Pueblo Response Plan Updates
as of December 1, 2008

Approval Process

A draft of this plan was approved by DNR, Parks, CDOW and Bureau of Reclamation on June 13, 2008. It was then presented for comment and supplied as an electronic draft on these dates to these water groups:

- The SE Water Conservancy District on July 17, 2008.
- The Arkansas Basin Roundtable on August 13, 2008.

Only minor comments/edits were received and a final draft was produced on August 14, 2008. All agencies authorized web posting of this plan as of November 20, 2008.

New Findings at Lake Pueblo

Since that time, statewide monitoring for ANS has brought several new findings to light including:

- Zebra mussel veligers have been confirmed at Lake Pueblo in plankton two sampling taken by CDOW and BOR during this summer and fall of 2008.
- DNA evidence from veliger samples has indicated that quagga mussels are also present in Lake Pueblo (September 26, 2008 CDOW Press Release).
- A bryozoan species that is suspected to be a south east Asian aquatic invasive species was reported by CSU researchers at Lake Pueblo (October 20, 2008).

New Findings Statewide

Invasive mussels' veligers have been confirmed in several other locations in the state:

- Lake Granby
- Grand Lake
- Willow Creek
- Shadow Mountain
- Tarryall Reservoir
- Jumbo Reservoir

These findings change the statement about elevation in the plan. Lake Pueblo is no longer that highest elevation occurrence.

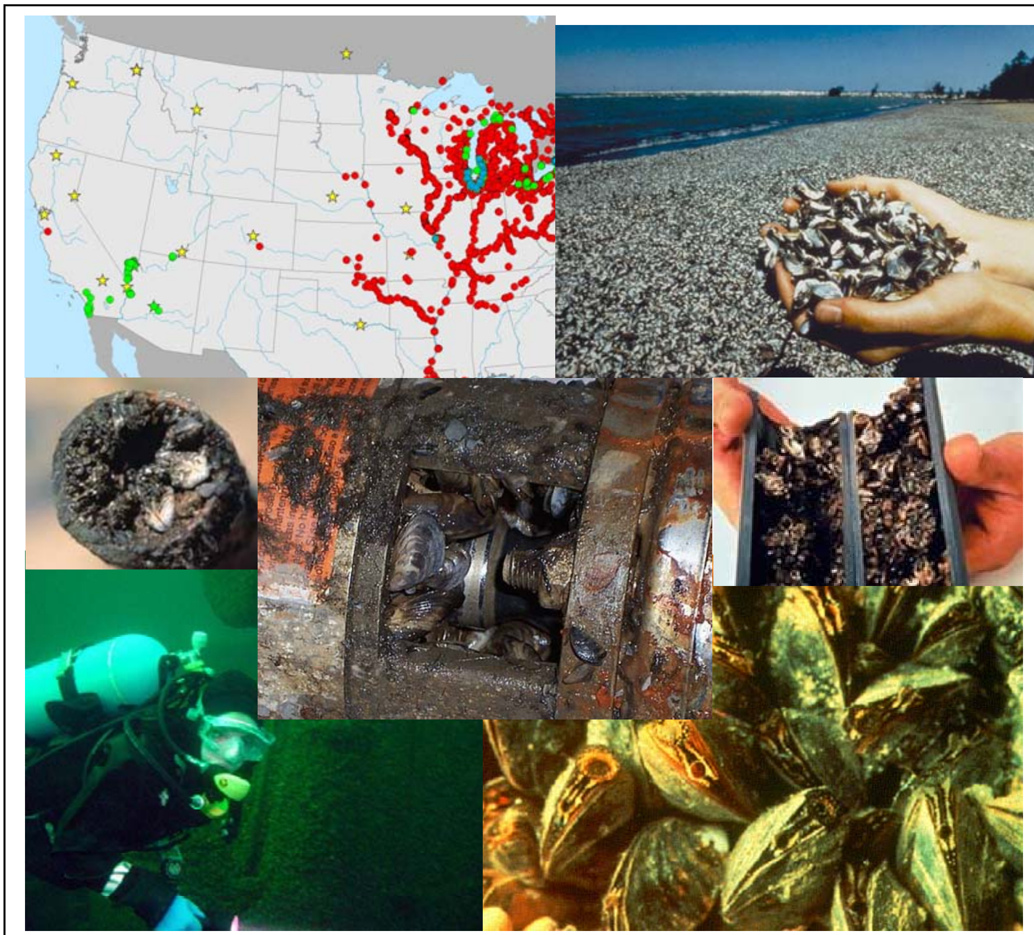
Operational Changes at Lake Pueblo Since this Plan

Lake Pueblo State Park has changed operational policies since 12/1/08 including:

- Hours of operation – The park is no longer open to boating 24 hours. It will be open to boating from 5am to 11pm during the six month period of 4/15 to 10/15 and from 5am to 6pm during the six month period of 10/16 to 4/14.
- Mooring/Beaching - Overnight mooring and anchoring and day time beaching is permitted, but overnight beaching is not permitted.
- Shore-launch – All trailered vessels including PWC must now launch from boat ramps and return to boat ramps, only hand-carried vessels and fishing aides may launch or be retrieved from the shoreline.

Lake Pueblo Zebra Mussel Response Plan

Last Edited August 14, 2008



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Executive Summary

These are the key findings and recommendations of this Response plan for zebra mussels at Lake Pueblo, also known as Pueblo Reservoir.

- Zebra mussel larvae were found in a sample collected at Lake Pueblo in November, 2007. Zebra mussel larvae are typically found in water above 52 degrees F, so this was late in the season for having larvae in the water. DNA testing confirmed the larvae as zebra mussel in January of 2008.

- The lake appears to be susceptible to rapid growth of zebra mussels based on chemical and temperature parameters, but it was, at the time of discovery, the highest known elevation of zebra mussel infestation. It appears to be very early in the infestation. Evidence suggests there is not yet a large population in the Lake. Zebra mussel population forecasting is very difficult, especially when population numbers are very low, as they are suspected to be at Lake Pueblo. All of US data currently available is from zebra mussel infestations in the eastern portion of the country and does not reflect the added variables of elevation, western water temperatures, humidifies, water use patterns and water quality.

- Zebra and quagga mussels, species in the genus Dreissena, can cause exorbitant economic impacts -- on the order of millions to billions of dollars. The power industry alone in the Great Lakes region spent $3.1 billion from 1993 to 1999 for increased operations and maintenance costs due to these species. In Colorado mussels have the potential to cause major problems to many water users, water transport, water treatment facilities, agricultural irrigation, drinking water, water based recreation, including game fish, and to ecosystems, including endangered fish and native mussels.

- Eradication is highly unlikely once mussels are established in large bodies of water; there have been no successful eradications in large bodies of water in the United States. History shows that <u>downstream</u> spread of mussels is almost inevitable from <u>heavily</u> <u>infested</u> <u>waters.</u> If, in the future, the population of zebra mussels in Lake Pueblo does go through an explosive growth scenario, then spread via veligers downstream on the Arkansas River is highly likely. Intensive monitoring is being performed to provide an early warning and guide decisions about downstream responses for containment at locations such as John Martin Reservoir. Until zebra mussel numbers explode, they are very difficult to detect in a water body.

- Evidence from other states shows that this species can spread between water bodies via recreational boating, however Minnesota and Wisconsin have been successful in minimizing the spread between watersheds with active programs for inspection and education. If we respond rapidly to contain this infestation in the Arkansas River watershed then it is likely we will be successful in minimizing the spread of zebra and quagga mussels to other watersheds throughout the state. This is a worthwhile investment to avoid, or at the very least defer significantly, the major environmental and economic damages that can be predicted based on this species behavior in other regions.

<u>What can Agencies, municipalities and water users do?</u>

- A comprehensive boat inspection and decontamination program was developed and implemented early this spring by Colorado State Parks (State Parks) and Division of Wildlife to minimize the risk of spread via recreational boating. The program is based on the best management practices developed in other states (primarily Minnesota, Wisconsin, California and Washington). Currently, all trailered watercraft on the water more than 24 hours are given a high risk inspection to search for attached mussels before they leave the boat ramps. Vessels on the water less than 24 hours are asked to Clean, Drain and Dry their vessel before they leave. All vessel owners are being provided with information/educational materials. Currently the system appears to be working well and is being accepted by the public.

- Currently staff at Lake Pueblo is also inspecting higher risk boats entering Lake Pueblo. The numbers of boats inspected on the way in may increase over time to address the possibility of other ANS species invading Lake Pueblo.

- Addressing the infestation of mussels in the West is a high priority for the Bureau of Reclamation (Reclamation) as it is central to the Agency's mission of delivering water and generating power. Reclamation is working closely with partners, customers and contractors to implement outreach and education programs, conducting research, providing monitoring and prevention of infestation, and working on control and mitigation. Reclamation is prepared to continue providing outreach, rapid response planning, facility assessments, and monitoring and inspection of facilities.

- Another pathway for movement of zebra mussels is through water diversions from one watershed to another. Water users and municipalities connected to Lake Pueblo should consider treatment on the water diversions. It would be wise to conduct formal analyses of the impacts of mussels on their operations and to identify the most cost effective methods and locations to deploy monitoring, prevention and treatments. They should also initiate infrastructure design discussions to allow for future cleaning and treatment without water supply interruption.

- Colorado State Parks (State Parks) and Colorado Division of Wildlife (CDOW) downstream water users should prepare for a possible population explosion and have appropriate emergency procedures ready to implement. If there is evidence of a population explosion, then increases in staffing, portable decontamination stations, and changes to protocols to temporarily or seasonally reduce boating capacity and increase containment effectiveness should all be options considered at Lake Pueblo and also at the downstream John Martin Reservoir. The operating procedures at the State Fish Hatchery at Lake Pueblo would have to be carefully evaluated at that time as well.

Continued Research, Monitoring and Modeling

- Intensive sampling of the zebra mussel population in Lake Pueblo is very important for the next several years. Sampling procedures have been set up and are being conducted at Lake Pueblo in a coordinated effort by CDOW, Reclamation, State Parks, Colorado State University and marina operators. Planktonic larval density sampling provides an effective early warning system for a population explosion, and would alert State Parks staff and Wildlife staff when changes to management tactics are necessary. Sampling expectations should be set carefully for the first year, however. It is a new population and it is possible none will be found this year. In other U.S. locations, larvae were detected one year but not found in the next year or two, and then large population explosions occurred in the third or forth years. Although zebra mussel population behavior is very difficult to predict, there is a good chance that zebra mussels will grow in Lake Pueblo.

- Spread from this location downstream should be modeled to assess the potential of zebra mussel larvae reaching John Martin Reservoir and any major water diversion structures downstream of Lake Pueblo. This should be addressed as a priority within the statewide rapid response modeling and risk assessment process.

Treatment

- Although the current mussel population at Lake Pueblo is estimated to be very small, options to treat or reduce the population are difficult due to the size of the lake and the complexity of the water issues. Drawdown, chemical treatment and removal by divers, are treatment options that have been used at other locations, but often with little or no success. These options are not feasible at this time in Lake Pueblo. Other treatment options, including barriers, "biobullets", drawdown or biocontrols may be more feasible in the future and a reassessment may be necessary in a few years to consider the cost effectiveness and potential impacts of these treatments. They are not recommended at this time.

Education and Partnership

- A statewide education process to affect a paradigm shift in boater behavior and recreational boating is critical. It will require many partners throughout Colorado to educate boaters to make "CLEAN, DRAIN, and DRY" a regular practice. This has been effective in other states to minimize the risk of spread of zebra and quagga mussels. The Clean, Drain and Dry message is the core message to the federal "Stop Aquatic Hitchhikers!" campaign, designed to encourage responsible behavior that will thwart *all* aquatic nuisance species—not just zebra and quagga mussels.

The scope of this plan is limited to the Lake Pueblo area. A separate statewide response plan is being developed by the Colorado Division of Wildlife and its partners. Preventing the spread of the zebra mussels, as well as preventing quagga mussels from spreading into the state, will require a high level of cooperation between *all* stakeholders. These recommendations apply to all stakeholders, for no single entity is responsible, or capable of, implementing all of the necessary actions in this plan.

Purpose

The zebra mussel, a highly invasive bivalve mollusk, was confirmed for the first time in January, 2008, in Colorado, at Lake Pueblo, also known as Pueblo Reservoir. These mussels probably arrived in ballast water (though likely as adults) into Lake St. Claire, Michigan and since the late 1980's, they have rapidly dispersed throughout all of the Great Lakes, and many rivers in the Midwestern U.S., including the Mississippi. Zebra mussels are now spreading westward, causing enormous environmental and economic costs.

A state Rapid Response Plan Team was formed and a Rapid Response was put in place in late March-early April of 2008. This plan was written to document that Rapid Response and address how that response needs to progress over the next several years. This plan is the result of the team's research, literature review and consultations with national zebra/quagga mussel experts.

The intent of this plan is to detail the actions taken in the short term and provide recommendations for responding in the longer term to the mussel invasion in Lake Pueblo. The scope of this plan is limited to the Lake Pueblo area, and the objective is to contain the infestation and to minimize the spread of zebra mussels to other locations in Colorado.

The Plan was written as a medium for interagency communication, as well as for water users and stakeholders connected to, or downstream from, Lake Pueblo, and ultimately as documentation for visitors and recreational users of the Colorado State Park and Wildlife Area. It also provides a blueprint for dealing with another infestation, if it should occur at another water body in Colorado.

Preventing the spread of the zebra mussel will require a high level of cooperation between *all* stakeholders. These recommendations apply to all stakeholders, for no single entity is responsible, or capable of, implementing all of the necessary actions in this plan.

Acknowledgements

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Introduction

The zebra mussel (*Dreissena polymorpha*) is a small bivalve mollusk with two matching half shells. Its common name is derived from the striped pattern on its shell. The zebra mussel originated in the Balkans, Poland, and the former Soviet Union, and was introduced in the mid-1980's into the Laurentian Great Lakes as a result of ballast water discharge or anchors, chains and other ship structures. Since its introduction, the zebra mussel has spread to 22 states and two Canadian provinces. It rapidly dispersed throughout the Great Lakes and much of the Mississippi River due to its tremendous reproductive capability. Passive drift of large numbers of pelagic (open water) veligers (larvae) also facilitates downstream invasion. The mussels also have the ability to attach to aquatic weeds and to boats surfaces. This allows the mussels to take advantage of passive dispersal to other water bodies by unsuspecting recreational boaters.

Continuing westward, zebra mussels were discovered in eastern Kansas in 2003, and quagga mussels (*Dreissena rostriformis bugensis*), a closely related species, were discovered in Nevada at Lake Mead in January, 2007. Additional surveys in the region documented quagga in several downstream lakes and waterways including Lake Havasu, Lake Mojave, the southern California metro district aqueduct system, and several reservoirs in the San Diego area. In the summer of 2007, possible quagga mussel larvae were found in Lake Powell, and sent to USBR for analysis. "The USBR laboratory reported positive microscopic results for both samples and positive results for one of the replicates using PCR analysis." (Palmquist, Granet and Anderson 2008). Additional microscopic analysis of 4 replicate samples by 3 different labs resulted in positives and negatives for zebra and quagga mussels.

In November of 2007, the Colorado Division of Wildlife discovered two mussels attached to a substrate sample at the North Marina of Lake Pueblo in Colorado. Unfortunately this sample degraded in transit to the Reclamation lab and there was too little biomass and too much fungus for a positive identification when it was received at the lab. However the Division of Wildlife conducted a plankton tow in this area and found larvae that were verified by DNA testing on January 14, 2008 as zebra mussel larvae. This was the first documented finding of Dreissena mussels in Colorado.

Environmental Impacts

The environmental impact of zebra mussels upon lakes and rivers can be profound. Zebra mussels compete effectively with many native species and may completely replace native mussels. Phytoplankton biomass declined 85% following mussel invasion in the Hudson River (Caraco *et al.* 1997). Prolific reproducers, zebra mussels can completely alter an aquatic ecosystem from a pelagic (open water) to a benthic (bottom) system, and significantly change the aquatic species living there. Zebra mussels may potentially disrupt the entire food chain by feeding voraciously on the plankton that form the bottom of the food chain. They also bio-accumulate toxins, and pass them up the food chain to larger species.

Economic Impacts

The economic impact of zebra mussels on water infrastructure is profound. Researchers from the U.S. Congress estimate that zebra mussels alone cost the power industry $3.1 billion from 1993 to 1999 in the Great Lakes region. In a survey of Eastern U.S. and Canadian water users in 1995, O'Neill found three hundred thirty nine facilities reported total zebra mussel-related expenses of $69,070,780 (O'Neill, 1997).

A California scientific advisory committee estimated that the "*impacts to the Western United States, where water resources are more limited, water transport is more critical and more water bodies appear to be chemically suitable, will likely be higher than in the Eastern US".* (CSAP 2007)

The Colorado Rapid Response Plan Team was formed to target Zebra mussels at Lake Pueblo: to contain and manage the population, and to prevent its spread. The plan is based upon team research, literature review and consultations with several out of state zebra/quagga mussel experts. Its intent is to provide a total picture of the response to the mussels in Lake Pueblo, as well as an Action Plan.

The plan was written for water users and stakeholders of Lake Pueblo, its diversions and downstream users, including visitors and recreational users of Colorado State Parks and the State Wildlife Area. It is also written as a clear plan of action for the short and long term, for the staff of the State Parks, CDOW and USBR.

The scope of the plan is limited to the Lake Pueblo area. A separate response plan is being developed by Colorado Division of Wildlife and its partners for the statewide response to all Aquatic Nuisance Species.

The overall goal of this plan is to minimize the spread of zebra mussels to other locations in Colorado. Achieving this goal will require significant cooperation between stakeholders. *The recommendations proposed apply to all the stakeholders -- for no single entity is responsible for, or even capable of, implementing all of the options included in this plan.*

References:

Aldridge, D.C., P. Elliott and G.D. Moggridge. 2006. Microencapsulated BioBullets for the control of biofouling Zebra Mussels. *Environmental Science and Technology* 40: 975-979.

