



National Park Service
U. S. Department of the Interior

Natural Resources Program Center
Fort Collins, Colorado

Quagga/Zebra Mussel Infestation Prevention and Response Planning Guide

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EXPERIENCE YOUR AMERICA

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Executive Summary

What are quagga and zebra mussels?

Quagga and zebra mussels are extremely invasive species that have infested midwestern and eastern bodies of water. Until the discovery of quagga mussels in Lake Mead in January 2007, they had not been detected west of the Rocky Mountains. They have never been successfully eradicated from a large body of water and can have significant impacts, including:

- disrupting the aquatic food chain and native species
- encrusting submerged cultural resources
- impacting recreational activities, including sport fishing
- fouling boats, boat engines, docks, ramps and other marina facilities
- clogging raw water intake pipes, increasing maintenance costs
- littering beaches with sharp shells that can smell as the mussels decompose.

What park units are at risk?

Generally, NPS areas west of the Rocky Mountains with lakes, reservoirs and streams are at the greatest risk. However, there are a number of factors that can influence the risk and all park units with such aquatic features should at least assess their situation to determine if the circumstances at their location require further action.

What is the focus of this Planning Guide?

This Planning Guide will assist park managers and staff in assessing the risk of infestation at their units and, subsequently, planning and implementing the appropriate levels of prevention and monitoring actions for their area based upon that risk. The Guide will also assist in pre-planning for a response and provides a framework for response should an actual infestation be discovered. The Guide also provides technical resources and subject-matter-expert contact information.

What should my park unit do?

Park units with aquatic features such as lakes, reservoirs, streams and rivers should complete the situation analysis found in the Planning Guide. The results of that analysis will then guide the actions that are needed. It is anticipated that the analysis process will allow most park units to easily identify their risk level and plan the appropriate actions. However, there may be some circumstances where the level is not clear-cut. In such circumstances, the park staff can collaborate with regional personnel and technical experts to determine its risk and plan the appropriate actions.

What happens if we do nothing?

No action increases the risk of infestation at your park unit and could result in the undetected spread of the mussels to previously non-infested areas; expanded and prolonged impacts to resources, facilities, visitor activities and park operations; and adverse reactions from other agencies, states and localities and the public.

Introduction

Background

On January 6, 2007, quagga mussels (*Dreissena rostriformis bugensis*), a type of invasive mussel related to zebra mussels (*Dreissena polymorpha*), were discovered in Lake Mead. Since that time, quagga mussel infestations have been discovered in Lakes Mohave and Havasu.

This is the first time that quagga mussels have been discovered in the Western United States. As of May, 2007, their infestation is believed to be limited only to Lakes Mead, Mohave, and Havasu. However, quagga and zebra mussels pose a major threat to western waters with potential mussel habitat.

Zebra mussels were first discovered in the U.S. in Lake St. Clair (near Detroit) in 1988. Within an extremely short time period, zebra and quagga mussels colonized most of the Great Lakes, the Mississippi River watershed, and many other water bodies in the Midwest and East. Zebra and quagga mussels have caused significant negative impacts to aquatic ecosystems, recreational opportunities, economics, and water delivery systems.

If zebra or quagga mussels were to infest additional western lakes, reservoirs, or rivers, they could:

- disrupt aquatic ecosystems and native species
- encrust submerged cultural resources
- impact recreational activities, including sport fishing
- foul boats, boat engines, docks, ramps and other marine facilities
- clog raw water intake pipes, increasing maintenance costs
- litter beaches with sharp shells that can smell as the mussels decompose.

The limited infestation of quagga mussels in the West provides the opportunity to contain this invasive species before it becomes established in other water bodies.

Purpose and scope of the Plan

Purpose. The purpose of this plan is to protect resources, recreational and visitor experiences, and facilities in National Park Service units by preventing the introduction and spread of quagga or zebra mussels. This plan serves as a guiding document for park managers to provide for the prevention, early detection, and rapid response to quagga mussel infestations in western waters.

Scope. This plan applies to both quagga and zebra mussels. Both of these species present similar threats to NPS resources, their spread is prevented by identical methods, and they are of the same genus (*Dreissena*). While this plan does not address the prevention of other aquatic nuisance species, many of the strategies used to prevent the spread of zebra or quagga mussels will also assist in preventing the spread of other aquatic nuisance species. This planning guide is adaptable for either the general invasive species issue or more specific individual threat-based application.

Objectives and Strategies

Overall Objectives and Strategies. The following are the overall objectives and strategies for preventing, detecting and responding to quagga/zebra mussels:

1. Prevent the introduction and further spread of quagga/zebra mussels to the greatest degree possible.

Strategies:

- The staff of each Park with aquatic features at risk from quagga/zebra mussels should complete a situation analysis that will show its potential risk level.
- Parks should take the appropriate prevention actions based upon their risk level.

- Build consensus and coordinate activities with allied Federal, tribal, state and local agencies, partners and others as needed.
- Conduct an education and outreach campaign.

2. Detect new infestations of quagga/zebra mussels.

Strategies:

- The staff of each Park with aquatic features at risk from quagga/zebra mussels should complete a situation analysis that will show its potential risk level.
- Parks should then take the appropriate detection actions and response pre-planning actions based upon their risk level.
- Coordinate activities with allied Federal, tribal, state and local agencies, partners and others as needed.

3. Respond to and minimize the impacts of new infestations of quagga/zebra mussels.

Strategies:

- If invasives are detected at any time, evaluate the potential response actions and take those actions that are appropriate and that minimize impacts to resources, recreation, economic activities and normal operations.
- Coordinate activities with allied Federal, tribal, state and local agencies, partners and others as needed.

4. Provide timely and accurate information to employees, management, stakeholders and the public.

Strategies:

- Develop and implement comprehensive quagga/zebra mussel communications/ education strategies as required by the situation.
- Establish an easily updated web page that exhibits quagga/zebra/invasives information.

5. Provide for the safety of involved personnel and the public.

Strategies:

- Employ only standard procedures and trained personnel, especially when conducting specialized operations, such as diving, boat operations, etc.
- Perform a risk assessment for all planned activities, using existing Job Hazard Analyses (JHA) when available, and develop JHAs when they are not available.
- Communicate and enforce the mitigations found in the JHAs as well as standard safety practices.

6. Keep costs commensurate with the values at risk.

Strategies:

- Evaluate all proposed actions to determine if they will truly achieve the desired results, to ensure that critical resources and facilities are appropriately protected and to ensure the actions provide the greatest benefit for the cost.
- Coordinate actions with cooperating agencies and organizations; share costs or resources when appropriate.
- Develop and implement cost containment measures.
- Implement accurate cost estimating and tracking programs.
- Properly document and justify expenditures.

Planning Assumptions

Identified Assumptions. These planning assumptions are based on the best information available at the time this Guide is being prepared:

- Quagga/zebra mussels are an invasive species that have the potential to infest/invade western waters managed by the NPS, and beyond. With diligent efforts, containment measures may be employed to manage their spread.
- Once quagga/zebra populations become established in lakes and rivers, they are very difficult to eradicate.
- Infestations are likely to disrupt and degrade:
 - Natural systems.
 - Recreation
 - Infrastructure
- Scientific and response communities have identified best management practices (BMPs) for containment and control of Quagga mussels. To the fullest extent possible, accepted and available BMPs have been incorporated into this plan for:
 - Prevention/education
 - Early Detection and Monitoring
 - Response
- An interdisciplinary team will be necessary to address this potential problem. It should include: management, resources (and other scientists), maintenance, interpretation/education, public affairs, concessions, enforcement efforts and Federal, tribal, state, local and private partners.
- Implementation of this plan will require substantial cooperation of government agencies at federal, state, and local levels, as well as other partners.
- Control of this aquatic invasive species (AIS) will cross jurisdictional boundaries.
- Funding beyond unit base budgets may be necessary to take actions necessary to limit or control spread of this AIS.
- Multiple potential vectors will facilitate the spread of this AIS.
- The known characteristics, and therefore potential control measures, of this AIS may evolve as the scientific knowledge expands or the species adapts in western waters. Containment, management and control measures may need to be altered to respond to changes.
- Uncontrolled infestations will have adverse economic impacts on facilities and the recreational industry.

- In some areas, funding may be available from a variety of sources, but in other areas special funding may not be available.

