RECLAMATION

Managing Water in the West

Upper Colorado Region Prevention and Rapid Response Plan for Dreissenid Mussels

Approved and Authorized by: _____
Regional Director

Recommended by: _____
Assistant Regional Director

U.S. Department of the Interior
Bureau of Reclamation
Upper Colorado Region
Salt Lake City, Utah

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Mission Statements

The US Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Upper Colorado Region Prevention and Rapid Response Plan for Dreissenid Mussels

Upper Colorado Region Dreissenid Taskforce:

Robert Radtke, Team leader, Regional Office

Nancy Coulam, Regional Office

Valerie Heath-Harrison, Regional Office

Lynn Hunter, Power Office

Russ Findlay, Provo Area Office

Kathleen Ozga, Western Colorado Area Office

Justyn Hock, Western Colorado Area Office

Nancy Umbreit, Albuquerque Area Office

Response Plan Prepared by:

Robert Radtke, Nancy Coulam, Valerie Heath-Harrison, Lynn Hunter, Russ Findlay, Kathleen Ozga, Justyn Hock, Nancy Umbreit and Doug Hendrix

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Executive Summary

The National Invasive Species Council (Council) has called upon federal agencies to coordinate actions to prevent the spread of invasive species through the United States. This early detection and rapid response plan for Dreissenid mussels was developed by the Upper Colorado Region of the U.S. Bureau of Reclamation following the Council's recommendations to develop guidelines for coordinated actions grouped into major tasks: 1) prevention, 2) early detection, 3) rapid assessment, and 4) rapid response or control of invasive species.

This plan is designed to be implemented by all the UC Regional and Power offices which should implement this plan along with partners from tribal, state, and local agencies, water districts and with private individuals and groups. A key component of the plan is identifying partners to these Reclamation offices who are concerned with the spread of Dreissenid mussels. As such, the plan has been developed in cooperation and conjunction with state plans, such as those developed by Utah, Colorado and New Mexico.

The plan includes a review of relevant legal authorities, coordinated planning for early detection, ranking of the regional projects at the greatest economic risk from and potential of mussel infestation (based on use and hydropower capacity), strategies for monitoring, detection, reporting and for disseminating mussel information and the education of water users. It also covers ways to prevent mussel introduction into regional waters. Monitoring and sampling procedures to aid in early detection are presented in the Plan. In the event that mussels are found in regional waters, the Plan covers the initial response procedure and ways to try and contain the mussels within the contaminated water. Lastly, control methods are covered, however, many of the listed control methods are still considered research methods. The Plan does not address specific methodologies for a given project since each project has its unique features. Therefore, each project or facility manager should conduct their own facility assessment and devise a project specific response plan to reduce the risk of mussel invasion and what to do if prevention methods do not work using the Facility Vulnerability Assessment Template, prepared by RNT Consultants.

The regional mussel taskforce is an integral part of the Plan. Team members need to work within their office and with partners to make sure all project waters are part of any assessment. The UC region participates in outreach efforts to inform the public how they can prevent the spread of mussels, has implemented an action plan for mussel detection strategies and, if necessary, preventive maintenance activities, and implemented internal control measures so Reclamation employees do not spread mussels while performing water-related tasks.

This Plan is a working document and will be updated as new information becomes available and implementation progresses. Following the Council, the hallmark of success for this plan will be that, 1) the threats from Dreissenid mussels are identified by the offices of the region to allow risk-mitigation measures to be taken, 2) when the mussels are confirmed in regional waters, responses are effective and environmentally sound, 3) adequate and accurate information is provided to Reclamation decision-makers, our partners, and the public; 4) lessons learned within and outside the region are used to guide current and future efforts.

Introduction

This plan describes how the US Bureau of Reclamation Upper Colorado Region (Region) will prevent and respond to the introduction and spread of two nonindigenous aquatic invasive species within the genus *Dreissena*: zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena rostriformis bugensis*). In compliance with Executive Order 13112, actions taken under this plan are designed to minimize the economic, ecological, and human health impacts of these nonindigenous aquatic invasive mussels. Much of the text and organization of this plan is based on plans prepared by Shaw (2004) and by the National Park Service's Natural Resources Program Center (2007). Additional information has been incorporated from plans and recommendations provided by the 100th Meridian Initiative, the Pacific States Marine Fisheries Commission, and various state agencies.

This document has been prepared by an interdisciplinary team formed within the Region. The plan summarizes the biology of the two species, their potential ecological and economic impacts, methods of introduction or dispersal of the mussels, a ranking of regional projects most at risk of mussel infestation, and a summary of federal and state authorities that can be used to control the mussels. The plan also includes a prevention and response plan that addresses structure, coordination, and responsibilities within the Region; as well as prevention, early detection and monitoring, and control strategies. This plan is expected to be a dynamic document that that is updated regularly to reflect current status of the mussels and control efforts across the region.

1.1 Biology and Mussel Characteristics that Create Risk for Reclamation

Although there are differences in the biology of the zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena rostriformis bugensis*), they share similar life histories and present similar risks to Reclamation and its managing partners. The following sections describe some basic biologic characteristics of the two species and some of their differences that may be important for controlling their spread throughout regional waters. Much of the information in these sections is copied directly from Mills et al. (1996) and Shaw (2004).

1.1.1 Zebra Mussels (*Dreissena polymorpha*)

The zebra mussel is a small bivalve mollusk belonging to the family Dreisennidae. Its name is derived from stripes on its shell. Its life span is three to five years, although some have been reported to live up to 15 years (Ludyanskiy 1993). It rapidly dispersed throughout the Great Lakes and much of the Mississippi River due to its reproductive capability, the fact that larvae are planktonic (microscopic and free floating) and can establish colonies downstream of spawning locations, and because it has the ability to attach itself to boats and other watercraft.

In the western United States, zebra mussel populations were confirmed in Lake Pueblo in Colorado and San Justo Reservoir in California during 2007-2008 (Figure 1). In 2009, zebra mussels were confirmed present in Electric Lake, Utah.

Zebra mussels are dioecious spawners (male and female) and exhibit external fertilization and reach sexual maturity in their first or second year when they are about one cm in length (Ludyanskiy 1993). Optimal conditions for spawning occur when water temperature exceeds 12°C (53.6°F). During one reproductive cycle, an individual female may release over 30,000 eggs, and over an entire spawning season, more than one million eggs (Moser 2002). The resulting larvae have a velum or ciliated swimming organ and are referred to as veliger larvae. The veliger larvae are free-swimming and planktonic and can live in the water column for about five days to three months as long as the water temperature stays from 10 to 25°C (50 to 77°F). However, since veligers are unprotected by a hard shell, this stage of the mussel's life cycle is the most vulnerable to environmental fluctuations and predation (Hincks and Mackie 1997). During this time, water currents or boats can easily transport the veligers from one body of water to another.

Once the zebra mussel larvae settle to the bottom, their survival depends on attachment to a hard or firm substrate (Moser 2002). Byssal threads are secreted from a gland at the base of the mussel's muscular foot to securely attach the mussel to a hard substrate. They are extremely adhesive and make the removal of the mussels from an object very difficult. Because zebra mussels are epifaunal - unlike most other freshwater bivalves - and not overly selective, they will colonize almost any solid, submerged surface such as buoys, water intake pipes, rocks, pier pilings, rooted aquatic plants, boat hulls, and the shells of other mollusks (Claudi and Mackie 1994). They often settle with the younger zebra mussels attaching to the top of older, bigger mussels resulting in large colonies, called druses (Ram et al. 1996). Druses have reached densities as high as 800,000/meter^2 (74,000/ft^2) in North America and 1,700,000/meter^2 (158,000/ft^2) in Europe. A zebra mussel's growth rate depends greatly on water quality and temperature and a single individual can grow at a rate of anywhere from 1.0 to 1.6 centimeter/year (Zebra Mussel Research Program Army Corps of Engineers 1992). A single population of zebra mussels may have an annual production rate as high as 29.8 grams of dry tissue/sq meter/year (Zebra Mussel Research Program Army Corps of Engineers 1992). This production rate is one of the highest among freshwater or marine bivalves.

Zebra mussels tend to be found in temperate freshwater lakes, embayments, rivers, canals, and reservoirs. Primary environmental requirements depend on temperature and water quality, pH levels, calcium concentrations, dissolved oxygen content, turbidity and salinity (Ludyanskiy et al. 1993). Zebra mussels prefer waters where salinity levels are less than 4 parts per thousand (ppt), a summer water temperature range between 17 to 23°C (62.6°F to 73.4°F), pH levels between 7.4 to 9.0, calcium concentration between 20 to 125 parts per million (ppm), turbidity between 40 to 200 nepherometric turbidity units (NTU), and a dissolved oxygen range between 8 to 10 ppm. Secondary environmental requirements include a water velocity of 0.2 to 1.2 meters/second (m/s) (0.66 – 3.9 feet/second) (f/s) and the presence of solid substrate. However, zebra mussels have been found in waters with less than optimal conditions. Zebra mussels are characterized by high genetic plasticity and have been known to adapt to systems with ecological parameters that lie outside their ideal ranges. This may allow the mussels to spread to brackish estuaries where salinity levels are as high as 10 to 14 ppt or to sub-tropical waters where summer temperatures exceed 30°C (86°F). They also can tolerate low levels of food, desiccation, and variable dissolved oxygen levels (Claudi and Mackie 1994). Zebra mussels' most limiting factors are pH and

calcium concentration. Laboratory experiments have shown evidence that a pH as low as 7.4 will sterilize a mussel population and low calcium concentration has a dramatic effect on the mussels' external morphology (Ludyanskiy et al. 1993). The availability of substratum has an effect on zebra mussels' ability to colonize.

Zebra mussels are filter feeders, filtering on average between 1 to 2 liters (0.25 – 0.53 gal) of water per individual per day (O'Neill and MacNeill 1991). They remove large quantities of particulate matter from the water column. Filtered particle sizes are reported to range from 0.4 to 750 micrometers or microns (µm) with reports of up to 1200 µm. Filtered particles are sorted, and either consumed, or rejected (Karatayev et al. 2002). Zebra mussels filter the water for both feeding and respiration (Karatayev et al. 2002). Water is constantly circulated through their siphons and over their gills. Ensuing water currents result from the steady beating of cilia on the gills of the mussels. Particulate matter is continually removed from the water in an unselective fashion. Zebra mussels are selective about what they consume. Unconsumed particles are rejected as mucus-bound psuedofeces, which prevents the particles from being resuspended in the water column.

1.1.2 Quagga Mussels (*Dreissena rostriformis bugensis*) and Environmental Limits

The quagga mussel resembles the zebra mussel, but is rounder with shells that appear asymmetrical when viewed from the front or ventral side. Until recently, quagga mussels in the United States were limited to the Great Lakes region. However, on January 6, 2007, live quagga mussels were found in Lake Mead. Since then, quagga mussels have been found downstream in Lakes Mojave and Havasu and in water bodies associated with the Colorado River Aqueduct and Central Arizona Project. In June 2008 a boat was intercepted at Flaming Gorge reservoir in Utah with *Dreisennia* (presumably quagga mussels). The mussels were dead, but this discovery has led the region to recognize that immediate action must be taken to prevent the introduction and spread of mussels in regional waters. The need for action was reinforced in July 2008 when quagga mussels were documented in Lake Granby, Colorado, which supplies water to both the eastern and western slope of the Colorado Rockies. In September of 2008, veligers were reported in three northeastern Utah waters. In February, 2009, quagga mussels were confirmed as present in Red Fleet Reservoir in northeastern Utah. This rapid distribution and detection of quagga mussels increases the risk that mussels will infest regional waters.