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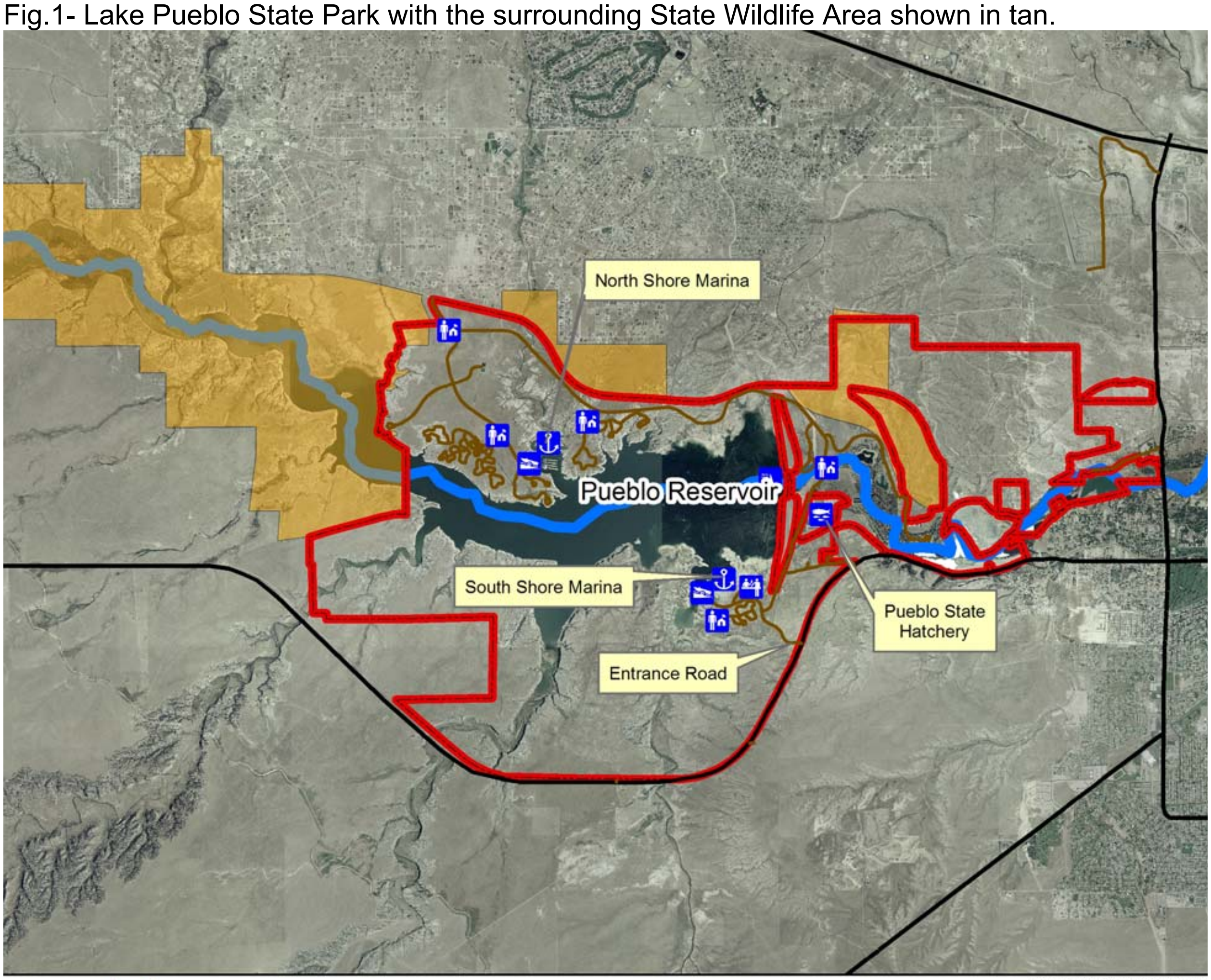
Background and Status
Of Zebra Mussels at Lake Pueblo

An aquatic nuisance species survey program has been operating since 2004 in Colorado. In November, 2007, the first zebra mussel was found at Lake Pueblo State Park by staff of the Colorado Division of Wildlife (CDOW) and a planktonic larval sample was confirmed by DNA analysis in January, 2008.

In March, 2008, the Bureau of Reclamation (Reclamation), with assistance from Division of Wildlife (CDOW) and State Park staff, conducted Rapid Reconnaissance surveys in the most likely habitats for zebra mussel populations. These areas included the North Marina, where the first find occurred, the South Marina and near Pueblo Dam. Divers used remote operated vehicles (ROV) and cameras, but found no additional mature mussels.

However, Lake Pueblo is 4,646 acres (1,880 hectares) in size, and survey hours were very limited. At this time, the evidence suggests that this is a fairly new and small population of reproducing zebra mussels established in Lake Pueblo.

Fig.1- Lake Pueblo State Park with the surrounding State Wildlife Area shown in tan.



Zebra mussels may cause ecological shifts in the water bodies they invade, with serious consequences to precious wildlife resources and related recreational industry. Algae-feeders, zebra mussels feed by filtering up to approximately a liter of water per day through a siphon. These mussels consume large portions of the microscopic plants and animals that form the base of the food web for all aquatic species in the lake. The removal of significant amounts of phytoplankton from the water can cause a shift in native species and a disruption of the ecological balance in a water body. Also, because these invasive mussels attach to hard surfaces like concrete and pipes, they attach in massive colonies to canals, pipes and aqueducts, and can block water intake and affect municipal water supply, agricultural irrigation, power plant operation and industrial cooling systems.

Zebra mussels can be transported naturally via water currents as well as by large and small watercraft. It is believed that the early rapid expansion in the Great Lakes and major rivers in the first 6-10 years of known invasion was due to shipping through the major rivers and downstream dispersal of larvae. It is presumed that at least one third of all inland lakes that are infested in the Great Lakes region were due to downstream spread (Johnson et al. 2006). Overland dispersal into new inland watersheds since that time has occurred much slower and is believed to be primarily due to human boating activities (Tammi, 1999). Given their demonstrated ability to attach to hard surfaces and survive out of water, it is logical that many new infestations have occurred by adult mussels hitching rides on watercraft. In addition, Dreissenids are known to frequently attach to aquatic weeds. Aquatic weeds in turn are often found clinging to boat trailers and boat propellers. By rafting on aquatic vegetation Dreissenid mussels can be transported to new water bodies without attaching to the actual boat surface. The microscopic larvae also can be transported in bilges, ballast water, live wells, or any other equipment that holds water. Both Dreissenid species, along with other aquatic nuisance species, can harm a boat or motor. These invaders will attach to boats and can cause damage to boat motors if they block the flow of cooling water through the engine.

The Colorado Aquatic Nuisance Species (CANS) Steering Committee is in the process of developing a statewide plan for aquatic nuisance species and the plan is nearing completion. Fourteen of nineteen western states have or are developing aquatic nuisance species plans. Colorado's plan will address measures needed for containing and preventing the spread of zebra and quagga mussels, among other species.

Simple voluntary measures, if implemented by all boaters and other recreational watercraft users, can effectively reduce the spread of aquatic nuisance species from one water body to another. These voluntary measures include: cleaning the boat's hull; draining the water from the boat, and live well; drying the boat and equipment; inspecting all exposed surfaces; and removing all plant and animal material from the watercraft. Voluntary measures alone do not go far enough however, given the risk posed to other water bodies. It may take only one contaminated boat to spread an aquatic nuisance species to another water body. For this reason, *it is imperative that many entities within Colorado take immediate action to contain and prevent the spread of zebra mussels to other waters of the state.*

On February 22, 2008, the Board of Parks and Outdoor Recreation of the State of Colorado adopted an emergency regulation aimed at containing and preventing the spread of aquatic nuisance species, including zebra mussels. The regulation makes all boats, including their motors, trailers and related equipment, subject to inspections for any non-native or exotic plant material and aquatic wildlife identified prior to launch or departure from state park waters. Boats may be denied access if inspection is refused. If positively identified zebra or quagga mussels are found on or within a boat or boating equipment and the boat owner refuses decontamination, the boat may be quarantined. The Board found that this emergency regulation is necessary for the preservation of public health, safety and welfare. The emergency regulation was only in effect on waters under the control and management of Colorado State Parks. However a new state statute was signed by the Governor in May that does apply to all waters of the state. Title 33, Article 10.5 is the new state Aquatic Nuisance

Species Act. This statute clarifies penalties for transporting or introducing aquatic nuisance species and clarifies the roles and responsibilities for enforcement.

References:
Johnson, L.E, J.M. Bossenbroek and C.E. Kraft. 2006. Patterns and pathways of the post-establishment spread of non-indigenous aquatic species across multiple spatial and temporal extents: the slowing invasion of inland lakes by the zebra mussel. Biological Invasions 8:475-489

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Projections of Growth and Spread

To evaluate the potential impacts of a zebra mussel infestation, it is critical to consider the mussel distribution, chemical suitability of water bodies and population growth estimates. It is also necessary to model and project larval densities and dispersal patterns into water diversions at dam outlets in order to alert downstream municipalities and water users, and determine the most appropriate, cost effective responses.

Distribution/Population Size

At this time, evidence suggests a fairly new and small population of reproducing zebra mussels established in Lake Pueblo, but more extensive, repeated sampling is necessary.

The Division of Wildlife (CDOW) conducted substrate sampling in 2005 and 2006 at the North Marina in Lake Pueblo with negative results. The substrate sample was checked three times in 2007 and in November, the DOW found two mussels attached to the substrate sample. A plankton tow was conducted in the North Marina area and microscopic analysis of the sample identified possible Dreissenid veligers. On January 14, 2008, DNA analysis confirmed the larvae were zebra mussels. In March, 2008, the Bureau of Reclamation, with assistance from CDOW and State Parks, conducted rapid reconnaissance surveys at the most likely areas for zebra mussel populations. They conducted a few days of surveying at the North and South Marinas and near the dam, but found no additional mature mussels.

This evidence strongly suggests that there are larvae in the water, but not a large population of zebra mussels. However, Lake Pueblo is a 4,646-acre (1,880 hectare) lake and the sampling methods, ROV and diving hours have been very limited. To more accurately predict the population size, additional plankton surveys and veliger density surveys will be necessary this summer (see details in the Monitoring section) as well as several times annually. If these surveys show reasonably high levels of larvae, then additional dive surveys should be conducted to locate the main population areas of mature mussels.

Chemical Suitability of Lake Pueblo and the priority lake of Colorado

Chemical measures and properties of water bodies can reliably predict successful invasions of zebra mussels. Cohen (2005) summarizes the probability of a lake being suitable for zebra mussels based on several water quality parameters. Table 1 lists the probabilities of zebra mussel suitability and also the actual water quality parameters for Lake Pueblo and John Martin Reservoir. Water quality data for both of these sites were available from the USGS Waterdata website.

Acquiring water quality data can be straightforward for a single lake, particularly if the data are available from the USGS or EPA STORET. Determination of whether the lakes were suitable or unsuitable for zebra mussels was performed with a presence/absence model developed by Ramcharan et al. (1992), which is based on pH and calcium concentrations. Data was downloaded from the EPA STORET Legacy database and the pH and calcium values were averaged.

Table 1: Water quality parameters that are indicative of low, moderate and high population abundance of zebra mussels. The corresponding data for Lake Pueblo and John Martin Reservoir are provided for comparison.

Parameters	Low	Moderate	High	Lake Pueblo Values	John Martin Values
pH	<7.3 or >9.0	7.3-7.5 or 8.7-9.0	7.5-8.7	8.2 (7.1 - 9.4)	8.4 (8 - 8.9)
Temp	<10° or >31° C	10-31° C	10-31° C	17 (0.9 - 28.5)	18.9 (11 - 26.5)
Calcium	<15 mg/l	15-25 mg/l	>25 mg/l	48.6 (23 - 75)	167.6 (160 - 180)
Hardness	<25-45 mg/l	45-90mg/l	>90 mg/l	175.6 (76 – 290)	794.3 (740 - 860)
Oxygen	<4-6 mg/l	6-8 mg/l	>8mg Oxygen/l	0 - 14.1 (seasonal and depth variations)	2.8 - 13.4 (seasonal and depth variations)
Salinity	>10 mg/l	5-10 mg/l	<5 mg Salinity/l	Data not available	Data not available

Values in this table are from Cohen 2005. Temperature ranges for Moderate and High are the same.

Conclusions of chemical suitability analysis

Lake Pueblo and John Martin Reservoir appear to be highly suitable for zebra mussel growth based on water quality parameters and temperature profile. It should be noted that the oxygen levels in Lake Pueblo fall into the “low” suitability level frequently during the summer months at depths below 10 m (~30 feet). The timing and depth of settlement of zebra mussels and the fluctuations in water level throughout the summer could substantially affect the establishment success of zebra mussels in these water bodies. Additional analysis is being conducted in Lake Pueblo on temperature and dissolved oxygen. Salinity is believed to be in the suitable range, but data was not available at the time of this report.

Analysis is also underway to evaluate susceptibility of water bodies across the state, but early results indicate that most of the reservoirs east of the continental divide will be considered suitable for zebra mussels whereas susceptibility in the mountain areas are more variable. It is important to note that zebra and quagga mussels were not thought to be able to tolerate very high temperatures since they are able to thrive in colder waters up into Canada, but new ranges for survivability and reproduction have been established based on the populations of mussels in locations such as Southern California and Arkansas. It is very likely that with very large sexually producing populations, that there is some adaptation occurring in these populations to local characteristics. Much of Colorado will be at higher elevations than these species have ever been found, but their ability to adapt suggests caution should be used about making predictions regarding the survivability, reproduction or explosive potential for a specific water body. Water quality data used to make predications should be specific to that water body and evaluated for each month of the year. The ranges shown above should be used with some caution given this issue.

Population Growth Possibilities in Lake Pueblo

To begin to assess the potential growth of zebra mussels in Lake Pueblo, the following steps were conducted:

1) outlined the stages of zebra mussels reproduction and the uncertainties involved in predicting the processes involved in each stage
2) collected data on growth curves of zebra mussels in other bodies of water
3) used an existing model to predict population densities based on water chemistry data

There have only been a few zebra mussel populations that have been surveyed well enough to show a growth curve. Most reports of zebra mussels, particularly in the United States, are characterized by a detection of zebra mussels at low population levels, with a rapid population growth phase in a year or two. Research supports chemical characteristics as a good indicator of whether a population may explode, but estimating the timelines to when a population may explode with a high degree of certainty is limited by both data and theory of the population biology of zebra mussels.

Growth Curve Analysis

The process of zebra mussel reproduction includes three main stages, each of them bringing essential uncertainty.

a) Reproduction Stage 1: Larvae production. Successful fertilization requires a small enough distance between male and female mussels. Due the need for close proximity of males and females a primary requirement of zebra mussel establishment is arrival in small colonies on boats and macrophytes. Each year zebra mussels can spawn up to 4 times and one pair can produce from ~100 to ~100,000 larvae. Most probably the highest larvae production is reached at the second year, when the mussel reaches its normal adult size. But there may be some variability, as shown by quagga in Lake Havasu where a growth rate of 1mm/week has been documented and spawning has started at approx 8mm (.31 inches).

b) Reproduction Stage 2: Larvae spread. The cloud of growing larvae spreads out with the water motion and mixing during larvae growth period, from 5 to 33 days. The location and the size of the cloud change during this time. Estimates of the final cloud radius, depending on duration of the larva stage and intensity of water mixing in a lake give the values between ~100m and ~1000m (328 to 3,280 feet), and the final area of the cloud can vary from ~0.03 km^2 to ~3 km^2 (.01 to 1.1 square miles).

c) Reproduction Stage 3: Larvae settlement. To survive and settle each zebra mussel larva has to land on a hard substrate. (It should be noted that quagga mussels are more successful in settling on soft sediments). The settlement stage causes major larvae mortality, 20% to almost 100%. Estimating larval settlement rates requires data on the proportion of the bottom covered with hard substrate and the oxygen profile through the summer. There may be periods of time in which the oxygen levels below 10 m may be unsuitable for zebra mussel establishment.

According to the mentioned features, zebra mussel population dynamics, like zebra mussel reproduction, has three main stages.

1) Population Stage 1: Initial introduction. If there are only a few reproductive pairs, the larvae typically settle too far from each other, and form new reproductive pairs only rarely. The population is rare with only a few dense points, average population density is almost zero, though the total number of mussels in the lake may be big enough. A model of settlement can give a very rough estimate of the increase in the number of spawning pairs *K* during one year,

$$\Delta K \approx \frac{K^2 n^2 S_0}{S},$$

where *n* is the number of new settled larvae, S_0 is the area of a circle that two mussels (male and female) must be within to have successful fertilization (Theoretical estimates give S_0~0.03m^2), and *S* is the area of the final settlement cloud (Potapov *et al*, unpublished). This stage ends when there are a few hundred spawning pairs. The duration of this stage may vary strongly from 1 year to several years. If the lake is not suitable for zebra mussel, they may go extinct at this stage.

2) Population Stage 2: Explosive Growth. When enough reproductive pairs exist, the explosive population growth phase begins. As observations in the Mississippi River by Cope *et al*. (2006) show, in 3-5 years the population density reaches it's maximum in the whole lake (if it is small) or

near the introduction point. In Cope *et al*. (2006) one can see that the density remains almost constant for two years, and then increases about 100 times (Fig. 2). Most probably this is related with mussels achieving maximum reproductive ability in the second year.

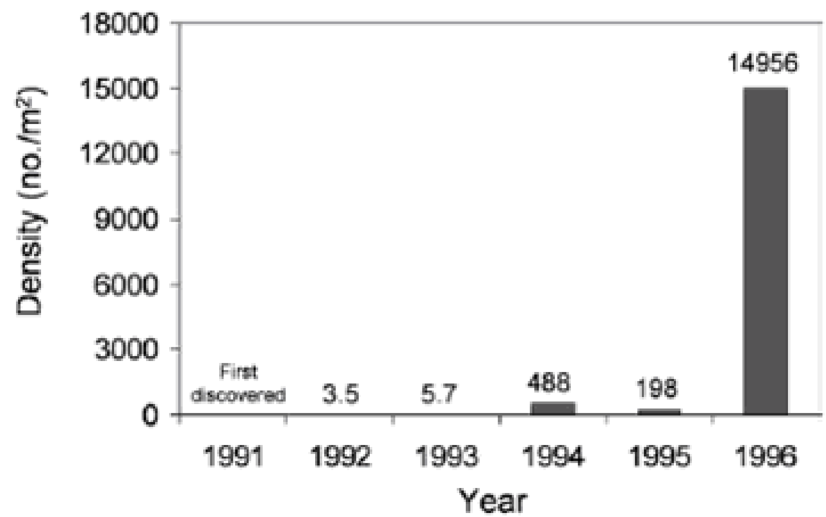

Figure 2. Annual density of zebra mussels in Pool 8 of the Upper Mississippi River from 1992 through 1996, averaged over habitat types and sites for the final sampling period (October) of a given year. (From Cope et al. (2006))

A few other examples of zebra mussel growth curve data exist, including Lake Oneida, Tennessee River, Mississippi River, and El Dorado Reservoir in Kansas. At the Watts Bar Dam in the Tennessee River, in comparison to the Mississippi River (Fig. 2), zebra mussels were reported at densities of 55 individuals/m^2 in 1996 and remained low for several years before increasing to over 5,000 individuals/m^2 in 2001, which is still much lower than the maximum densities achieved in the Mississippi River. In the El Dorado Reservoir in Kansas, a system more similar to Lake Pueblo, zebra mussel densities reached 25,178/m^2 only three years after discovery. In almost all of these systems, population densities quickly increased after only one or two years. The one system where zebra mussels stayed in low densities for several years was at the Watts Bar Dam.