Potential Scope. There is significant potential for exponential spread of quagga/zebra mussel populations to infest/invade western waters of North America. Using zebra mussels in the Great Lakes as a indicator (see figures 1 and 2), the Quagga mussel infestation documented at Lake Mead NRA could spread to other western waters if active measures are not immediately taken. These measures should include: assessment, monitoring, education, and control/management. Each affected entity/jurisdiction will have different priorities based on their basic mission; many of these will overlap, some may be in conflict. Based on these priorities, agency response actions will vary. Sorting thru the complex web of jurisdictions will be necessary to coordinate productive and cost effective actions.



Figure 1 zebra mussel distribution in 1988. (stars represent mussel interdictions).



Figure 2 zebra mussel distribution in 2005

Policies

National Park Service Policy for the Management of Invasive/Alien Species. NPS *Management Policies* (2006) identify the responsibility of parks to manage non-native, alien plant and animal species and to cooperate with other agencies with jurisdiction. Highest priority is given to the management of alien species that have, or potentially could have, a substantial impact on park resources. For alien species where management appears to be feasible and effective, park superintendents are directed to: (1) evaluate the species' current or potential impact on park resources; (2) develop and implement exotic species management plans according to established planning procedures; (3) consult, as appropriate, with federal, tribal, local, and state agencies as well as other interested groups; and (4) invite public review and comment, where appropriate. This document provides the framework and guidance to assist parks in developing site-specific plans for the prevention and response to Quagga/Zebra mussel infestation in accordance with requirements under NPS Management Policies.

Environmental Compliance Considerations. The National Environmental Policy Act (NEPA) provides policies and planning mechanisms to protect and mitigate park resources from damage. Affected parks will abide by all applicable requirements under NEPA for actions related to quagga/zebra mussel prevention and control.

Other Management Considerations. This plan is not intended to establish or modify NPS or individual park policy. This plan should be considered "highly recommended advice" to parks. The applicability of legal constraints and obligations, policy requirements, applicable definitions (such as impairment) and strategic management goals must be considered when planning and taking actions.

Roles and Responsibilities

Each level of the National Park Service has a role and responsibility for the prevention of and response to a quagga/zebra mussel infestation.

The Park **Superintendent** and staff have direct responsibility for:

Conducting an immediate situation analysis to identify the kind of aquatic resources that may be at risk and to determine if management actions are needed.

If the situation analysis indicates that parks have a moderate or high risk of quagga or zebra mussel infestation, the superintendent and staff should:

- Designate a quagga mussel coordinator.
- Identify and take the appropriate prevention, detection and response actions that may be needed in their area.
- Build and coordinate partnerships with local stakeholders, including gateway communities, local businesses, and concessionaires.
- Coordinate with state government agencies at the technical and political level as appropriate.
- Conduct periodic situation reviews to determine if additional actions are warranted.
- Coordinate funding requests and other activities with the region.
- Participate in river basin-wide teams of the 100th Meridian Initiative.

The **Regional Director** and the regional **staff** have responsibility for:

- Providing/coordinating technical expertise to parks regarding quagga/zebra mussel infestation prevention and control.
- Insuring that parks within their region develop an appropriate quagga mussel prevention program or response strategy as directed by this plan.
- Designating a regional quagga mussel coordinator.
- Coordinating activities and resources among their Parks, appropriate regional staff and with other regions.
- Building communications networks to allow park specialists to effectively communicate.
- Identifying available funds, assisting parks in developing funding requests, and coordinating funding requests with the Washington Office.
- Coordinate with the Western Regional panel on aquatic invasive species.

The **Washington Office** (Natural Resources Program Center) has responsibility for:

- Designating a quagga mussel coordinator.
- Providing technical expertise to regions and parks regarding quagga/zebra mussels.
- Providing briefing statements and briefings to the NPS directorate, departmental executives, Congress and others as needed.
- Building and coordinating relationships with national organizations, such as boating organizations.
- Coordinating interagency activities at the national level.
- Coordinating communication among the regions.
- Coordinating funding requests and approving them as appropriate, given other priorities within the NPS.
- Sit on and participate on the Aquatic Nuisance Species (ANS) Task Force.

The Department of the Interior has identified:

- The U.S. Fish and Wildlife Service as the lead agency within the Department of the Interior for zebra and quagga mussel prevention.

Partnerships and Communications

Partnerships

Most government entities and organizations share the common goal of preventing quagga mussels in the West, although their reasons for doing so may vary based on the organization's interests. Fundamentally, this presents a significant opportunity for the NPS, as all affected entities share the goal of preventing quagga mussels. The NPS can capitalize on this opportunity best by partnering with these entities.

Further, no one entity can prevent the spread of quagga mussels by itself. If zebra or quagga mussels become established at other lakes in the West, containing them will become incrementally more difficult. If quagga mussels were to become established in locations upstream of National Park Service units, Flaming Gorge Reservoir, for example (managed by the U.S. Forest Service), they would likely be transported downstream simply by the river's current.

Ultimately, combating quagga mussels will require a response much broader than just the National Park Service. The surrounding states play a vital role in helping to contain the spread of zebra mussels. The strong support of the business community will be imperative. Parks will need people in the surrounding area to help spread the message. Most importantly, parks will need the help of boaters to make sure they do not inadvertently transport aquatic hitchhikers.

Partners:

- Aquatic Nuisance Species Task Force (ANSTF).
- Western Regional Panel, ANSTF.
- 100th Meridian Initiative.
- Western Association of Fish and Wildlife Agencies.
- Pacific States Marine Fisheries Commission
- State governments – governor's offices, natural resource agencies, state water resource agencies, state wildlife management/enforcement agencies, state boating agencies, state power authorities, state water delivery entities.
- Other federal agencies – U.S. Fish and Wildlife Service, U.S. Forest Service, BLM, Bureau of Reclamation, USGS, Western Area Power Administration, U.S. Army Corps of Engineers, U.S. Coast Guard, Environmental Protection Agency, Bureau of Indian Affairs and the Department of Energy.
- Business community – boat hauling organizations, boat storage facilities, boat dealers and equipment suppliers, boat launch and retrieval businesses, water related guiding businesses, float plane operators.
- Gateway communities.
- Concessioners, permittees and researchers.
- Recreational organizations: fishing organizations, fishing tournaments, boating associations.
- Environmental and conservation groups.
- Mexico and Canada.

- Power/water management agencies and organizations.

Communications

Effective communications are especially important to the National Park Service’s quagga mussel response because of the number of stakeholders involved in preventing quagga mussels in the Western United States. Communication objectives include:

- To coordinate quagga/zebra mussel prevention and response among federal, state, and local stakeholders.
- To communicate to the public the National Park Service’s efforts to prevent and respond to quagga/zebra mussels in park units
- To communicate internally so that all NPS employees and partners understand their role in quagga mussels prevention
- To communicate a consistent message from all agencies and partners

Internal Audiences

- NPS leadership and management: directorate, national leadership council, regional management teams, superintendents, Department of the Interior officials
- Technical experts: aquatic ecologists, fisheries biologists, hydrologists, toxicologists
- Field staff: interpretation and law enforcement rangers, maintenance staff, entrance staff
- Partners: concessioners, contractors, researchers, permittees

External Audiences

- Media
- Congressional offices and committees
- State governments
- Gateway communities
- Businesses
- Boating organizations
- Water management agencies
- Other Federal agencies
- Park visitors
- Non-profit organizations
- Special interest groups

Communications actions:

Action	Who is Responsible	Target Audiences	When
News release highlighting the development of this plan	WASO	Media, partners, public	April 23, 2007
News release announcing the availability of the plan	WASO	Media, partners, public	Appx. May 2007

Action	Who is Responsible	Target Audiences	When
News releases highlighting individual park's efforts to prevent/respond to quagga mussels	Parks	Media, partners, public	Ongoing
Inside NPS features	WASO	NPS employees, partners	Ongoing
Contacts at technical level with state and federal natural resource agencies	Parks, regions, WASO	State and federal partners	Ongoing
Briefings to states – governor's offices	Regions, parks	States	Summer 2007
Briefings to DOI officials	WASO, regions	DOI	Summer 2007
Briefings to Congressional staff and committees	WASO, regions	Congressional offices and committees	Summer 2007
Websites updated with quagga mussel information: www.nps.gov ; park websites;	WASO, Regions, parks	Public, partners,	45 days after this plan is adopted
Public messaging in parks – signs, educational materials, interpretive programs	Parks	Park visitors	No later than summer 2007
Slip renters – all slip renters in the NPS will be sent materials concerning quagga/zebra mussel prevention	Parks	Slip renters	No later than summer 2007
Development of public service announcements to be played by local radio stations	Parks	Park visitors, local residents	Summer 2007
Inclusion of quagga mussel messages on traveler information systems (i.e., 1610 AM)	Parks	Park visitors	Ongoing
Quagga mussel messages in park newspapers	Parks	Park visitors	Ongoing