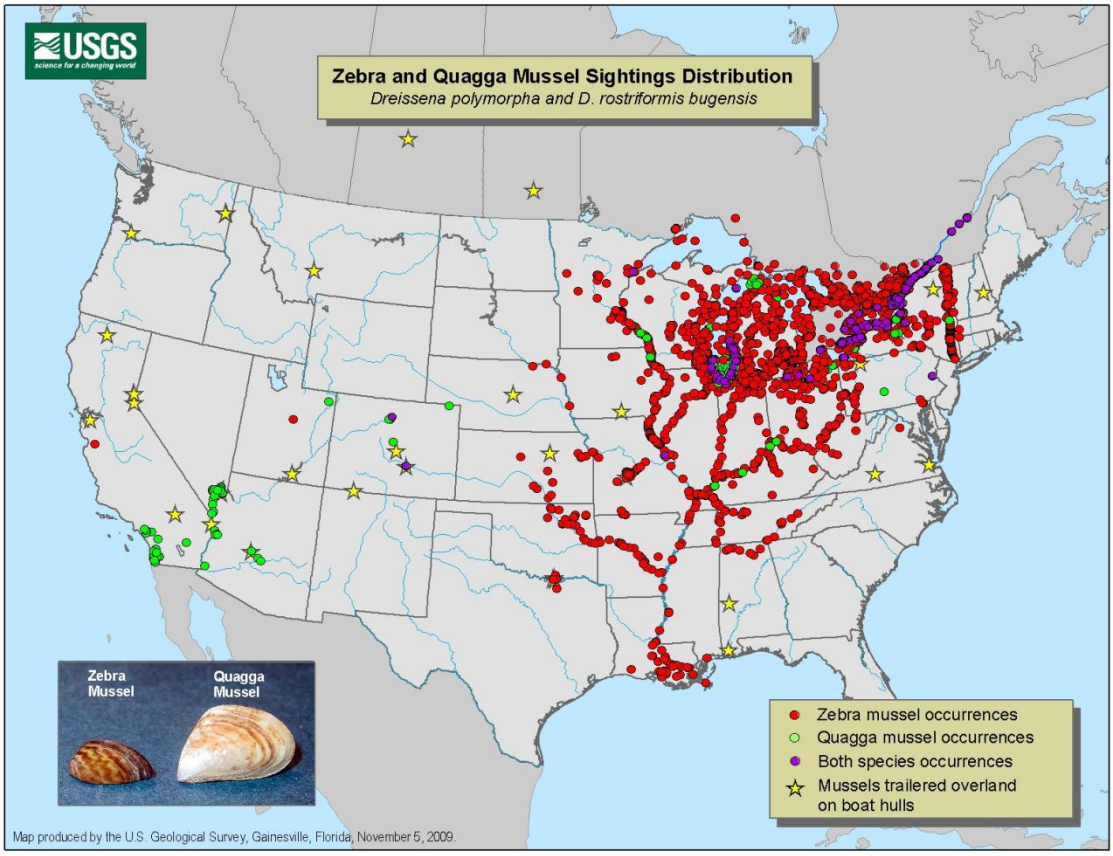


Figure 1. Zebra and quagga mussel distribution in the United States. Courtesy of USGS Aquatic Nuisance Species website.

Quagga and zebra mussels appear to have different tolerance for salinity, temperature, and depth, but Mills et al. (1996) have concluded that the North American *Dreissena* species are highly adaptable. Within a few generations, they have adapted to greater ranges of temperature, salinity, and depth than European *Dreissena*. Nonetheless, there are some differences in tolerances of the species that may be of importance in controlling them. For example, in one laboratory experiment exposure to 1.66 parts per thousand sodium chlorice (ppt NaCl) for one week was shown to be fatal to European zebra mussels, but not to quagga mussels. Experiments with North American *Dreissena* have shown that both species may survive up to 5 ppt NaCl, although survival decreases with warmer temperatures (5 to 20°C; 41 to 68°F). The upper thermal limit on the North American quagga mussel appears to be lower than that of the zebra mussel. The zebra mussel can survive indefinitely at temperatures of 30°C (86°F), while the quagga mussel shows rapid mortality at this temperature. Experiments have shown that even though most quaggas die at lower temperatures than kill zebra mussels, a few exceptional quagga may be as tolerant of elevated temperatures as zebra mussels (Mills et al. 1996).

The depths at which both quagga and zebra mussels have been observed in Lake Ontario (Mills et al. 1999) are among the deepest ever recorded for the genus. Of the two species, quagga mussels are more abundant in deep waters than zebra mussel. Quagga mussels also appear to tolerate a wider range of depths than zebra mussels. These differences in depth distributions may be due to thermal stress in the quagga mussel above certain depths.

In the Great Lakes, the Dreissena species have been found on all types of hard substrata. Quagga colonize on soft substratum in water depths exceeding 40 m (131 ft) and sand and sandy silt between 10 and 30 m (32 – 98 ft) (Mills et al. 1999). The only substrates in the Great Lakes devoid of the *Dreissena* species are areas where periodic anoxia occurred (Mills et al. 1999).

1.1.3 Economic Impacts Caused by *Dreissena* Mussels

The potential cost of *Dreissena* mussels infesting western waters might be in the billions of dollars. These costs are largely due to biofouling (Marsden 1992, Moser 2002), or the deposition of mussel colonies on submerged substrates or structures. Observations of the mussel colonies in the Great Lakes indicate the biofouling usually occurs on structures or equipment submerged below 1.2 meters (4 ft) depth (Claudi and Mackie 1994). Water intake pipes and structures are particularly susceptible to fouling.

In the Great Lakes, the greatest costs of Dreissenid biofouling have been to hydroelectric plants that have had to be shut down and retrofitted. Ontario Hydro is spending around $376,000 per year per generating station to control Dreissenids on the Canadian side of the Great Lakes. Congressional researchers (New York Sea Grant 1994) have estimated that between 1993 and 1999 industries, businesses and communities have spent over $5 billion to control zebra mussels around the Great Lakes. The estimated annual cost of controlling zebra mussels in the Great Lakes now range from $100 to $400 million, according to NOAA Great Lakes Environmental Research Laboratory Director Dr. Stephen Brandt.

In the Columbia River basin, which has not yet been infested, Bonneville Power Administration commissioned a study (Phillips et al. 2005) of economic costs they might expect should Dreissenids invade their facilities. They estimate the costs for installing sodium hypochlorite systems and applying antifouling paint at $1.8 million per hydropower dam (Phillips et al. 2005). Personal communication from Leonard Willett at Lake Mead is that coatings cost about $1050 per megawatt (mW), with an addition $50 per mW operational costs.

O'Neil (1997) noted that dams or diversion structures that do not generate hydropower are also susceptible to costs. Submerged structures will incur maintenance costs due to mussel fouling. O'Neil (1997) reported costs of $1,700 per structure for dealing with biofouling of dams and other submerged structures.

In addition to economic impacts to hydropower facilities and dams, *Dreissena* mussels will adversely impact recreation and the tourism industry. Boats and recreational watercraft may become infested, as well as buoys, ropes, piers, and docks. *Dreissena* mussels also adversely affect recreation by littering beaches and swimming areas with dead sharp shells and with the associated impact of the air becoming filled with the stench of decaying mussels (Ludyanskiy et al. 1993). O'Neill's (1997) estimates were at least $750 per facility for marina costs to deal with mussel fouling.

Additional socioeconomic impacts occur to sport fisheries (Ludyanskiy et al. 1993; Shaw 2004). Impacts to sport fisheries are due to combinations of environmental and economic impacts because the entire benthic-pelagic energy balance may become altered due to reduced algal and detrital availability, increases in the number of benthic species, biodeposition of nutrients, and reductions in biomass along with the shift in zooplankton and fish production. In addition Vilaplana et al. (1994) found a four percent decrease in boater recreation due to mussel introduction.

The region has yet to study the costs of *Dreissena* prevention and control, but one purpose of this plan is to raise awareness among all regional staff, particularly individual facility managers, that the costs could be great. This plan is designed to enable managers and staff to program the appropriate levels of budget to prevent *Dreissena* from infesting their facilities and projects.

1.1.4 Environmental Implications of *Dreissena* Mussel Functioning

A host of environmental problems are associated with invasion by *Dreissena*. Among the most significant environmental problems for the region are the threats that *Dreissena* pose to endangered fish and other aquatic species in Reclamation reservoirs or in downstream rivers. Environmental problems created by *Dreissena* mussels are due largely to their efficiency as water filterers. They filter one to two liters (.26 - .53 gal) of water per day per individual and remove a significant amount of particles from the water column (O'Neill and MacNeill 1991). This efficient filtering behavior increases water clarity because large amounts of both plankton and inorganic particulates are removed. Enhanced water clarity increases the total lake volume available for photosynthesis, extending the depth of the photic zone, thus augmenting primary productivity of submerged plants. *Dreissena* mussels' filtration activity increases deposition of organic and inorganic matter in the water body, altering the benthic taxonomic assemblage, trophic structure, and biomass. The mollusks' subsequent psuedofeces and feces production increases the sedimentation of suspended matter - resulting in reduced levels of phytoplankton and increased numbers of benthic species that feed on the deposited organic matter (Karatayev et al. 2002). In this way, the mussels create benthic-pelagic coupling by building a direct connection between the plankton and the benthos. Although the number of deposit feeders greatly increases after zebra mussel introduction, zebra mussels end up dominating the benthos in terms of biomass, which can reach 10 to 50 times more than the total mass of all other benthic invertebrates combined (Karatayev et al. 2002). They also out-compete the native filter feeders, reducing the population of native species. *Dreissena* mussels are a biofouling organism and have been found encrusting other benthic organisms such as native mussels and crayfish. This dramatic shift in the benthic community only occurs where there are druses or large colonies of *Dreissena* mussels.

Dreissena mussels also have dramatic effects on interspecies interactions (Karatayev et al. 2002). Because they consume phytoplankton, they compete with zooplankton for microalgal foods. As indicated above, *Dreissena* mussels compete with native filter feeders for plankton. In addition, there is evidence that mussels compete with fish for benthic space by encrusting and covering fish spawning and nursery habitat. Planktivorous fish abundance (including larval fish of many species) will most likely be negatively affected since the zebra mussels tend to decrease the abundance of zooplankton.

1.1.5 Environmental Impacts Caused by Dreissena Mussel Structure

Dreissena mussels possess hard, calcium carbonate shells. The colonies of sessile animals create three-dimensional structures that provide habitat for a variety of species that would otherwise not be common in the water body. *Dreissena* mussel shells do not decompose quickly, they collect on the bottom of water bodies, forming reef-like structures. These structures provide additional surface area for organisms (including additional mussels) to live under and attach to, transforming the bottom habitat from soft sediment to hard substrate (Karatayev et al. 2002).

1.1.6 Pathways or Methods of Dispersal of *Dreissena*

Natural pathways for *Dreissena* mussel dispersal within an infested watershed occur as veligers are passively transported from colonized lakes or reservoirs through connected outflowing streams (Horvath et al. 1996; Schneider et al. 1996). This natural dispersal allows mussels to colonize all downstream waters directly connected with the outflowing water. Little can be done to control such natural dispersal once mussels are in a watershed. This natural pathway means projects located in headwaters of the region's rivers and streams should be prioritized for preventive measures and control.

Diversions, canals and water delivery systems are another significant pathway for moving mussels within the region. Movement would be similar to that in a natural stream, moving mussels or veligers with the flow of water. This could allow for cross contamination from an infested water to an uncontaminated water, even one outside of the water basin of the originally contaminated source.

This human induced dispersal of mussels is controllable, so this plan focuses on preventing human caused dispersal, particularly transportation pathways. Following the National Invasive Species Council, transportation pathways of concern with *Dreissena* mussels include air transport via seaplanes; water or aquatic transportation via boats and other types of aquatic vessels or vehicles or equipment; and land transportation, including all methods or media that might result in the movement of mussels across the ground.

A key land transportation pathway of concern to the region is terrestrial transportation of boats or other vessels such as personal watercraft or construction equipment that have been immersed in infested waters. The ability of Dreisennids to resist desiccation further increases risk of their dispersal via these mechanisms. If a boat or watercraft has been in an infested body of water, mussels may be attached the bottom of the vessel, in intake pipes for the engines, veligers or eggs may be present in bilges, bait buckets, or live wells; and adults, veligers, and eggs may be present on any wet surface. Once the vessel is transported to an uninfected body of water, the mussels may migrate off the vessel and reproduce, thereby infecting the new water body.

Mussels may also attach to aquatic plants. If plants from infested waters are transported among water bodies, it is likely that mussels are transported as well. Unintentional transport includes aquatic plants infested with mussels where the plants are attached to trailers, boats, anchors or lines, in bait buckets, or other fishing gear.

1.2 Ranking Regional At-risk Projects

Given Reclamation's mission of delivering power and water, the region considers all projects that store or deliver water or generate hydropower at risk of environmental or economic impacts from mussel invasion. The region encourages all managers to evaluate their submerged structures, systems, or facilities for risk of infestation and to begin preparations for *Dreissena* control.

The Region has developed a preliminary risk assessment by project based on the proximity of each project to infested waters and visitation and the potential economic risk to hydropower generation capacity (kilowatts). Data behind the risk analyses are presented in Appendix A. Table 1 presents the rank-order of hydropower projects at risk, with the Glen Canyon Unit of the Colorado River Storage Project at the highest risk rank. Table 2 ranks Regional waters for potential mussel introduction. Each project manager is encouraged to perform a facility and system-specific risk assessment to determine its risk and plan accordingly. This risk assessment will be updated as information changes, but this represents the ranking by which the region will focus its immediate prevention and control efforts.

Table 1. Risk ranking of regional hydropower producting projects by capacity.