3) Population Stage 3: Variable Dynamics. Finally, after reaching the density close to maximum, zebra mussels often change the ecosystem structure, and their further dynamics may vary strongly.

Conclusions of growth curve analysis

There are very little data on the current zebra mussel abundance in Pueblo reservoir, though some data exists on the water quality and physical qualities of the lake, including its size and bathymetry. Based on the available data and in particular from the shape of the North Marina bay, two major scenarios may be suggested:

A) Rapid Explosive Growth. If there is little water exchange between North Marina bay and the main body of the lake, during the first stage most larvae will remain within the bay and settle there. Then, if one assumes that the proportion of larvae survival is 0.1, and that *S* is close to the area of the bay, for only a single spawning pair (*K*=1) the stage 1 may take 3-4 years. If *K*=10, the stage 1 will take only 1-

2 years, and then there will be explosive population growth within the bay. Then the larvae production will be very intense, and the distribution to other lake regions will commence.

B) <u>Delayed/Uncertain Growth.</u> There is intensive water exchange between the bay and the main body of the lake. If this occurs, there is large uncertainty in settlement locations and densities. In this case stage 1 may take several years, and it is not clear where the explosive growth will start. For example, such a point may be close to the dam, where the larvae may arrive with the water current.

In the literature the modeling of zebra mussel populations is considered for stages 2 and 3, (Alcakaya and Baker, 1998; Hannon and Ruth, 2001; Cope *et al*. 2006), but cannot be related to the stage 1, where in most cases the population is practically unobservable.

Potential Density

To predict the potential population density of zebra mussels in Lake Pueblo, a model by Ramcharan et al. (1992) was used, which is based on pH and phosphate concentration. Population estimates were also made for several other water bodies that have already been invaded by zebra mussels and for which actual densities estimates are available (Bossenbroek et al. 2007). Data on water chemistry for these water bodies were retrieved from the Environmental Protection Agency (EPA) STORET database (http://www.epa.gov/STORET) and USGS National Water Information System (http://waterdata.usgs.gov/nwis). Where data had time series from several sampling sites within a water body, we averaged all data retrieved for a particular water body to estimate pH and phosphate values. When possible, only data from the past 15 years was used, although for some water bodies it was necessary to use data from as far back as the 1960s. Simple linear regression was used to compare the maximum observed versus predicted densities. To estimate the potential densities of zebra mussels in Lake Pueblo, the densities were modeled based on the Ramcharan model. The model results were then incorporated into the equation developed from the linear regression.

Reported densities of zebra mussels in the United States ranged from 55/m^2 in the Tennessee River to over 250,000/m^2 in southern Lake Michigan (Fig. 1). These densities do not closely match the abundances we predicted based on water-quality parameters from Ramcharan's model, which ranged from 273/m^2 to 2,941/m^2, but the model was positively related to the observed values ($r^2 = 0.43$, $p = 0.078$) (Fig. 3). Based on density predictions, if zebra mussels were established in Lake Mead, Roosevelt Lake on the Columbia River in Washington State or Lake Pueblo, Lake Mead would have the highest densities of zebra mussels followed by Lake Pueblo followed by Roosevelt Lake. Lake Pueblo's potential maximum population density could reach 100,000s/m^2 (Fig. 1).

Conclusions of potential density

Based on the water quality of Lake Pueblo, the potential exists for population densities to reach high enough levels to have substantial consequences and for those populations to occur in a very quick period of time, i.e. 1 to 2 years. The Watts Bar Dam data set is one of the few examples for which population levels did not rapidly increase in a short number of years. One caveat to note, however, is that there have been few reports of population growth in lakes like Lake Pueblo, which are not connected to a continual source of zebra mussels. In Fig. 3, all of the water bodies studied are connected to the major shipping routes in the eastern U.S., except Oneida Lake. And even Oneida Lake is connected to the Great Lakes via a canal system; it just no longer receives major shipping traffic. A continual source of new introductions of zebra mussels via shipping and canals could have affected the rate at which these populations grew. In comparison, Lake Mead was discovered to contain quagga mussels in 2007 and it is now believed that they have been there for 3 or 4 years, yet their populations have not increased at a similar rate as zebra mussels did in the Great Lakes. This may be a due to a number of possibilities including: differences between zebra mussels and quagga mussels, a function of the water quality or oxygen levels of Lake Mead, or a lack of new veligers from an upstream location.

The potential density is the primary indication or the potential impact zebra mussels will have on the ecology or economics of a reservoir. Thus, the impact would be directly related to this growth and density.

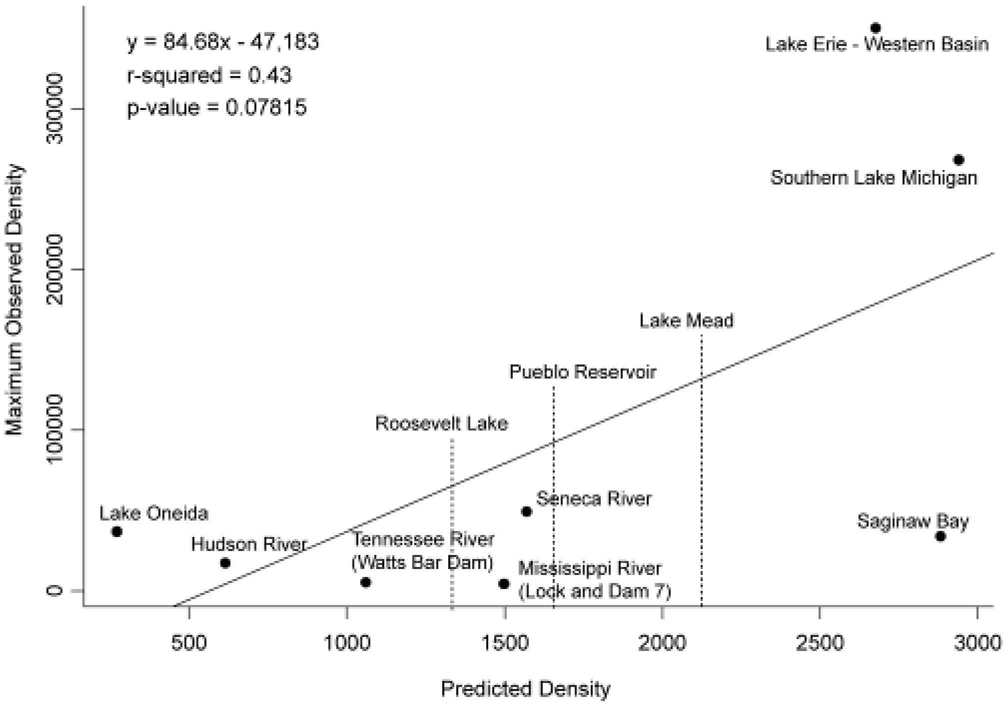

Fig. 3: Maximum reported densities of zebra mussels compared with predictions calculated with the model in Ramcharan (1992). Dashed lines indicate the predicted densities of Lake Mead, Pueblo Reservoir and Roosevelt Lake. The observed values were obtained from the following sources: Nalepa et al. (2003), Saginaw Bay; Mellina et al. (1995), Lake Oneida; Caraco et al. (1997) Hudson River; Waterways Experiment Station (1995), Mississippi River (Lock and Dam 7); Leach (1993), Lake Erie - Western Basin; Marsden et al. (1993), Southern Lake Michigan; Effler and Sigfried (1994), Seneca River; and Tennessee Valley Authority (2002), Tennessee River – Watts Bar Dam.

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POTENTIAL IMPACTS

Ecological Impacts

Filter Feeding Alters the Food Chain

The feeding behavior of zebra mussels directly affects ecosystems. Zebra mussels are efficient filter feeders that process up to approximately one liter of water per mussel per day (based on 10-100ml/mussel/hour from Stanczykowska et.al 1976). Microscopic plankton and algae in the water column are removed and either eaten by the mussels or wrapped in mucus and ejected as psuedofeces. Microscopic aquatic plants (phytoplankton or algae) and animals (zooplankton) comprise the base of the food chain and serve as food for larval fish and pelagic (open water) fish species, which in turn are forage for larger predatory fish. Native mussels and aquatic invertebrates, for example insect larvae also depend on plankton for food. Large populations of zebra mussels can significantly decrease or eliminate plankton and disrupt the entire food chain and the fish that are the basis of the fishing recreation industry in the area.

The level of impact to the aquatic ecosystem from mussel filter feeding is a function of both the abundance of mussels and the amount of plankton contained in a water body. Lake Pueblo is supported by a large drainage area which, combined with its lower elevation, provides a moderate level of aquatic productivity, sometimes referred to as a mesotrophic condition.

This level of productivity (referred to as primary productivity – that which is associated with algae and plankton abundance) provides an abundant food base for aquatic animals (secondary productivity). The quality of Lake Pueblo's ecological productivity and its solid food chain is reflected in the excellent fishery that currently exists. Consequently, this healthy aquatic ecosystem is somewhat resilient to reductions in plankton caused by mussel filter feeding. However it is possible that a large mussel population could significantly interfere with the stability of fishery resources.

Changes in Water Clarity

Mussel filter feeding also indirectly affects the aquatic environment by "cleaning" particulates from the water, thereby increasing water clarity. From an aesthetic standpoint, some might consider a clear water reservoir an improvement over the usual, cloudier, water conditions. But in fact, significant increases in water clarity disrupt the aquatic ecosystem in many detrimental ways. Increased water clarity allows light to penetrate deeper into the water column, which encourages the growth of rooted aquatic vegetation on the lake bottom. Increase in aquatic plants, along with bottom-dwelling forms of algae, can promote the development of a lake-bottom based (or benthic) biological system. Such a diversion of food-energy flow by zebra mussels from a pelagic (open water) to a benthic (bottom) food chain can negatively impact pelagic fish populations.

Bioaccumulation of Pollutants and Toxic Metals

Zebra mussels also have the potential to accumulate environmental contaminants. Because of the large volumes of water they filter and their high body-fat content, zebra mussels bio-accumulate contaminants at greater levels than native mussels. Recent studies have shown that zebra mussels may mobilize toxic materials from the sediments into the food chain in two ways. First, when the mussels filter algae that has absorbed toxic materials, they either ingest the toxic materials, which accumulate and concentrate in the mussel's fatty tissue or shells and are then passed on to fish and ducks that prey on mussels, or they release the toxins as waste (or pseudofeces), returning toxic waste into water column. Also, the release of gametes tends to dissipate the fat stores so it does depend when feeding by other organisms occurs. Amphipods that graze on the pseudofeces containing the toxins are then eaten by fish, thereby introducing toxins to the food chain via a new mechanism.

This potential to significantly affect contaminant cycling is a serious concern in the Arkansas drainage, particularly for heavy metals like cadmium, selenium or mercury. Several reservoirs within the Arkansas basin already have health advisories for mercury and for consumption of some species and sizes of sport fish.

There is some evidence that zebra mussels have the potential to concentrate pollutants and pass them up the food chain to predatory fishes. If sport fish mobilize heavy metals from the bottom substrates, it can lead to poor spawning success or shortened life span, resulting in fewer adult, mature sport fish in the population structure. If this were to occur in Lake Pueblo, it could increase the likelihood of consumption restrictions and catch limits on some species or sizes of fish.

Alteration of Waterfowl Migrations

Consumption of zebra mussels by migrating or overwintering waterfowl has been noted. Changes in waterfowl abundance and migratory flight patterns can occur if zebra mussel abundance is sufficient to attract the attention of passing birds. Diving ducks (like canvasbacks, redheads, scaups and mergansers) are most attracted to zebra mussels as food. Because zebra mussels can bioaccumulate pollutants, predation on zebra mussels by waterfowl can threaten the health of these birds or their offspring.

Limited Positive Effects of Zebra Mussels

In certain circumstances, zebra mussels can have some positive impacts on aquatic ecosystems. Many native fish, birds, and other animals eat young and adult zebra mussels. Some species of waterfowl (e.g. lesser scaup, *Aythya affinis*) and fish (e.g. freshwater drum, *Aplodinotus grunniens)* eat zebra mussels. Yellow perch also feed heavily on zebra mussels, as do catfish, and many species of sunfish. Note, however, that predatory consumption is typically negligible given mussel reproduction rates, and insufficient to keep the population in check. In addition, the increase in macrophytes, (large aquatic plants), due to improved water clarity, can result in more nursery habitat for young fish and can increase some species such as smallmouth bass.

Population Fluctuations

The potential impacts of zebra mussel infestation on the fishery of Lake Pueblo will depend upon the spatial and temporal variation that may occur. The degree of infestation on a spatial scale throughout the Lake determines which areas are most highly affected by the mussels. Habitat varies from the lower to upper reaches of the Lake and ranges from nearly vertical shale walls to shallow, sandy coves. Localized variation in mussel density will likely be associated with the proclivity for preferred attachment substrate. Temporal variation occurs because mussel numbers tend to fluctuate from year to year, based on information from other states. Consequently, impacts upon fisheries will fluctuate with these temporal and spatial fluctuations.

Decrease in Sport Fish

As previously mentioned, zebra mussel infestation tends to change aquatic productivity from pelagic (open water) environments to benthic (bottom) environments. This in turn affects which fish species thrive, and which do not.

The highest probability is a decrease in abundance of gizzard shad in the Lake. Gizzard shad is a highly pelagic species that requires abundant plankton to thrive. A shift in productivity from pelagic plankton to a benthic environment could have a negative impact on gizzard shad numbers. Since gizzard shad are the primary forage base for most sport fishes in the Lake, secondary impacts could occur on sport species. For example, striped bass hybrids (also called wipers) are a popular sport fish that are dependent on foraging almost exclusively on pelagic gizzard shad. Lower shad numbers would likely mean lower wiper production in the Lake.

In addition, extensive infestations of zebra mussels in spawning areas could interfere with spawning activities of some species. At Lake Mead, divers have documented quagga mussels in razorback sucker spawning areas and have made the observation that the sharp shells of the mussel could impact razorback spawning behavior of rubbing against rocks on the bottom to spawn.

Some fish species in the Lake tend to occupy both pelagic and benthic environments and, as such, may feel less pronounced impacts from zebra mussel infestation. Both walleye and rainbow trout feed on gizzard shad, and a paucity of gizzard shad would force these species to look for food in other locations. Walleye and rainbow trout will feed on invertebrates and crayfish in a benthic environment as an alternative to pelagic feeding. Nonetheless, some reduction in these two species is possible.

The remaining fish species found in Lake Pueblo tend to favor benthic environments, but also feed on the abundant shad in the Lake. These species include largemouth bass, bluegill, smallmouth bass, spotted bass, crappie, yellow perch, carp, channel catfish and flathead catfish. A shift in forage to the benthic environment caused by zebra mussel would have a lower impact on these species.

Sport fish that utilize shoreline habitat, however, may experience a positive impact, depending on the degree of change in the forage base. These fish have the capability to feed primarily on invertebrates and crayfish – forage that could increase with a shift to a benthic food web. In turn, their forage - invertebrates and crayfish -would become more abundant due to increases in rooted vegetation (their preferred habitat) that occur with improved water clarity.

<u>Additional Potential Fishing Recreation Impacts at Lake Pueblo</u>

The fishery in Lake Pueblo is of good quality and is a popular destination for anglers across the State. It is a particularly important fishing resource in southern Colorado. Targeted species for sport fishing include walleye, bass, wiper, crappie, trout, catfish, bluegill and yellow perch. Catch rates (number of fish caught per hour) are relatively high for most of these species, which assures a good fishing experience for anglers. Fish are taken home to eat, and there is significant harvest on some species, particularly walleye, wiper and trout. Recreational fishing demand is high at Pueblo and any reduction in the fish populations will result in a loss of recreation for the fishery program in the area and possibly to related economics as well.

The Lake is also a key state source of walleye eggs to meet production goals for that species for both in-state needs and for fish trades with other states, so the impact would be felt statewide as well as in other states.

Impacts to Facilities:

Below are rapid assessments of potential impacts to facilities, however agencies should consider conducting more formal facility impact assessments to identify risks and provide recommendations for facility modifications to reduce impacts from mussel infestations. A Hazard Analysis and Control Point (HACCP) planning strategy may be advisable for some facilities.

Pueblo State Hatchery

The Pueblo State Hatchery is immediately downstream from Lake Pueblo. The Arkansas River i.e. Lake Pueblo, is the primary source of water for this facility. Zebra mussel veligers can potentially be drawn into the hatchery during normal water operations. Hatchery staff continue to monitor the water and inspect for adult zebra mussel infestation; to date none have been detected.

There are known treatment methods to reduce the risk of transporting mussel veligers or adult mussels in fish hauling tank water. When the fish are loaded into the hauling tank (filled with well-water) on the stocking truck, the tank water and fish will receive potassium chloride (KCl) treatments and an additional treatment with Formalin at concentrations lethal to veligers and adult mussels. Then these fish may be safely transported to other waters for stocking.

Nevertheless, despite all precautions, zebra or quagga mussels may appear at other state/federal fish hatchery units as well as private aquaculture facilities. This situation could arise if mussel adults or veligers are found on a unit, in the hatchery water supply or upstream from a hatchery unit as in the case of Pueblo Hatchery. CDOW and the US Fish and Wildlife Service (USFWS) will conduct a risk assessment analysis on their hatchery units and make recommendations to prevent, control and/or eradicate mussel infestation.

Impacts on Water Diversions and Municipal Facilities

Bessemer Ditch

Bessemer Ditch is a 21-mile (33.8 kilometer) concrete and earthen ditch that transports water directly from Pueblo Dam primarily to agricultural uses downstream but also to the St. Charles Mesa Water district. Water leaves the dam through a large diameter pipe. Typical flow is 200 cubic feet per second (cfs) (5.66 cubic meters per second from March through November. The ditch remains dry from November 15th through March 14th. Excess water returns to the Arkansas River.