Situation Analysis and Resulting Actions

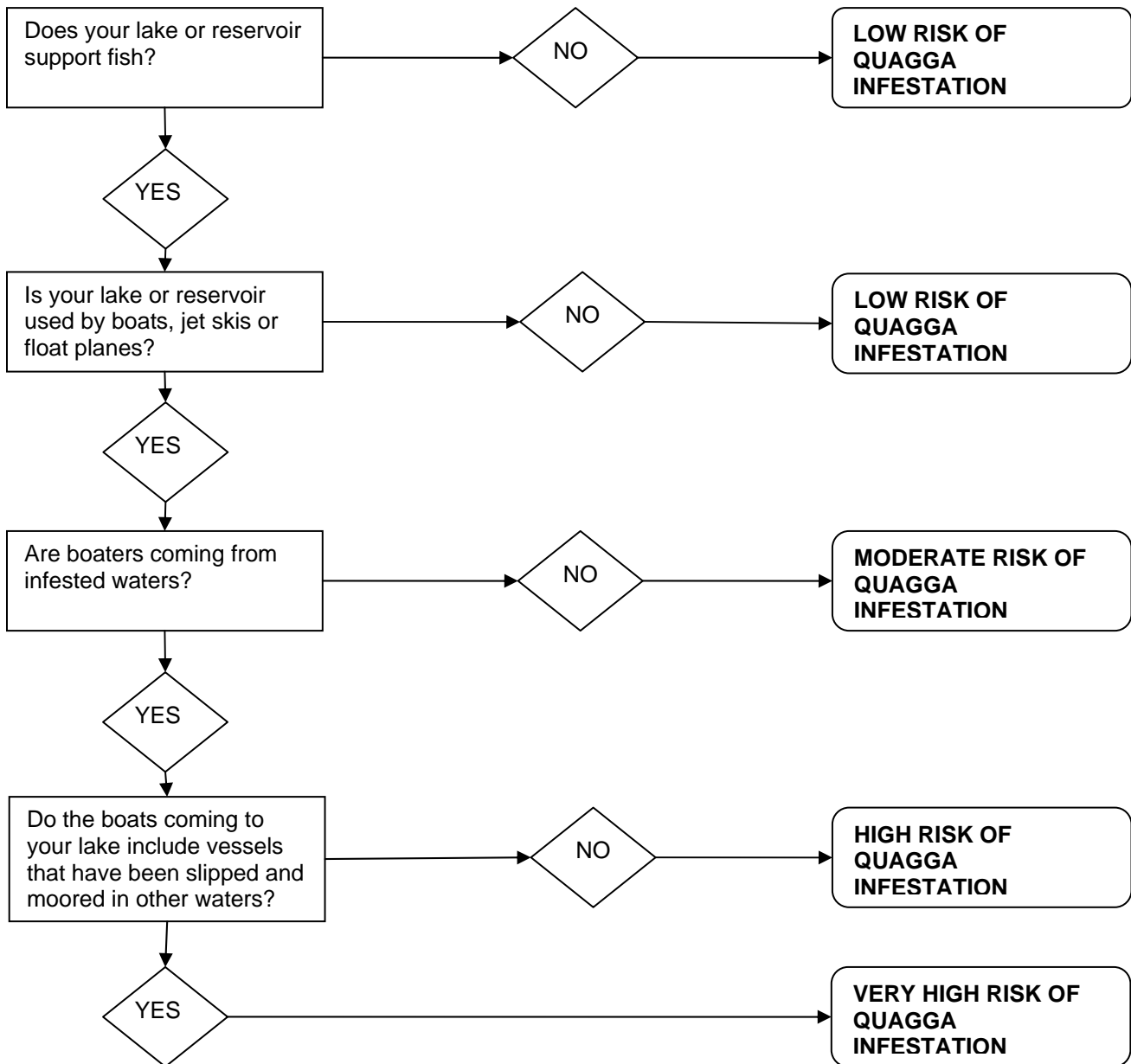
Situation Analysis - Introduction

All park managers with aquatic resources should complete this situation analysis to determine the level of risk for their park unit. After determining your risk level, complete the appropriate list of recommended actions shown on pages 17 and 18.

The following decision trees are provided as general guidelines for determining the level of risk for a particular water body. Interconnected waters are often managed by different agencies operating under separate authorities. Because of the potential for colonization by drifting larvae, an effective response will typically require coordination among these agencies.

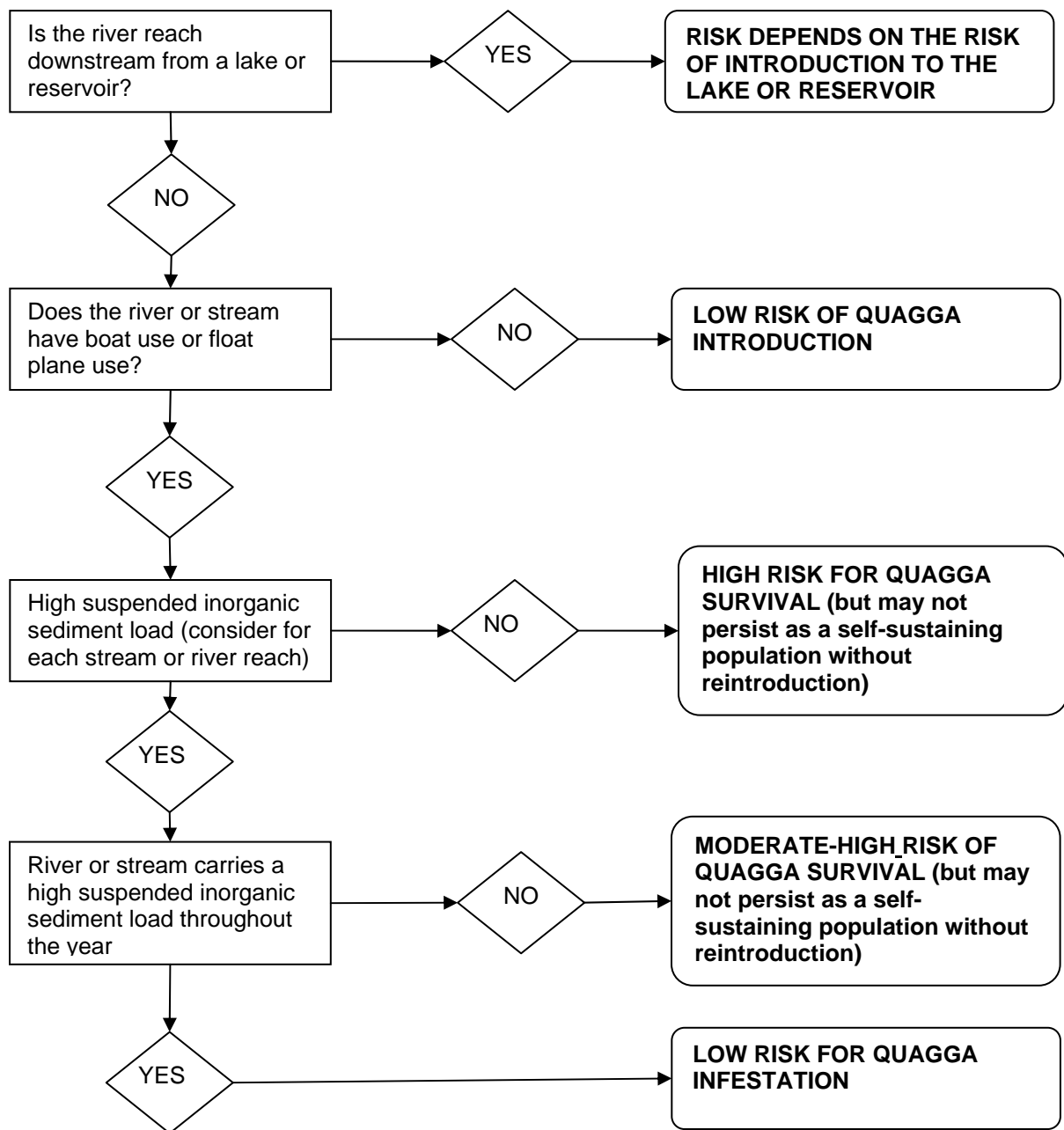
This analysis is quick and simple. Parks may wish to have a thorough scientific, professional risk analysis completed by qualified specialists.

