha*), closely related Dreissenid species native to eastern Europe and western Russia, are thought to have been introduced to North America via the ballast of commercial ships traversing the St. Lawrence Seaway. University researchers first found zebra mussels attached to the surfaces of rocks, piers, and other underwater structures in Lake St. Clair, which is connected to Lakes Huron and Erie, in 1988. It is unclear how long the species was present in US waters before detection.

TEL: 916-654-0986 Nov 24, 93 15:17

FORM 65-020 STATE OF CALIFORNIA/DEPT. OF FOOD & AGRICULTURE
PLANT INDUSTRY-PEST AND DAMAGE RECORD

ACTIVITY OWNER ERNEST QUEVEDO S-04297 GCS
SITUATION ADDRESS
SECTION CITY OR NEAREST P.O. NO. DAY YE
TOWNSHIP COLLECTOR W.P. Humphreys AFFILIATION 1035072
RANK QUARANTINE SHIPPER

BASE & MERIDIAN QUARANTINE ORIGIN Michigan / Lake Erie ZIP CODE
SMPL. SIZE QUARANTINE DESTINATION Long Beach ZIP CODE

CODES HOST-CROP NAME/TYPE OF TRAP SAIL BOAT

GENERAL OR PLANT PARTS NUMBER OF PLANTS INVOLVED: NO. % OF PLANTS AFFECTED:

PLANT DISTRIBUTION LIMITED SCATTERED WIDE SPREAD ERADICATED

PLANT PARTS AFFECTED
 BUDS TUBERS GROWING TIPS LEAVES, UPPER SURFACE
 SEEDS BLOSSOMS FRUITS OR NUTS LEAVES, LOWER SURFACE
 STEM PETIOLES BUDS OR CORNS
 TRUNK ROOTLETS BRANCHES LARGE
 BARK LARGE ROOTS BRANCHES, TERMINAL

PLANT SYMPTOMS LIMITED GENERAL
 GALLS ROOT ROT LEAF FALL LEAF MOTTLING
 CANKER DIE BACK FRUIT SPOT MARGINAL BURN
 GUMMING YELLOWING FRUIT ROT SLOW DECLINE
 WILTING SHOT HOLE ROUGH BARK SUDDEN COLLAPSE
 STUNTING LEAF SPOT MALFORMATION INTERNAL DISCOLORATION

ENTOMOLOGY CONDITION ALIVE DEAD TRAPPED # / SWEEP
 STAGE EGG LARVA NYMPH PUPA ADULT # / TRAP
 # / ROOT # / LEAF # / STEM # / LEAF # / ANIMAL # / SO. YD. # / TRAP

WEED & VERTICILLATE DENSITY LIGHT MEDIUM HEAVY ACREAGE GROSS
 TYPE OF LOSS
 TYPE OF LOSS TYPE OF LOSS TYPE OF LOSS TYPE OF LOSS TYPE OF LOSS

REMARKS: RUSH - Zebra Mussel?

008A # 238 to Los Angeles County of

DETERMINATION: *Pelocypoda*
Dreissena polymorpha
 Zebra Mussel
Pel-Hardy

SEND REPORT TO: Wccolas INSP. STATION

FIGURE 23.1 First record of zebra mussels in the Western United States.

Unfortunately, containment efforts after the initial discovery in North America were inadequate, largely due to a general failure of officials to recognize the significance of the introduction. Consequently, necessary resources were not allocated. By 1989, zebra mussels had spread to Lake Ontario and the St. Lawrence River. By the early 1990s, the mussels were found throughout the Great Lakes and in major eastern US river systems connected to the Great Lakes watershed via the Chicago Sanitary and Ship Canal. This included the Ohio, the Mississippi, and the Missouri Rivers.

In addition to the passive spread of mature and immature stages of the mussels in flowing water, Dreissenid mussels use byssal threads to actively attach to trailered boats, docks, anchors, and related gear, allowing for frequent *hitchhiking* on such equipment between unconnected waterbodies. This particular pathway has intensified the rate of spread in the United States and Canada.

Early efforts to systematically inspect trailered boats began at California Department of Food and Agriculture (CDFA) Border Protection Stations in the early 1990s. Records from the CDFA show that zebra mussels were first intercepted on a sailboat from Lake Erie at Needles, California, in 1993 (Figure 23.1). This was the first record of zebra mussels in the Western United States (C. McNabb, personal files).

Alarmed by this interception, which occurred approximately 5 years after the first mussels were detected in the Great Lakes, resource managers began to recognize the significance and potential consequences of the North American Dreissenid invasion. During the early 1990s, the United States Fish and Wildlife Service (USFWS), the National Park Service (NPS), and the United States Bureau of Reclamation (USBR) conducted many interagency meetings and mussel workshops in Denver, Boise, and Chicago where participants struggled to develop strategies to address the issue (C. McNabb, personal files). Interestingly, many of the strategies that were developed in those meetings are still relevant today.