It is unlikely that the ditch will be adversely affected by zebra mussels. The fact that the channel is dry through the winter months makes it likely that any colonization in the summer would die off during the winter. It is an open channel with mechanical slide gates that are generally easier to clean than pipelines. An area of possible concern is water stored by the St Charles Mesa Metropolitan District. This water flows through the Bessemer ditch where it is then stored in settling ponds. These are small ponds but infestation could be a problem. These ponds should be monitored for infestations. Draining or chemical treatment may be options for treatment but cost efficiency, clearance and impacts must be considered.

Pueblo Board of Water Works Municipal Intake

The City of Pueblo obtains its drinking water from Lake Pueblo through 5.5 miles (8.8 kilometers) of cement-mortar lined and coated steel pipe. The pipe ranges from 66 to 84 inches (1.6 to 2.1 meters) in diameter. Flows range from a low of 12 million to a maximum 140 million gallons (45 million liters to 530 million liters) of water per day (13,440 to 156,800 ac-ft per year respectively). Pressures also vary, from 30 to a maximum 65 pounds per square inch (psi) (206 to 448 kPa). Zebra mussels could potentially attach to the 5.5 miles (8.8 kilometers) of pipe, obstructing water flow or cause greater pumping pressure requirement to achieve the same flow.

Fountain Valley Authority Conduit
This pipeline delivers 20,100 acre-feet (61,707 MGD) of water to the communities of Colorado Springs, Security, Widefield, Fountain and Stratmoor Hills. It is the first pumping station directly below Lake Pueblo. The pipeline runs 27.9 miles (44.9 kilometers) and is a pre-stressed concrete cylinder pipe that is 39 to 42 inches (.99 to 1.06 meters) in diameter. A 1.1 million gallon (4.1 million liters) concrete forebay is at each pumping station.

Both the Fountain Valley Conduit, Pueblo West and Pueblo Board of Water Works (PBWW) municipal pipelines are areas of concern for zebra mussel infestation. The extensive length of the Fountain Valley pipeline may make certain treatments cost prohibitive. PBWW does have backup systems that do not use the municipal pipeline to deliver water to the treatment plant, and these backup systems provide more treatment options.

Since both the Fountain Valley Conduit, Pueblo West and the Pueblo Pipeline divert water from the same municipal manifold, the entities could collaborate and pool resources to deal with the problem.

Treatment Options for Water Diversions, Pipelines and Municipalities

Various strategies exist to control mussels. These include both chemical and nonchemical treatments. Controls that would prevent settlement of mussels within system components are mostly chemical in nature (e.g., chlorine and copper ion generation), although small pore self cleaning filters and UV lights have also been used. Coating of pipes has shown some effectiveness in preventing settlement. Reactive controls are used to treat after some level of mussel establishment has occurred. They include chemical (e.g., oxidants and nonoxidizing organic molluscicides, pH depression) or nonchemical treatments (e.g., pipeline pigging, manual cleaning, and thermal treatment). Each control strategy has associated benefits, costs, and risks.

Summary of Impacts
In summary, zebra mussels can alter the aquatic ecosystem dramatically by depleting microscopic plants and animals that form the base of the food chain, changing the ecosystem from a pelagic to benthic, affecting the numbers and species of larger fish that can survive, changing water clarity, bioaccumulating toxics and passing them up the food chain, altering waterfowl migration patterns and more.

Lake Pueblo (also known as Pueblo Reservoir) has conditions which may have both positive and negative influence on potential mussel abundance. The rocky topography of the Lake should favor the zebra mussel, but on the other hand the extreme annual water level fluctuation and oxygen depletion in the lower depths of the Lake may be detrimental to the establishment or expansion of zebra mussels. The extent and degree of water temperature stratification of the lake may also be detrimental to zebra mussels in the summer. The loss of nutrient levels in the Lake that could occur with higher mussel infestation levels, may in part be offset by the addition of nutrients that continuously flow from the Arkansas River into the lake during most times of the year.

Yet the degree of change to the fishery at Lake Pueblo is extremely hard to predict without a clear understanding of the severity of zebra mussel infestation that may occur in the lake. From a review of literature and conversations with professionals from infested states, it is clear that mussel infestation and fishery impacts are highly variable between lakes. The combination of physical, chemical, and biological conditions in some lakes tends to favor zebra mussels, while conditions in others do not. Even though there are unknowns, given the evidence that there are reproducing zebra mussels in Lake Pueblo, we should plan for some impacts to the aquatic ecosystem, the hatchery, downstream users and diversions, and the recreation industry of Pueblo Reservoir.

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Treatment and Containment

Short Term Treatment and Containment Options:

Eradication or Treatment within the Lake

Although eradication has been suggested as the means of control at other locations, it is not a viable option at the Lake Pueblo currently.

Chemical Treatment - Chemical treatment is one possibility; however eradication by chemical treatment is highly unlikely. Eradication, by chemical treatment, of a small population of mussels dispersed in a large body of water would have a small chance of success. That small population in a large body of water would also have a difficult time growing. To date, chemical treatment has only succeeded in very small bodies of water. The sole available case study of chemical eradication is from a small quarry in Virginia. This site was treated with thousands of gallons of potassium chloride solution over a three-week period. The salt solution did not pose a threat to humans or the environment but the eradication process cost about $365,000, so the quantity of chemical needed for Lake Pueblo would not be cost effective. At Lake Pueblo, the area to be treated is far too great and the mussel population distribution has not been determined.

Barriers or Biobullets - Curtains or barriers to contain chemical treatment in a local area or using biobullets to localize delivery with chemical treatment are two ways to control a population that have been considered. However, the ratio of cost to potential for success is not favorable. Since little is known about the distribution in Lake Pueblo, attempting to localize the treatment in the North Marina would offer little assurance of treating the majority of the population. This has only been attempted in a few places (such as Darwin Bay, Australia) so there is little track record of success of treatment of this type in large water bodies. Costs would be very high, and considerations for impacts to drinking water and marina operations would have to be carefully considered.

Hand Removal - Removal of mussels with divers is a possibility, but highly unlikely to be successful. If there was a very small finite and localized population then divers could remove mussels by hand or with suction apparatus, however there would be no assurance that this would get a majority of the mussels. This method has been used at a few lakes where chemical parameters suggest that they are not suitable for population explosions, such as Lake George in New York. This is not the case at Lake Pueblo though, since the chemical parameters indicate the lake is suitable for zebra mussels.

Drawdown - Lake drawdown is another possibility; however this would be considerably problematic and costly at Lake Pueblo and would have low probability of success. Legal implications of drawdown are complicated, and no reservoir in the country has successfully eradicated zebra mussels via drawdown. There have been some successful reductions in population size however. The variation in drawdown which occurs from year to year at Lake Pueblo can be as much as 60ft, (18.3 meters) and may help control mussel populations in future years. Certainly it is the top 60 feet (18.3 meters) which tends to support the majority of adult zebra mussels. Exposing this area to desiccation would lead to significant if not total mortality of settled adults in the exposed area, but could leave seed populations at lower levels or on structures. If such a drawdown was to occur, it would be important to remove any buoys, floating docks and watercraft from the lake to make sure that there was no seed population of mussels remaining on such structures until the drawdown was completed. Analyzing dissolved oxygen levels throughout the year at different depths and modeling oxygen behavior during a major drawdown event would be important factors to evaluate the potential success of this method.

Containment through boating policies

Boat Inspections - Recreational boaters have been identified as the primary vector of overland dispersal of zebra mussels, so addressing this route of dispersal is essential. While this longer term plan was in development, a rapid response plan was put in place at the Pueblo State Park to conduct boater education, boat inspections, and acquire boat washing equipment. This 24/7 response is up and running and is fully detailed in Appendix A.

The policies that have been put in place are structured after procedures used at the California and Washington State border stations, as well as Lake Mead National Recreation Area in Nevada and Arizona and in Minnesota and Wisconsin. Utah is also putting in place a similar program to what has been set up in at Lake Pueblo. Watercraft inspection trainers were brought in from Lake Mead, and operations were up and running by this April, before water temperatures reached levels of concern for zebra mussel spawning.

The procedures being used are very conservative on the side of containment and at the current population levels offer a high level of assurance of containment. All trailered watercraft are contacted before they launch and are given a time stamp. When the watercraft come back to the ramps to leave, all are contacted and all those on the water less than 24 hours are given a check to be sure they fully drain, and all on the water longer than 24 hours are fully inspected for mussels. Any boats found to have mussels will be decontaminated with wash facilities that are being widely used in the Southwestern US.

To minimize the spread to other water bodies in Colorado and possibly to other states, continuing to fully support the boat inspection and cleaning program is of crucial importance. Equally important is the planned statewide education and outreach program aimed at recreational boaters and anglers to reduce risks across the state.

As the distribution of mussels in Lake Pueblo is uncertain, it is recommended that inspections are considered for all trailered boats on the way in as well as on the way out of the lake. This step is suggested both because of the potential introduction of quagga mussels, which may have worse impacts, but also because of there is a very low possibility that the zebra mussels which were found in lake Pueblo may not able to establish a founding population. Inspections of boats on the way in would prevent a second introduction in that event. Because there are inspectors in place, it may be beneficial and cost effective to conduct inspections in both directions.

Though decontamination procedures are currently being implemented free to users of the State Park, the State and marina operators at Lake Pueblo may need to consider establishing revenue-generating concessions related to boat washing in the future. Concessions have been used in other states as a way to defer costs and to maintain a sufficient level of response focused on the highest risk vessels.

Containment to prevent infestation of the Lake Pueblo Fish Hatchery

Impact to other Hatcheries - The Willow Beach National Fish Hatchery (NFH), 14 miles (22.5 kilometers) southeast of Hoover Dam has started experiencing significant problems due to quagga mussel infestation. Screens, pipes, wooden boards and walls of the raceways have been colonized and have to be manually cleaned. The hatchery, where 300,000 rainbow trout, 20,000 endangered razorback suckers and 35,000 bonytail chub are raised, could face a cost of 2 million to 5 million dollars to fix if the facility is converted to well water or a treated water supply.

Preventive Treatment Options - As zebra mussel veligers could be drawn into the hatchery at Lake Pueblo, during normal water operations, thereby causing similar impacts as the Willow Beach NFH, it might be cost efficient to consider either filtering the incoming water with small pore self cleaning filters or using a UV system. Alternately the use of ozone as a chemical treatment could be considered. Ozone has a very short half life, so that treatment of water at the point of withdrawal for the hatchery could allow sufficient time for ozone to decay before reaching the fish.

Containment to prevent spread through the Water Diversions

To prevent the spread of zebra mussels through the existing outlets and diversions, evaluations of available technologies versus the risk to assets and increased likelihood of spread should be carried out.
In the short term, the following should be evaluated:

Chemical Treatments - Chlorine, as liquid sodium hypochlorite, or other oxidizing chemical could be added to the drinking water supply lines leaving Lake Pueblo. The chemical addition could be a very simple injection point/diffuser fed from a mobile tanker. The concept would be to add high enough concentration of Total Residual Chlorine (TRC) to induce zebra mussel veligers to close their shell. This in turn would cause the veligers to sink to the bottom of the channel/pipeline. If sediment is present at the bottom, the veligers would likely sink into the sediment and die. Alternately, if the speed of flow is such as to prevent this settlement, the veligers may be carried all the way to the point of flocculation and become part of the sediment to be removed.

Addition of flocculent instead of chlorine at the point of withdrawal should be evaluated for practicality as well as the potential for adding potassium chloride.

In the longer term, another chemical worth noting as potential treatment is ferrate. Ferrate is the anion FeO42- in which iron is in a +6 formal oxidation state (iron VI). This chemical has recently received approval for use in drinking water and tests of impact on zebra mussels are underway.

Non-Chemical Treatments - Two non-chemical technologies which should also be evaluated are the use of small pore self cleaning filters and the use of medium pressure UV systems. The success of these technologies in creating a barrier to zebra mussel spread is dependent on the water quality at the point of withdrawal. High suspended solids make the use of both filter and UV more difficult. In addition, for UV installations, the transmittance characteristics of the water to be treated needs to be tested. Small pore self cleaning filters, using 50 micron absolute (.002 inch) and 100 micron (.0039 inch) absolute screens are currently being tested by the USBR at a site on Lake Havasu.

Antifouling coatings such as copper rich coatings or soft silicone barrier coating can be used on surfaces which would suffer from mussel infestation. However, it should be noted that at this time there is no coating which can be applied underwater. Therefore, any surface to be coated needs to be removed from the water, or a structure must be de-watered, the surface must be fairly dry and clean before the coating is applied. The coating usually consists of a three step process. This makes coating applications both time consuming and expensive.

For critical surfaces which can not be coated, periodic mechanical cleaning will have to be done. Pressure washing of dewatered surfaces is a common strategy. Surfaces which can't be dewatered may have to be cleaned by divers using the scrape and vacuum method. Collected shell material can be composted on-site or disposed of in a landfill. Coordination with affected land management agencies is advised regarding disposal of collected shell material.

Impact to Dam Structures
Assessing the impact to the dam structures will require detailed evaluation beyond the scope of this plan. Reclamation should consider a detailed evaluation to prepare for the problems likely to occur if or when zebra mussel infestation levels rise. Any fixed grates or penetrations in the face of the dam are likely to be the first places obscured by mussel colonies. These should be checked regularly.

Impact of zebra mussel fouling on water seepage and drains, an important aspect of dam safety for earthen dams, should be evaluated by the dam safety team. Unfortunately, there is very little in terms of preventative actions that can be performed at this time, and it is likely this dam will experience some impacts and should anticipate an increase in maintenance costs. Close coordination with USBR staff at Lake Havasu is advised.

Long Term Treatment and Containment Options:

Treatment Possibilities:

Biocontrols - In the long term, it may be possible to reduce population growth in the lake with the use of a microbial biocontrol currently undergoing registration. This product, based on naturally occurring *Pseudomonas* bacteria is being tested for commercial application specifically in pipelines and other water movement structures by Marrone Organic Innovations. The product is very specific to Dreissenid mussels and there is every expectation of successful registration in the near future. Given the size of Lake Pueblo however, the cost and effectiveness of application still may be impractical.

Chemical treatments – As surveying results elucidate the location and size of the population of zebra mussels in Lake Pueblo, it may become possible to consider chemical treatment as a way to keep the population low. However in a reservoir the size of Lake Pueblo, it still would likely not be cost effective. Barriers or curtains may be ways to localize chemical treatment, but would offer almost no chance of eradication, only some population control.

Containment through changes to boating policies

Boating during Population Explosion - Monitoring larval densities throughout the next few summers will provide critical information to inform State Parks and Division of Wildlife on the likely effectiveness of the education and inspection program for containment. If high densities of larvae are observed in mid-summer, then there will be a short period of 2-4 weeks before settlement begins to occur in mass.

This would be a critical time period to re-evaluate policies. It is likely that more boats would need to be inspected and washed if this occurs. Changes to consider should include:

- A significant increase in inspection/washing facilities and staff
- Shortened period of day use such that higher number of boats are carefully inspected for mussel attachment
- Setting a reduced boating capacity to allow for better correspondence between staffing and facilities and numbers of boaters.
- Washing more boat and considering chemical treatment of water left in the boats
- Development of boat rental facilities, as boats that stay on the lake do not present a risk of spread.
- Limiting access to only those ramps that can be monitored or adequately staffed

References:

Claudi Renata & Gerald L. Mackie Practical Manual for Zebra Mussel Monitoring and Control Lewis Publishers, ISBN 0-87371-985-9, 1993

O'Neill, Charles, Jr. "The zebra mussel: Impacts and Control" New York Sea Grant, Cornell Cooperative Extension, Information Bulletin 238. 1996.

Survey/Monitoring/Detection

Survey and Monitoring will be a key component of the response at Lake Pueblo.

Monitoring Plan Summary:
Sampling at Lake Pueblo will be a joint program coordinated by Vicki Milano at CDOW, Denise Hosler at Reclamation and Dr. Scott Herman from Colorado State University (CSU). State Parks will assist as needed.

- **<u>Plankton Sampling:</u>** CDOW will conduct plankton tows every two weeks. These will be triplicate samples for cross polarization microscopy; one for CDOW, one for Reclamation, and one for Pueblo-CSU. These samples will be taken from 6 sites at the reservoir and at the hatchery intake. Reclamation will also conduct sampling and may alternate between the CDOW sampling periods. Reclamation did their first sampling in May, 2008, and CDOW in June 2008. Next year sampling will occur between April and November of 2009.

- **<u>DNA Verification:</u>** All samples with veligers will be confirmed by PCR by two labs - CDOW will use one lab and Reclamation another lab.

- **<u>Water Quality Monitoring:</u>** CSU will be taking water quality parameters once a month and will coordinate their schedule with CDOW sampling times. CSU will also take downstream samples, including plankton tows, if veligers are found at the hatchery. If mussels are found in John Martin, sampling sites will be established on the Arkansas River between the 2 reservoirs and CSU will do the plankton tows.

- **<u>Substrate sampling:</u>** CDOW will check the deployed substrates every 2 weeks. Reclamation may also deploy additional substrates for additional studies of substrate sampling efficiency.

<u>Background</u>
An Aquatic Nuisance Species (ANS) survey program was designed by the Colorado Division of Wildlife (CDOW) in April 2004 to determine distribution of aquatic invertebrates and the presence/absence of ANS in Colorado. The objective of this survey was to establish baseline data and monitor impacts of ANS introduction. It was also designed to provide early detection of ANS and enable rapid response. Initiation of full-scale surveys began in earnest in November 2005 after the report of New Zealand mudsnails, *Potamopyrgus antipodarum*, in Boulder Creek. During the remainder of 2005-2006, approximately 65 mollusk and crustacean collections were made by various CDOW aquatic personnel and cooperators in addition to about 50 surveys by Aquatic Animal Health Laboratory (AAHL). Colorado State Parks joined survey efforts in May 2006. A total of 140 surveys were conducted, not including return trips to monitor substrates in 2006. In 2007 approximately 144 collections were made.