Situation Analysis - Lakes and Reservoirs



Situation Analysis – Rivers and Streams

The probability that quagga mussels will become established in a river or stream reach depends upon suspended inorganic sediment, the existence of low velocity habitats and whether or not there is an upstream lake or reservoir. Lack of low velocity habitat and high sediment loads reduce the likelihood the quagga mussels will become established or persist in a river reach. Upstream reservoirs or lakes may increase the probability that mussels will be introduced to the receiving stream and can serve as a continual source of veliger larvae that may maintain populations that would otherwise not be viable. In general, the risk of infestation is lower in a river or stream than in a lake or reservoir. However, zebra mussels have demonstrated the capability to proliferate in the large slow flowing rivers of the Midwest. It is possible that quagga mussels may be able persist in large rivers under similar conditions.



Resulting Actions

If you currently have no infestation...		
Use the Situation analysis to determine if your park has a low, moderate or high risk of infestation		
<i>If your park has a low risk of infestation, then take the “Low Risk Actions” shown in table 1 below.</i>	<i>If your park has a moderate risk of infestation, then take the “Moderate Risk Actions” shown in table 2 below.</i>	<i>If your park has a high risk of infestation, then take the “High Risk Actions” shown in table 3 below.</i>

TABLE 1. Low Risk Actions	
Prevention	1. Implement basic educational components (such as website messages and some signs) to inform the public and cooperators of quagga/zebra infestation as shown starting on page 19.
Monitoring and Early Detection	1. Monitor waterways and likely infestation points on a regular basis as shown starting on page 25.
	2. Establish baseline data as shown on page 25.
	3. Periodically reevaluate the park’s risk using the situation analysis. If the status changes, refer to the moderate or high risk action tables.

TABLE 2. Moderate Risk Actions	
Prevention	1. Implement educational components to inform the public and cooperators of quagga/zebra infestation as shown starting on page 19.
	2. Implement administrative controls by including quagga/zebra mussel control language in contracts and permits as shown on page 23.
	3. Train park staff in the use of Hazard Analysis and Critical Control Point (HACCP) plans and prepare plans for likely activities.
Monitoring and Early Detection	1. Set a scheduled sampling and monitoring plan that checks waterways and likely infestation points as shown starting on page 25.
	2. Establish baseline data as shown on page 25.
	3. Survey boat and parking lots as shown on page 21.
	4. Periodically reevaluate the park’s risk using the situation analysis. If the status changes, refer to the moderate or high risk action tables.
Pre-Detection Response Planning	1. Conduct the pre-planning activities as shown in the “Response” section of this Guide, as shown on page 27.
Other actions	1. Implement a Communications Strategy as shown starting on page 12.
	2. If necessary, initiate OFS/PMIS requests as shown on page 40.
	3. Designate a quagga mussel coordinator.

TABLE 3. High Risk Actions	
Prevention	1. Implement a comprehensive educational program to inform the public and cooperators of quagga/zebra infestation as shown starting on page 19.
	2. Implement administrative controls by including quagga/zebra mussel control language in contracts and permits.
	3. Require contractors, permittees and concessioners to institute a boat washing program as shown on page 19.
	4. Institute a boat washing program for vessels arriving from infested waters as shown on page 19.

	5. Institute Hazard Analysis and Critical Control Point (HACCP) plans and other measures designed to prevent spread by agency and partner personnel as shown on page 33.
	6. Define the available law enforcement authorities and determine the needed law enforcement plans and actions.
Monitoring and Early Detection	1. Set a robust, scheduled sampling and monitoring plan that checks waterways and likely infestation points as shown starting on page 25.
	2. Establish baseline data as shown on page 25.
	3. Survey boat and parking lots as shown on page 21.
Pre-Detection Response Planning	1. Conduct the pre-planning activities as shown in the “Response” section of this Guide, as shown on page 27.
Other actions	1. Identify and coordinate activities with federal, state and local agencies and private organizations as shown on page 19.
	1. Implement a Communications Strategy as shown starting on page 12.
	2. Establish close coordination with the regional quagga/zebra mussel coordinator.
	3. If necessary, initiate OFS/PMIS requests as shown on page 40.
	4. Begin programming park funds for prevention, detection and response and consider emergency funding sources as shown on page 40.

If you have an infestation...

Immediately undertake the actions listed in the “Initial Response” portion of the Response chapter.

Preventing Quagga/Zebra Mussel Infestations

Strategies for Preventing the Introduction of mussels into park waters

Quagga or zebra mussel infestations can be prevented with a multi-faceted, coordinated management approach. The following functions are critical in preventing quagga/zebra mussel infestations: (1) education; (3) screening boats; (2) decontaminating boats; (4) certifying vessels as mussel free; (5) developing a response plan; (6) law enforcement and (7) administrative controls. The following section describes each of these management functions.

1. Education

The foremost component to prevention is education. The National Park Service and its partners must continue to highlight the threat of quagga/zebra mussels with the media and park stakeholders at every opportunity. Many quagga mussel educational materials have already been developed and are available to the NPS. Visitors can be educated in a variety of ways: at visitor centers, kiosks on launch ramps, brochures, roving rangers, the news media, NPS websites, boating clubs, etc.

See Appendices for this information:

- Identify Your Audience
- Interpretive Opportunities
- Signage

2. Decontaminating Boats

It is imperative that all vessels and equipment that have been exposed to infested waters are disinfected prior to being used in non-infested waters. Disinfection can be characterized as falling into two major categories: washing with complete dry and decontamination. Washing to disinfect involves ordinary procedures for cleaning, followed by complete drying; required drying times (5 to 30 days) can be determined with the Quarantine Estimator tool available under the LE section of the 100th Meridian Website. If drying time is not available, decontamination is required. Decontamination is accomplished by washing the boat, trailer, and all equipment, and flushing all wet areas with scalding hot water of at least 140 F.

All NPS units should educate visitors on decontamination procedures, areas of boat needing attention, and the importance of drying to kill aquatic invasive species. The best message for the general public is available through the national Stop Aquatic Hitchhikers Campaign (www.ProtectYourWaters.net).

NPS Concessioners should develop zebra mussel decontamination stations at all concessions marinas or warehouses. Plans should be made to accommodate the expected demand for boat decontaminations in all future contracts or by adding additional decontamination stations.

Alternative Decontamination Procedures

Professional boat-washing/decontamination with high-pressure water sprayed at 140°F.

=OR=

Self-wash with a high-pressure wash at 104°F and completely dried for at least 5 days.

See www.100thmeridian.org for chart on drying times and temperature for your locale.

Parks should actively seek to partner with local businesses around park areas to establish additional decontamination stations in gateway communities. This will help make boat washing and decontamination as convenient as possible for park visitors.

Note that effluent resulting from decontamination activities must be controlled and properly treated in accordance with regulations and procedures.

Basic Principles and Procedures

After exposure to waters known to potentially contain invasive mussels, all vessels and trailers which came in contact with water should be decontaminated. Visual inspection cannot determine the absence of invasive mussel. Young mussels are microscopic, and can exist in any standing water associated with the boat, trailer, or equipment or be attached to any surface that contacted infested waters.

Use of pesticides, some disinfectants and some other treatments present potential risks to people and the ecosystem and will require the submission of Pesticide Use Proposal System (PUPS) requests prior to purchase and use of the product. Contact your local IPM coordinator for information on requests and requirements.

Compartments

All boaters should drain bilges, wet wells, live wells, and any compartment that could hold water from infested locations. These compartments should be allowed to dry completely (at least 5 days) before launching in non-infested waters. If drying time is not available, compartments should be drained and flushed with hot water (at least 140 degrees F). Parks should work to establish professional decontamination facilities by partnering with concessioners, outside businesses or state and local agencies and organizations.

Hulls, surfaces, anchors, diving platforms and trailers:

Visually inspect and remove any clinging organic or other material from all surfaces of the boat and trailer by scrubbing with brushes or spraying with high pressure water.

Allow a boat hull, anchor, platforms, equipment, and trailer that has been thoroughly cleaned and visually inspected to dry completely (at least 5 days).