In 1994, the USFWS published a document entitled *Feasibility of Preventing Further Invasion of the Zebra Mussel into the Western United States*. This forward-thinking report aimed to determine the feasibility of preventing westward spread and establish the USFWS as the lead agency in this endeavor. The report determined pathways and vectors for westward spread, including detailed information on major highways and other land routes across the Continental Divide, encouraging roadside inspections for all boats traveling west. The authors also recognized the potential for passive spread hydrologically, identifying major east-west rivers. If these strategies had been implemented early in the invasion process, the ecological and economic problems associated with these species in Western states would most likely have been avoided.

The popularity of water-based recreation makes this pathway difficult to manage. For example, the Lake Mead National Recreation Area has more than 7 million visitors per year, thousands of which engage in boating activities, attracted by the availability of day use launches and moorage facilities. It is widely accepted that trailered boats were the pathway that introduced Dreissenid mussels to Lake Mead sometime prior to January 2007.

Following the detection of Dreissenid mussels in Lake Mead in early 2007, the mussels quickly spread to connected waters and reservoirs in Arizona and southern California via the California Aqueduct and Central Arizona Project. Quagga and/or zebra mussels have also invaded many other hydrologically disconnected waterbodies in the Western states of Nevada, Arizona, California, New Mexico, Colorado, Texas, and Utah. To date, invasive mussels have not been found in Idaho, Oregon, Washington, Montana, Wyoming, Alaska, or Hawaii.

The State of Idaho: What Is at Risk?

Congressional researchers estimate that that the zebra mussel infestation in the Great Lakes in the period from 1993 through 1999 cost the power industry \$3.1 billion, with a total economic impact on industries, businesses, and communities in the area of more than \$5 billion. In response to extensive documentation of negative impacts these species have had in the Great Lakes, and the subsequent discovery of the mussels in the Western United States, the state of Idaho (IISC, 2009) conducted an analysis of the potential effects these species would have on Idaho's environment and industries.

The Idaho Invasive Species Council report reviewed existing databases and published manuscripts to generate estimates on possible occurrences in Idaho. The results reflect an estimated cost of direct and indirect impacts on infrastructure and facilities that use surface water. Most of the published data that

TABLE 23.1

Estimated Potential Costs of a Dreissenid Invasion to the State of Idaho

Facility	Number	Estimated Cost Per Unit	Estimated Cost Statewide	Citation
Hydro power	26	\$1,817,000	\$47,242,000	Phillips et al. (2005)
Other dams	86	\$1,730	\$148,700	O'Neill (1997)
Drinking water	100	\$42,870	\$4,287,000	O'Neill (1997)
Golf courses	114	\$150	\$17,100	O'Neill (1997)
Boat facilities	380	\$750	\$285,000	O'Neill (1997)
Hatcheries/aquaculture	194	\$5,860	\$1,136,800	O'Neill (1997)
Boat maintenance	90,000	\$265	\$23,850,000	Vilaplana and Hushak (1994)
Angler days (4% reduction)	2,917,927	\$150	\$17,507,500	Vilaplana and Hushak (1994)
Irrigation POD	56,175			Little current published data
Total estimate			\$94,474,000	

were reviewed did not report annual costs; however, annual maintenance costs are expected to increase for all categories examined. In some cases, economic impacts could not be estimated. For example, no comparable economic data exist for mussel impacts to irrigation systems; therefore, they are excluded from the potential cost estimates. The estimates are considered conservative and for the most part are reported in 1997 dollars, not having been adjusted for inflation (Table 23.1).

The following categories were examined:

Hydro power: Estimates were based on a study commissioned by the Bonneville Power Administration that examined the estimated hydropower maintenance costs associated with zebra mussel. Costs associated with control of Asian clams at the Bonneville Dam First Powerhouse and a survey of costs of zebra mussel mitigation at other hydropower generation facilities in North America were used. The study estimated the costs for installing sodium hypochlorite systems and applying antifouling paint to 13 federal hydroelectric projects in the Columbia River Basin. The Idaho estimate was based on the BPA average cost per project (\$1.8 million) for the 26 hydropower dams in Idaho (Phillips et al. 2005).

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Other dams: Data from water impoundment structures not associated with power generation were included in estimates as these structures would most likely incur maintenance costs associated with mussel fouling of pipes and structures. Estimates based on figures from O'Neil (1997) for navigational lock structures (\$1700 per structure) applied to 86 structures in the state.