Several sites within each major river drainage of Colorado were selected based on boating and angler activity. These sites were surveyed 1-3 times within a six-month period. All sites were normally searched for at least one person-hour. The surveyor searched for mollusks, crayfish and ANS in suitable aquatic habitats -- among vegetation, on sticks, and rocks, on exposed sandbars, and under overhanging trees or overhanging banks. All live specimens were immediately placed in jars or vials partly filled with 70% ethanol and labeled with the site name and date. A data sheet was also filled out with location and ecological data. If the site appeared suitable for crayfish, crayfish traps baited with chicken were strategically placed and the traps were retrieved the next day. Concurrently, zebra/quagga mussel substrates were placed in key reservoirs and checked monthly. During the first 2 years of the survey Portland State University substrates were employed. Substrates designed by

USBR were used in subsequent years. These substrates were attached to boat docks, marinas, or buoys. Many native mollusks and crustaceans were catalogued and subsequently donated to the Invertebrate Collection at the Colorado University Museum. Plankton tow sampling was added to the survey in 2007 to examine for the presence of zebra/quagga mussel veligers. Guidelines are provided by USBR in their publication titled *Collecting Water Samples For Dreissena spp. Veliger PCR Analysis* (See Appendix K).

From May 8, 2006 through January 16, 2008, Lake Pueblo was surveyed eight times. On November 7, 2007 two adult mussels were found on a substrate by a CDOW seasonal employee. The substrate had been placed at the North Marina on September 17, 2007. The employee had to remove the mussels from the substrate with a pair of forceps since they were firmly attached. She tentatively identified the mussels as belonging to the genus *Dreissena*. A plankton tow water sample was also taken in the same area on November 7, 2007. The samples were preserved in 70% ethanol and examined by the seasonal employee's supervisor and a USBR employee on November 21, 2007. During transport, the adults became heavily covered with fungus, possibly a result of not being preserved in a timely fashion. Due to the presence of fungus, it was difficult to make a confirmatory identification. Since the tissue was so degraded, it was decided to have DNA analysis run on the adults. No absolute identification of the species of the two mussel samples was possible because they were extremely degraded and covered with fungus.

The plankton tow water sample was also examined at the same time using cross polarization microscopy. One veliger was identified in the examination. On January 14, 2008, this sample was confirmed by DNA analysis to be zebra mussel.

Zebra Veliger Monitoring Protocols

Sampling for veligers provides the earliest warning of zebra mussel presence at a site. It is an expensive and labor intensive form of monitoring as it requires microscope work by trained personnel. Cross polarization microscopy is the recommended technique for microscope sample processing.

USBR's protocol *Collecting Water Samples for Dreissena spp. Veliger PCR (Polymerase Chain Reaction) Analysis* provides guidelines for veliger monitoring (See Appendix K). Sampling will involve the clearance of at least 1000 liters (264 gallons) of water through the filter. When collecting water samples in shallow water, equipment must be at least one foot (0.3 meter) from the bottom, and sediment must be kept out of the sampling gear. In deeper water, sampling should be done below the photic zone if possible, but always above the thermocline. Additional habitat data such as water depth, temperature, calcium concentration, pH and dissolved oxygen is taken in order to track long term changes in veliger populations.

Plankton tow sampling for veliger detection will be performed every two weeks at both marinas, the dam, the canal outlet, settling basins, Pueblo State Fish Hatchery and the two Colorado Division of Wildlife boat launches. At least 3 replicates are taken from each habitat site. All water samples collected shall be preserved with 25% ethanol or grain alcohol. The container is clearly labeled with site name and date.

Adult Zebra Mussel Monitoring

Adult zebra mussel monitoring serves several purposes:

(1) To track the spread by collecting additional data on lakes where veliger monitoring is not being conducted; (2) to verify a reproducing population if veligers have been identified as being present in a water sample; and, (3) to determine the population densities of mussels after an infestation has occurred.

Photographs of mussels when found on substrates, particularly before they are detached, will be important as inexperienced surveyors or the public may report Asian clams.

Two methods can be used for adult zebra mussel monitoring:

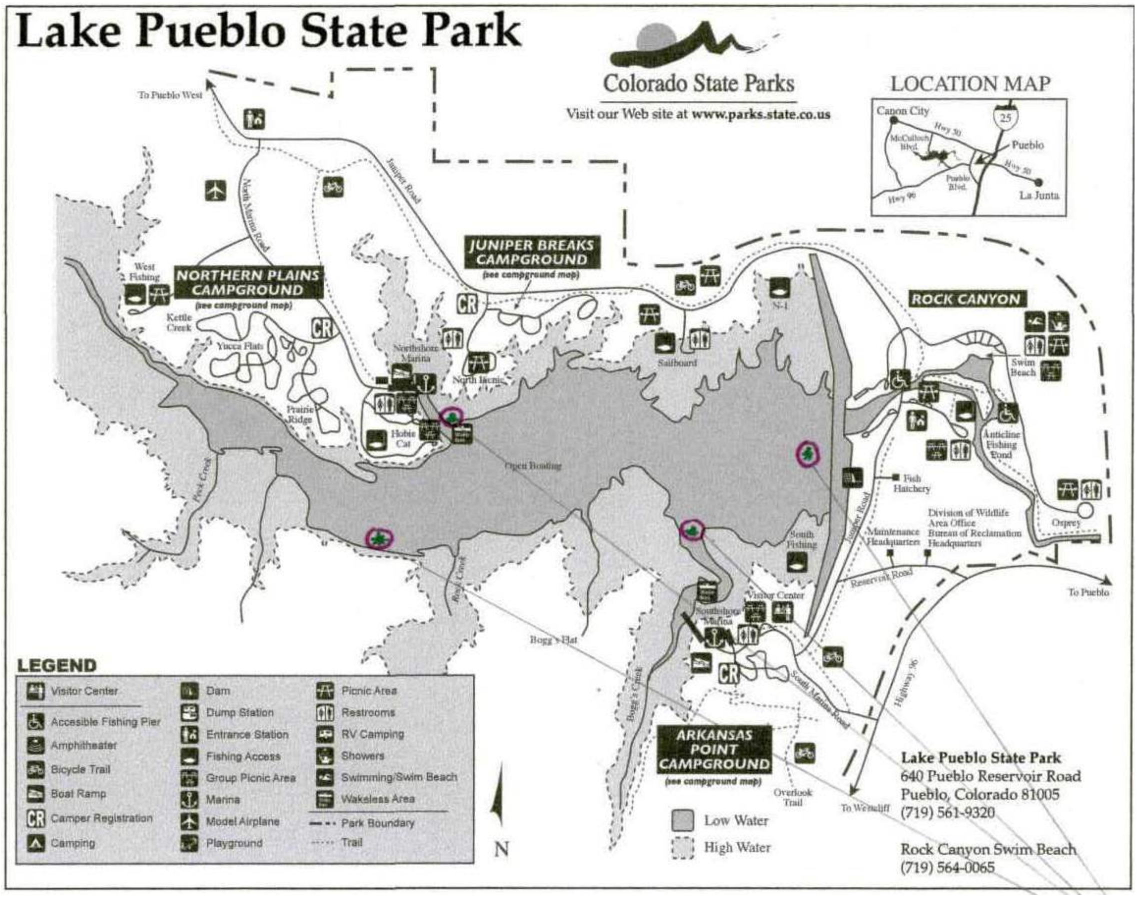
1. **Shoreline surveys**- Regular inspections of structures in the water can determine the presence/absence of zebra mussels. A single observer can monitor large areas of substrate at a given location in a short period of time.

    - Surveys should be conducted about once every two weeks.
    - Target areas should be around public boat ramps or areas that are likely to have a lot of boating traffic in the vicinity.
    - Any solid surface is a suitable substrate to observe. Rub your hands along some of the submerged surfaces. Zebra mussels on the surface will feel like sandpaper.
    - Check docks, piers and buoys.
    - Zebra mussels do not like direct sunlight and are more often found on the underside of rocks and in cracks and crevices of rocks and structures. Small zebra mussels can be attached to plants as well.

2. **Artificial Substrate monitoring -**A substrate is any substance in the water that zebra mussels may attach to. Substrates will be placed at both marinas, the dam, the canal outlet, settling basins, Pueblo State Fish Hatchery and the two Colorado Division of Wildlife boat launches. They will be checked every two weeks by USBR, State Parks or CDOW personnel. Several types of substrates (USBR design, tile, glazed flower pot) will be used for a side by side comparison.

    - Place the substrate in an area where there will be little chance of vandalism. Obtain written permission from marina owner prior to placement.
    - Hang the substrate from a dock, pier, buoy or other structure found in the water. An existing float or buoy may be used to suspend the substrate in the water column.
    - Avoid placing substrate in areas where there is a strong current.
    - Put three substrates at each location chosen for monitoring.
    - Suspend the substrates at 10’ (3.05 meters) intervals

Fig. 4- Locations of artificial substrate samplers and plankton tow sampling in Lake Pueblo. Locations circled in purple represent multiple samples in these areas.



For tracking the movement of zebra mussel infestations, a negative report is as important as an actual finding of zebra mussels at a location. All monitoring efforts should be reported. All DNA confirmation should be confirmed by two labs, for instance the Reclamation lab and an independent lab such as Pisces Molecular that was used for the first veliger confirmation at Pueblo.

Sampling Equipment Decontamination

Preventing the spread of zebra mussels to non-infected waters is the top priority during surveys. Depending on the equipment, there are various techniques that can be employed. It is critical that the appropriate decontamination technique be used no matter how time consuming. Prior to field deployment, each member of the survey team shall be advised as to what decontamination methods will be used for their gear. The sampling team coordinator will be responsible for oversight of decontamination (See Appendix J and K for Decontamination Procedures).

Survey Training

Training is an essential key to education about the target species, consistent survey methodology and decontamination procedures. All personnel assigned to zebra mussel surveys will complete training prior to being deployed on surveys. All staff assisting with the project need to understand their roles in the project and how to not spread invasive species during field work. Additionally, information will be provided on the other invasive species, such as quagga mussel, New Zealand mudsnail and Eurasian watermilfoil.

Mapping
The survey will require extensive use of GIS to coordinate the various components of the project. The tracking of field activities will be coordinated using hand-held Trimble GPS units preloaded with maps of the appropriate survey area. Personnel will keep the GPS turned on and tracking at all times to aid in finding the proper survey location, and to document the survey path taken and to highlight any areas missed. All GPS units will be downloaded at the end of the day to update the strategy team. This is invaluable to ensure all target areas have been checked and allows to visually depict gaps in the coverage. GIS capacity will also allow producing high quality, informative products to distribute to agencies and the public to describe our activities and the current status of the project.

Conclusions

In conclusion, the population growth of zebra mussels at Lake Pueblo has a high degree of uncertainty. It is the first population in Colorado and was, at the time of discovery, the highest elevation population. However the chemical and temperature characteristics suggest that it has explosive population potential, such as has been seen with zebra mussels in reservoirs in Kansas and with quagga in the Southwestern US.

The altered boating policies put in place by State Parks and the Division of Wildlife provide a high level of containment given what is currently known about the population size of the mussels in the Lake. However, these policies should be carefully re-evaluated if monitoring indicates an exponential growth phase.

Treatment or eradication of zebra mussels within the lake does not appear to be feasible at this time. There has been virtually no success in large water bodies across the country with chemical, manual or water drawdown methods. Containment and prevention of new infestations is the best strategy.

Monitoring of larvae within Lake Pueblo and at downstream locations will be critical to determine appropriate levels of response to continue a containment approach. Further study of lake parameters such as dissolved oxygen levels will help with determining if treatment or control methods will become more feasible over time.

The impact to the dam and other facilities should be assessed in detail, but it is likely there will be increased maintenance costs at this facility if the mussels go through an explosive growth phase.

Some preventative measures and treatment could be considered at the fish hatchery and chemical treatment methods could be considered in the water diversions. These may prove cost effective when weighed against potential impacts.

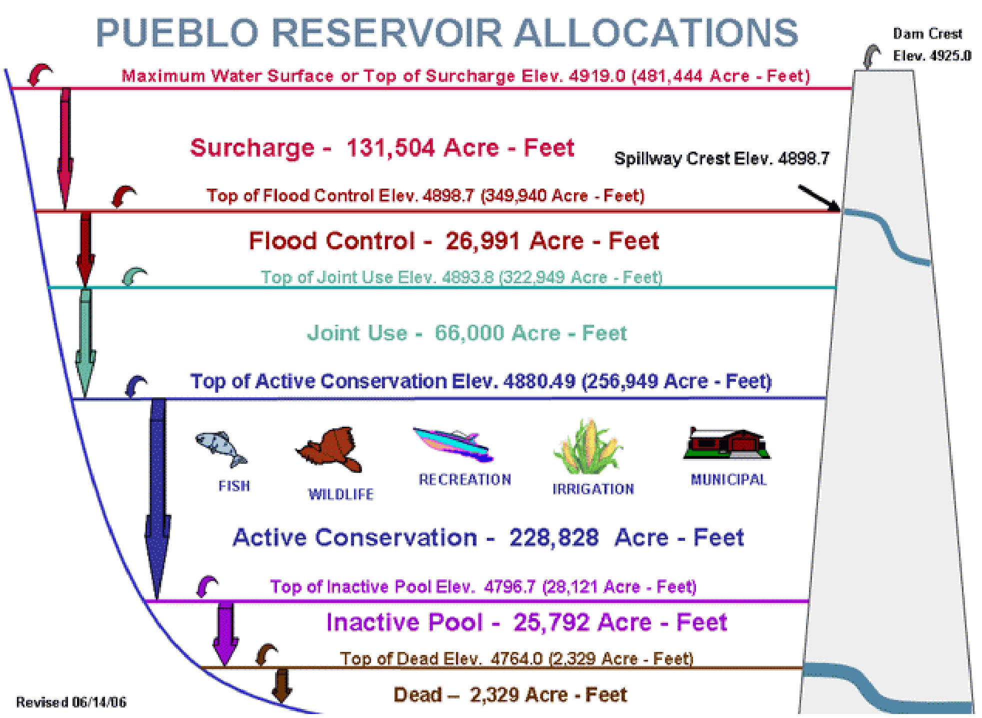
Future treatment possibilities with biocontrols show some potential, but as these controls will be patented, it is not yet clear whether costs of control in a large lake will be economically practical.

Statewide education efforts will be critical in Colorado to ensure new infestations do not occur, as introduction of zebra or quagga mussels from other states will be an increasing possibility over the coming years.

APPENDIX A.

Lake Pueblo: Hydrology and Statistics

Figure A1. Pueblo Reservoir Pool Diagram



Lake Pueblo

Lake Pueblo, also known as Pueblo reservoir, is approximately 4,646 surface acres (1,880 hectares) in size at ordinary high water, with approximately 60 miles (96 kilometers) of shoreline. The Lake has a total storage capacity of 349,940 acre-feet:

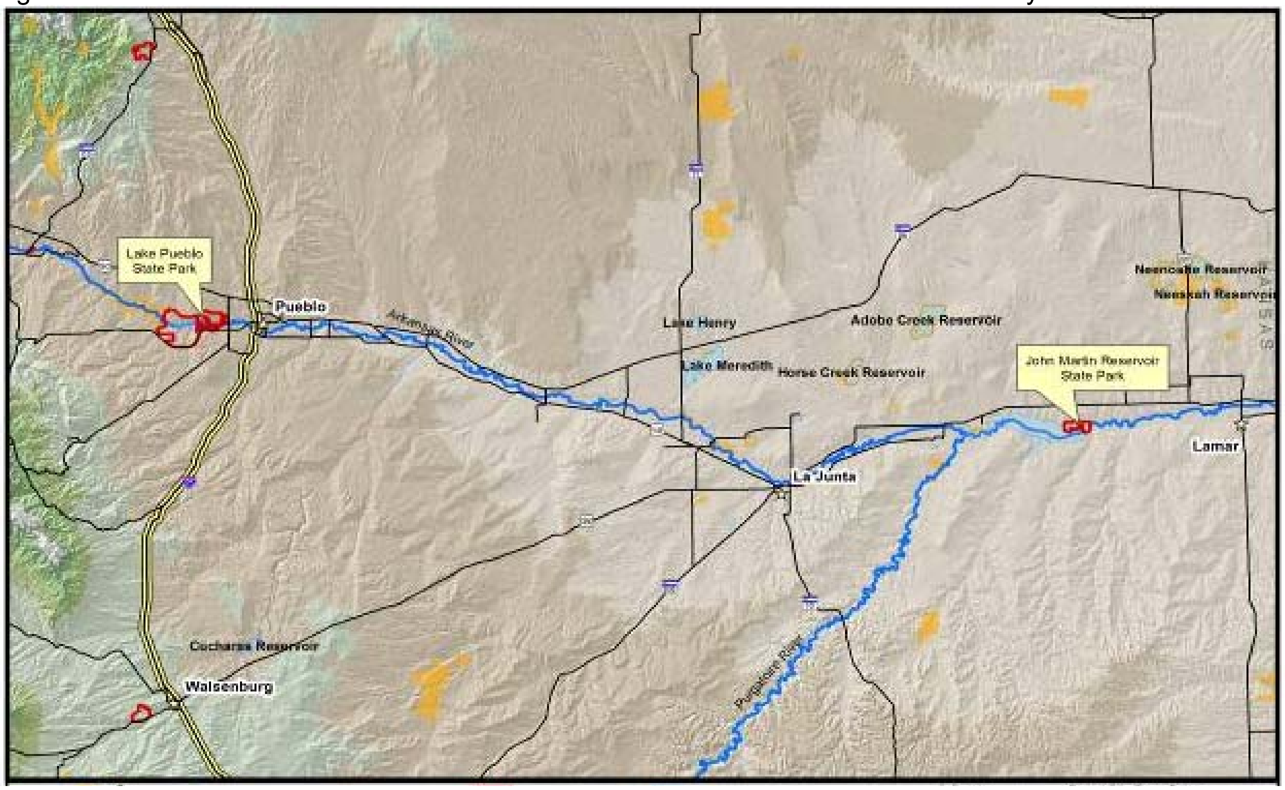
- 28,121 acre-feet of dead and inactive capacity
- 228,828 acre-feet of conservation capacity
- 66,000 acre-feet of joint-use capacity, and
- 26,991 acre-feet of exclusive flood-control capacity.

On June 17, 2008 at pool elevation of 4,873.71 feet, (1,490 meters) Lake Pueblo was approximately 11.4 miles long (18.3 kilometers) and averages a width of 0.8 miles (1.2 kilometers). At its deepest point it is 119 feet (36.3 meters) deep. At the North Marina it is approximately 85 feet (25.9 meters) deep, at the South Marina it is 81 feet (24.7 meters) deep.