If drying time is not available, a professional decontamination is required to remove the risk spreading mussels. Professional decontamination can be conducted by washing all areas of the vessel, trailer, and equipment with scalding hot water (>140F).

Special attention being paid to: 1) cracks and crevices in which mussels may be protected, and 2) aquatic macrophytes harboring juvenile mussels that may be present on trailers or propellers. Particular attention must be paid to trailer pads made of carpet and foam rubber, which could trap tiny mussels. If possible, such material should be removed from trailers used in zebra mussel-infested waters.

See the “ProtectYourWaters.net” website for detailed float plane and other decontamination procedures.

3. Screening Boats Entering the Park

Screening at staffed locations.

Staff at entrance stations can ask a series of questions to determine whether or not a watercraft poses a risk for harboring quagga/zebra mussels. Entrance station staff can ask visitors questions to determine when and where their boat was last used.

If the boat does not present a threat of harboring quagga/zebra mussels, the boat may be launched. Visitors may be given a “Mussel Free” certificate to display on their vehicle’s dashboard while they are parked within National Park areas.

If visitors need to get their boats decontaminated, they can be directed to any of the local decontamination stations.

Screening at unstaffed locations.

Automatic fee machines can issue quagga/zebra mussel information and a self-registered “Mussel Free” certificate that can be displayed on their vehicle’s dashboard. Signs and self-certification stations can be used in areas with no automated fee machines.

4. Allowing Visitors to Certify that their Boats are Mussel Free

Visitors will be able to look at a simple set of questions to determine whether or not their boats need to be decontaminated before they launch. Visitors not needing a decontamination will sign a certificate stating their boats are mussel free (included with the self-certification packet).

For visitors needing to get their boats decontaminated, maps will be included in the packet directing them to local stations. To make the program convenient for visitors, self-certification packets will be distributed widely: on the park’s website, at park visitor centers, on launch ramps, at hotels, boat shops, sporting goods stores, and other local businesses.

5. Develop a Response Plan.

Parks with moderate or high risk waters should develop rapid response plans. See Page 27 to identify needs that will be immediate in the event of infestation. Develop contact lists and preplan for any steps possible.

6. Law Enforcement

Quagga/zebra mussels require a multiple jurisdictional approach to enforcement by establishing and supporting an inter-jurisdictional process to ensure compatibility and consistency among state, tribal, and federal agencies

Authorities.

36 C.F.R. § 1.5 Superintendent's Compendium can be used to establish regulatory authority for actions needed in the prevention of AIS infestations to park waters.

36 C.F.R. § 3.2 allows the National Park Service to assimilate federal and state regulations that may be used to effectively prevent the transportation of nuisance species such as zebra and quagga mussels.

Federal laws which apply directly to the introduction of non-indigenous species include the Lacey Act, the Federal Noxious Weed Act, the Federal Seed Act, the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990, and the National Invasive Species Act of 1996. The Endangered Species Act also would apply if an aquatic nuisance species (ANS) was shown to threaten the survival of a federally listed species, such as the humpback chub.

Parks may establish inter-jurisdictional approaches to facilitate legislative, regulatory and other actions needed for the prevention of aquatic invasive species (AIS) infestations to park waters. Parks may also use the Superintendent's Compendium authority. For example, the Superintendent's Compendium could be used to require that all boats that had been launched in states with quagga or zebra mussel infestations within the last 30 days to be decontaminated before launching in the park.

Examples of state laws and regulations the NPS could use under 36 C.F.R. § 3.2 include:

State of Utah (*Administrative Code*)

[R657-3-22.\(q\) Rules for Invertebrates](#), Quagga mussel, Dreissenidae Family (Dreissena bugenses) is prohibited for collection, importation and possession;

State of Arizona (*Arizona Commission Rule*)

[R12-4-406](#) restricts transportation of live wildlife and specifically lists zebra mussel (m-3) and Quagga mussels (m-5) as "restricted"

[ARS 17-309. \(A\)](#). Unless otherwise prescribed by this title, it is unlawful for a person to: (1). Violate any provision of this title or any rule adopted pursuant to this title. (2). Take, possess, transport, buy, sell or offer or expose for sale wildlife except as expressly permitted by this title.

Arizona's Aquatic Nuisance Species web site;
<http://ag.arizona.edu/azaqua/extension/ANS/ANS.htm>

California ANS Law (*Fish and Game Code*)

[3.3.3.2270-2272](#) No live aquatic plant or animal may be imported into the state without prior written approval of the department pursuant to regulations adopted by the commission.

State of Nevada

Currently Nevada ANS Laws ([Chapter 503](#)) do not address quagga mussels as a specific ANS species. The State has deemed the quagga mussel to be detrimental and the species listing will go into effect no later than May 14, 2007.

Additional ANS laws for specific western states can be accessed on the 100th Meridian web site in the [Database of State Laws](#) at; <http://www.100thmeridian.org/Laws/usmap.htm>

Controlling vectors into and aquatic activities in park land/waters- The NPS may use all applicable authority to protect park resources. Thus, law enforcement can enforce all laws, regulations, and rules applicable to the operation and use of watercraft, trailers, equipment, and other visitor activities.

Controlling vehicles and watercraft exiting park lands – In the absence of a 36 C.F.R. § 1.5 Superintendent's Compendium regulations, NPS law enforcement personnel would not have the authority to detain and inspect watercraft/trailers leaving park waters/lands for AIS unless state law provides jurisdiction. Therefore, law enforcement personnel must determine the provisions of state law that apply. Determination of facts constituting reasonable suspicion and probable cause that a violation has been committed should be determined in light of state law. Facts which may be considered in determining possession and transport of an AIS on/in vessels/trailers include, but are not limited to: plain view of mussels, voluntary statements regarding last launch site, statements about the number of days out of water, etc.

Personnel should be trained in the appropriate protocols for inspecting vessels for the presence of mussels and decontamination. See the "It only Takes One" law enforcement training video that can be downloaded at www.100thmeridian.org.

7. Administrative Controls

Parks should develop Hazard Analysis and Critical Control Points (HACCP) plans (see Reference Section) for agency and partner activities that could inadvertently spread quagga/zebra mussels.

In addition, language outlining requirements to take preventive actions should be developed and inserted into pertinent permits, contracts, agreements and similar documents.

It may be feasible to train canines as a tool for detecting Quagga and Zebra mussels in and on watercraft and trailers. The methodology of using canines as a detection tool would result in an innovative, non-invasive sampling method that would improve the efficiency of quagga detection while reducing visitor impact. In addition a canine mussel program could include the underwater detection of mussel beds.

Additional information may be obtained from:

Working Dogs for Conservation, Missoula, Mt. (406) 285-9019
(www.workingdogsforconservation.org/index.shtml)

Pack Leader Dog Training Gig Harbor, Wa (253) 884-5959
(www.packleaderdogtraining.net)

Monitoring and Detecting Quagga/Zebra Mussel Infestations

Introduction

The goal of detection monitoring is to determine whether mussels are present in a waterbody as soon as possible after an introduction occurs. Early detection is important for containment and control. Detection monitoring can be done several ways, and can easily be accomplished with volunteers or minimal staff time. Detection of invasive mussels triggers response actions (see response section).

Modified Portland Samplers

Artificial substrate samplers provide the most cost effective and simple detection monitoring approach. Modified Portland Samplers developed by Portland State University, consist of sections of ABS or PVC pipe suspended in the water column at various depths. Settling stage invasive mussels can be detected when attached to the sampler. Samplers can be suspended with rope or thick monofilament line. Mesh or scrub pads inside the pipe improve effectiveness. Removable pipes can be incorporated into the design. Samplers are examined by volunteers or NPS staff with minimal training and equipment every 4-6 weeks at times when veligers may be settling.

Artificial substrate samplers are recommended for high and medium risk waterbodies. Samplers are best deployed in shaded areas. Samplers with some biofilm are more attractive to settling mussels. See appendices for details including how to construct samplers, contact information for the Portland State University Center for Lakes and Reservoirs, which can provide samplers and monitoring support, and suggested sampling protocols.

Some species experts believe that vertical plates provide a more desirable surface for settling mussels than pvc pipes and are more likely to result in successful early detection. Both the Portland sampler and plate-type sampler are described in greater detail in the appendices.