Drinking water intakes: Estimates included information from drinking water facilities that draw surface water for municipal or public drinking water use. Mussels foul intake piping and water processing infrastructure, increasing maintenance costs and degrading water flavor due to mussel waste and decomposition in water lines. Private single family homes with water intakes for drinking and irrigation were not included in this estimate. Estimates based on O'Neill (1997) figures from water treatment facilities (\$42,000 per facility) applied to 100 facilities in Idaho.

Golf courses: Golf courses are also at risk for additional maintenance costs for irrigation systems. Fouling of pipes and pumps and clogged sprinklers are projected to increase operating expenses. Estimates based on O'Neill (1997) costs from golf courses (\$150 per facility) were applied to 114 Idaho courses.

Boating facilities: Boating facilities included marinas, docks, and boat launches located in Idaho. Increased cost estimates are based on maintenance associated with dock and boat launch fouling. Estimates based on O'Neill (1997) figures from marinas (\$750 per facility) were applied to 380 Idaho facilities.

Fish hatcheries and aquaculture: Hatcheries and aquaculture facilities are vulnerable to fouling from Dreissenid mussel. Pipes, pumps, and raceway structures would be subject to increased operations and maintenance costs. Estimates based on O'Neill (1997) figures for hatcheries and aquaculture impacts (\$5800 per facility) were applied to 163 facilities in Idaho.

Boater costs: More than 90,000 motorized boats were registered in the state of Idaho in 2007. Potential increases in costs to boaters are based on estimates for antifouling paints and increased per-boat maintenance costs. Estimates were based on Vilaplana et al. (1994) for increases in boater maintenance costs (\$265 per boat).

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Fishing use: Recreational fishing is a \$430 million industry in Idaho. Research related to impacts of mussels on fisheries is limited, but reductions of fish numbers are likely. Vilaplana et al. (1994) found a 4% decrease in boater recreation because of introduction of mussels. The Idaho estimate was based on a 4% reduction of use applied to 2,917,972 Idaho fishing trips a year averaging \$150 per trip (IDFG 2003).

Irrigation: Approximately 56,175 points of diversion (POD) were identified in Idaho by the Idaho Department of Water Resources. Multiple points of use (POU) may be associated with each POD. Each POD and POU could potentially be affected by dreissenid mussels. The mussels can grow up to 0.5 mm/day under ideal conditions, and could impact water conveyances that are seasonally dry. Fouling and shell production from mussel establishment is cumulative; increased fouling and flow reduction could occur in ditches, pipes, pumps, fish screens, and diversion structures over time. Published research on mussel-related flow reduction in irrigation systems is minimal, but mussel establishment in pipes and pumps is well documented. The true impacts of dreissenid mussel introduction on irrigated agriculture in Idaho are uncertain, but there is a high likelihood that these mussels will increase maintenance costs for operations that rely on surface water for irrigation.

Idaho's Policy

Within months of the discovery of quagga mussels in Lake Mead on January 7, 2007, the Idaho legislature began drafting legislation to address the threat of dreissenid mussels to Idaho's waters. At the time, Idaho did not have an Invasive Species Law. Existing laws and rules such as the Idaho Noxious Weed Law, the Idaho Plant Protection Act, and the Deleterious Animal Rule provided authorities for certain taxa, and groups of species, but the authorities were piecemeal, and the state lacked a comprehensive Invasive Species Law.

The Idaho Invasive Species Law (Title 22, Chapter 19, Idaho Code) was enacted by the Legislature in 2008. The law provides policy direction, planning, and authorities to combat invasive species and to prevent the introduction of new invasive species to the state. This law establishes the duties of the Idaho State Department of Agriculture (ISDA) and its director, authorizes the ISDA director to promulgate rules, and gives the state authorities to conduct inspections as necessary. It also establishes an invasive species fund.

The resultant Idaho Invasive Species Rules (IDAPA 02.06.10) were promulgated by ISDA and underwent extensive negotiation with impacted stakeholders. Engaged stakeholders included the Idaho Water Users, Northside Canal Company, Aberdeen-Springfield Canal Company, Clear Springs Foods, the Aquaculture Association, the Idaho Farm Bureau, the Idaho Department of Fish and Game, the Idaho Conservation League, The Nature Conservancy, Trout Unlimited, Boise Canal Company, the Pend Oreille Basin Commission, Bonner County, and several western states. The rules outline the duties of the department and govern the designation of invasive species, inspection, permitting, decontamination, recordkeeping, and enforcement of regulated species.