Risk Rank	ProjectName	Area Office	State	Facility at Risk from Dreissenids	Capacity kW
1	Glen Canyon Unit	UCPO	AZ, UT	Glen Canyon Dam and Reservoir, Power Facility	1,320,000
2	Aspinall (Curecanti) Unit	UCPO, WCAG	CO	Blue Mesa Dam and Reservoir, Crystal Dam and Reservoir, Morrow Point Dam and Reservoir, Morrow Point Pump House	291,234
3	Flaming Gorge Unit	UCPO	UT	Flaming Gorge Dam and Reservoir, Power Facility	151,490
4	Navajo Unit	WCAG	NM	Navajo Dam and Reservoir	30,000
5	Rio Grande	ABAO	NM	Caballo Dam and Reservoir, Elephant Butte Dam and Reservoir, Elephant Butte Power Facility, Leasburg Diversion Dam, Mesilla Diversion Dam, Percha Diversion Dam, Picacho North and South Dams, Riverside Dam	27,900
6	Collbran	WCAG	CO	Upper and Lower Molina Power Facility, Cottonwood Pipeline, East Fork Feed Canal, East Fork Diversion Dam, Atkinson Reservoir, Bonham Reservoir, Cottonwood Reservoir, Kitson Reservoir, Little Meadows, Neversweat	13,500
7	CUP, Bonneville Unit	PRO	UT	Jordanelle Dam and Reservoir, Currant Creek Dam, Docs Diversion Dam, Jordanelle Dam, Knight Diversion Dam, Layout Creek Diversion Dam, Lost Lake Dam, North Bottle Hollow Dam, Rhodes Diversion Dam, Soldier Creek Dam, South Bottle Hollow Dam, Starvation Dam and Reservoir, Upper Stillwater Dam, Vat Diversion Dam, Washington Dam, Water Hollow Diversion Dam, Win Diversion Dam	13,000

8	Dolores	WCAG	CO	McPhee Dam and Reservoir, McPhee Powerplant, Great Cut Dike, Towaoc Canal, Dawson Draw	12,778
9	Seedskadee Unit	UCPO	WY	Fontenelle Dam and Reservoir, Fontenelle Power Facility	10,000
10	Weber Basin	PRAO	UT	AV Watkins Dam and Reservoir, Causey Dam, Willard Canal and Pumping Plants, Layton Canal, Pinewview Dam and Reservoir, Pumping Plant, East Canyon Dam, Lost Creek Dam, Slaterville Diversion Dam, Stoddard Diversion Dam, Wanship Dam, multiple small dams. Gateway Canal, Wanship Powerplant, Causey Powerplant	8,650
11	Middle Rio Grande	ABAO	NM	El Vado Dam and Powerplant, Low Flow Conveyance Channel	8,000
12	Pine River	WCAG	CO	Vallecito Dam and Reservoir, Vallecito Powerplant	5,844
13	Provo River	PRAO	UT	Deer Creek Power Plant, Deer Creek Dam and Reservoir, Duchesne Diversion Dam, Murdock Diversion Dam, Weber-Provo Diversion Dam	4,950
14	Weber River	PRAO	UT	Echo Dam and Reservoir, Echo Powerplant	4,500
15	Strawberry Valley	PRAO	UT	Indian Creek Crossing Diversion Dam, Spanish Fork Diversion Dam, Strawberry Dam and Reservoir, Strawberry Valley Diversion Dam	4,150
16	Grand Valley	WCAG	CO	Grand Valley Diversion Dam, Government Highline Canal (Palisade, CO)	3,000
17	Grand Valley	WCAG	CO	Government Highline Canal Fish Screen	3,000
18	Ogden River	PRAO	UT	Pineview Dam	1,800
19	Mancos	WCAG	CO	Jackson Gulch Dam and Reservoir, and Inlet Canal	260
20	Florida Unit, CRSP	WCAG	CO	Lemon Dam and Reservoir, Lemon Powerplant, Florida Farmers Diverison Dam	120

Table 2. Ranking of regional waters for likely introduction of Dreissenids

Risk Rank	ProjectName	Capacity kW	Minimum Distance (mi)	Latest available visitation numbers
1	Red Fleet	0	0	37,826
2	Lake Powell	1320000	299	1,921,691
3	Flaming Gorge	151490	32	1,500,001
4	Elephant Butte	27900	497	1,215,558
5	Blue Mesa	86400	186	1,007,440
6	Navajo	30000	292	855,412
7	Strawberry	3750	86	504,940
8	Pineview	1800	150	400,001
9	Deer Creek	4950	82	347,083
10	Ridgway	0	241	332,433
11	Willard Bay	0	159	311,758
12	Jordanelle	13000	110	202,134
13	Wanship (Rockport)	1950	128	196,970
14	Caballo	0	525	192,617
15	Rifle Gap	0	152	175,332

16	Echo	4500	144	152,929
17	Scofield	0	19	97,135
18	Huntington North	0	10	45,311
19	Steinaker	0	12	55,666
20	Vega	0	188	125,750
21	Crawford	0	225	124,885
22	Heron	0	238	118,798
23	McMillan	0	470	118,798
24	Causey	2200	169	112,256
25	East Canyon	0	143	109,446
26	Joes Valley	0	51	85,001
27	Hyrum	0	190	68,472
28	Starvation	0	73	59,932
29	Brantley	0	478	71,537
30	EL Vado	8000	240	45,372
31	Sumner	0	336	44,670
32	Jackson Gulch	260	315	38,733
33	Nambe Falls	0	305	32,345
34	Moon Lake	0	84	14,801
35	Paonia	0	222	21,693
36	Lost Creek	0	144	19,001
37	Currant Creek	0	102	10,001
38	Midview	0	60	
39	Stateline	0	97	6,001
40	Taylor Park	0	183	10,000
41	Upper Stillwater	0	98	5,001
42	Big Sandy	0	151	8,001
43	Lemon	120	275	7,325
44	Fontenelle	10000	155	4,201
45	Newton	0	206	5,001
46	Meeks Cabin	0	184	2,501
47	Avalon	0	485	5,000
48	Fruitgrowers	0	144	
49	Eden Lake	0	150	
50	Morrow Point	173,334	184	0
51	Crystal	31500	185	0
52	Bonham	0	190	
53	Kitson	0	190	
54	Platoro	0	194	
55	Silver Jack	0	216	
56	Vallecito	5844	279	860
57	Ridges Basin	0	284	
58	McPhee	1283	330	
59	Great Cut Dike	0	330	
60	Leasburg Diversion Dam			87,734
61	Percha Diversion Dam			44,945

Ranking based on 1/distance to infested water * 1000 + visitation numbers / 1000

1.3 Federal Legal Authorities

Control of Dreissenid mussels is an operation and maintenance activity which is authorized under project-specific laws and under Reclamation law. The federal law giving Reclamation authority to take action (and prepare this plan) is the National Aquatic Invasive Species Act of 2005 (NAISA). The NAISA reauthorized and amended the prior Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, and the National Invasive Species Act of 1996 (PL 104-332) (NISA).

While it has been replaced by NAISA, the NISA is important to this plan because it authorized the Corps of Engineers to develop a program of research and technology to control zebra mussels in and around public facilities and to make available information on control methods. Much of the information on control developed under NISA is incorporated in this plan. It is also important to note that NISA established a federal interagency Aquatic Nuisance Species Task Force (ANSTF), co-chaired by the United State's Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA). This task force coordinated federal efforts related to aquatic nuisance species (ANS) in the United States.

The NISA and the prior Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 were both reauthorized and amended by the National Aquatic Invasive Species Act of 2005 (NAISA). The control of *Dreissena* mussels is authorized by NAISA. Important authorizations under this law are the directives to states to develop Aquatic Nuisance Species Management Plans. The NISA provides the opportunity for federal cost–share support for a plan's implementation once it has been approved.

It is important to review what actions the NAISA authorizes and how these actions and authorities relate to Reclamation. Section 301 of NAISA authorized the National Invasive Species Council to develop sampling protocols to support a national system of ecological surveys for rapid detection of aquatic invasive species. This national system was designed to establish communication protocols and help identify pathways distributing aquatic invasive species. Nation-wide protocols have not been developed as of 2009.

Section 302 established a rapid response fund to provide grants to states to implement approved rapid response contingency strategies. This plan was copied from several of these model plans.

Section 304 authorized the Environmental Protection Agency (EPA) to promulgate regulations to evaluate treatment methods to ensure no adverse effects on human health, public safety, or the environment resulting from their use. The EPA was directed to publish lists of approved treatment methods.

Section 306 expanded educational programs of the National Park Service and others to address the spread of aquatic invasive species by recreational boats.

The only other federal laws relating to prevention or control of *Dreissena* are summarized here. In the early 1990s, USFWS amended its regulations to include the zebra mussel. The importation of live zebra mussels, veligers or viable eggs into the United States, or transportation between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any territory or possession of the United States by any

means is prohibited except by permit for zoological, educational, medical or scientific purposes. This prohibition includes any live species of the genus *Dreissena*. Under the amended regulation, viable eggs or progeny may not be sold, donated, traded, loaned, or transferred to any other person unless USFWS issues a permit.

Finally, the Federal Insecticide, Fungicide, and Rodenticide Act of 1947, as amended, (7 USC §136 et seq.) gives EPA authority to regulate pesticides, and more importantly to Reclamation, calls upon federal agencies to combine the use of biological, cultural, physical, and chemical tools to control pests in a way that minimizes economic, health, and environmental risks. The Department of the Interior's pest management policy (517 DM 1) reinforces the requirement to use integrated pest management in management of aquatic invasive species including *Dreissena*.

1.4 State Legal Authorities and Contacts

Laws and authorities for controlling mussels and other aquatic nuisance species vary from state to state across the region. The region is concerned with how it cooperates and communicates with state partners in Arizona, Colorado, New Mexico, Texas, Utah and Wyoming. The current state laws and authorities are summarized here and the contact persons identified.

Arizona. State law R12-4-406 restricts transportation of certain wildlife and specifically lists the zebra and quagga mussels as restricted. Also, ARS 17-309 makes it illegal to transport wildlife in the state except as permitted by statute. Arizona has placed signs along the Colorado River to warn boaters of aquatic nuisance species. Arizona has also formed an invasive species advisory council. Arizona has an ANS website at http://ag.arizona.edu/azaqua/extension/ANS/ANS.htm. The Arizona Game and Fish Department's statewide ANS contact is Tom McMahon (623-236-7271).

Colorado. In 2008, Colorado passed a law (ANS Act; SB08-226) prohibiting possession, importation, transportation, release of any aquatic nuisance species, including *Dreissena* mussels. The law allows authorities (Colorado Division of Parks and Outdoor Recreation) to inspect vehicles, boats, and trailers if they have a reasonable belief such species are present. The division is developing regulations and establishing decontamination procedures, as well as identifying which waters of the state are infested with aquatic nuisance species. The USFWS aquatic nuisance species coordinator for Colorado (and all the Mountain-Prairie Region, Region 6) is Ms. Tina Proctor, US FWS in Denver (303) 236-4515, email: bettina_proctor@fws.gov. The state of Colorado ANS contact is Ms. Elizabeth Brown, Colorado Division of Wildlife (303) 291-7362; email: elizabeth.brown@state.co.us.

New Mexico. In 2009, New Mexico passed the ANS Act (HB 467) which provides the authority for the control and prevention of the spread of aquatic invasive species in New Mexico. The USFWS aquatic nuisance species coordinator for New Mexico (and all of the Southwest Region, Region 2) is Mr. Robert Pitman at (505) 248-6471; email: bob_pitman@fws.gov. The state ANS contact is Ms. Barbara Coulter of the New Mexico Department of Game and Fish (505) 476-8188 x 8047; email: barbaraj.coulter@state.nm.us.

Texas. In Texas, the USFWS aquatic nuisance species coordinator is the assistant coordinator for the Southwest Region. The coordinator is Mr. David Britton, (817) 272-3714; email: david_britton@fws.gov. The state ANS contact is Mr. Earl Chilton of the Texas Parks and Wildlife Department (512) 389-4652; email: earl.chilton@tpwd.state.tx.us. An additional mollusk contact within Texas is Ms. Brenda Bowling of the Texas Parks and Wildlife Department (281) 534-0104; email: Brenda.Bowling@tpwd.state.tx.us.

Utah. The state of Utah passed the Aquatic Invasive Species Interdiction Act in 2008. Utah R657-3-22.q "Rules for Invertebrates" prohibits the importation, and possession of all Dreisennidae. The act authorized the Utah Division of Wildlife Resources (UDWR) to stop, detain, and inspect any vessel or vehicle that might contain *Dreissena* mussels. It allows UDWR to inspect or close any water supply system, water body, or facility if *Dreissena* mussels are present. It requires all water supply systems to implement a response plan if infested. It requires all persons to report the presence or suspected presence of *Dreissena* mussels to UDWR For the further details on this law, associated penalties, or to report mussels, contact Mr. Larry Dalton, Utah's ANS Coordinator; (801) 652-2465; email: larrydalton@utah.gov. Additional Utah contacts are Mr. Walt Donaldson at UDWR who oversees the Utah ANS program, email: waltdonaldson@utah.gov. For ANS enforcement in Utah contact Captain John Pratt, email: johnpratt@utah.gov. For education and media coverage of quagga or zebra mussels in Utah contact Mr. Dean Mitchell; email: deammitchell@utah.gov.

Wyoming. Yellowstone National Park has already been invaded by the New Zealand mud snail and preventing further infestations is a state priority. Wyoming has not yet listed *Dreissena* as pests of concern, although the giant African snail is a listed mollusk pest. The state weed and pest coordinator is Mr. Slade Franklin at Wyoming Department of Agriculture; (307) 777-6585. Mr. Paul Day at Wyoming Game and Fish Department is the aquatic habitat program manager; (307) 777-4505.