Veliger sampling

Veliger sampling with a zooplankton tow net can provide the greatest chance of early detection, but is more labor intensive and costly than using artificial substrate samplers. Veliger sampling may be useful for detecting presence at remote sites where regular site visits are impractical. Protocols for collection and preservation will vary depending on methods that will be used to process samples and detect veligers. Veliger sampling is only effective when veligers are present, so sampling should be conducted during periods when conditions are suitable for spawning. See appendices for details.

Dive surveys

Dive surveys are useful in certain circumstances for surveying relatively small and high risk areas such as marinas. Diver surveys are most useful in response to a newly discovered infestation or to find an adult population that has been indicated by veliger or artificial substrate samplers. Divers should search for mussels on the surfaces of boats, docks, retaining walls, and other submerged structures (especially concrete) in the vicinity of marinas.

Parks should also consider the use of underwater cameras, ultra-sensitive sonar and remote diving vehicles to monitor and search for mussels.

Response to a Quagga/Zebra Mussel Infestation

Organization of this Chapter:

This chapter is organized into four sequential planning horizons:

- I. Pre-plan:** organization for a response before the time of initial detection in that area, watershed, or park
- II. Initial Response:** immediate actions to be taken in the first days to weeks after the initial detection in that area, watershed, or park
- III. Extended Response:** actions to be implemented for the upcoming visitor use/boater season in the weeks or months after initial response
- IV. Long-term Response:** actions to be implemented as part of day to day management actions and facility designs in the first few years after extended response.

The break points between these planning horizons will vary by site and situation based on date of discovery, method of discovery, seasonality of water access and boat use, and other site specific factors. In any case, the initial detection should trigger an initial response.

I. Pre-planning Stage: organization for a response before the time of initial detection in that area, watershed, or park.

Task 1: Define the Geographic Scope

High and moderate risk NPS areas should assess the geographic, administrative, and political area potentially affected by the invasive aquatic species in order to establish multiple response organizations/teams and establish effective coordination. Parks should consider areas upstream and downstream of the affected area, as well as adjacent waterbodies not necessarily hydrologically connected. Affected NPS areas may define the geographic scope of the infestation and coordinate a response based on:

- Hydrologic basins (HUC units)
- Political boundaries (Federal, state, county, municipal, tribal)
- Collateral enforcement jurisdictions
- Administrative and legal authority of Federal, state, and local water storage projects and conveyance structures
- Location/Use of Federal, state fish hatcheries (water source connectivity and stocking destinations)
- Federal and state Congressional districts
- Local and regional visitor use patterns

Resources to define the scope of infestation and response could include:

- Local or regional GIS staff
- Local and state water districts and authorities
- State wildlife and water quality management agencies.
- Regional and WASO NPS WRD/BRD technical staff
- District USGS BRD/WRD technical staff
- Regional FWS technical staff

Task 2: Identify Interagency Partners

Within the determined geographic scope, identify management federal, state, or other agencies with management authority for water, fish, boats, or shorelines in the water basin (e.g. a reservoir, a river reach, or combination). These are hereafter referred to as *partner agencies* in this document. For example, the agencies involved in the quagga mussel infestation response at Lake Mead included National Park Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, Arizona Game and Fish Department, Nevada Department of Wildlife and the Southern Nevada Water Authority. In many parts of the west, this list may also include tribes and the Bureau of Indian Affairs.

Task 3: Establish Coordination and Preplan for Response in the event of detection

NPS *Management Policies* (2006) directs that the Incident Command System (ICS) will be used to manage significant incidents and events within the National Park Service, so ICS will be the framework for response when quagga/zebra mussel infestations are detected on NPS administered lands. Depending upon the expertise within the partner agencies identified in Task 2 above and the scope of the situation, the interagency partners could choose to coordinate in a Unified Command with an Incident Commander from each agency. Alternatively, an All Hazard Incident Management Team could be ordered and each agency's interests could be represented by a person designated as an Agency Representative and their personnel could be assigned to the incident. For ICS to work, either in unified command or under a single Incident Commander (IC), the partner agencies would need to identify funding to support the response, agree on timeframes, identify available resources to commit to the response, and provide a delegation of authority to the IC. Review the NPS Incident Complexity Chart in appendices to determine what type of ICS response makes sense in your situation.

Establish a dialogue with those partner agencies at an organizational level that will provide both the management authority to take action as well as the specific knowledge of the operations and resources at that location. This will vary from agency to agency and from area to area. It is also recommended that an overview of the Incident Command System (ICS) and reference materials be provided so that partner agencies can train and prepare for future involvement. Online training is available at <http://training.fema.gov/EMIWeb/IS/is100.asp> or <http://training.nwccg.gov/classes/i100.htm>,

During pre-planning the interagency partners should try to agree on response objectives that will be used in the event of a detection. This information will be very useful in preparing the delegation of authority for Incident Commander and/or Incident Management Team and will be

critical to focusing the response to maximize efficiency and effectiveness. Below is an example of objectives that were used at Lake Mead NRA and may be useful for other parks to adapt or adopt as appropriate. The remainder of this chapter is organized around these objectives.

Recommended response objectives:

1. Complete the initial assessment to determine the extent of infestation.
2. Contain the infestation through management of boat movement, boater education, boat inspection and decontamination.
3. Investigate treatment options and implement those, if any, that are feasible.
4. Identify actions needed to fulfill each agency's management responsibilities taking into consideration the long-term implications of quagga mussel invasion.

Determine funding sources within National Park Service as well as through partners and other agencies. Establish agreements to share funds and resources as needed to complete pre-planning tasks and prepare for response upon detection.

II. Initial Response Stage: immediate actions to be taken in the first days to weeks after the initial detection in that area, watershed, or park

Task 1: Verification of initial detection

This task should be undertaken by the park upon initial detection and prior to official notification of interagency partners.

Assemble and prepare data for initial report

- Record and document site specific information, including...
 - Date and time of initial sighting
 - Person or persons who made the sighting
 - Include contact information for follow up
 - Include organization or agency affiliation
 - Location for initial sighting. Try to determine geographic coordinates (longitude and latitude)
 - Record specific information regarding the discovery
 - How was it discovered?
 - If a monitoring device was used, which kind?
 - What depth?
 - Was the sample alive when seen?
 - How many were found?
 - Who conducted the verification?
 - What were the specific site characteristics?
 - What were the water quality parameters, if known?
- If possible, take high resolution photographs of samples
 - Photograph multiple individuals from multiple angles
 - Include common objects (like coins) or a ruler so that scale can be determined
 - Photograph from various distances, and use a camera capable of macro imagery if possible
- Collect samples for verification
 - Hold samples in source water, freeze as soon as possible to preserve specimens
 - Ethanol (70% grain alcohol non-denatured) may also be used as a preservative

Notify primary NPS response contacts

- These may be internal within park, region, WASO; NPS response contact should identify initial response leader (person)
- If primary NPS response contacts are not defined or are unknown, report initial sightings to the 100th Meridian Initiative ANS Hotline (1-866-786-7267)
- Convey all information regarding the initial sighting to response contact

Confirm validity of report

- If initial reports are microscopic veliger larvae then samples should be analyzed with PCR techniques to identify species

- Coordinate this with Bureau of Reclamation and US Fish & Wildlife Service, who have an ongoing active program see appendices for contact information. Multiple samples should be submitted for PCR analysis to minimize possibility of a false positive resulting from contamination.
- If PCR analysis results in a positive indication for zebra or quagga mussels, a second sample should be analyzed to confirm (because of potential contamination)
- If initial discovery is of adults or juveniles, contact an expert to ascertain species identification if samples are juveniles or adults
 - Send photographs and specific collection information to a recognized expert to confirm validity of initial report.
 - Request positive identification from a recognized expert
 - Samples may be shipped to the expert (see appendices for contact information)
 - If a local expert is available, bring the expert to the collection site to see the samples *in situ* when possible
 - Once identification has been confirmed, notify the USGS's Invasive Species Alert System (<http://nas.er.usgs.gov/SightingReport.asp>)

Compile facts and post at a central, coordination area (100thMeridian Initiative website, for example)

- Concise specifics will be useful for later stages of response, including planning, news releases, briefing statements and others.
 - What was found?
 - Where was it found?
 - How was it found?
 - Why is this important?
 - What has been done so far?
 - What is being done now and by whom?
 - Who has been contacted?
 - Where can more information be found?
- Photographs should be submitted to a central location for sharing with additional experts. A central repository reduces the necessity to send potentially large files through email.