The total Arkansas River drainage area above the dam is 4,669 square miles (37,992 square kilometers). Water stored in Lake Pueblo is used by at least 80 different entities. Its largest storage components are water diverted in the Colorado River basin as part of the Frying Pan - Arkansas Project and water stored by agricultural ditch companies east of Pueblo as part of the Winter Water storage program.

Flows out of Lake Pueblo can range from 50 cfs (1.42 cubic meters per second, cms) in the winter months to a maximum allowed flow of 6,000 cfs (170 cms) during spring runoff. Typical summer flows are in the 500 to 2000 cfs (14.2 to 56.6 cms)range. The amount of water released from Pueblo Dam is determined not just by native flow, but also releases of account water, storage into accounts, and exchanges into and out of the Lake.

Fig. A2- Lake Pueblo State Park and John Martin Reservoir State Park are connected by the Arkansas River



THE ARKANSAS RIVER

After release from Pueblo Dam, water in the Arkansas River travels approximately 206 river miles (332 kilometers) before reaching the Colorado/Kansas state line. In that distance the water connects with seven off-stream reservoirs, is diverted by more than twenty farm ditches, and passes directly through John Martin reservoir. Its main uses are agricultural, followed by industrial and municipal uses. However, it is not used as a municipal source downstream of the City of Pueblo. In all but the highest flood years, the Arkansas River dries up before Garden City, Kansas, and never connects with the complete Arkansas River drainage.

PUEBLO DAM

Pueblo Dam is a composite concrete and earthfill structure, about 10,200 feet (3,110 meters) long at the crest elevation of 4925.0 feet(1,500 meters). The concrete section has a structural height of 250 feet (76.2 meters) and a hydraulic height of 191 feet (58.2 meters). The earthfill portions consist of the left and right abutment embankments, totaling 8,450 feet (2,580 meters) in length. The concrete dam consists of 23 massive-head buttresses which total 1,750 feet (533 meters) in length. It has a 550-foot (166 meters) verflow spillway section and a 1,200-foot (366 meters) non-overflow section. The uncontrolled overflow spillway has a crest elevation of 4898.7 feet (1,490 meters) and is located in the overflow section of the buttresses. The spillway consists of a concrete ogee crest, training walls, flip bucket, stilling basin, and an outlet channel. The spillway design flow is 191,500 cfs (5,420 cms) at reservoir elevation 4,919.0 feet (1,500 meters).

DAM OUTLETS

Five separate outlets operate at Pueblo Dam:

1. The river outlet consists of one metal trashrack on the upstream face of the dam, one 4' by 4' (1.22 meter x 1.22 meter) stainless steel conduit, and two 4' by 4' (1.22 meter x 1.22 meter) high pressure slide gates in tandem located in Buttress 16 over the streambed. The maximum discharge of the River outlet is 1,120 ft3/s (31.7 cubic meter per second).

2. The spillway outlets consists of three 6' by 6.5' (1.83 x 1.98 meters) conduits located in Buttresses 9, 11, and 13 of the spillway section. Each spillway outlet works consist of one metal trashrack structure on the upstream face of the dam, one 6' by 6.5 steel conduit, (1.83 x 1.98 meters) and two 6' by 6.5'(1.83 x 1.98 meters) high pressure gates in tandem located in the gate chamber in the dam. The combined maximum discharge capacity is 8,190 ft 3/s (232 cubic meter per second).

3. The fish hatchery outlet works located in Buttress 8 consists of four intakes at various elevations, three metal trashracks structures protecting the intakes, two butterfly valves on each line in the gate chamber, and four 30" (76.2 centimeters) mortar lined pipes merging into a single 30" (76.2 centimeters) pipe that extends 2000' (610 meters) to the fish hatchery. The maximum discharge rate is 30 ft3/s (0.85 cubic meter per second).

4. The south outlet works consists of three level intake lines which are used for controlling water quality and a single level intake for emergency use, all located in Buttress 7. The three level intake line consists of three intakes at various elevations, a metal trashrack structure at each intake, two slide gates on the upstream face of the dam for the upper two intakes, one butterfly valve in each of the upstream and downstream gates chambers , and one 48" (122 centimeter) diameter pipe. The single level intake line consists of a metal trashrack structure at the intake, one butterfly valve in the upstream gate chamber, and 48" (122 centimeter) diameter pipe. The 48"(122 centimeter) lines run into a 120" (3.05 meters) manifold line that supplies a maximum discharge of 359 ft3/s (10.2 cms)to municipal and industrial water customers.

5. The Bessemer Ditch, located in the right embankment, consists of an upstream 7' (2.13 meters) diameter pressure conduit, four 3.6" by 3.6" (9.14 cm x 9.14 cm) high-pressure gates, and a downstream conduit with a radius of 4.9' (1.49 meters). The maximum discharge of the Bessemer outlet is of 393 ft3/s (11.1 cubic meter per second).

Additional installed equipment includes two 500 GPM (1.89 cubic meters per minute) sump pumps, reservoir level gage, gate filling and vent lines, form drains, foundation drains, and piping for instrumentation.

APPENDIX B:
Lake Pueblo Rapid Response

The following rapid response was implemented in April, 2008.

BACKGROUND

Lake Pueblo State Park is one of Colorado's most popular State Parks. Located on the Arkansas River in the northwestern Pueblo County, the park is within two hours of Denver and Colorado Springs. It is about six miles (9.66 kilometers) upstream and on the western edge of the Pueblo metropolitan area and abuts the eastern slope of the Rocky Mountains. Abundant recreational opportunities including fishing, boating, sailing, water-skiing, camping, hunting, hiking, bicycling, swimming, and wildlife viewing are available. The park's low elevation (4,900 feet) (1,490 meters), convenient locale, and numerous outdoor recreation opportunities attract around 1.6 million visitors each year. Projected expenditure by park visitors in FY03/04-$16,658,313 (*Source: Colorado State Parks Market Assessment Study, 2002).*

Pueblo Dam and Reservoir (also known as Lake Pueblo) are major features of the Park. They were planned and built by the Reclamation as part of the Frying Pan-Arkansas River Project. Lake Pueblo, with 60 miles (96.6 kilometers) of shoreline and 4,646 (1,880 hectares) surface acres of water at capacity, is one of the largest bodies of water along the Front Range and the largest body of water within a 100-mile (161 kilometer) radius. The Lake provides terminal storage for imported project water from the Colorado River Basin on the Western Slope, and native flows to the Arkansas River. The dam and Lake regulate water for supplemental irrigation, municipal and industrial water to the city of Pueblo, Colorado Springs, surrounding areas, and downstream communities, and provides flood control, recreation, conservation, and the development of natural resources.

Lake Pueblo State Park is 11,318 acres (4,580 hectares) in size, with 4,646 (1,880 hectares) surface acres of water. Colorado State Parks leases 2,160 acres (874 hectares) from the Bureau of Land Management (BLM), and manages an additional 4,512 acres (1,830 hectares) of land and the 4,626 water acreage (1,880 hectares)

The Colorado Division of Wildlife currently manages a Wildlife Area on the west side of Lake Pueblo and has two established boat ramps on the north side. Historical use of the ramps has been small water craft, hand propelled, canoes, kayak and small motor boats, 50 hp (37.3 kilowatts) or less.

ISSUE:

Lake Pueblo State Park management staff was notified on January 14, 2008 that samples taken from Lake Pueblo in November, 2007 had been confirmed as zebra mussels through DNA testing. Since notification, management staff has been working cooperatively with State Park biologists, CDOW, and Reclamation to plan, develop, and implement actions to prevent or slow the spread of zebra mussels to other waters of the State.

Currently the CDOW boat ramps are closed until further notice and completion of the Lake Pueblo Response Plan. Shoreline launching is allowed within the State Park for hand-launch day use craft only with education and enforcement by roving Park rangers. Colorado State Parks boat ramps remained open, as this is where the majority of boats are launched and where staff could be deployed immediately for inspections.

POTENTIAL IMPACTS on VISITATION

Many factors affect the number of visitors to Lake Pueblo State Park. Among them are:

1. **Fluctuating Water Levels**
   Since Lake Pueblo is a major reservoir and source of supplemental irrigation, municipal and industrial water, its water levels fluctuate throughout the year. In wet/good water years, when the reservoir is filled to capacity, water demands downstream can draw down of 10-15 feet (3 - 4.5 meters) in elevation annually. In dry/drought years such as 2002-2005, the annual draw down can reach 55-60 feet (16.8 – 18.3 meters in elevation).

2. **Weather Conditions**
   Visitation, which is highest on weekends, can drop significantly during wet/rainy or hot/dry weather conditions. Storms accompanied by rain/snow, high winds, and cooler temperatures along with fire bans during hot/dry weather conditions also reduce weekend visitation.

3. **Social/Economic**
   Visitation patterns can be affected by changing social and economical factors. Longer school terms with earlier start dates in mid-August and ending dates in early June have shortened the "typical" high-use recreation season. Economic impacts such as higher fuel prices, increases in recreational equipment cost, user fees, and associated costs can affect visitation patterns.

   On the other hand, population in the Pikes Peak/Pueblo region has dramatically increased, which may explain the nine percent increase in FY08 visitors (1.8 million) over FY07 (1.6 million.

   Visitors to Lake Pueblo directly affect the local economy, contributing $37 million annually (Price Waterhouse Coopers Market Assessment study).

4. **Zebra Mussels**
   In addition to the above traditional factors which impact visitation, the addition of the zebra mussel factor may have an impact on the annual visitation numbers at Lake Pueblo. Mussels may affect the reservoir fishery,; resulting in increased fees related to boating and containment efforts, requirements of vessel inspection and decontamination processes, education of boaters in de-watering their vessels, restrictions on launching areas etc. The result may be increased fees and wait times to launch or retrieve vessels, which may affect boater expectations and experience.

   It is anticipated that initial zebra mussel containment efforts may result in a temporary reduction of boater visitation to the park. However, with good education efforts, streamlining of the inspection/decontamination program based on a lesson learned/best management practices approach, and proper funding, it is anticipated that boating visitation will recover and potentially increase as boaters become familiar and comfortable with the containment process and requirements.

<u>Operations and Funding</u>
As a major water based recreation area along the front range and particularly the Pikes Peak Region, Lake Pueblo State Park has a large scale operations program to serve the annual 1.6 million park visitors. The zebra mussel containment program is complex and is in addition to the existing park operation.

The management of this new program cannot be absorbed by the existing program resources. As such, the zebra mussel program will be treated as a separate program from existing park operation programs, requiring separate funding, staffing, implementation, and more.

SHORT TERM CONTAINMENT AT LAKE PUEBLO

Based on biological recommendations and similar actions taken in other States, an operation plan for Lake Pueblo State Park has been developed. The plan includes a public education component for aquatic nuisance species, particularly zebra mussels, their impacts, and prevention; a date/time stamp component using the standard of 24 hours or more on the waters of Lake Pueblo as a trigger for mandatory inspections; an inspection component for vessels coming to and/or leaving the waters of Lake Pueblo State Park; a decontamination component, and an enforcement component to insure compliance with Colorado laws and regulations. A description of each component follows:

1**. Education Component (See Attachment A)**
The foremost component of prevention is education. Lake Pueblo State Park and its partners must continue to highlight the threat of aquatic nuisance species, particularly zebra mussels, their impacts, and prevention with visitors, the media, and park stakeholders at every opportunity. Visitors will be educated in a variety of ways: at the entrances, visitor center, through signage, brochures/flyers, roving rangers and boat ramp staff, the news media, Colorado State Park website, boating clubs, marinas, and more.

Key messages are:

1. Clean, Drain and Dry Boats between water bodies.
2. When taking boats and equipment out of the water at any lake:
    - Drain water from the motor, live well, and bilge on ramp.
    - Completely inspect your vessel and trailer, removing any visible mussels, but also feel for any rough or gritty spots on the hull. These may be young mussels that can be hard to see.
    - Remove any vegetation and mud attached to the equipment.
    - Air-dry the boat and other equipment before launching in any other waters.
    - Do not reuse bait once it has been in the water and allow all fishing tackle to air dry before fishing in other lakes and streams.
    - Visit www.100thmeridian.org and www.ProtectYourWaters.net to find more information about zebra mussels and other aquatic nuisance species.
    - Click here to watch a video on how to clean your boat (link to http://www.100thmeridian.org/Video/Clean.asp)
3. Report zebra mussel finds to the park immediately!

2. Date/Time Stamp Component (See Appendix G)

All vessels unloading and load at the boat ramps will receive a date/time stamp card. If vessels are on the waters of Lake Pueblo for 24 hours or more, a mandatory inspection of the vessel, trailer, and equipment will be completed by trained staff inspectors at inspections stations.

3. Inspection Component (See Appendix H)

Inspections for zebra mussels on or contained within watercraft, on watercraft hauling vehicles and trailers, and on water-related recreational equipment will be conducted at inspection areas following the procedures outlined in the Colorado State Park Aquatic Nuisance Species Inspection and Education Handbook.

4. Decontamination Component

If identified through the Inspection Component, all vessels requiring decontamination will be directed to an approved decontamination station. Decontamination will be conducted by park staff following approved decontamination procedures.

5. Enforcement Component

Prevention requires the establishment and support of inter-jurisdictional law enforcement to ensure compatibility and consistency among local, state and federal authorities.

APPENDIX C:
Lake Pueblo State Park Operations Plan: Logistics/Tactics

The Lake Pueblo Operations Plan covers a nine month period between March 1st and November 30th of every year. It is based on the following assumptions:

- The park will remain open to boating 24 hours a day during the nine month period
- overnight mooring, beaching and anchoring is permitted
- there will be 24/7 staffed coverage at both boat ramps to provide education, conduct inspections, and provide decontamination as necessary
- shorelines will be patrolled to ensure compliance with new policies, laws, and regulations.

During the nine month period, Lake Pueblo Staff will:

1. Implement watercraft inspections for zebra mussels throughout the nine month period to insure compliance with regulations and policies.

2. Educate the public about aquatic nuisance species, particularly zebra mussels, their impacts, and prevention as well as distribute educational or outreach materials on invasive species.

3. Date/time stamp vessels at the boat ramps.

4. Conduct approved inspections for zebra mussels on or contained within:

    - watercraft at boat ramps.
    - watercraft hauling vehicles and trailers at boat ramps.
    - water-related recreational equipment at boat ramps.

5. Decontaminate boats, trailers, and water-related recreational equipment as needed at decontamination stations when installed.

6. Ensure compliance with Colorado laws and regulations.

7. Recruit, train and supervise twenty seasonal rangers on how to:

a) Educate the public regarding aquatic nuisance species, particularly zebra mussels, their impacts, and prevention as well as distributing educational or outreach materials on invasive species as needed;
b) Date/time stamp vessels at the boat ramps;
c) Conduct approved inspections for zebra mussels on or contained within watercraft at boat ramps;
d) Conduct approved inspections for zebra mussels on: watercraft hauling vehicles , trailers , and water-related recreational equipment at boat ramps;

   e) Decontaminate boats, trailers, and water-related recreational equipment as needed at decontamination stations; and
   f) Ensure compliance with Colorado laws and regulations.

10. Recruit, train and supervise nine seasonal entrance attendants how to:
   a) Educate the public aquatic nuisance species, particularly zebra mussels, their impacts, and prevention as wells as distributing educational and outreach materials on invasive species as needed.

11. Recruit, train and supervise seasonal maintenance workers how to:
   a) Educate the public regarding aquatic nuisance species, particularly zebra mussels, their impacts, and prevention as wells as distributing educational or outreach materials on invasive species as needed;
   b) Date/time stamp vessels at the boat ramps;
   c) Conduct approved inspections for zebra mussels on or contained within watercraft, watercraft hauling vehicles, trailers and water-related recreational equipment at boat ramps;
   d) Decontaminate boats, trailers, and water-related recreational equipment as needed at decontamination stations;
   e) Maintain informational and educational signage; and
   f) Maintain decontamination equipment.

12. Cooperate with continued biological sampling and monitoring for zebra mussels in Lake Pueblo.

13. Design and update printed education materials on aquatic nuisance species, particularly zebra mussels, their impacts, and prevention as needed.

14. Maintain and update Lake Pueblo's website on aquatic nuisance species, particularly zebra mussels, their impacts, and prevention.

15. Maintain informational and education signage.

16. Maintain decontamination equipment.

17. Conduct media coordination and advertisement to ensure public awareness of the threat from aquatic nuisance species, particularly zebra mussels, their impacts and prevention.

APPENDIX D:

STATE PARKS BUDGET ESTIMATES

A zebra mussel containment program was developed for Lake Pueblo State Park based on the following assumptions: containment program will operate over a nine-month period between March 1st and November 30th of every year, the park will remain open to boating 24 hours a day during the nine month period; overnight mooring, beaching and anchoring is permitted; there will be 24/7 staffed coverage at both boat ramps to provide education, conduct inspections, and provide decontamination as necessary; shorelines will be patrolled to ensure compliance with new policies, laws, and regulations.

To implement and maintain an Annual Containment Program, $926,414.91 will be required for staffing and operating. Costs are outlined below.

Item	PUE Cost
FTE Staffing	157,614.00
Seasonal Staffing	704,100.91
Operations	57,200.00
Utilities - water, electric, nat gas	7,500.00
Subtotal Personnel, OPS, Util, SWP	$ 926,414.91

A minimum of $535,900.00 will be required in capital equipment to implement an Annual Containment Program Costs are outlined below.

Capital Costs	PUE Cost
Boat Wash Station	300,000.00
Signage, hardware and posts	8,000.00
Traffic Cones with signage	6,500.00
Barriers	6,000.00
LE Equipment to outfit seasonal lease vehicles	8,000.00
Variable Message Signs	54,000.00
Mobile Radios @$4500 each	27,000.00
Portable radios @ $3000 each	45,000.00
MDT's - LE computers in vehicles	11,400.00
Lights @ inspection stations	70,000.00
Subtotal Capital Costs	$ 535,900.00

BOATING INFRASTRUCTURE AND STATISTICS

Lake Pueblo State Park has two six-lane boat ramps and two marina concessionaires with a capacity of 800 slips. According to the most recent Price Waterhouse Coopers Market Assessment study, 64% of our visitors participated in motorized boating. No surveys or studies have been completed to date to accurately record the number of boaters.

Appendix E:
Educational Fliers

ALERT!

Stop the spread of

ZEBRA MUSSELS

CLEAN • DRAIN • DRY

Stopping their spread is critical to protect boating and fishing.