2 Regional Prevention and Response Plan

2.1 Goal

The goal of this plan is to keep *Dreissena* mussels out of regional projects, or if and when found, to control their spread and impact. It focuses on prevention, but also includes early detection, monitoring, and various methods of control. The UC Region is concentrating on proactive measures to help reduce the post-introduction spread and impacts of the mussels to Reclamation facilities and structures, thereby lessening the need for time-consuming and most costly measures of eradication. For purposes of this plan, "control" is defined differently than in Executive Order 13112 which includes prevention with control. Given our goal of preventing the spread of Dreissenid mussels, we restrict “control” to eradicating, suppressing, reducing, or managing invasive species populations once they are present in a water body, as well as taking steps to restore native species and habitats to reduce the adverse effects of invasive species once they are present.

As mussels become more common in the region and as they invade regional projects, project or facility specific plans are encouraged, particularly for the high risk projects in Table 1. The region consists of 69 congressionally authorized projects with 44 of them at risk of mussel invasion. Again, risk assessments in Table 1, 2 and Appendix A are based on hydropower production, annual visitation and proximity to infested waters. As of August 2008, *Dreissena* mussels have been found in Lake Mead, NV; Lake Granby, CO; and Lake Pueblo, CO, and boats infested with live and dead mussels have been documented and interdicted at Lake Powell, Flaming Gorge and Navajo Reservoirs. In Nov 2008, zebra mussels were confirmed in Electric Lake, UT in the San Rafael Drainage and in Feb 2009 quagga mussels were confirmed in Red Fleet Reservoir, near Vernal UT. In 2008 suspected (inconclusive lab analysis) waters in UT included Huntington North, Joe's Valley, Pelican Lake and Midview reservoir. Without vigorous preventative action, live *Dreissena* mussels will be introduced in other regional waters and will rapidly spread, causing adverse economic and ecological impacts.

The primary prevention strategies outlined in the following sections of this plan are outreach; inspection of boats and trailers; and with the assistance of managing partners, decontamination or quarantine of boats and trailers leaving or traveling from contaminated waters. Outreach consists of educating anglers and boaters (including the public and staff) on ways to prevent human caused dispersal. The region, working with partners, will also support efforts to inspect and prevent contaminated watercraft from entering uncontaminated regional waters. This requires the legal authorities for quarantine, funds for installing decontamination systems, and staff to manage such systems. The plan outlines how to conduct these actions and also outlines procedures for communication and coordination with managing partners.

2.2 Structure, Coordination, and Responsibilities

Needs: Following the recent discovery of both live and dead mussel-infested boats at Lake Powell, Flaming Gorge and Navajo Reservoirs and infestations of Lake Mead and Lake Granby (Big Thompson Project waters) and confirmed identification at Red Fleet Reservoir and Electric Lake, the regional leadership team has identified a need for better coordination internally, as well as externally with other federal, state, and local agencies and stakeholders regarding the mussel.

2.2.1 Objective 1: Assemble a regional interdisciplinary team.

Given the diverse knowledge and skills that will be necessary to prevent and control mussels, an interdisciplinary approach is needed.

Actions and Responsibilities:

The regional director and area managers will:

- Commit to taking actions to prevent the spread of Dreissenid mussels in regional waters and to control mussels.
- Identify possible candidates for the interdisciplinary team regional Dreissenid rapid response team. Coordinate appointment of staff members to serve on the rapid response team (henceforth the team). The team shall have members representing functions

including public affairs, environmental resources, recreation, and at least one staff member from each area office (Albuquerque, Power, Provo, Western Colorado).

- Appoint one designated regional Dreissenid mussel coordinator. The coordinator shall serve as chairperson for the response team and the regional point of contact for external communication and coordination. The coordinator shall also be responsible for funding requests and tracking the budget on mussel expenditures.

- Seek funding and coordinate funding requests with the Budget Review Committee (BRC) and other regional directors and area managers. Note that in fiscal year 2010 there is funding in the budget as recommended by the BRC.

- Ensure that individual high-risk projects begin taking the appropriate prevention and control actions through facility assessments.

The Dreissenid rapid response team shall:

- Establish team roles and responsibilities. Hold an initial organizational meeting so that everyone understands how they contribute to the goal.

- Prepare a rapid response plan and take appropriate control actions.

- Provide technical assistance regarding the plan to facility and project managers.

- Encourage area offices that have projects with highest risk rank (Table 1, Appendix A) to begin to develop their own project-specific prevention programs and response plans.

- Report at least quarterly to a designated top manager (in this case, to one of the assistant regional directors).

- Prepare and coordinate funding requests for fiscal year 2011 forward. Ensure appropriate work team receives requests and will support them. Educate the work teams and the Budget Review Committee on the importance of prevention and control work.

- Update this plan as necessary.

2.2.2 Objective 2: Coordinate and communicate with partners.

Implementation of this plan will require substantial cooperation and coordination within the region, as well as with external partners from other federal, state, tribal, and local agencies; water and irrigation districts; recreation management partners; and experts on mussel biology, taxonomy, and control. Regional and area office staff will need to work cooperatively with partners to prevent the spread of the mussels throughout regional waters and the western United States.

Actions and Responsibilities:

The team will:

- Identify managing partners at regional projects with interests in mussel control. Correlate in Appendix A with related projects.

- Identify all related partners in efforts to prevent and otherwise control mussels. Include in this identification a listing of all relevant state aquatic nuisance species (ANS) coordinators and obtain copies of their management and response plans. Review existing response plans from ANS coordinators and other organizations within the region. Maintain these communication links with partners.

- Coordinate mussel prevention and control with all appropriate federal, state, tribal, and local organizations (including ANS coordinators) by attending meetings, workshops, phone calls, etc.

- Communicate with partners regarding Reclamation's efforts to prevent the spread of mussels and control them. Communicate a consistent and accurate message. Work with Public Affairs and partners to develop messages and the best way to communicate it.

Contingent upon appropriation and authorities, provide funds or cost sharing opportunities with all appropriate managing partners to implement this plan.

- Work with public affairs staff to create a link to the Reclamation wide mussel webpage. Information should be quickly updated as information changes. The website should include at a minimum:

    - General introduction to mussels and their impacts.
    - The Reclamation regional response plan
    - Photographs showing how mussels encrust and obscure dams, hydropower plants, or other facilities.
    - Map of mussel infestations in region, updated as necessary or linked to USGS's map. The chairman of the regional response team shall be responsible for reporting data on the sites and dates of confirmed mussel sightings, introductions, and established populations to the USGS and partners.
    - Links to each state's laws and information on mussels.
    - Links to additional sources of current, scientifically accurate information, i.e. 100th Meridian Initiative, U.S. Army Corps of Engineers (COE) Zebra Mussel Information System, and the ANS Task Force's "Protect your Waters Campaign."
    - The webpage should have a link enabling individuals to report a mussel sighting to the region and USGS

- Various State ANS coordinators and other partners have already produced excellent educational materials (billboards, brochures, permits, etc.) to try and educate the public about the risks of aquatic invasive species and how to prevent the spread of invasives, particularly Dreissenids. Collect and examine such material for distribution within the region. As appropriate, copy or modify extant material for regional distribution (check on copyrights). Distribute educational material. Send a consistent message about prevention. Brochures or cards should be distributed to marinas, boat launches, bait and tackle shops, and to volunteers and participating families in events that Reclamation sponsors or participates in such as CAST for Kids, water fairs, Earth Day activities,

and so forth. While all projects should receive such material, follow the risk ranks in Table 1 unless funds permit wider dissemination.

- Post this plan on the region's website when it is approved by the regional director. Update as necessary.

2.2.3 Objective 3: Educate regional staff.

Needs: It is important that top managers make it clear to their employees that they consider mussel control important and worthwhile, and that employees they supervise (especially those on the team), are encouraged to work on mussel control. For those managers who may be unfamiliar with the risks involved with Dreissenids, educate them via this plan and with educational material.

Actions and Responsibilities:

The regional director and area managers and supervisors will:

- Encourage their staff to obtain the 100th Meridian Initiative online training certificate for preventing the spread of aquatic nuisance species.

- Ensure that all employees are informed of their role in preventing mussel and aquatic nuisance species spread.

The team shall:

- Provide a hard-copy of this plan to top managers and all of the team's supervisors. Inform them of prevention strategies, rapid response initiatives, and make sure they know their team representative. Remind managers of the actions that must be taken for prevention and control at meetings such as the regional leadership team meetings. Keep managers updated.

- Increase awareness among regional staff. Have public affairs design and post bulletin boards about mussel prevention throughout the region. Each area office should present mussel awareness trainings, with specific activities targeted to different segments of the staff. This could be a one-time event, or a series of events. While the regional projects ranked the highest risk in Table 1 should be the focus of activities (and funding) at first, eventually (and as rapidly as possible), all regional projects should have information disseminated about prevention of mussel introduction or control.

2.3 Prevention

Needs: Preventing introductions of Dreissenid mussels is critical to maintaining the health of the region's aquatic ecosystems and of maintaining a reasonable budget for ongoing project operations. At this time, prevention is the focus of the region's activities and outreach, inspection and decontamination of boat or other water craft are the main strategies. The region needs to work with managing partners (water and irrigation districts, recreation partners, concessionaires, federal, state, and tribal agencies) to raise awareness and share information about the mussel's ecological and economic impacts, to help limit their spread, and to plan for rapid response. The region also needs to identify its legal authorities, those of managing partners, and limitations available for prevention activities.

Specific preventative objectives and actions are listed below. Ultimately, prevention is dependant on the awareness and honesty of boat operators.

2.3.1 Objective 1: Educate target audiences to prevent introductions.

Actions and Responsibilities:

The team, working with partners, will:

- Identify external target audiences including media outlets (newspapers, television, radio, internet), congressional offices and committees, water and power customers, federal agencies, state agencies, local agencies, recreational users of Reclamation projects, and commercial transporters of boats and watercraft. Fishing and boating organizations should be primary target audiences given the pathways discussed in this plan.

- Locate existing educational media (such as posters, pamphlets, brochures, billboards, stickers, cards). If necessary edit media for regional use and immediately distribute them to targeted audiences at high-risk projects. Eventually distribute to all projects.

- Encourage boaters to use the "clean, drain and dry" for mussel prevention / control in regional waters.

- Coordinate with partners to distribute educational materials to high-risk projects. Locate visual material at marinas, boat ramps, and entrances to high-risk projects.

- Encourage all states within the region to mail out mussel identification cards, self-certification forms, or other awareness materials with boater registration and fishing licenses to try and raise awareness and prevent introductions of mussels.

Public Affairs division shall:

- Work with the team to ensure the appropriateness of the educational material available via partners. If necessary, edit or redesign region-specific educational information that shall be distributed at high-risk projects initially, and eventually to all projects. Work with team to distribute and disseminate information.

- Design and distribute mussel prevention bulletin boards for the regional and area offices.

- Distribute preventative materials to recreation areas or gateway communities associated with Reclamation projects.

The team members should contact the Acquisitions Department and encourage all contracting officers or grant officers and their representatives to:

- Include requirements to take preventive actions or otherwise control mussels in pertinent contracts, cooperative agreements, grants, etc. In particular, contracts or agreements with fish hatcheries should be modified to include requirements for mussel prevention and control.

2.3.2 Objective 2: Inspect and screen watercraft entering regional waters.

Preventing at-risk water craft or boats from launching is one of the best preventative actions the region can take. However, given limited legal authority and few trained staff located at launch ramps and along reservoir shorelines, this is a difficult objective to achieve.

Actions and Responsibilities:

To the extent there is legal authority, available personnel, and funding, managing partners at boat launch ramps and visitor centers, or other facilities will:

- Ask questions of boat owners to determine if a watercraft has been in infested waters and poses a risk for harboring mussels. It is important to determine if sufficient drying time has elapsed from when a boat or watercraft was in infested waters and from the day the at-risk watercraft desires to launch. Ensuring sufficient time has elapsed for the mussels to be dead is a key preventative strategy.

  Observe the boat to see if there are any signs of mussels; attached shells, byssal threads, rough surface on hull, boat registration from states with mussel infested waters, etc.

- If the watercraft poses no threat, allow it to launch. If it poses a threat, try and prevent the launch. See Objective 3.

The Team shall:

- If not already made available by the managing partners provide mussel-free certificates to display on watercraft while they are in regional waters. (The UDWR has such certificates available for copying and distribution.). Distribute such stickers or cards to regional reservoirs and recreation areas.