Task 2: Notifications

After verification, compile the pertinent facts into a dated fact sheet that outlines what is currently known about the infestation and distribute to interagency partners. With interagency partners, review the NPS Incident Complexity Chart. See appendices and prepare an incident complexity analysis. Based upon those results and the decisions made during pre-planning, initiate a response by organizing at the appropriate level.

Task 3: Conduct Initial Response

General Strategies for Initial Response:

- Prepare a site-specific Incident Action Plan to identify objectives, priorities and timeframes
- Establish and maintain internal communication protocols with partner agencies
- Establish and maintain communications with other geographic response organizations (downriver, upriver)
- Raise public awareness via media outlets by issuing news releases, sponsoring a media day event, etc.
- Develop briefing statements to inform senior management within the partner agencies
- Participate in efforts to address quagga/zebra mussel via established River Basin Teams (look at www.100thmeridian.org for a list of these)
- Establish a science advisory team, composed of both subject matter experts on *Dreissena* spp. as well as limnologists and aquatic ecologists familiar with the watershed, to provide input on all response goals
- Establish an interagency public affairs team to promote coordinated public outreach effort
- Query parallel organizations in the Great Lakes states and other areas who have dealt with invasive mussels to learn from their experiences
- Ensure that the response meets National Park Service business practices and adheres to the Interagency Incident Business Management Handbook (<http://www.nwcg.gov/pms/pubs/IIBM2/iibmh.pdf>)
 - Accurately track costs and cost estimates of the response. Provide justifications for expenditures.
 - Communicate financial responsibility to all incident responders

Objective	Strategies
Objective 1. Complete the initial assessment to determine the extent of infestation.	Establish training and assessment protocols, then conduct presence/absence inspections (preferably using underwater divers) for adult mussels at all marinas and boat launch facilities
	Conduct presence/absence inspections for adult mussels at partner fish hatcheries on the water body, if applicable
	Conduct presence/absence inspections for adult mussels at the raw water intakes and associated impoundments, if applicable
	Conduct presence/absence inspections for adult mussels at dams and hydroelectric facilities, if applicable
	Compile inspection findings and distribute the information via a website that is accessible to partner agencies and the public (suggested: www.100thmeridian.org)
	Collect samples to verify species identification from subsequent discoveries
	Identify values at risk, including infrastructure and natural and cultural resources (consider using GIS analysis and establish geodatabase to capture incoming data)
	Modify existing substrate samplers and protocols to look for invasive mussels/other relevant species
Objective 2. Contain the infestation through management of boat movement, boater education, boat inspection and decontamination.	Design and produce posters and handouts for general boat cleaning procedures (acquire pre-existing templates, if possible)
	Complete temporary sign posting at all marinas and boat launch facilities
	Provide handouts to all vehicles passing through entrance stations
	Initiate community outreach at special events, such as boat shows

Objective	Strategies
	<p>and fishing tournaments</p> <p>Distribute posters and handouts to related businesses in the local community</p> <p>Review HACCPs and establish standard operating procedures for cleaning agency-controlled boats, SCUBA gear, and other field equipment at critical control points</p> <p>Train field personnel and cooperators in mussel detection and public messaging</p>
Objective 3. Investigate treatment options and implement those, if any, that are feasible.	Identify possible treatment options, including the potential for eradication. <i>Note:</i> Possible tactics are summarized at the end of this chapter in the treatment/ eradication table
Objective 4. Identify actions needed to fulfill each agency's management responsibilities taking into consideration the long-term implications of quagga mussel invasion.	<p>Identify agency-specific operations that will require modification due to quagga mussel</p> <p>Inform agency-authorized cooperators of mussel infestation</p>

III. Extended Response Stage: Actions to be implemented for the upcoming visitor use/boater season in the weeks or months after initial response

Task 1: Transition from Initial Response to Extended Response and assure adequate resources and expertise are assigned.

General Strategies for Extended Response:

- Draft an interagency Extended Response Plan or similar document to detail the full scope of the response effort, identifying objectives, priorities and timelines
- Institutionalize internal communications with partner agencies
- Maintain communications with the other geographic response organizations
- Continue to raise public awareness via media outlets
- Update briefing statements for upper management within the partner agencies
- Continue to participate in efforts to address quagga mussel in partnership with relevant River Basin Teams
- Continue to use a science advisory team or specific experts as needed
- Continue to ensure that the response meets National Park Service business practices and adheres to the Interagency Incident Business Management Handbook (<http://www.nwcg.gov/pms/pubs/IIBMh2/iibmh.pdf>)
 - Accurately track costs and cost estimates of the response. Provide justifications for expenditures.
 - Communicate financial responsibility to all incident responders

Objective	Strategies
Objective 1. Expand the initial assessment to determine the extent of infestation.	Based upon advice from Science Advisory Team, expand assessment efforts to better characterize the infestation. May include systematic sampling for adults and/or veligers, distribution and abundance measurements for adults and/or veligers, targeted resources at risk, etc.
	Extend presence/absence assessment to include other non-marina locations if not completed under Initial Response
	Engage recreational community in reporting sightings via www.100thmeridian.org
	Add additional substrate samplers to look for quagga mussels
	Continue to compile assessment data and distribute the information via website
	Analyze and describe potential impacts to values at risk including infrastructure, recreational use, natural and cultural resources
Objective 2. Contain the infestation through management of boat movement, boater education, boat inspection and decontamination.	Develop a site-specific interagency boater education campaign, including messages targeted for different audiences and delivery methods
	Mass produce large quantities of signs, handouts, and other written materials in support of the boater education campaign
	Install permanent entry and exit signs at all marinas and boat launch facilities as well as strategic locations on access roads
	Continue and expand community outreach at special events, such as boat shows and fishing tournaments
	Distribute interagency posters and handouts to related businesses in the local community
	Continue to refine the standard operating procedures for cleaning

	agency-controlled boats and SCUBA equipment as well as fish stocking operations
	Develop other HACCPs and standard operating procedures for water related activities conducted by the agency partners
	If feasible, add additional staff and continue to train field personnel in mussel detection and public messaging
	Initiate mandatory inspection and decontamination of slipped/moored boats upon entry and exit in cooperation with park concessioners
	Use direct mailing to contact boat related organizations
	Install portable hot water pressure wash systems at marinas
	Install permanent boat wash facilities
Objective 3. Investigate treatment options and implement those, if any, that are feasible.	Evaluate the feasibility and potential impacts of various treatment options. <i>Note:</i> All proposed pesticide treatments must be submitted to the Service's Integrated Pest Management program for approval. Procedures include the preparation of Pesticide Use Proposals (PUP) and their submission through normal agency channels.
Objective 4. Identify actions needed to fulfill each agency's management responsibilities taking into consideration the long-term implications of quagga mussel invasion.	Implement administrative changes to agency-specific operations (e.g. permit conditions for regattas, fishing tournaments, etc)
	Initiate planning, engineering, and design actions for facility related modifications. Possible tactics are summarized at the end of this chapter in the Mussel Control Options for Piped Systems table.

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IV. Long-term Response Stage: actions to be implemented as part of day to day management actions and facility designs in the first few years after extended response.

Task 1: Transition from extended response to normal park operations.