- These invaders **reproduce quickly** and once established, they cannot be eliminated.
- They can **damage boat motors, steering components** and cooling intakes.
- They can cause **millions of dollars in damage** to fisheries, recreation and water systems.
- They can spread by **attaching to boat hulls** or being **transported as larvae in water** (through bilge, ballast or live wells).

For additional information please contact:

Colorado State Parks

303-866-3437 303-297-1192

National Invasive Species Hotline
1-877-786-7267

CLEAN • DRAIN • DRY

ALERT!

Stop the spread of

ZEBRA MUSSELS

CLEAN • DRAIN • DRY

Before moving your boat to another body of water:

CLEAN → Remove all plants, animals, mud, and thoroughly wash everything coming into contact with the water.

DRAIN → Drain all water before leaving the area, including wells, bilge, ballast, and any other areas of your boat holding water.

DRY → Allow everything to completely dry before launching into another body of water.

BAIT → Dispose of unused live bait in the trash.

PWC → **(PERSONAL WATERCRAFT)**
- Do not run through aquatic plants.
- When loading, push or winch the PWC onto the trailer without running the engine.
- After loading, run the motor for 5–10 seconds to blow out excess water and contaminants.
- **Clean, drain, dry.**

**REPORT ANY SIGHTINGS OF ZEBRA MUSSELS!
1-877-STOP-ANS (1-877-786-7267)**

Before Leaving & Before Launching...

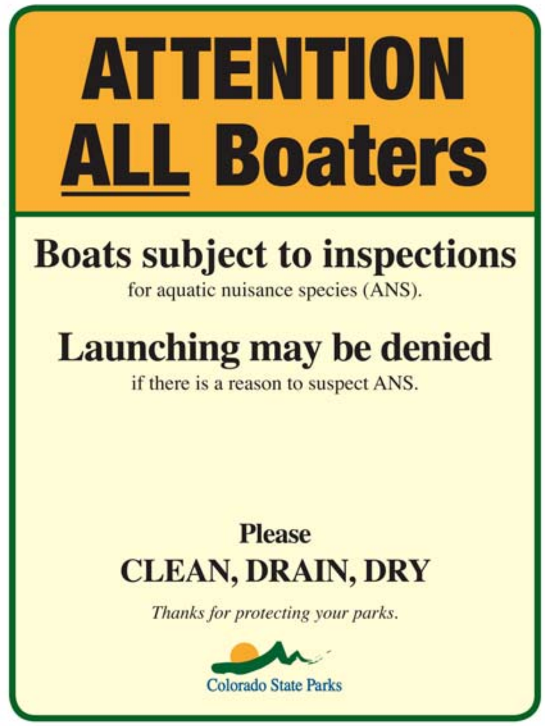
Inspect Everything!

In Colorado, it is unlawful to possess, import, export, ship or transport zebra mussels or other aquatic nuisance species.

Appendix F: Signage

Pueblo Entrance sign

Entrance for other parks



Inspection Point:

Boat Ramps:

Appendix G:
Date/Time Stamp Card

LAKE PUEBLO STATE PARK

DATE/TIME STAMP CARD 00000

CL#/Owner ____________________

Date/Time In ____________________

Date/Time Out ____________________

Retain - DO NOT LOSE!

Card must be returned to inspection staff at boat ramp.

If this Date/Time Stamp Card is **lost or not returned** to inspection staff or your vessel has been on the waters of Lake Pueblo ***longer than 24 hours*****, your vessel must be inspected for zebra mussels. If an inspection is required, EVERYTHING WILL BE INSPECTED, PLEASE DO NOT STOW GEAR.**

If your vessel has been on the waters of Lake Pueblo *less than 24 hours*, an inspection is not required.

You will be required to drain ALL water from your boat including the live well, bilge, motor well, all water-holding compartments, ballast tanks, bladders, and motor cooling system before leaving the boat ramps.

Thank You For Your Cooperation!

Lake Pueblo State Park

Colorado State Parks

Appendix H:
Vessel Inspection Forms

Original Inspection form used at Lake Pueblo (March - June 2008)

LAKE PUEBLO STATE PARK - VESSEL INSPECTION REPORT

Date/Time:______________________ Vessel Registration #:____________________

Location (check box): ❑ N. Ramp ❑ S. Ramp ❑ Other (specify):____________________

Vehicle Reg. #:________________________ Trailer Reg. #:________________________

Inspected By (print name):____

Inspected by (signature):____

REASON FOR INSPECTION

❑ Lost Date/Time Stamp ❑ On waters > 24 Hours ❑ Leaving Marina Slip
❑ Vegetation Attached ❑ Zebra Mussels Visible (Mandatory Decontamination)
❑ Other:____

List lakes/reservoirs recently visited within last 12 months:

❑ Powell ❑ Mead ❑ Mojave ❑ Havasu ❑ El Dorado ❑ Cheney ❑ Perry

____
____
____

Last lake/reservoir boat was in (lake/reservoir name, state):___________________________

Number of day's vessel has been out of water:_______________________________________

VESSEL INSPECTION

Overall Appearance/Feel (check box): ❑ Clean/Smooth ❑ Dirty/Rough

Close-Up Inspection Results (see back)

VESSEL DECONTAMINATION

Boat Owner/Operator Name:____

Boat Owner/Operator Date of Birth:____

Address:____

Zip code_______________

Estimated # of Mussels Present (check box): ❑ < 10 ❑ 10 – 100 ❑ >100

Describe any existing damage to vessel:____
____
____
____

Decontamination completed by: ❑ Hot water sprayer ❑ Quarantined

Decontaminated By (print name):____

Decontaminated By (signature):____

Miscellaneous Comments:____
____
____
____
____

(Take photos of vessel contamination)

(Check all that apply)	(Circle)		(Circle)		(Circle)	
VESSEL EXTERIOR						
❑ Entire Hull	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trim tabs (top & bottom of hinges)	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Through hull fittings	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Motor Well	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Transom	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Transducers	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Pilot tubes	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Cavitations Plate(s)	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Ropes & Lines	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Anchors	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Depth Sounders	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Water Intakes	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Water Outlets	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Lights	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Water holding compartments (pockets, etc.)	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Foot Recesses - PWC	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Centerboard Box – Sailboat	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Rudder and Transom – Sailboat	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Keel – Sailboat	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Fittings – Sailboat	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Other (Describe Below):	Mussels	Y N	Vegetation	Y N	Other	Y N
MOTORS						
❑ Exterior Housings	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Propeller & Assemblies	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Propeller Shafts	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Propeller Shaft Supports	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Propeller Guards	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Rudders	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Propulsion Systems	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Lower Units	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Gimbal Areas	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Water Intakes & Outlets	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Other (Describe):	Mussels	Y N	Vegetation	Y N	Other	Y N
TRAILER						
❑ Trailer Rollers & Bunks	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer License Plate	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer Lights	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer Wiring	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer Axles	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer Springs	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer Fenders	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer Pockets & Hollow Spaces	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Trailer Wheels & Tires	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Hangers	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Other (Describe):	Mussels	Y N	Vegetation	Y N	Other	Y N
CONTENTS						
❑ All Nets	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Float Belts	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ PFD's	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Float Cushions	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Rope Lockers	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Equipment Lockers	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Waterfowl Decoys & Blinds	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Water Skis & Ropes	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Ski Gloves	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Diving Gear	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Clothing & Footwear	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Floats	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Bait & Live Wells	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Water weenies, torpedoes, towable tubes, inflatable pontoons, & similar items.	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Downriggers & other fishing equipment that has entered the water.	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Internal Ballast Tanks–Special Ski Boats	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Special Systems-AC, Personal Sanitation, Water Pump Systems (cleaning, waterslides, General use, etc. – Larger Vessels.	Mussels	Y N	Vegetation	Y N	Other	Y N
❑ Other (Describe):	Mussels	Y N	Vegetation	Y N	Other	Y N

Standard Inspection Form in use at all State Parks from July 2008

COLORADO STATE PARKS
STANDARD ANS INSPECTION CHECKLIST

For use on trailered watercraft entering a park
Version 7, 6/16/2008

These are instructions. This is not a form to fill out. This protocol should take 2-3 minutes to complete.

1. MAKE EDUCATION CONTACT

- Introduce yourself and explain you're **inspecting for Zebra mussels**
- Explain WHY mussels are bad and its important to CLEAN, DRAIN DRY
- Hand them a mussel pamphlet.
- Ask them to set **Parking Brake** and Step out
- Put **Chocks** under trailer wheels

2. DETERMINE RISK FACTORS

	Points
• **Out of State?** Based on tags/CL#, ask if boat has been out of CO in last 30 days?	2
• Been in **infested waters** in last 30 days? (Pueblo, Powell, Mead, Havasu, San Diego, Eastern Kansas, Michigan, etc)	2
• **Dirty/Crusty/Slimy** below waterline?	2
• **Big/complex** boat?	2
• **Wet** (water in tanks/wells) boat?	1

If **3 or more** points, then STOP switch to **HIGH RISK** inspection form!!!!

If **wet and in infested waters** in last 30 days, then **call Ranger, send to Decontamination!**

3. RAPID EXTERIOR INSPECTION

- **Explain/educate** about what you're looking for
- **Look and feel hull** - ridges/seams, recessed bolts for attached mussels.
- Carefully check the rear of boat - intakes, motor, and lower motor areas, propeller.
- Carefully check trailer lights/electrical, license plate and trailer pads.

If plants, mussels or sandpapery bumps are **found STOP, call Ranger, send to Decontamination!**

4. ENSURE BOAT DRAINED

- On smaller boats ASK driver to **Remove bilge plug** (and other plugs if needed) to show drained.
- On large boats, ASK inspectors to STAND CLEAR, ASK driver to climb in & **activate bilge pump** to show no/little water.
- Ask to see and/or **drain ALL bait wells, ballast tanks**, other water compartments

If a lot of water (10+ gallons), then STOP call Ranger, send to Decontamination!

5. CLOSEOUT

- Ask **Owner** to **REPLACE BILGE PLUG**. They are responsible to ensure it's water-tight.
- Ensure all Inspectors are done, nothing found? Yell **STAND CLEAR** & **REMOVE Chocks**
- **THANK Owner** for keeping their boat CLEAN, DRAIN and DRY and tell them they can launch
- **Click Counter** to record that a Standard Inspection was completed – report tallies at shift end

Remember Personal and Public Safety is priority #1 at all times

High Risk Inspection Form in Use at All State Parks July 2008

COLORADO STATE PARKS
HIGH RISK ANS INSPECTION FORM

For use on High Risk Trailered Watercraft, Ver 7, 6/16/2008

Park and Location: ____________________________ Date/Time: _____________________

Vessel Reg# (CL#):____________Vehicle Tag #: ____________Trailer Tag. #:____________

REASON FOR HIGH RISK INSPECTION (check all that apply)

❑ Out of State Registered or Used Out of State Recently

❑ Been in Infested waters within last 30 days:

❑ Lake Pueblo (CO) ❑ Cheney (KS) ❑ El Dorado (KS) ❑ Perry (KS) ❑ Havasu (AZ/CA) ❑ Mead (AZ/NV) ❑ Mojave (NV) ❑ Powell (AZ/UT)
Other (lake name, state):______________Number of day's since vessel in water: ______

❑ Big/Complex Boat ❑ Wet/Water Present ❑ Vol Request

❑ Dirty/Crusty/Slimy Below Waterline ❑ Entering/Leaving Marina ❑ Other:_________

VESSEL INSPECTION (inspect very methodically and carefully)

Overall Look and Feel of Hull (check box): ❑ Clean/Smooth ❑ Bumpy/Sandpaper Feel ❑ Other_________
(if bumpy/sandpaper feel, then look at bumps with magnifying glass to see if mussels)

❑ **VESSEL EXTERIOR CHECKED**

Entire Hull	Trim tabs (top & bot.)	Through hull fittings	Motor Well	Transom
Transducers	Pilot tubes	Cavitations Plate(s)	Anchors & Ropes	Depth Sounders
Water Intakes/Outlets	Lights	Water holding pockets	Recessed bolts	PWC – foot recesses
Sailboats –	Centerboard Box	Rudder and Transom	Keel	Fittings

❑ **MOTOR CHECKED**

Exterior Housings	Propeller & Assemb.	Prop. Shaft	Prop. Shaft Supports	Prop Guards
Rudders	Propulsion System	Lower Unit	Gimbal Area	Water Intake/Outlets

❑ **TRAILER CHECKED**

Rollers, Bunks, Pads	License Plate	Trailer Lights	Trailer Wiring	Trailer Axels
Trailer Springs	Fenders	Pockets & Hollows	Wheels & Tires	Hangers

❑ **INTERIOR / EQUIPMENT CHECKED**

Bait & Live Wells	Internal Ballast Tanks	PFD's	Float Cushions/Belts	Rope Lockers
Equip Lockers	Waterfowl Decoys	Water Skis & Ropes	Nets	Other wet equip.

❑ **VESSEL THOROUGHLY DRAINED**

Bilge Plug or Pump	Bait & Live Wells	Ballast Tanks	Lower Unit (if possible)	Other
Large boats, ASK driver activate bilge pump and if time allows have them drain lower unit of motor				
If **wet and in infested waters** in last 30 days, then **call Ranger, send to Decontamination!**				
Large volumes of water (10+ gallons) require Decontamination or Turning Away (draining/washing or chemical)				

❑ **CLOSEOUT (if nothing is found):**

Ask Owner to Replace BILGE PLUG	Yell STAND CLEAR & Remove CHOCKS	Thank Them for CLEANING, DRAINING, & DRYING

VESSEL INSPECTION FINDINGS

❑ **DID NOT FIND** Any Identified or Suspected ANS Species

❑ **FOUND:** ❑ Large Vol Water, ❑ Suspected ANS in Water ❑ Mussels ❑ Vegetation ❑ Other ______ Location(s):________

INSPECTION COMPLETED IN ACCORDANCE WITH STATE PROCEDURES:

Inspected By (print name): ____

Inspected By (signature): ____

Decontamination Form in Use at all State Parks July 2008

COLORADO STATE PARKS

VESSEL DECONTAMINATION FORM

For use on watercraft with identified or suspected ANS

Version 5, 5/22/2008

☐ Call Ranger before informing Boat owner that Decontamination will be required

VESSEL/OWNER INFORMATION

Park and Location: ____________________________ Date/Time: ______________________

Vessel Reg# (CL#):_____________Vehicle Tag #: ____________Trailer Tag. #:_____________

Vessel Owner/Operator Name:____

Vessel Owner/Operator Date of Birth:_____________________

Address: ____

City, State & Zip code_________________________________

REASON FOR DECONTAMINATION

☐ Vegetation Attached – Location(s) on boat_____________________________________

☐ Possible Mussels (bumps that look like mussels) – Location(s) on boat_________________

☐ Zebra\Quagga Mussels Visible - Location(s) on boat _______________________

Estimated # of Mussels Present (check box): ❑ < 10 ❑ 10 – 100 ❑ >100

☐ Vessel has recently been in infested water and is wet/has water

☐ Vessel has large volume of ballast/other water – estimated gallons_____________

☐ Other:____

DOCUMENTATION AND REPORTING PROCEDURES

☐ PHOTOS: Take 3 digital photo closeups of ANS before it is detached from boat

☐ WRITE DESCRIPTION of finding: who, when, where and how it was found, if the suspected mussels were attached to a surface or not, and all locations the boater has been in the last 6 months.

☐ EMAIL photos and description immediately to:
Rob.Billerbeck@state.co.us, Greg.Gerlich@state.co.us, and Vicki.Milano@state.co.us

☐ CALL Rob Billerbeck – 303-548-6169

☐ SAMPLE: Scrape off a few suspected ANS/mussels and if there is any living tissue, then put them in an ethanol sample jar (grain alcohol, not rubbing alcohol). Fedex sample to Vicki Milano at CDOW.

☐ DECONTAMINATE Completely – do not allow the boat to leave until complete.

DECONTAMINATION

Describe any existing damage to vessel: ____________________________________

Photos taken (take several for all 3 if possible):

❑ BEFORE ❑ DURING ❑ AFTER Decontamination Photo #'s/notes______________

METHODS: (check all that apply)

❑ Draining ❑ Potassium Chloride ❑ Bleach Solution ❑ Scrub Brush ❑ Steel Wool

❑ Hot water sprayer (wash and flush) ❑ Quarantined

If quarantined, comments: ____

Decontamination performed by: ❑ Vessel Owner ❑ Park Staff ❑ Other______________

Other Comments: ____

DECONTAMINATION COMPLETED IN ACCORDANCE WITH STATE PROCEDURES:

Decontaminated By (print name): ____

Decontaminated By (signature): ____

Clean, Drain Dry Checklist in use at all State Parks, July 2008

COLORADO STATE PARKS
CLEAN DRAIN DRY CHECKLIST

Version 2, 6/6/08

These are instructions. This is not a form to fill out. This protocol should take 1 minute (or drain time) to complete.

The purpose of this checklist is to:

1. Ensure contact has been made with boater before leaving the boat ramp
2. Verify the boat is CLEAN and DRAINED prior to leaving

1. EDUCATE – Why we CLEAN, DRAIN and DRY
   - ☐ EXPLAIN that zebra mussels have been found in Lake Pueblo
   - ☐ Adult mussels and weeds and be transported on boat hull or motor
   - ☐ Larvae can be transported in water
   - ☐ Clean, Drain and Dry is the most effective way to stop spread of Zebra mussels

2. ENSURE BOAT HULL IS CLEAN
   - ☐ LOOK quickly for any obvious Weeds or Mud
   - ☐ ASK them or HELP them remove all weeds/mud everything before they leave
   - ☐ FEEL along hull and on lower unit, if sandpaper like feel, conduct a **HIGH RISK INSPECTION**
   - ☐ IF anything looks like a mussel, then conduct a **HIGH RISK INSPECTION**

3. ENSURE BOAT IS DRAINED
   - ☐ ASK boat owner to open bilge plug (may need a tool) to show it is drained.
   - ☐ ASK to see the live bait well, ensure its drained
   - ☐ ASK to see ballast tanks or any other compartment with water and ensure they are drained.
   - ☐ ASK if bait has been disposed of in trash

4. ENCOURAGE ADDITONAL CLEANING, DRYING
   - ☐ ENCOURAGE them to CLEAN BOAT with hot water and dry out equipment before next use.
   - ☐ THANK them for PROTECTING OUR BOATING AND OUR LAKES!