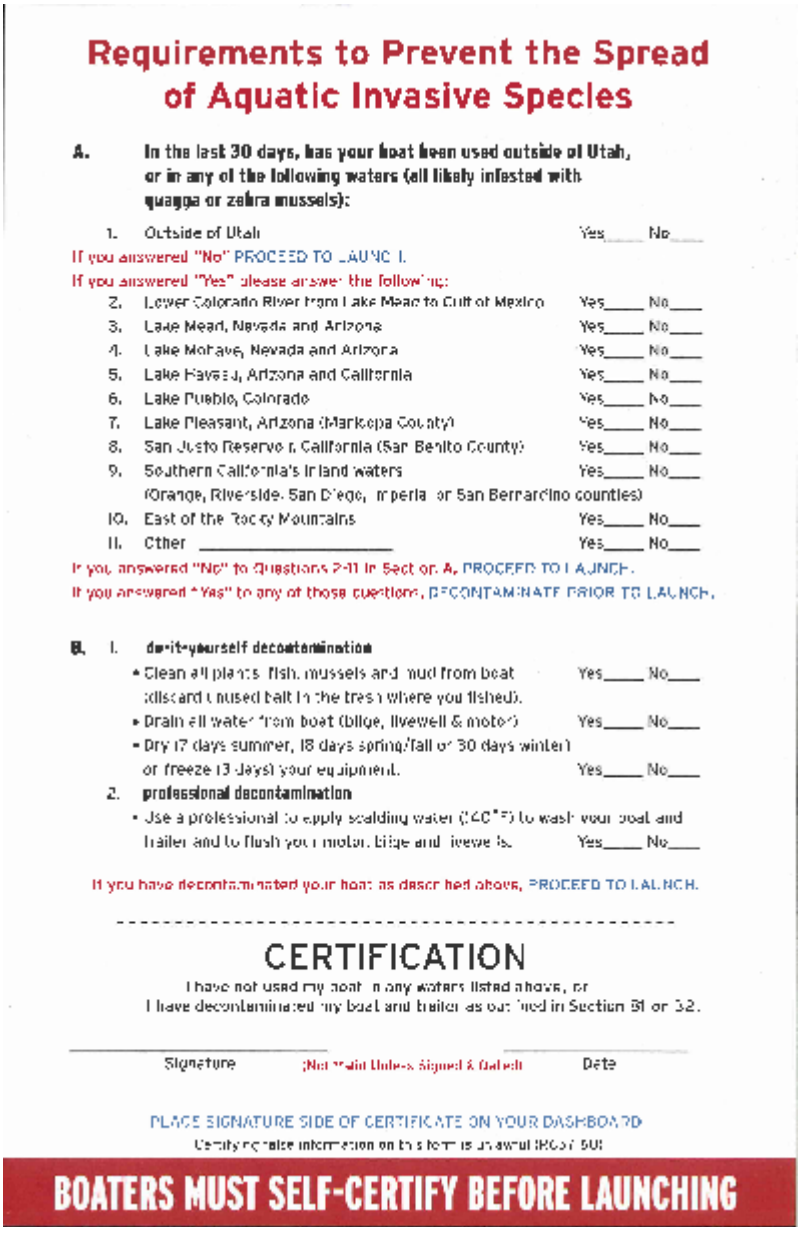
- Ensure educational media (waysides, brochures, signs) are available at unstaffed locations.

  On the following page is an example of a one page sheet that could be modified and adopted by the Team to distribute regionally. This example is from UDWR.

2.3.3 Objective 3: Quarantine or decontaminate at-risk watercraft.

All watercraft, transportation equipment such as boat trailers, fishing gear such as waders, bait buckets, or recreational devices such as water skis, personal flotation devices, that have been submerged, docked, or used in infested waters which have not been cleaned, and sufficiently dried must either be decontaminated or quarantined and prevented from launching into uncontaminated regional waters. Following protocols developed by the 100th Meridian Initiative, the following actions should be taken.

Actions and Responsibilities:



Requirements to Prevent the Spread of Aquatic Invasive Species

A. In the last 30 days, has your boat been used outside of Utah, or in any of the following waters (all likely infested with quagga or zebra mussels):

1. Outside of Utah — Yes____ No____

If you answered "No" PROCEED TO LAUNCH.

If you answered "Yes" please answer the following:

2. Lower Colorado River from Lake Mead to Gulf of Mexico — Yes____ No____
3. Lake Mead, Nevada and Arizona — Yes____ No____
4. Lake Mohave, Nevada and Arizona — Yes____ No____
5. Lake Havasu, Arizona and California — Yes____ No____
6. Lake Pueblo, Colorado — Yes____ No____
7. Lake Pleasant, Arizona (Maricopa County) — Yes____ No____
8. San Justo Reservoir, California (San Benito County) — Yes____ No____
9. Southern California's inland waters — Yes____ No____
   (Orange, Riverside, San Diego, Imperial or San Bernardino counties)
10. East of the Rocky Mountains — Yes____ No____
11. Other _____ — Yes____ No____

If you answered "No" to Questions 2-11 in Sect on A, PROCEED TO LAUNCH.

If you answered "Yes" to any of those questions, DECONTAMINATE PRIOR TO LAUNCH.

B. 1. do-it-yourself decontamination

- Clean all plants, fish, mussels and mud from boat (discard unused bait in the area where you fished). — Yes____ No____
- Drain all water from boat (bilge, livewell & motor) — Yes____ No____
- Dry (7 days summer, 18 days spring/fall or 30 days winter) or freeze (3 days) your equipment. — Yes____ No____

2. professional decontamination

- Use a professional to apply scalding water (140°F) to wash your boat and trailer and to flush your motor, bilge and livewells. — Yes____ No____

If you have decontaminated your boat as described above, PROCEED TO LAUNCH.

CERTIFICATION

I have not used my boat in any waters listed above, or
I have decontaminated my boat and trailer as outlined in Section B1 or B2.

_____ _____

Signature (Not Valid Unless Signed & Dated) Date

PLACE SIGNATURE SIDE OF CERTIFICATE ON YOUR DASHBOARD

Certify remake information on this form is unlawful (R657-60)

BOATERS MUST SELF-CERTIFY BEFORE LAUNCHING

Managing partners or regional staff will:

- Establish quarantine or decontamination procedures for all projects. Begin with those projects with the highest risk rank in Table 2, and then establish procedures for all project waters.[1]

[1] Partners may not rank water bodies the same way the Region does. Therefore, this action and other references to high-risk projects are based on the Region's risk assessment in Appendix A.

- Following 100th Meridian protocols, kill mussels by drying every watercraft, transportation equipment, or gear that has been submerged in infested waters. First clean all watercraft and equipment, removing any clinging organic matter. Scrub surfaces with brushes or spray with hot water. Completely dry watercraft and equipment. Drying will take between 5 and 30 days following the 100th Meridian Quarantine Estimator, with the time dependant upon the locale and season (www.100thmeridian.org).

- Treat contaminated watercraft and equipment at the source of infestation, not uncontaminated destinations; i.e., boats should not be allowed to leave launching areas on contaminated waters until they have been decontaminated. That way the limited decontamination resources can be concentrated on waters that are already infested rather than distributed widely and thinly across uncontaminated waters. Work with Lower Colorado Region and other regional offices on this action item.

- If sufficient drying time is unavailable (30 days or as per 100th Meridian Initiative quarantine estimator tool), the watercraft must either be prohibited from launching or it must be professionally decontaminated following the 100th Meridian Initiative protocols. Special decontamination units must spray scalding water of at least 140 ^{o} F (60 ^{o} C) on all surfaces and components that have been submerged in infested waters.

The Team will:

- Contingent upon appropriations, prepare interagency agreements with partners to pay for utilities, or purchase, install, and staff mussel decontamination units. In other words, the Team shall work with partners to get more units in place and manned at high-risk projects.

- Actively work with concessionaires and recreation-related businesses located at or near high-risk projects to establish decontamination stations.

2.3.4 Objective 4: Coordinate with law enforcement officials.

Reclamation lacks the necessary law enforcement capabilities and authority to quarantine watercraft; however, state and local managing partners may have authority to stop and inspect watercraft, bait boxes, etc. and to quarantine them if necessary. Work with partners in Wyoming (Colorado, Utah and New Mexico have these authorities) to get laws passed for authority to stop watercraft from launching or otherwise quarantine at risk equipment.

Actions and Responsibilities:

The Team will:

- Define the legal authorities that may be used by Reclamation and managing partners to inspect boats and that authorize limitations on mussel occurrence, movement, and transport for each state in the region.

- Enhance law enforcement capabilities by seeking cooperative jurisdiction or other strategies.

- Publicize penalties (where they exist) for distributing and transporting mussels.

- Work with partners to get legal authorities in place in those states or locales where legal authority for quarantine is lacking.

2.4 Early Detection and Monitoring

Needs: Early detection is critical if the region wishes to keep *Dreissena* mussels out of its waters and projects. Long-term monitoring is also necessary once the mussels are found within a regional water body, but before the species become widespread. Currently the region is only monitoring at Glen Canyon Dam and Lake Powell (along with State of UT and NPS), with the states of UT and CO monitoring some waters within their states and the Fish and Wildlife Service monitoring 4 reservoirs in NM. With federal funds (ARRA or Stimulus Act Funding) 18 reservoirs in the region will be sampled during 2009 and 2010 for mussel presence. This sampling has been coordinated with the states so no duplication of effort will occur. An early detection and monitoring program needs to be implemented region-wide on all project waters. As part of the early detection and monitoring program, the region needs to formalize its internal and external communication lines to report and confirm observations of mussels. Detection of mussels should automatically trigger particular response actions, as described below. The overall objective of this component of the plan is to detect all new mussel infestations, but for management purposes, this objective is broken down into more manageable goals.

2.4.1 Objective 1: Design an early detection and monitoring program.

Currently, the region is only monitoring for mussels at Glen Canyon Dam, however, the states of Utah, Colorado and Wyoming are sampling some of their waters. Some of Reclamations waters are and will be sampled with ARRA program funding in 2009 and 2010. While this is a high priority project, there must eventually be a region-wide monitoring program that includes all projects. Other regions have discovered that sometimes projects with lower risk ratings are the first water bodies to become infested. The inability to predict which water body will become infested makes a widespread early detection program critical.

Actions and Responsibilities:

The team will:

- Coordinate with partners to determine the status of their mussel monitoring programs and identify gaps in existing monitoring networks (i.e., high sensitivity areas or regional high-risk projects that may be a regional management priority, if not a managing partner priority).

- Either prioritize regional projects for inclusion in a region-wide long-term intensive monitoring program using the risk analysis or consider a statistically random sampling protocol.

- Coordinate with partners to ensure sampling protocols meet regional and national needs for information. This includes choice of sampling devices, frequency of observations, need for precision and accuracy, etc. For example, Modified Portland samplers and Veliger samples should be tested. Portland State University has designed PVC or ABS pipes that can be suspended in the water column at various depths.

Settling stage invasive mussels can be detected when attached to the samplers. Samples can be suspended with rope or thick monofilament line. Mesh or scrub pads inside the pipe improve effectiveness. Samplers are examined by staff or volunteers with minimal training and equipment every four to six weeks at times when veligers may be settling. These substrate samplers work best when deployed in shaded areas. Samples with some biofilm are more attractive to settling mussels. Details are available from Portland State University Center for Lakes and Reservoirs, which can provide samplers and monitoring support and suggested sampling protocols.

- Veliger sampling with a zooplankton tow net can provide early detection, but is more labor intensive and costly than Portland samplers. Veliger sampling may be useful to detect juvenile planktonic mussels, while Portland substrate samplers may detect the non planktonic form or adult mussels. Protocols for collection and preservation will vary depending on methods that will be used to process samples and detect veligers. Veliger sampling should be conducted when mussels are likely to be spawning (water temps over 12 C, 54 F).

- Work with partners to make sure same protocols are being used and effort is not duplicated.

2.4.2 Objective 2: Implement early detection and monitoring program.

The team will:

- Design and implement a baseline monitoring program to determine if and when *Dreissena* invade regional waters. Initially, the monitoring program may non-randomly sample regional projects with the highest risk of mussel infestation. The goal is establishing baseline samples of all high risk projects by the end of fiscal year 2009 or a statistically randomized sample of regional water storage and hydroelectric projects.

- Install modified Portland State University samplers in all of the regional waters. Work with any local area offices, marinas, concessionaires, or volunteers to check the samplers, at 4-5 week intervals, during the time frame when mussels are expected to be spawning with free floating veligers in the given waters.

- Train staff or fund partners to perform baseline monitoring.

- Sample high priority waters with veliger net to meet sample design. Send collected samples to Denver TSC lab for microposcopy and or PCR analysis. Any positive results will entail a resampling and split of the sample to another independent lab for verification.

- Results from field observations or lab results will be e-mailed or phoned to team members and team chairperson then to be distributed to appropriate managers and partners as per objective 3.

2.4.3 Objective 3: Formalize initial reporting process.

Persons identifying mussels should report to an on-scene coordinator who in turn shall report to the team chairperson.

Upon initial report of detection, the on-scene coordinator should attempt to collect the following information.

- Date and time of initial sighting
- Persons making the discovery (include contact information for follow up and organization or affiliations.)
- Location of sighting, try and get geographic coordinates (latitude-longitude or UTM).
- Record specific information including;
    - How was it discovered?
    - If a monitoring device was used, what kind, what depth, etc.?
    - How many were present?
    - Have samples been sent for verification?