- General Strategies for Long-term Response:
- Evaluate the need for an ongoing Response Team and, as appropriate, disband the incident organization and transition to communication and coordination via normal operating procedures
- Continue to participate in efforts to address invasive mussel issues via the River Basin Team and coordinate with other NPS units
- Evaluate the need for a science advisory team, and disband if appropriate.
- Consult individual experts as needed to implement infrastructure modification
- Continue to ensure that the response meets National Park Service business practices.
 - Accurately track costs and cost estimates of the response. Provide justifications for expenditures.
 - Communicate financial responsibility to all incident responders

Objective	Strategies
Objective 1. Complete the initial assessment to determine the extent of infestation.	Evaluate habitat suitability to determine potential population size and distribution Transition from assessment to long-term monitoring of population distribution and abundance, ecological effects, and economic impacts. One tactic may be to incorporate long-term monitoring into the NPS Inventory and Monitoring program.
Objective 2. Contain the infestation through management of boat movement, boater education, boat inspection and decontamination.	Continue to distribute interagency boater education materials via normal agency channels Maintain permanent signs at all marinas and boat launch facilities on both lakes as well as strategic locations on access roads Install additional boat wash facilities Administratively adopt the standard operating procedures Continue training and awareness for agency staff, especially seasonal employees Identify and promote private-sector opportunities to decontaminate boats Institutionalize mandatory inspection and decontamination of slipped/moored boats upon entry and exit
Objective 3. Investigate treatment options and implement those, if any, that are feasible.	Complete environmental, engineering, and cost/benefit analysis of treatments under consideration Implement approved treatments If treatment is eradication, establish a monitoring program to assure treatment effectiveness
Objective 4. Identify actions needed to fulfill each agency's management responsibilities taking into consideration the long-term implications of quagga mussel invasion.	Complete planning and, to the extent possible, implementation of facility related modifications Foster and support a volunteer force to do awareness training and outreach

Table 1. Possible Treatment/Eradication Approaches identified by Dr. Andy Cohen, January 30, 2007

APPROACH	DESCRIPTION	COMMENT
Batch Treatment with Biocide	Release sufficient biocide to raise the concentration throughout the water body to a lethal level.	Batch treatment was successfully used to eradicate the Black-striped Mussel <i>Mytilopsis sallei</i> from 3 boat basins in Darwin, Australia, and to eradicate Zebra Mussels from a quarry pond in Virginia.
Biocontrol	Release live organisms to control the target population through predation, parasitism, interference with reproduction, or other mechanisms.	There is no demonstrated biocontrol treatment for <i>Dreissenid</i> mussels, but a bacterial agent is under development by Dr. Dan Malloy of the New York State Museum.
Isolate & Treat with Biocide	Isolate the infested area with curtains, inflatable barriers, earth berms, etc. and treat the isolated water volume with biocide.	Isolation curtains have been used for the herbicidal treatment of aquatic plants. Large inflatable barriers are being installed to protect the City of Venice from flood waters. Corrugated metal bulkheads have been used to contain construction sediment. Isolation/barrier technologies developed for containing chemical spills or sediments raised by dredging might be applicable.
Wrap & Treat with Biocide	Isolate the infested surfaces by wrapping or covering them, and inject biocide under the wrap or cover.	Two infestations of the seaweed <i>Caulerpa taxifolia</i> in southern California lagoons were eradicated by covering with PVC tarps held down by sandbags around the edges, and pumping chlorine underneath through valves in the tarps.
Wrap	Wrap or cover the infested surfaces.	Experimental covering of Zebra Mussels with large plastic tarps in Lake Saratoga, New York, killed 99.9% of the mussels, apparently by the combined stress of no food, low oxygen, high ammonia concentrations, etc.
Remove	Remove the mussels by hand, suction, scraping or hydroblasting combined with suction, or other methods.	The initial removal of 19,000 zebra mussels by hand from Lake George, New York in 2000, with annual follow-up collections of smaller numbers has progressively reduced the population, which appears to be dying out. Removal of 1.6 million intertidal snails by hand from a southern California cove eradicated an infestation of a parasite that used the snail as one of its hosts. Suction dredges of various sizes have been used for biological sampling of benthos, underwater archaeological excavation, and dredging sediment.
Bury	Bury with uninfested sediment using dredges.	
Coat	Spray with an underwater polymer or other suitable coating.	Smothers mussels.
Heat	Apply heated water, steam	In 2001, the exotic seaweed <i>Undaria pinnatifida</i>

	or flame to infested surfaces.	was eradicated from the hull of a sunken vessel 2 km off Chatham Island, New Zealand, using electric heating elements inside a plywood box attached to the hull with magnets, which heated the water to 70°C within 10 -15 minutes. Small inaccessible areas were treated with a modified cutting torch. Superheated steam has been applied to benthic populations of <i>Undaria</i> .
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Table 2. Mussel Control Options for Piped Systems as presented by Black and Veatch at the Quagga Mussel Symposium on March 16, 2007.

	Protect intake	Protect pipeline	Effective-ness	Relative cost	Water quality benefit	Safe for drinking water?
Construction Materials (Copper, Galv. Iron, Aluminum)	X	X	X	\$\$\$	No	Yes
Chemical treatment (chlorine, chlorine dioxide, ozone, permanganate)	?	X	XX	\$-\$	Yes	Yes
Antifouling and thermal spray coatings	X		X	\$	No	?
Infiltration intakes	X	X	XX	\$\$\$\$?	Yes
Mechanical filtration (traveling screens, strainers)	X		X	\$\$	No	Yes
Mechanical cleaning (pigging, jet cleaning, blasting)	X	X	X	\$\$	No	Yes
Non-intrusive (acoustic, elec., electromagnetic)	X	?	X	\$\$	No	?
UV light (non-continuous)	X		X	\$\$	No	Yes
Biological control (spoonbill catfish)	X		?	\$	No	Yes

Safety Considerations

Many of the response actions identified in this plan involve potentially high risk job duties. It is critical for park managers to carefully evaluate resource values versus safety risk when implementing activities identified in this plan. Most, if not all, of the potentially high risk duties have required training and certifications. Nothing in this plan minimizes or replaces safety protocols or standard operating procedures.

Risk assessment and Job Hazard Analysis should be performed for each work element in your program with particular attention to the high risk tasks or conditions. These high risk duties may include (but are not limited to):

- Diving
- General Boat operations
- Boat based work platforms in high traffic areas
- Sample collection
- Driving
- Towing boat trailers
- Loading boat trailers
- Decontamination of personnel and equipment
- Field work where personal protective equipment (PPE) is used or where heat stress may become a factor
- Pesticide applications
- Effluent disposal

All field work conducted in conjunction with this plan should be reviewed by a safety professional. No work should take place unless appropriate safety controls and considerations are in place. Employees should have proper training, be well rested, and be alerted to hazards prior to undertaking work.

Job Hazard Analysis guidance (along with select JHA forms) is provided in the Appendices.

Financial Considerations

This Planning Guide and its specific recommendations cannot be implemented without adequate, stable and dedicated funding. National Park Service sites will be limited by the availability of immediate and available funding needed for prevention, monitoring, and response.

At both Lake Mead and Glen Canyon, initial funding was available from alternative sources (the Southern Nevada Public Lands Management Act for Lake Mead and revenues derived from concessions operations for Glen Canyon). Other park sites likely will not have alternative funding sources of this scope. The NPS must determine need and funding sources for prevention, detection, and response.

NPS high risk sites should coordinate efforts to pursue funding options for program development, training and implementation. Organizations and industries that have a vested interest in successful early detection and rapid response systems should be identified in order to participate in the development of funding sources or to partner in response.

- a. Funding Analysis: Consider, and possibly study, the following types of funding sources:
 - Temporary funding sources: Park managers should talk to their regional office for needed immediate contingency funding after local park funding options are exhausted. Parks need to identify this problem as a very high priority for funding within their park budgets. Regions may have to reprioritize OFS requests as the problem emerges.
 - Natural Resources service wide funding may be available but may have limited application: www1.nrintra.nps.gov/scc/2009 is a good source for monies as part of the service wide comprehensive call. National Resources Preservation Program (NRPP) for Biological Resources and for Resource Protection may be options. High Priority Watershed Projects, funded annually through the Natural Resources Program Center (NRPC) could also be considered.
 - A permanent funding source (or sources) maintained solely for rapid response actions. PMIS and OFS needs should be anticipated and submitted early.
 - Fee Demonstration Funding: Fee Demo monies may be available at individual park sites to address the public education and prevention components. Glen Canyon has used fee demo monies for recreational education as part of their prevention program.
 - Private/public partnerships for these efforts in the form of equipment, supplies, personnel or funding: NPS sites should explore these partnerships, interagency MOUs, reimbursable accounts and other cooperative agreements with federal agencies, state entities, local governments, park concessionaires, and park partners. Possible quagga infestation will have great impact that will be felt far beyond park boundaries. Parks should outreach to these partners to explore shared solutions, response, and funding. The US Boat Foundation may have grant monies for education

and prevention. Parks may consider working with boat or engine manufacturers for funding to support educational outreach. NOAA and US Fish and Wildlife Service may be other options.

- One-time grants for specific planning or research projects related to rapid response. Glen Canyon had received some funding through a Colorado Plateau CESU
- b. Cost Analysis: Parks will need to maintain and track costs for the prevention, monitoring, and response portions of this plan and be able to adequately justify expenditures.
- c. Funding Development: Consider using funding for development purposes (i.e. grant writing).

Please see Appendices section for examples of previous funding requests and grant options.

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Appendices

(see separate document)

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