The Idaho Invasive Species Act of 2008 created the Idaho Invasive Species Fund, but the fund lacked a dedicated funding source. The Invasive Species Prevention Sticker Rules (IDAPA 26.01.34) were enacted by the legislature in 2009. The rules, which are under the Safe Boating Act (Title 67, Chapter 70, Idaho Code), require motorized and nonmotorized boats to display an invasive species sticker to launch and operate on Idaho's waters (Figure 23.2). The sticker program established annual user fees for resident, nonresident, and nonmotorized vessels. Revenue generated from this program (~\$1.7 million/annually) is deposited in the invasive species fund. The fund is administered by the ISDA. With revenue generated by the Invasive Species Prevention Sticker program, ISDA developed a comprehensive statewide prevention

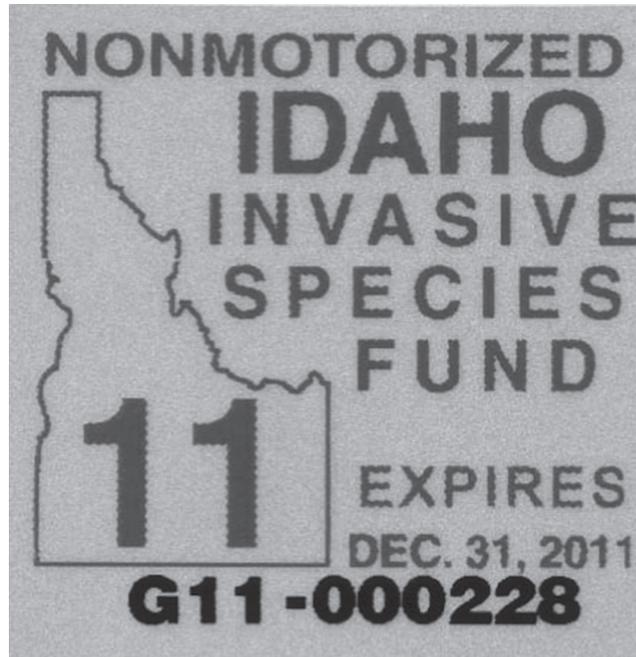


FIGURE 23.2 Idaho's invasive species sticker program is a dedicated funding source for the state's operational inspection stations.

program designed to educate the public about invasive species, monitor Idaho waterbodies for possible introduction of those species, and inspect and decontaminate watercraft that travel to and through Idaho (ISDA 2014).

Idaho's invasive species policy provides basic authorities for mandatory inspections and decontaminations of infested conveyances. It also provides several unique elements that contribute to Idaho's progressive prevention program.

Key elements include the following:

- Idaho's white list

Section 102 of the rules governing invasive species provides that Idaho has a *white list* for invasive species. New species must be approved by the ISDA prior to import. It states:

INTRODUCTION OF NEW SPECIES TO THE STATE. Species that are not previously known to occur in Idaho cannot be introduced to the state without a determination from the Department that the subject species is not invasive.

- Invasive species fund

Section 22-1911 of the Idaho Invasive Species Law provides that the invasive species fund can not only receive revenue but can also accrue and carry forward funds. This is important to the invasive species program, as species outbreaks are inconsistent by nature. The ability to accrue funding and carry balances forward allows the state to spend funding effectively. It states:

22-1911. INVASIVE SPECIES FUND. There is hereby established in the state treasury an invasive species fund. (1) The fund shall receive such appropriations as deemed necessary by the governor and the legislature to accomplish the goals of this chapter. The fund shall also receive moneys from the collection of reasonable fees for permits or as otherwise required by

this chapter or rules promulgated hereunder. The fund may also receive, at the discretion of the director, moneys from any other lawful source including, without limitation, fees, penalties, fines, gifts, grants, legacies of money, property, securities or other assets, or any other source, public or private. (2) Moneys in the invasive species fund are subject to appropriation for the purposes of this chapter. The fund shall be used to support activities related to the prevention, detection, control and management of invasive species in Idaho. (3) All interest or other income accruing from moneys deposited to the fund shall be redeposited and accrue to the fund. Any unexpended balance left in the fund at the end of any fiscal year shall carry forward without reduction to the following fiscal year.

- Idaho's emergency fund
Section 22-1912 of the Idaho Invasive Species Law authorizes the use of a deficiency warrant in the event of an infestation. ISDA is authorized to spend up to \$5 million in unbudgeted general funds annually for control and eradication costs.

22-1912. CONTROL AND ERADICATION COSTS—DEFICIENCY WARRANTS—COOPERATION WITH OTHER ENTITIES AND CITIZENS. Whenever the director determines that there exists the threat of an infestation of an invasive species on state-owned land or water, private, forested, range or agricultural land or water, and that the infestation is of such a character as to be a menace to state, private, range, forest or agricultural land or water, the director shall cause the infestation to be controlled and eradicated, using such moneys as have been appropriated or may hereafter be made available for such purposes. Provided however, that whenever the cost of control and eradication exceeds the moneys appropriated or otherwise available for that purpose, the state board of examiners may authorize the issuance of deficiency warrants against the general fund for up to five million dollars (\$5,000,000) in any one (1) year for such control and eradication. Control and eradication costs may include, but are not limited to, costs for survey, detection, inspection, enforcement, diagnosis, treatment and disposal of infected or infested materials, cleaning and disinfecting of infected premises or vessels and indemnity paid to owners for infected or infested materials destroyed by order of the director. The director, in executing the provisions of this chapter insofar as it relates to control and eradication, shall have the authority to cooperate with federal, state, county and municipal agencies and private citizens in control and eradication efforts; provided, that in the case of joint federal/state programs, state moneys shall only be used to pay the state's share of the cost of the control and eradication efforts. Such moneys for which the state shall thus become liable shall be paid as a part of the expenses of the Idaho state department of agriculture out of appropriations that shall be made by the legislature for that purpose from the general fund of the state. In all appropriations hereafter made for expenses of the department, account shall be taken of and provision made for this item of expense.