- Team chairperson will respond upon any reported identification whether from monitoring or some other source of information.

- Team chairperson will brief managers of the project, as well as area office managers, and the regional director's office. To assist with briefings, see the attached Information Paper and Talking Points. These documents should be updated periodically to include new information and technology.

2.4.4 Objective 4: Verification of reports.

Needs: Once mussels are sighted or reported as potentially present in a regional project or water body, the identification must be verified before determining what rapid response action to take. Depending on where the initial sighting is made, those responsible for the project will first need to determine if their facilities are located within or downstream of the potentially infested area. If mussels are in another drainage, the project manager (with assistance from the team) should determine the likelihood of mussels being spread to the Reclamation project or facility. If mussels are found in another drainage or isolated lake, then dispersal to the region's water bodies in a worst-case scenario could be expected within a year or two and severe infestation within two or three years after that.

It is logical to expect that mussels will disperse to facilities located downstream due to the natural dispersion pathway. Because settlement does not occur until four to five weeks after spawning, larval zebra and quagga mussels can disperse a considerable distance downstream. Depending on distance, productivity, and spawning conditions (water temperatures greater than 12^{o}C, 54^{o}F) it can take a few years for populations to reach a "nuisance" level. If the initial discovery is of the larval life stage, that suggests spawning adults are present and it may take a year or two before facilities are affected to the point that remedial measures must be taken. Thus, early detection may provide several years before treatments need to be implemented. This can be important for developing and managing a program within budget cycles.

Actions and Responsibilities:

To verify the presence of mussels in regional waters, the Team will adapt the following protocols from the 100th Meridian Initiative.

- If initial reports are that veligers are present, then at least two replicate samples should be analyzed with PCR techniques to identify and confirm species. The team chair should make sure that the lab which identified the mussels submits the samples for PCR analysis.

- The team chair should coordinate this confirmation that veligers are present and report to Reclamation management, the USFWS, and state ANS coordinators. The goal is to minimize the possibility of a false positive.

- If one polymerase chain reaction (PCR) analysis results in a positive identification for *Dreissena* mussels, at least one other replicate sample should be analyzed to confirm the finding and eliminate the possibility of contamination or laboratory error.

- If the initial discovery is of adults or juveniles, the team chairperson should contact a recognized taxonomic expert to ascertain species identification.

- Once mussels are confirmed, then upper management should be briefed. This early management briefing will provide information to facilitate approval of and guidance on acceptable response actions, including identification of a response action team and confirmation of their roles and responsibilities.

- Once identification has been confirmed, notify the USGS's Invasive Species Alert System (http://nas.er.usgs.gov/SightingReport.asp), and the Aquatic Nuisance Species Hotline at 1-877-STOP-ANS (1-877-786-7267). This voluntary reporting system is managed by the US Geological Survey (USGS) in Gainesville, FL.

  Based on the information requirements from USGS's alert system, the team should prepare briefing statements including answers to the following questions:

  - What was found (which species)?
  - Where was it found (geographic coordinates and datum)?
  - Why is this important?
  - What has been done so far and what is being planned?
  - Who has been contacted?
  - Where can more information be obtained?

2.4.5 Objective 5: Initial response.

Once mussels are confirmed present in a regional project, immediate and a specific rapid response management plan is necessary to control the invasion. The following actions should be implemented unless the project has a project-specific plan.

Actions and Responsibilities:

The regional director, area managers, or field or project office manager shall appoint on-scene coordinators for each response and control effort. Coordinators may be appointed prior to waters being contaminated. If so, this coordinator should become an official

member of the regional Dreissenid response team. The on-scene coordinator shall work with the regional team in initial response and long-term control efforts. Specific actions for the on-scene coordinator and the Team include the following once mussels are reported.

- Contact and inform state ANS coordinator about discovery.
- Inspect all project submerged facilities that can be visually inspected for presence of mussels and to determine the extent of infestation. Table 2 lists some of the mechanical or physical systems or facilities that should be inspected at this stage. It also includes some potential preventative actions to reduce risk of infestation.
- The extent of infestation will be used to determine the appropriate "rapid response." Sites to check initially include the artificial substrates that are part of the existing monitoring program, turbine unit air coolers, fire suppression systems, and surfaces of all submerged facilities. Remote operated vehicles or cameras may be useful for this task.
- In unwatered facilities that have been in contact with raw infested water, attention should be directed to darker areas (out of direct light) with low ($\leq$ 2 m/s; $\leq$ 6 f/s) water velocities or in higher water velocity areas where there are irregular surfaces that could provide settling sites. Unusual changes in fish condition, such as increased descaling and lacerations, could also indicate mussels are in fish passage conduits. Their shells have sharp edges that could easily descale or more severely injure fish that rub against them.

2.4.6 Objective 6: Contain the mussels.

Needs: Once mussels have been confirmed present in a regional project, then all efforts must be made to contain the mussels and keep them from spreading to other waters and projects. This can be accomplished by managing transportation pathways, educating boaters, anglers, pilots of seaplanes, construction and maintenance equipment operators, watercraft inspection, and watercraft decontamination procedures.

Actions and Responsibilities:

To initially contain a confirmed mussel presence, the on-scene coordinator and Team will:

- Work with law enforcement and management partners (state and local agencies, water districts), shall attempt to contain the infestation through quarantine of watercraft, boater and angler education, watercraft inspection, and decontamination procedures.
- Mass produce and then widely distribute brochures, pamphlets, signage, install wayside exhibits, and distribute other educational information.
- Install educational information where targeted visitors will see it. Given concerns with transportation pathways, post signs, information at all marinas, launch ramps, parking lots.
- Initiate local community outreach. Distribute educational information to local businesses.
- Follow watercraft cleaning protocols for watercraft and other wetted equipment.

- Train project staff in mussel detection and in the messages that should be conveyed internally and externally.

2.5 Control

Needs: Once a *Dreissena* observation has been confirmed, it is critical to assess the size of the infestation relative to available control methods and to the goals of continuing to deliver water and power to Reclamation customers and to maintaining mussel-free ecosystems. This is based on a principle from integrated pest management that thresholds for action should be predetermined.

2.5.1 Objective 1: Investigate possible treatment and control measures.

The need to control *Dreissena* mussels has led to the development of both chemical and non-chemical treatment methods. The physical removal of established mussel colonies is a temporary solution to control biofouling in industrial and municipal facilities. Physical removal treatments need to be repeated often because recolonization occurs quickly. Control options identified for *Dreissena* mussels in open water systems are limited to hand harvesting and dredging. Once a population becomes established in large bodies of water, eradication is virtually impossible. Chemical treatment methods have been most commonly used to treat internal and closed systems where biofouling has occurred (Sprecher and Getsinger 2002). Table 2 lists some of the systems at regional projects that are subject to infestation, their risk level, and potential control measures.

Actions and Responsibilities:

The Team will:

- Consult with Denver Technical Services Center regarding potential treatment and control. The goal is to assemble a variety of approaches that could be applied using an integrated pest management approach. Information in this plan has already been gathered the bibliographic database on the Sea Grant National Aquatic Nuisance Species website: http://www.cce.cornell.edu/aquaticinvaders/ and the US Army Corps of Engineers (2002) website: http://www.wes.army.mil/el/zebra/pdf/trel00-1.pdf.

- Consult with other federal and state agencies (particularly regulatory agencies such as the Environmental Protection Agency) regarding compliance or permitting needs for particular treatment and control measures. Compliance needs are summarized in this plan in Table 3.

- Consider a programmatic environmental impact statement for treatments across the region. Coordinate with environmental divisions in the regional and area offices and with Denver Program and Policy Services and other regions.

- Keep abreast of current and pending laws or regulations that contain provisions regarding access to affected properties for containment, treatment, and control or any legal or regulatory concerns related to treatment.

Table 3. Risk to regional systems and possible controls

System or Equipment	Risk Level	Reason for Risk Level	Potential Preventative Actions
Turbine cooling systems	High	Use raw water with no domestic water backup	Provide redundancy in supply lines Provide additional water supply capacity Repair or replace leaking valves
Fire suppression systems	High	Use raw water with no domestic water backup	Provide redundancy in supply lines Provide additional water supply capacity Repair or replace leaking valves Provide domestic water backup
Fish passage facilities	High	Use raw water with no domestic water backup	Provide redundancy in supply lines Provide additional water supply capacity Repair or replace leaking valves Improve access to all facilities in contact with raw water Use of anti mussel coatings on screens and ladders Eliminate leakage of raw water into unwatered facilities Provide backup equipment for removable components (e.g., various screens and gratings)
Drains and sumps	High	Exposure to raw water	Provide redundancy in drain lines Repair or replace leaking valves Provide backup pumps
Forebay-tailwater sensors	High	Exposure to raw water	Provide redundant sensing capability
Oil-water separators	High	Exposure to raw water	Provide redundancy in supply lines Provide additional water supply capacity Repair or replace leaking valves
Dissolved gas monitors	High	Exposure to raw water	Provide redundant monitoring capability
HVAC[1] systems	High	Use raw water with no domestic water backup	Provide redundancy in supply lines Provide additional water supply capacity Repair or replace leaking valves Convert to domestic water
Turbine intake trashracks	High	Exposure to raw water	Provide backup equipment to allow replacement of racks for cleaning
Boats	High	Exposure to raw water	Provide site for storing boat out of the water when not in use, Inspect after use, decontaminate if mussels are present.
Construction or maintenance equipment, sampling or service gear	High	Exposure to raw water	Inspect after use, decontaminate if mussels are present
Air compressors	Medium	Use domestic water with raw water backup	Inspect after use, decontaminate if mussels are present
Gland water for cooling or lubricating	Medium	Use domestic water with raw water backup	Provide redundancy in supply lines Provide additional water supply capacity Repair or replace leaking valves
Spillways	Medium	Exposure to raw water but should remain operable	Paint with protective, antifouling coating

Ice and trash sluiceways	Low	Exposure to raw water	Paint with protective, antifouling coating, scraping mussels if present
Hatcheries	Low	Use of raw water	Educate personnel
Visitor centers	Low	No exposure to raw water	Educate personnel and visitors

Table 4. Environmental compliance possibly needed for *Dreissena* control

Law	Pesticides	Bacterial Toxins	Freezing and Desiccation	Thermal Shock, Oxygen Starvation	Sound	Vibration	Electrical	UV Radiation
CWA, Sect. 401	Yes, depending on treatment	Yes, depending on treatment	YES unless WQ standards not affected	YES unless WQ standards not affected	NO	NO	YES unless WQ standards not affected	YES unless WQ standards not affected
CWA, Section 402, NPDES	Yes, depending on treatment	NO	NO	NO	NO	NO	NO	NO
CWA Sect. 404, RHA Sect. 10	NO unless isolation structure used	NO unless isolation structure used	YES	NO unless structure needed	NO unless structure needed	NO unless structure needed	NO unless structure needed	NO unless structure needed
ESA Sect. 7	YES	YES	YES	YES	YES	YES	YES	YES
FIFRA License	YES	Possibly	NO	NO	NO	NO	NO	NO
NEPA	YES	YES	YES	YES	YES	YES	YES	YES
RCRA	YES	Possibly	NO	NO	NO	NO	NO	NO

2.5.2 Objective 2: Develop project-specific response plans and compliance.

Once the presence of mussels is confirmed, then treatment actions must be designed and a response plan implemented. Response plan development tasks should include the following elements.

Actions and Responsibilities:

The Team, assisting the project manager, will:

- Assess the site invaded by mussels and determine appropriate control methods. Determine whether eradication is possible or if the target is some form of control.
- Develop a project-specific response plan to determine the needed information to implement control protocols.
- Apply for rapid response funding through the USFWS's ANS Task Force or other source to develop response plan.
- The team environmental compliance specialist, working with the local environmental compliance specialist, shall ensure appropriate environmental

compliance is followed for any proposed treatment. Table 4 lists some of the environmental compliance considerations.

- Brief upper management on proposed control proposals. Seek their decisions and document.
- Enact communication protocols through the Public Affairs division.
- Implement the approved control methods after completing any necessary compliance documentation and public outreach.
- After treatment, designate and fund personnel to monitor for efficacy of treatments. Determine if control methods were effective and met desired thresholds.

The following sections summarize some of the control possibilities. At this time, effective chemical or other control measures are limited due to risks to the environment. Table 5 lists some non-chemical treatments for controlling *Dreissena* mussels. Table 6 lists various chemical treatment methods. Table 7 provides additional information about various non-oxidizing chemical treatment methods (commercial products) for *Dreissena* control.

2.5.2.1 Non-chemical Control

If equipment or components of Reclamation facilities or structures can be removed and replaced or if backup systems can be used, the response can be rapid and effective. In accessible areas, mussels can be physically removed by a variety of means, including scraping, suction, pressure washing, or pigging (internal pipe scraping). Pressures of 2,000 to 3,000 pounds per square inch (psi) should remove mussels, but it may take 4,000 to 10,000 psi to remove their byssal fibers (the fibers that they use to attach to hard surfaces). While the byssal fibers may not have to be removed to substantially improve water flow, their presence could allow increased corrosion of metal surfaces by anaerobic bacteria. Pigging would not be practical in pipes and conduits with lots of bends or size changes. Suction dredges might be used to remove mussels from bottom sediments.

Physical removal can be labor intensive and time consuming which may pose problems for completing removal within necessary time frames. Once the mussels are removed, they will have to be disposed of. The potentially large volume of dead and putrefying mussels must be considered when choosing physical removal.

Mussels are susceptible to exposure and desiccation. They are more sensitive to longer exposure times than either higher temperatures or freezing. Dewatering may be particularly appropriate for canals. If dewatering is an option, the project should plan on dewatering a facility for a minimum of three weeks in non-freezing temperatures. This can be reduced to about a week if air temperatures can be raised to > 25^{o}C (77^{o}F). Freezing will kill mussels within a day although exposure time will need to be increased to a few days if there are clumps of mussels to assure thorough freezing. After a facility is re-inundated, there will still be dead mussel bodies and shells to collect and transport to appropriate land disposal locations.

In projects or systems that cannot be dewatered, the project may elect to try and isolate the area for either treatment with hot water or through oxygen deprivation (anoxia). The water temperature should be about 33 to 35 ^{o}C (91.4 to 95 ^{o}F) to assure a kill and this should be repeated once or twice a year for longer-term applications. For oxygen deprivation to

work, the system must be well sealed as the mussels will survive for long periods in low-oxygen environments. Depending on water volume and mussel density, it could take several weeks for a system to go sufficiently anoxic to assure a kill. This can be accelerated if the water is warmer (up to about 25 ^{o}C; 77 ^{o}F) or if certain chemicals, such as hydrogen sulfide gas or sodium metasulfite, are added to eliminate oxygen. Additives should not be used without consideration of their potential impacts in discharge water. As with desiccation, there will be mussel disposal requirements post-treatment.

Table 5. Non-chemical *Dreissena* treatments

Method	**Life Stage**	**Effectiveness**	**Duration of Treatment**	**Notes**
Oxygen starvation	All		2 weeks + @ 0 mg/l	Must isolate population
Freezing	Juveniles	100%	2 days @ 0° C	Must dewater system
	Adults		5-7 hours @ -1.5 °C	
			under 2 hours @ -10 °C	
Desiccation	Juveniles	100%	Immediate @ 36 °C	Must dewater system for several days
	Adults		5 hours @ 32 °C	
			2.1 days @ 25 °C	
Cavitation	All	100%	veligers in seconds @ 10-380 kHz	May affect other species, reduced success in high flows, needs power source
			juveniles in minutes	
			adults in a few hours	
Ultrasound	All	100%	veligers in seconds @ 39-41 kHz	May impact other species, needs power source
			adults in 19-24 hrs	
Vibration	Veligers, juveniles	100%	intermittent @ 200 Hz & 10-100 kHz	Structural integrity may be threatened
UV radiation	All	100%	juveniles -4 hrs	Lethal to many species, effectiveness limited by turbidity and suspended solids
			adults – continuous	
Benthic mats	Juveniles, adults	Up to 99%	9 weeks	Initial tests promising for limited infestations
Bacterial toxin, *Pseudomonas fluorescens*	All	95%	6 hours	Low toxicity to other organisms, few treatments needed, not yet available in commercial quantities.
Low frequency sound	Juveniles	Inhibits settling	4 to 12 min @ 20 Hz – 20 kHz	Not lethal, needs power source
Low voltage electricity	Adults	Prevents settling	immediate results @ 8 volt AC	Not lethal, needs power source
Plasma pulse technology	Juveniles, adults	Prevents settling	intermittent high energy pulses	Not lethal, private technology
Manual removal	Juveniles	Variable	N/A	
	Adults			
Electric field pulse	Juveniles, adults	Lethal to juveniles Inhibits adult settling	seconds	May affect other species, needs power source

Predation	All	Low	Continuous	Harvest of potential predatory species must be limited

Sources: Information above from COE website at www.el.erdc.usace.army.mil/zebra/zmis/idxlist.htm. Information on the bacterial toxin, *Pseudomonas fluorescens*, is available on the National Energy Technology Laboratory website at http://www.netl.doe.gov/technologies/publications/factsheets/project/Proj291.pdf

2.5.2.2 Biological Control

Biological control options are limited at this time, but are under investigation. Some waterfowl (e.g., lesser scaup) and fish (freshwater drum, carp, and some sunfish) will feed on zebra mussels, but not to the point of controlling populations and certainly not within project facilities. Research is ongoing to determine if any known mussel parasites or microbes could be used to control zebra mussels. For example research with a bacterial toxin, *Pseudomonas fluorescens*, is being conducted. Unfortunately, at this time biocontrol seems unlikely to provide controls for project facilities, however this plan should be updated if organisms are identified that may be useful.

2.5.2.3 Chemical Control

Chemical controls fall into two general categories, those that are lethal and those that are irritants (generally oxidizing chemicals) that discourage settlement or inhibit respiration, growth, or metabolic function. General information will be provided to illustrate possible chemical control options but, because of their potential impacts on non-target organisms, including ESA-listed species, prescriptive alternatives will be left for later development and coordination once mussel control is needed. This section should be periodically updated, particularly if new, effective chemical products become available.

Lethal chemicals include molluscicides, copper sulfate, and certain metal ions (e.g., potassium). These may be used with or without detoxification and some are proprietary (e.g., Clam-trol). Use of chemicals will also likely require a National Pollution Discharge Elimination System (NPDES) permit from the Corps of Engineers. Copper sulfate and most metal ions are also toxic to other organisms in the region's water bodies and would have to be contained.

Oxidizing chemicals approved for use in drinking water, such as chlorine, potassium permanganate, ozone, and bromine, are effective in controlling mussels but they also impact non-target organisms and may result in adverse environmental impacts. Sodium hypochlorite (bleach) (NaOCl) injection systems have been used by Ontario Power Generation, Canada, and MWD of Southern Cal. Another product, BioBullets, has been developed that uses the encapsulation of an active ingredient potassium chloride (KCl) in microscopic particles of edible material designed for ingestion by mussels. It is also supposed to affect Asian clams.

2.5.2.4 Control Monitoring and Evaluation

An in-progress evaluation should be conducted to provide feedback on the efficacy of rapid response actions and to provide recommendations for improvements to either process or to identify additional control actions. In addition, a follow-up evaluation should be conducted to identify opportunities to improve rapid response capabilities. Plans should also be made for a long-term monitoring strategy to address continuing risks from

Dreissenid mussels, as well as other potentially harmful invasive species.

2.5.2.5 Looking Forward

Although the purpose of this plan is to provide information for project use in preventing mussel spread and responding to a reported mussel invasion, some opportunities may arise to modify project facilities during routine maintenance or facility upgrades. If these proactive changes could be made as part of ongoing maintenance schedules, they could be very important and effective, compared to the potential impacts of unscheduled project shut-downs. This section reviews some of these proactive measures that managers should be considering for implementation.

1. Redundant systems. If possible and cost effective (facility cost versus maintenance and loss of facility operation costs), add redundancy to existing systems or build new systems with redundancy. This will allow one part to operate while the second is down for maintenance, isolation, or other treatment. This is especially effective for pipes.

2. Short versus long conduits or pipes. Short conduits will have less surface area to deal with if it becomes fouled.

3. Water velocity. Less mussel settling occurs in smaller diameter pipes with higher water velocities (> 2 m/s; > 6.6 f/s) and smooth surfaces that are continuously running as opposed to intermittent high-velocity pipes or larger, slow-moving systems.

4. Over-design. Systems should be over-designed to be able to deliver enough water despite some level of mussel colonization that would otherwise inhibit water flow.

5. Pipe and conduit surfaces. Smooth or slippery surfaces are preferable to minimize settling opportunities (silicone or other slick surfaces). Copper and galvanized metals also provide less hospitable settling sites. Likewise, straight pipes and conduits would be preferred over numerous bends to also minimize potential settling sites.

6. Isolate systems. Provide the capability to isolate systems so they can be sealed and treated (e.g., desiccation, thermal, or chemical).

7. Access. Improved access for people and equipment will facilitate maintenance activities for Dreissenid mussel removal and control.

8. Spare parts. If critical components could be easily and quickly replaced with spares, then outage times could be minimized. Easy access would also simplify periodic monitoring of critical areas.

9. Steam injection. Steam injection could be used for periodic thermal control. Consideration would have to be given to discharge water temperatures to avoid downstream impacts.

10. Electification - Research is ongoing with use of electricity as a control method for mussels.

Table 6. Chemical treatment methods for *Dreissena* control

Treatment	Target Age	Efficiency	Contact Time, Concentration	Comments
NON-OXIDIZING CHEMICALS				
Copper ions	Veligers	100%	24 hours @ 5 mg/l	Lethal to other aquatic species
Potassium ion (KOH)	All	100%	Less than 10 mg/l	As above
Potassium ion (KH2PO4)	All	100%	continuous @ 160-640 mg/l	As above
Potassium salts (KCL)	Juveniles, adults	Prevent settlement	50 mg/l	Lethal to other mussel species, non-toxic to fish at required dose rate
	All	50%	48 hrs @ 150 mg/l	
		95-100%	3 weeks @ 95 – 115 mg/l	
Chloride salts (NaCl)	Veligers/ juveniles	95-100%	6 hours @ 10,000-20,000 mg/	Low cost, low environmental Impacts, very high dosage rates
Copper sulfate	All	55%	5 hrs 300 mg/l @ 22.5 °C	Lethal to other aquatic species
		40%	5 hrs 100 mg/l @ 22.5° C	
		50%	48 hrs 2 – 2.5 mg/l @ 17 C	
OXIDIZING CHEMICALS				
Chlorine	Veligers	100%	0.25-5mg/l 1 to 9 days	Lethal to many aquatic species
	All	90%	2.0 mg/l continuous	
	Adults	95%	0.3 mg/l 14-21 days	
	Adults	75%	0.5 mg/l 7 days	
Chlorine dioxide ClO2	Veligers	100%	0.5 mg/l 24 hours	Most successful on veligers
Chloramine	Veligers	100%	1.2 mg/l 24 hours	Less toxic to other aquatic life than chlorine
		95%	1.5 mg/l continuous	
Hydrogen peroxide	Veligers Juveniles	100%	6 hours	High dosage rates required. Lethal to other aquatic species
Ozone	All	100%	Veligers in 5 hours @ .5 mg/l	Lethal to other aquatic species
			Adults in 7 days @ .5 mg/l	
Potassium permanganate	All	90-100 %	2.0 mg/l for 48 hours	Must have high continuous dosage, lethal to other species

Table 7. Non-oxidizing chemical treatment methods (commercial products) for *Dreissena* control

	Target Age	Efficiency	Contact Time, Concentration	Comments
QUATERNARY AMMONIUM COMPOUNDS				
Clam-Trol CT 1	All	100% 48 hours after exposure	1.95 mg/l @ 11 °C for 12 hours	More toxic to veligers than adults and more toxic to mussels than to trout
			1.95 mg/l @ 14 °C for 14 hours	
			1.95 mg/l @ 20 °C for 6-14 hours	
Calgon H-130	All	100% after 48 hours	0.85-1.12 mg/l	1.1 mg/l toxic to salmonids, must be deactivated, corrosive, flammable
Macro-Trol 9210	All	100%	5-50 mg/l continuous	Lethal to aquatic organisms, must be detoxified
Bulab 6002	All	100%	2 mg/l 7-10 days	Lethal to fish, especially salmonids
			4 mg/l 5-8 days	
AROMATIC HYDROCARBONS				

Mexel 432	Veliger	Deters veliger settlement	Dose at 1-4 mg/l once a day	96 hr LC 50 for rainbow trout 11mg/l, corrosive
EVAC – endothal formulation	All	100%	0.3-3 mg/l for 5 to 144 hours	Lethal to fish but rapidly degrades, does not bioaccumulate
Bulab 6009	All	100%	2 mg/l 4 to 10 days	96 hr LC 50 for rainbow trout 1,1 mg/l, corrosive
			4 mg/l 3 to 8 days	

Notes: Products listed above have been approved for aquatic use by EPA if applied according to label instructions by a licensed applicator. They may not be approved by the individual states and must have that approval before they can be applied. The molluscicides have been primarily developed for use at water impoundment and hydropower facilities, treatment facilities, water intake structures, etc. Their use in open water is not generally recommended but might be possible under certain circumstances.

Information on the products listed above, including manufacturer, chemical formulation, application rates, toxicity, hazards, etc. is available on the COE website at www.el.erdc.usace.army.mil/zebra/zmis/idxlist.htm

3 Implementation Tables

A series of four implementation tables summarizes the actions described in this plan. These tables repeat information in the sections above, but the action items are uniquely numbered so progress on any one element of the plan may be tracked. For each action identified under the management components (1 structure, coordination and responsibilities; 2 prevention; 3 early detection; 4 control and management), we have identified a time frame for the action, identified who is responsible for the action, the funding or cost if it is known or can be estimated. In many cases costs are unknown, but will be added as information is gained.