State Response

The Idaho invasive species program was the first of its kind in the United States. Several western states have since patterned funding, inspection, and prevention programs after the Idaho model. Nationwide, the majority of aquatic nuisance species laws and authorities are housed within fish and game departments. Idaho is the only state in the country where the lead agency for aquatic nuisance species is a department of agriculture. Departments of agriculture in the United States have a long history of detection, prevention, and quarantine of invasive species—from insect pests to pathogens to noxious weeds. This expertise and the nexus of invasive species threats to irrigated agriculture make ISDA the most logical choice for the inspection program within Idaho state government.

The invasion of Dreissenid mussels to western waterbodies has resulted in increased prevention efforts across the region. At the state level, numerous western states have increased efforts in mussel prevention through enhanced monitoring, public outreach, and watercraft inspection programs.



FIGURE 23.3 Trailered boats are a major pathway for Dreissenid mussels to the Pacific Northwest.

It is notable that the western watercraft inspection programs are funded with few federal dollars, since nearly all states, including Idaho, fund the programs with state boater license fees, user fees, sticker fees, or general funds. Of particular concern to many western resource managers is the continued state interception of mussel-fouled watercraft originating from federally managed waterbodies in the Lower Colorado River (Figure 23.3).

Idaho's resource managers developed a progressive and proactive prevention program to minimize the risk of introduction to Idaho's waters via mussel-fouled watercraft. Idaho's watercraft inspection program began in 2009. Idaho's inspection stations are placed on major highways at or near the Idaho state line (Figure 23.4). This strategy is designed to maximize contact with boats that are traveling into the state from mussel-infested states. The inspection stations on the southern and eastern borders of the state intercept the majority of the mussel-fouled boats. The Idaho inspection program has inspected boats from every state in the United States (Figure 23.5). A comprehensive summary of Idaho state inspection data can be found on the ISDA website (ISDA 2014).

Boats that have been in mussel-infested states recently (within the last 30 days); watercraft coming from another state (especially commercially hauled boats); boats that show a lot of dirt, grime, or slime below the waterline; or boats that have standing water on board are considered *high risk* to the state of Idaho. High-risk inspections are intense and include a thorough inspection of the exterior and interior parts of the boat.

Idaho's inspections include a thorough and complete visual and tactile examination of all components of the boat, including compartments, bilge, trailer and any equipment, gear, ropes, or anchors (Figure 23.6). If any biological material is found on the vessel or equipment, the inspectors conduct a roadside *hotwash* of the watercraft. This is done to prevent the spread of other invasive species such as New Zealand mudsnail, Eurasian watermilfoil, and hydrilla. Boats that have mussels attached are impounded and decontaminated per ISDA policy.

In 2011, Idaho began issuing voluntary Invasive Species Passports to local boaters (Figure 23.7). This system gives Idaho and Pacific Northwest boaters an expedited *fast pass* when they repeatedly come through Idaho's stations. Boaters are issued a uniquely numbered passport booklet at the beginning of the season. They show the assigned number to inspectors during subsequent inspections throughout the boating season. Inspectors ask boaters if they have left the Pacific Northwest in the last 30 days. If the answer is no, the boat receives an expedited inspection, the passport is stamped