Table 8. Structure, coordination, and responsibilities

Objective 1: Assemble a regional interdisciplinary team.				
Task	**Task Description**	**Task Duration**	**Person Responsible**	**Cost**
1.01	Top managers commit to prevention and control of mussels.	Initiated FY2009. Complete by 1st quarter 2010.	Regional director, area managers	
1.02	Appoint team members to represent area offices and divisions. Appoint team chairperson.	Completed	Regional director, area managers	0
1.03	Contact and confirm team membership with supervisors.	Completed	Regional director, area managers	0

1.04	Ensure that individual high-risk projects begin taking the appropriate prevention and control actions.	Initiated FY2008. Ongoing	Regional director, area managers	
1.05	Convene 1st organizational meeting for team to define roles and review responsibilities.	Completed	Team chair, team	
1.06	Prepare regional plan, begin taking control actions	Completed	Team chair, team	500
1.07	Provide technical assistance regarding the plan to facility and project managers	Ongoing	Team chair, team	
1.08	Encourage projects with highest risk rank (Table 1, Appendix A) to begin to develop their own project-specific prevention programs and response plans. (Facility assessments)	Ongoing	Team chair, team	5000
1.09	Prepare and coordinate funding requests for fiscal year 2011 forward	Completed	Team chair, team	
1.1	Report at least quarterly to a designated top manager (in this case, to one of the assistant regional directors).	Ongoing	Team chair, team	
1.11	Update this plan as necessary.	Ongoing	Team chair, team	
Cost Estimate:				
Objective 2: Coordinate and communicate with partners.				
Tasks	**Task Description**	**Task Duration**	**Person Responsible**	
2.01	Identify managing partners at Reclamation projects with interests in mussel control.	1st version complete, ongoing	Team	
2.02	Identify partners to help prevent and control mussels. Identify ANS coordinators.	1st version complete, ongoing	Team	
2.03	Obtain copies of partners' response plans.	Ongoing	Team	
2.04	Coordinate mussel prevention and control with all appropriate federal, state, tribal, and local organizations by attending meetings, workshops, phone calls, etc.	Ongoing	Team	
2.05	Work with partners on funding this (and their) response plans.	Ongoing	Team	
2.06	Communicate with partners regarding Reclamation's efforts to prevent the spread of mussels and control them.	Ongoing	Team	
2.07	Work with Public Affairs to create an aquatic nuisance species webpage for the region.	Ongoing	Team, Public Affairs	
2.08	Produce, acquire and distribute educational material.	Ongoing	Team, Public Affairs	
2.09	Post this plan on the region's website. Update as necessary.	Ongoing	Team, Public Affairs	
Cost Estimate:				
Objective 3: Educate regional staff.				
Tasks	**Task Description**	**Task Duration**	**Person Responsible**	

3.01	Encourage all Reclamation staff to obtain the 100th Meridian Initiative online training certificate for preventing the spread of aquatic nuisance species.	Began 1st quarter FY2009, ongoing	Regional director, area managers, supervisors	
3.02	Ensure that all employees are informed of their role in preventing mussel and aquatic nuisance species spread.	Began 1st quarter FY2009, ongoing	Regional director, area managers, supervisors	
3.03	Provide a hard-copy of this plan to all managers and supervisors in the region.	1st quarter FY2010	Team	
Cost Estimate:				

Table 9. Prevention

Objective 4: Educate target audiences to prevent introductions.

Task	Task Description	Task Duration	Person Responsible	Cost
4.01	Identify external target audiences based on pathways.	Completed	Team	
4.02	Locate, edit, and distribute educational media (such as posters, pamphlets, brochures, billboards, stickers, cards).	Ongoing	Team	
4.03	Distribute such stickers or cards to regional reservoirs and recreation areas.	Ongoing	Team	
4.04	Coordinate with partners to distribute educational materials to high-risk projects.	Ongoing	Team	
4.05	Coordinate with partners to distribute media to all projects.	Ongoing	Team	
4.06	Encourage states to mail out mussel ID cards and self-certification forms with boater registration and fishing licenses.	Ongoing	Team	
4.07	Develop appropriate educational materials for the region.	Ongoing	Public Affairs	
4.08	Design bulletin boards and posters for internal regional offices.	Ongoing	Public Affairs	
4.09	Disseminate and distribute preventative information and media to gateway communities and recreation areas.	Ongoing	Public Affairs	
4.1	Include requirements to take preventive actions or otherwise control mussels in pertinent contracts, cooperative agreements, grants, etc.	Ongoing	Team, Acquisitions	
Cost Estimate:				
Objective 5: Inspect and screen watercraft entering regional waters.				
Tasks	**Task Description**	**Task Duration**	**Person Responsible**	**Cost**
5.01	Ask questions to determine if a watercraft has been in infested waters and poses a risk for harboring mussels. It is important to determine if sufficient drying time has elapsed from when a watercraft was in infested waters.	Ongoing	Partners	
5.02	Look for mussels. If present, try and prevent launch.	Ongoing	Partners	
5.03	If the watercraft poses no threat, allow it to launch. If it poses a threat, stop the launch.	Ongoing	Partners	
5.04	Provide mussel-free certificates to display on watercraft while they are in regional waters. (The UDWR has such certificates available for copying and distribution.)	Ongoing	Team, Public Affairs	
5.05	Distribute such stickers or cards to regional reservoirs and recreation areas.	Ongoing	Team, Public Affairs	
5.06	Ensure educational media (waysides, brochures) are available at un-staffed locations.	Ongoing	Team, Public Affairs	
Cost Estimate:				0
Objective 6: Quarantine or decontaminate watercraft.				

Tasks	Task Description	Task Duration	Person Responsible	Cost
6.01	Establish quarantine or decontamination procedures. Focus on not allowing boats to leave contaminated waters and launch elsewhere.	Ongoing	Team, partners	
6.02	Try to treat contaminated watercraft and equipment at the source of infestation, not uncontaminated destinations.	Ongoing	Team, partners	
6.03	If sufficient drying time is unavailable, the watercraft must either be prohibited from launching or it must be professionally decontaminated following the 100th Meridian Initiative protocols.	Ongoing	Team, partners	
6.04	Prepare interagency agreements with partners to pay for decontamination.	Ongoing	Team	
6.05	Work with concessionaires and recreation-related businesses located at or near high-risk projects to establish additional decontamination stations.	Ongoing	Team	
6.06	Use restricted pesticides or other forms of chemical treatment, beginning with a Pesticide Use Proposal (PUP). The team and the facility managers will work with their Integrated Pest Management Coordinators on PUP review.	Ongoing	Team; IPM coordinators	
Cost Estimate:				0
Objective 7: Coordinate with law enforcement officials.				
Tasks	**Task Description**	**Task Duration**	**Person Responsible**	**Cost**
7.01	Define extant legal authorities that may be used by Reclamation and managing partners to inspect boats and that authorize limitations on mussel occurrence, movement, and transport for each state in the region.	Completed	Team	
7.02	Enhance law enforcement capabilities by seeking cooperative jurisdiction or other strategies.	Ongoing	Team, law enforcement officials	
7.03	Publicize penalties (where they exist) for distributing and transporting mussels.	Ongoing	Team, partners	
Cost Estimate:				0

Table 10. Early Detection

Objective 8. Design a pilot early detection and monitoring program for the region.				
Task	**Task Description**	**Task Duration**	**Person Responsible**	**Cost**
8.01	Review existing monitoring plans and identify deficiencies.	Completed	Team	
8.02	Either prioritizes monitoring locations using risk analysis or selects random samples.	Two weeks	Team	
8.03	Coordinate with partners to ensure pilot protocols will meet needs.	3 months	Team	
8.04	Test the pilot program.	6 months	Team	
Objective 9. Implement early detection program.				
9.01	Design and implment early detection program. Have baseline samples by end of fiscal year.	One FY--end of FY09	Team	
9.02	Provide for regional coordination of monitoring	Ongoing	Team	
9.03	Develop web-based reporting site for public zebra mussel sightings	1 year	Team	
Cost Estimate:				

Table 11. Control and Management

Objective 10. Investigate possible treatment and control measures.				
Task	**Task Description**	**Task Duration**	**Person Responsible**	**Cost**
10.01	Conduct extensive literature review of chemical and non-chemical eradication and control methods evaluated in laboratory or field; contact all relevant professionals to determine eradication or control strategies	Completed for plan, ongoing	Team	
10.02	Consult with regulatory agencies on compliance needs.	Ongoing	Team	
10.03	Coordinate with Public Affairs to direct educational materials at the appropriate audiences	Ongoing	Team	
10.04	Consider programmatic compliance with NEPA or other laws.	Ongoing	Team	
10.05	Keep abreast of law and regulations relating to control.	Ongoing	Team	
Cost Estimate:				
Objective 11. Develop project-specific response plans and compliance.				
Task	**Task Description**	**Task Duration**	**Person Responsible**	**Cost**
11.01	Assess the site invaded by mussels and determine whether eradication or control is the best option	1 week from verification	Team	
11.02	Develop a plan to determine the needed information to implement an eradication or control protocol	2 weeks	Team	
11.03	Apply for rapid response funding.	2 days	Team	
11.04	Conduct environmental and health safety compliance.	As long as needed	Enviro. compliance staff	
11.05	Brief management and obtain treatment decisions.	1 day	Team	
11.06	Carry out work plan, and determine and implement the most appropriate eradication or control methods	As long as needed	Team	
11.07	Conduct follow up surveys to determine if eradication or control measures have been effective	As long as needed	Team	
Cost Estimate:				

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Appendix B. Sample Press Release in the Event of Discovery of Dreissenid Mussels, from 100th Meridian Initiative

Date

Contact information:

On [date], the U.S. Bureau of Reclamation, [office] received a report that live zebra [quagga] mussels were present in _____. This report has been initially verified by [agency or recognized expert], and efforts are underway to [describe what's next, if anything, to confirm i.d.].

This discovery is a serious environmental and economic concern. Zebra [quagga] mussels are small nonnative freshwater mollusks that have caused major economic and ecological problems in the eastern United States after their introduction in the 1980s.

[Insert quote from a lead agency administrator]

Officials have not yet determined how these mussels arrived to the [present in _____]. Recreational boats are known to be a major source of mussel spread in the United States, and there are a number of past incidents where boats fouled by live mussels have been intercepted prior to launching in western waters.

The Upper Colorado Region, in cooperation and coordination with other federal and state agencies and with organizations such as the 100th Meridian Initiative campaign, has been preparing for this unfortunate incident, and recently completed a rapid response plan for possible zebra and quagga mussel infestation in the region. As called for by this plan, Reclamation is coordinating activities such as measuring the extent of invasion, evaluating control options, and initiating measures to prevent further spread.

[Insert more details on specific next steps for surveys, etc.]

Background on Zebra and Quagga Mussels:

It is not certain how great the impact will be in _____, but an interagency coordinating group, led by _____, is extremely concerned. Once the mussels become established, it is almost impossible to get rid of them. The best hope is to launch an early, coordinated program to contain the current infestation and hopefully determine a means of control.

The _____ (group) is fortunate to have a head start using the rapid response strategy. Similar rapid response programs have been most successful when there was early detection of an invasive species and all of the agencies that had to be involved were able to quickly respond with well-coordinated actions.

In the meantime, Reclamation has _____ (restricted access) to _____ (infected location) to help prevent further dispersal of the zebra mussels. The public can help by avoiding the ____ (infected area) and following these general guidelines. They should clean, drain and dry all boats, trailers, and other equipment after leaving a lake or stream and never release any live organisms into the wild.

How can boaters help prevent the spread of mussels: These aquatic nuisance species can hitch a ride on our clothing, boats, and items used in the water. When visitors go to another lake or stream, the nuisance species can be released. If the conditions are right, these introduced species can become established with detrimental results. By following a simple procedure each time boaters leave the water, they can help stop aquatic hitchhikers. Knowing which waters contain nuisance hitchhikers is not as important ---- as accomplishing the following procedure every time boaters leave any lake, stream or coastal area:

Remove any visible mud, plants, fish or animals before transporting equipment

Eliminate water from equipment before transporting

Clean and dry anything that came in contact with water (Boats, trailers, equipment, clothing, dogs, etc.)

Never release plants, fish or animals into a body of water unless they came out of that body of water.

Possible Quotes:

"We have been aware of problems zebra mussels have caused in the Great Lakes region and have been working with various agencies organizations since the early 1990s to prevent their introduction into the west."

"Although eradication is extremely difficult, our first concern is to contain the zebra mussel infestation within _____ to avoid it being spread to other vulnerable areas."

"Although the recent discovery of zebra mussels is alarming, we are fortunate to have a Rapid Response Plan available to facilitate a coordinated regional effort to deal with this new invader. "The successes we have seen in other areas were the result of the region's ability to rapidly respond with a coordinated intense effort."