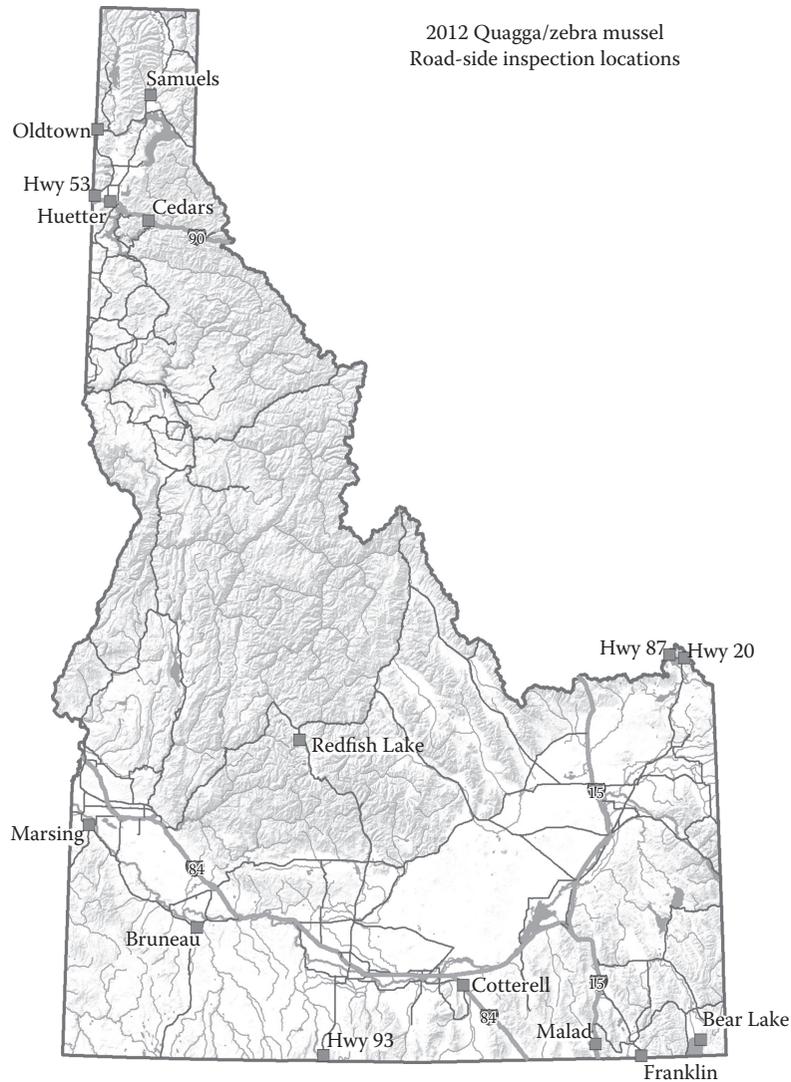


FIGURE 23.4 Idaho's inspection stations are strategically placed on major roadways to intercept boats from high-risk waters.

with the inspection station location, and the boater's information is logged with a handheld data unit. This program dramatically reduces field data collection time and allows for tracking of repeat boaters.

Several stations (such as the one located at I-90 eastbound from the state of Washington) inspect a large volume of boats that travel between the Spokane (WA) area and the lakes of northern Idaho. The passport system allows inspectors to quickly screen boaters based on risk. This is especially critical during busy times when inspectors are able to give low-risk boats an expedited inspection and spend additional time scrutinizing high-risk boats that have come into the region from elsewhere. The system was well received by the boating community and could serve as a model for a regional *PNW Invasive Species Passport*. The concept of a regional passport will become increasingly valuable as other western states establish roadside inspection programs.

More than 154,000 watercraft inspections were conducted in Idaho from 2009 to 2013. Ninety three (93) mussel-fouled boats were intercepted in Idaho during this 5-year time period. The majority of these boats came from federally managed waterbodies in the lower Colorado River system (ISDA 2014).

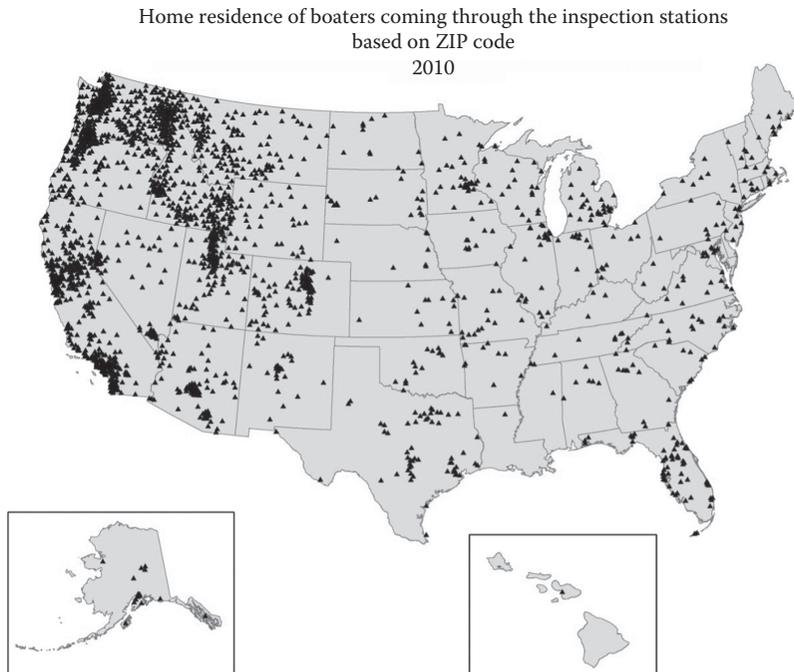


FIGURE 23.5 Idaho's program inspects boats from every state in the country.



FIGURE 23.6 Inspectors are trained to feel the outsides of the vessels and look closely at the outside and inside of boats entering the state.

What If Prevention Fails in Idaho?

Although the chances of eradicating a new population of zebra or quagga mussels in an Idaho waterbody are small, success depends directly on the ability of the state to respond quickly (and effectively) once a nascent population is detected. There is an urgent need to develop control technologies for dreissenid mussels in Idaho's systems. Water managers in impacted western states (i.e., CA, NV, AZ, and TX)

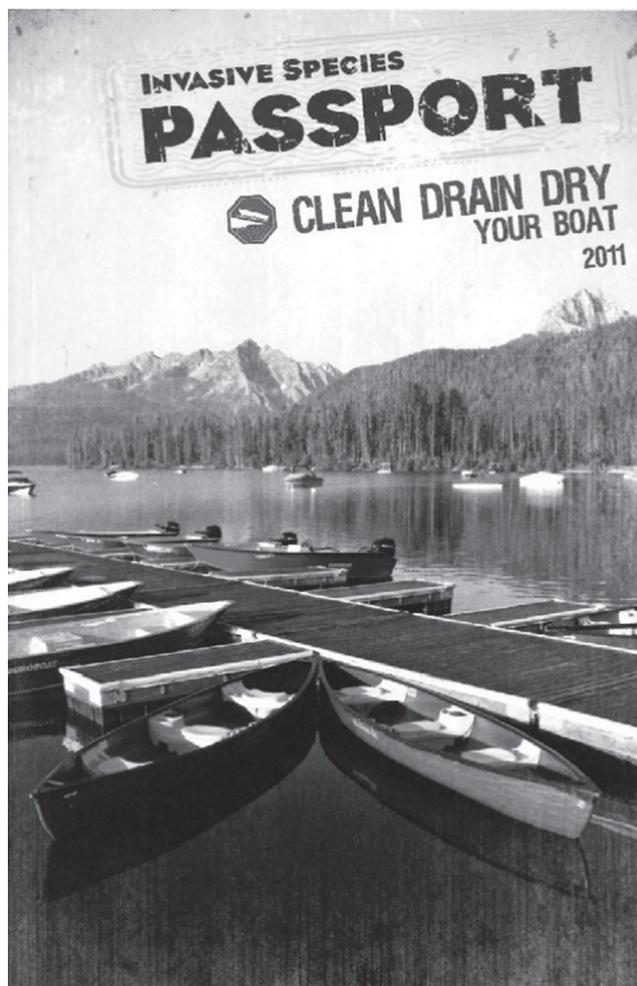


FIGURE 23.7 Idaho's Invasive Species Passport system began in 2011.

have been forced to scramble to develop control technologies within water delivery infrastructure systems. This work began in 2007, shortly after the discovery of the mussels in the Lake Mead National Recreation Area. Unfortunately, control options for lakes, rivers, and naturally flowing river systems remain poorly developed.

To date, there are no known control technologies available for use outside of closed (infrastructure-type) systems. Applied research is needed to find new tools to eradicate or contain these species in a field response situation in Idaho. Waterbodies such as the Snake River have numerous private and public stakeholders who have access or management authorities. Diversion facilities for irrigation, hydroelectric power generation, municipal water systems, aquaculture, and recreation are just a few of the uses and management influences on the river.

In 2009, the Idaho Invasive Species Council convened a roundtable of stakeholders, including conservation groups, water users, canal companies, irrigation districts, utilities, municipal water companies, and germane state and federal agencies, to determine what steps should be taken to prepare for an invasion of zebra or quagga mussels. Participants were asked to weigh options in the event that these species are discovered in the state. Given the complexities of preventing and treating waterbodies if quagga or zebra mussels are discovered in Idaho, the group recommended that the state develop an *Exclusion Strategy and Contingency Plan*.

The state of Idaho, in cooperation with the Aquatic Ecosystem Restoration Foundation (AERF), assembled a panel of experts to develop the contingency plan. The group's goals were to compile a summary of Idaho's waterbody data, review available control technology options, and assess Idaho's technical and regulatory gaps, including endangered and threatened species concerns. The *Exclusion Strategy and Contingency Plan* was completed in early 2012 (AERF 2012).

The AERF report clearly stated that the discovery of exotic mussels in large river run reservoirs in Idaho would most likely be impossible to eradicate. This conclusion was based in part on the length of time (often weeks or months) between the collection of monitoring samples and subsequent analyses with confirmation. This temporal lag would likely allow mussel populations to reproduce and spread beyond pioneer infestations in marinas or boat moorage locations into free flowing reservoirs and rivers. In addition, an eradication program in large reservoirs would undoubtedly be cost prohibitive.

The AERF panel found that the biology and ecology of Dreissenid mussels are well known, as are their pathways of spread. However, data and control technologies that could be used for proactive monitoring and management of mussels are lacking. The panel concluded that there are currently no economic or technical means to control exotic mussels in large river run reservoirs such as the Snake River, Lakes Pend Oreille, Lake Coeur d'Alene, and similar bodies of water in Idaho. Unfortunately, most of the molluscicides that could be used for dreissenid mussel control are toxic to native mussels. In addition, many of these products are toxic to fish, some of which are classified as threatened or endangered.

Additional AERF Panel Recommendations

- The ISDA should share the invasive mussel contingency plan with federal agencies and adjoining states in an effort to foster greater cooperation and to integrate and increase regional prevention efforts.
- Idaho and neighboring states should encourage, insist on, and use all possible means to ensure that states and authorities enforce decontamination of boats leaving mussel-infested waters. Every one of these vessels has the potential to infest other waterways, so it is common sense—from both environmental and economic standpoints—to ensure that departing vessels are decontaminated.
- Increase, improve, and intensify prevention and monitoring programs.
- Educational efforts need to be expanded to include marina owners/operators and commercial boat haulers.
- Engage with a rapid response team (similar to the Columbia River Basin Team that includes WA, OR, MT, and ID) that represents appropriate state, federal, and tribal interests from all neighboring states to evaluate and coordinate the response following any suspected finds of mussels, develop specific treatment plans, and define agency responsibilities and commitments.
- Work with other Idaho state agencies to include mussel exclusion clauses and inspections in state construction contracts when equipment (barges, silt barriers, water tanks, etc.) might be brought into Idaho and placed in waters of the state.
- Collect additional water temperature data on highly vulnerable lakes to optimize the timing of monitoring efforts.

Discussion and Future Needs

Hindsight is always 20/20. Had resource managers initiated effective containment in the Great Lakes in the early 1990s, there is a good chance dreissenid mussels would not have crossed the 100th meridian and invaded western waters. Prevention is an improbable award winner, though. It is extremely difficult to measure (or appreciate) the value of what was prevented, especially when it comes to invasive species.

While states in the Pacific Northwest are doing their best to intercept mussel-contaminated boats coming into the region, inspection and decontamination at the *source*-infested waterbodies is lacking. As evidenced by the watercraft inspection data for the Pacific Northwest, the majority of infested boats entering the region come from the lower Colorado River, and from Lake Mead in particular, which puts the long-term viability of state prevention programs in question. Many western states and organizations such as the Northwest Power and Conservation Council, The Nature Conservancy, the Pacific Northwest Economic Region, and Lake Tahoe have joined Idaho to advocate for inspections and decontaminations of departing watercraft from federally managed mussel-infested waters. In particular, these groups have asked the U.S. Department of the Interior to implement a mandatory inspection and decontamination program for moored watercraft departing the Lake Mead National Recreation Area.

The federal government demonstrated good intentions early in the North American dreissenid invasion curve. Several meetings and workshops were held where innovative strategies were developed in the early 1990s, but decisive action was not taken; dreissenid mussels spread throughout the country's waterways. Learning from this example, Idaho acted quickly to launch a unique invasive species program when the mussels were discovered in the Western United States in 2007. The proactive program includes legislation, authorities, a dedicated funding source, and political support.

The ISDA reports (ISDA 2014) that in the program's first 5 years, approximately 100 mussel-fouled boats were intercepted by the state inspection program. Although the state plans to continue this important work, it recognizes that federal partners must also effectively manage mussel-infested waterbodies such as Lakes Mead, Mojave, Havasu, and Powell. For Idaho's program to be successful, federal agencies must do their part to institute parallel and complementary mandatory federal inspection and decontamination programs at *point sources* on the Lower Colorado system. Additionally, states in the Pacific Northwest must work cooperatively as a region instead of focusing on protecting individual jurisdictions. Individual states are connected by highways and by flowing waters; it is critical that all states in the Pacific Northwest recognize their dependency on each other and work cohesively to prevent these species from being introduced to the region. This is the only way to a sustainable and effective containment and prevention strategy for the western United States.

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Author Queries

[AQ1] Please check if the edit to the chapter title is okay.

[AQ2] Please provide the expansions for “BPA and PNW” at the first mention, if appropriate.

[AQ3] Please provide complete details for reference “Vilaplana et al. (1994).”

[AQ4] Please provide accessed date for references “Aquatic Ecosystem Restoration Foundation (2012), Idaho State Department of Agriculture (2014), and IDFG Economic Report (2003).”

[AQ5] Please provide in-text citation for reference “Tyus et al. (1994).”