Appendix I:
Additional Details of Chlorination

Non-proprietary oxidizing chemicals, primarily in the form of liquid sodium hypochlorite, are the most frequently used means of biofouling control. Chlorine has been used for almost hundred years in the treatment of potable water. It is a well known chemical, with well documented use and by-products. It is a strong oxidizing agent capable of eliminating all biofouling organisms. It can be used in a proactive mode; continuous or semi-continuous low concentration (0.3 to 0.5 ppm Total Residual Chlorine) from May to October in temperate climates of North America. The semi-continuous application requires 15 minutes of 0.3 – 0.5 ppm TRC followed by no chlorine for 30 to 45 minutes (Claudi and Mackie, 1994). This strategy takes advantage of the reaction most filter feeding macrofoulers have when they sense noxious chemical present in the ambient water. They quickly close their shell, which forms a barrier against the outside environment, and only cautiously re-open the shell 30 to 45 minutes later. While the shell is closed, any chemical present in the water stream is being wasted. By switching to a semi-continuous treatment, a four unit nuclear facility on Lake Huron decreased their annual sodium hypochlorite consumption from 400,000 L to just 100,000 L (106,000 to 26,400 gallons). This translates to a saving of $75,000 /annum. Even more important was the overall drop of Total Residual Chlorine in the combined water discharge. The plant was able to meet the discharge objective of 10 ppb TRC required by the regulator without having to install a de-chlorination system. Chlorine applied continuously or semi-continuously will prevent biofouling from ever reaching a problem level. This allows the industry to prevent performance losses due to biofouling and to minimize the impacts of biofouling on the materials of construction.

Chlorine can also be used successfully as periodic treatment for macrofouling control. In this treatment the macrofoulers are allowed to settle. Chlorine is then applied continuously at a level of 0.5 – 3 ppm TRC for 10 to 20 days. The length of treatment is dependent on the ambient temperature of water and the physiological state of the macrofoulers. Once again, when the macrofoulers sense the presence of a noxious chemical, they close the shell. In this instance, the continuous application of chlorine prevents the macrofouler from re-opening the shell and feeding or breathing. If the ambient water temperature is above 15 ºC (59 ºF), the metabolic rate for most macrofoulers is such that they are not able to keep the shell closed for more then 5 to 7 days. Once they re-open the shell, they are exposed to a level of chlorine which results in relatively swift mortality.

Before a facility can decide if they should use a proactive (continuous or semi-continuous) treatment or if a reactive (periodic) treatment is adequate, a number of variables have to be considered.

The most important consideration is how much macrofouling can be tolerated by the various components of a cooling system. If the system has large runs of small diameter piping, many in-line heat exchangers with small orifices and low or intermittent flow in parts of the system, chances are such system is more prone to macrofouling. The diameter of the smallest piping will determine the maximum mussel shell size that can be tolerated by the system without plugging. It is wise to apply some factor of safety to the maximum shell size tolerated. Unless a system has been designed with substantial spare cooling capacity, it would be inappropriate to allow macrofoulers to settle until accurate information on the macrofouling population in the area is available.

The level of the macrofouling population likely to settle in-between treatments and the rate of growth by the invading individuals is the next consideration. Low population levels and low rates of growth will present less of a problem then a large population of fast growing mussels. It essential to remember that the population one sees in the environment is an underestimate of what we will see settling in the plant. This has been the experience of all of the facilities which have had to cope with macrofouling problems. The reason for this is that the cooling water piping is exposed to a much greater volume of water then an equivalent area of substrate in the aquatic environment. When water is pumped through a system, this water contains ready to settle macrofouling larvae and the cooling system provides a perfect environment for settlement. This is especially true when the water velocity is low or if the pumping starts and stops. Piping systems into plants essentially become “solid substrate that has protection from predators and a continuous supply of oxygen and food”

The third consideration is how the various regulators react to the macrofouling treatment needs identified by industry. For example, the regulators of nuclear facilities place great value on preventing macrofouling in critical cooling circuits. This objective may override the desire of the environmental regulator to minimize the use of chemicals. The fire marshalls and the insurance companies take a dim view of fire protection system which may become plugged by macrofoulers. In other instances, the macrofouling of cooling systems may have no other penalty then a short shutdown of the system for manual cleaning.

A fourth consideration to initiating any treatment is the degree to which an existing facility is already infested with zebra mussels. The significance of this consideration relates to the financial implications of a potential shut down of the impacted system. Where there is already infestation, and shut downs are cost prohibitive, treatment should be initiated with caution or scheduled as part of a planned outage so that it can be combined with manual removal of shells.

Application of these four considerations described above requires some assessment of risk and is dependant on where the facility is in the zebra mussel treatment evolutionary process. When faced with a new infestation of macrofoulers, most facilities will choose the prudent path of minimizing risk by preventing settlement or at least preventing build–up of macrofoulers in their cooling water system. Once the facility is able to get data on the population and rate of growth of the macrofoulers and gains assurance on the behavior of the cooling systems, they can begin the optimization of the treatment strategy.

References

Claudi Renata & Gerald L. Mackie Practical Manual for Zebra Mussel Monitoring and Control Lewis Publishers, ISBN 0-87371-985-9, 1993

O’Neill, Charles, Jr. “The zebra mussel: Impacts and Control” New York Sea Grant, Cornell Cooperative Extension, Information Bulletin 238. 1996.

APPENDIX J.
Plankton Survey Net Decontamination Procedures

Introduction
The purpose of this plan is to conduct surveys in waters without introducing zebra mussels into non-infested waters. It is critical that the appropriate decontamination technique be used *no matter how time consuming*. After collecting field samples from bodies of water known or suspected to contain live zebra mussels at any life stage, all field equipment used to collect those samples, or that was in some way in contact with the body of water, should be thoroughly cleaned before moving to another site outside the known range of the zebra mussel.

Method
Visually inspect all equipment and remove all visible material including mud and plants. Particular attention must be given to places where the mussels could be accidentally trapped, such as the treads of boots and waders.

Acceptable Disinfection Methods

•Live steam, boil or hot power wash with hot (140° F or 60 ºC) water and allow to dry.

•Soak equipment in Chlorine bleach (>5% sodium hypochlorite) for 1 hour at a concentration of 3oz/5 gallons of (88 cc /18.9 liters) water.

•Freeze at -10° C (14° F) for at least 4 hours.

•Dry for at least 2 weeks if temperature is below 70° F (21.1° C) or 1 week if weather is >70°F (21.1° C) and less than 40% humidity.

•For plankton nets soak in a 5% v/v acetic acid bath. A 5% acetic acid solution may be purchased as white vinegar, or a 5% solution may be prepared with concentrated (glacial) acetic acid and water. The ideal soak time is overnight; however, if it is necessary to use the net at the next sampling location during the same day, a one hour soak followed up with a rinse prior the next sampling should be the minimum. The same acetic acid bath may be used repeatedly for all sample sites. These steps will both denature the DNA for the PCR process and dissolve the veliger shells visible in microscopic observations.

APPENDIX K:
Collecting Water Samples for Dreissena ssp. Veliger PCR Analysis

Bureau of Reclamation
Technical Service Center
Denver, Colorado

Equipment Needed:

- 63-µm (0.0024 inch)Plankton Tow Net (Mesh size is critical). (We use custom Wildco plankton net with a 500 mm (19.6 inches) diameter opening, flow meter (optional), and a 2-m length (6.6 feet).)
  (The 33-E28 Veiliger Net is specifically for sampling zebra mussel larvae and is available through Wildco)
- Spray Bottle – 1-L (1.05 quart)
- Ethanol (lab grade, 200 proof; or from a local liquor store, e.g., Everclear 190 proof = 95% or Rum 151 proof = 75.5%)
- Sample Bottles (1000-mL (1.05 quart) Nalgene leak-proof poly (HDPE))
- Disposable Diapers
- Plastic electrical tape
- Ziploc Bags – 1-gal.
- Plastic Garbage Bags (large enough to hold 4 sample bottles)
- Waterproof Markers and Labels
- Data Sheet and Waterproof paper
- Ice chest with cubed/crushed ice or frozen “blue ice”
- Decontamination container for sampling net (e.g., ½ plastic barrel with inside diameter greater than plankton net hoop to permit complete submersion)
- White vinegar (from grocer) or 5% acetic acid solution - 12-16 L (3.1 to 4.2 gallons)(i.e., enough to coverplankton net in decontamination container)

Sample Collection Procedures:

1. Introduction - These procedures are designed to collect the veligers or the free-swimming larval form of zebra and quagga mussels (*Dreissena* spp.) as plankton samples for laboratory detection using polymerase chain reaction (PCR). Step-by-step collection procedures are included below. The volumes of water sampled through the plankton net are needed both for sample size standardization and for calculating the number of veliger density by microscopic methods to confirm the PCR results. Collect a minimum of two replicate plankton samples at each location.

Note: If the plankton net has been contaminated with zebra or quagga mussel veligers from previous collection events, it should be decontaminated with acetic acid (vinegar) and rinsed prior to sample collection. Go to Steps 6-8 for this procedure. Save the final water rinsate sample for laboratory analyses to confirm decontamination. Record and label information about the rinsate (Step 5).

2. There are two methods of acquiring the water sample:

   a. <u>Plankton net tow</u> – Lower the net to the desired, measured depth and slowly tow it for a known recorded distance. The volume of water that is sampled can be determined based on the diameter of the net opening and the distance towed. A minimum sample volume of 1,000 L (1.05 quarts)is recommended. Record: Depth and distance of the tow.

(**Caution**: To assure accuracy of the sample volume, do not let the retrieval speed exceed the filtration rate of the net.) Remember that veligers from spawning zebra and quagga mussels are more commonly found in deeper water so sample accordingly. Go to Step 3.

b. Pumped source – This may be taken either by a portable pump from a boat or from the raw, untreated water plumbing system of a dam or water treatment plant. Open the flow valve and completely purge the supply line of any stagnant water. If a flow meter is not available on the pipe, use a five gallon bucket and a second timer to determine the flow rate (gallons per minute) through the pipe. Calculate the mean of at least 3 replicate runs for determining the flow rate. Place the plankton tow net under the hose and collect all of the water flowing out of the valve and keep an accurate measure of the volume of water flowing into the net by recording the elapsed time. A minimum of 1,000 L (1,005 quarts) must pass through the net. Record the total volume of filtered water collected per sample and the water depth of the intake of the water source. Go to Step 3.

3. Using water, wash down the net from the outside to concentrate veligers into the collection cup. Carefully unscrew the collection cup and pour the sample into a 1000-mL (1.05 quarts) Nalgene leak-proof poly bottle. Thoroughly rinse the collection cup with spray bottle with minimal volume of water and transfer the rinses into the same sample bottle. Take care to keep the wash and/or rinse water away from the opening of the plankton net and wash only along the outside of the plankton net and cup, so that the filtered volume remains unchanged. MARK THE WATER LEVEL ON THE SAMPLE BOTTLE WITH PERMANENT INK (Draw a line on the bottle and label "Level 1).

4. Add an appropriate volume of ethanol to get 25% final concentration in the sample bottle (visually estimate, does not have to be exact). For example, if using lab grade ethanol or 190 proof Everclear, use 3 parts lake water and 1 part Everclear. Replace bottle cap snugly. (Note: The volume of ethanol will be needed in the calculation of number of veligers per unit volume; therefore be sure that the sample bottle is marked with a second line to indicate total volume (sample + ethanol) so that the lab can also determine the volume of ethanol that was added.) Draw a line on the bottle and label "Level after ETOH". Tape the secured bottle cap with black electrical tape to cover the seam between the cap and bottle to prevent leakage. Wrap the bottle in a disposable diaper and place in a Ziploc bag (push all air out of bag before closing). Put both the replicates from same location into one single plastic garbage bag. Put on ice in cooler for transport.

5. Labeling sample bottles. Use waterproof Sharpie pens for bottle labels and mechanical pencils for data sheets. Be careful to avoid spillage of ethanol – Sharpie ink will run if contacted with ethanol. For backup, record sample bottle information with a mechanical pencil on a piece of waterproof paper and insert paper into the Ziploc bag along with the sample bottle. Record the following information on both sample bottle and data sheet:

- Sample Date
- Sample Location (GPS if available, otherwise describe location – i.e. near North shore boat dock, etc.
- Sample depth or intake depth in water column
- Volume of water filtered through the plankton net
- Mark sample poly bottle with two lines of permanent ink, one for level of sample and one for total level of sample + ethanol
- Preservative used (e.g., 25% ethanol)

- Name of person collecting sample with contact information (phone number)

6. Veligers easily stick to the walls of the plankton net. Decontamination (and disinfection) is critical to avoid cross contamination from one sample location or event to another and possibly the spread of mussels to new waters. It is recommended that each sampling location (lake or reservoir) has a dedicated collection net. Each time the net is used at a new sample site, the procedure will require a soak treatment in a 5% v/v acetic acid bath. A 5% acetic acid solution may be purchased as white vinegar, or a 5% solution may be prepared with concentrated (glacial) acetic acid and water. These steps will both denature the DNA for the PCR process and dissolve the veliger shells otherwise visible in microscopic observations.

7. The recommended treatment for the plankton net following sample collection is to first rinse the net with clean water to wash as many veligers from the net as possible, and then totally immerse the net in the 5% acetic acid bath. The ideal soak time is overnight; however, if it is necessary to use the net at the next sampling location during the same day, a one hour soak followed up with a rinse prior to the next sampling should be the minimum. The same acetic acid bath may be used repeatedly for all sample sites. Following the acetic acid soak, rinse the net with a large volume of clean water (e.g., 100 L or 105 quarts) allowing the rinse water to drain and collect into the collection cup.

8. Pour the collected rinsate into a sample bottle, preserve with ethanol, and labeled as directed in Steps 4 and 5. The final rinsate from each sample location may be combined at the end of the day and sent as one sample. Ship on ice with the other samples at the address given.

9. Keep samples cool at all times. Samples may be stored under refrigeration for a few days if a delay is necessary to avoid shipping over a weekend.

10. Ship samples using FedEx Overnight Express (AVOID WEEKEND DELIVERIES!) to:

Vicki Milano
Colorado Division of Wildlife
122 East Edison
Brush, CO 80723

Denise Hosler (86-68220)
U.S. Bureau of Reclamation
Denver Federal Center
Corner of 6th Ave. & Kipling
Bldg 67, Room 152
Denver, CO 80225-0007

Contact information:

Vicki Milano Phone (970) 842-6308 vicki.milano@state.co.us
Denise Hosler: Phone: (303) 445-2195; dhosler@do.usbr.gov

APPENDIX L:
Zebra/Quagga Mussel Biological Summary
Colorado Division of Wildlife, January 2008

- Two species have invaded North America via the Great Lakes: zebra mussel, *Dreissena polymorpha*, and quagga mussel, *Dreissena rostriformis bugensis*.
- Physically they are very similar, but the quagga mussel typically colonizes much deeper water than the zebra mussel.
- The quagga mussel is native to the Dnieper River drainage in the Ukraine.
- The zebra mussel is native to the Black, Caspian and Azov Seas.
- Both are highly tolerant of adverse physical and chemical conditions.
- Both can colonize various substrates in lakes and reservoirs as well as attaching to anchor lines, buoy lines, boat hulls, piers, water pipelines, water intake and pump units, etc.
- Both mussel species can reach very high densities.
- The two species are believed to have arrived in North America in or near Lake St. Clair (between Lake Huron and Lake Erie) in the late 1980s, most likely via ship's ballast water or as attached adult mussels on anchors, rope, chains or other ship structures from an eastern Europe port.
- In 30 years the zebra mussel has spread throughout the Great Lakes and St. Lawrence River, most of the Mississippi main stem, the Missouri River into northeastern Nebraska and southeastern South Dakota, the Arkansas River through northeastern Oklahoma into central Kansas, the Ohio River, the Hudson River, and the Tennessee River.
- It appears that the quagga mussel is still rapidly expanding its range. The species occupies four of the five Great Lakes but is so far mostly absent from Lake Huron. It has colonized the Finger Lakes of western New York and a few other lakes in the upper Midwest and Northeast. In the past 2-3 years it has turned up in the lower Colorado River reservoirs including Lake Havasu, Lake Mead, Lake Mohave, and now Lake Powell (although there is conflicting information and uncertainty about the population at Lake Powell)
- Both bivalve species are shaped like primitive hatchet heads with the shells being more or less straight along the hinge and curved on the open edge, pointed toward the front and broad toward the back. Protruding from the hinge is a series of extremely strong *byssal threads* with which the mussels attached themselves to substrates.
- Both species are extremely variable in coloration – generally cream to tan or brown with a series of variable brownish stripes; although some may be solid colored. Both can reach about 2 inches (5.08 centimeter) in length though the average is much smaller.
- Zebra mussels are eaten by some duck species, notably lesser scaup, long-tailed duck, and scoters. The filter-feeding mussels tend to concentrate heavy metals and other toxins and ducks that feed upon them have in turn been found to contain enormous concentrations of these contaminants.
- North American fishes that feed on Dreissenid mussels include freshwater drum, channel catfish, red-eared sunfish, pumpkinseed, and certain redhorse suckers.
- The Asian black carp, *Mylopharyngodon piceus*, is a molluscivore that has been touted as a biological control. However, fears of the damage its introduction could do to native mollusks and the ecosystem in general are blunting enthusiasm for this proposal.

Potential Impacts

- Introduction of Dreissenid mussels irrevocably alters an ecosystem.
    - In the absence of natural enemies, Dreissenid mussels are so prolific that they completely coat lake bottoms and any stationary object in the water including boat hulls, municipal and industrial intakes, and even slow-moving animals such as turtles and crayfish.
    - Enormous sums of money are spent each year combating the effects of Dreissenid biofouling.
    - Dreissenids are filter-feeders. Each mussel sucks in a comparatively huge quantity of water through its siphon each day, consumes whatever planktonic material it chooses, and discards other material by coating it with mucus and discharging the pellet.
    - It has been estimated that the entire volume of Lake Erie passes through Dreissenid mussels every two days.
    - Native bivalves are frequently out-competed for available habitat and smothered out.
    - Alteration of water clarity can in turn alter temperature patterns and either aid or disrupt various aquatic vegetation and plankton distribution.
    - Mussel shells foul beaches and shoreline areas.
    - Dreissenids cause huge changes in plankton composition (greatly reducing planktonic biomass in many instances) and a lake's nutrient cycle, the consequences of which extend throughout the food chain.
    - Viral Hemorrhagic Septicemia (VHS) virus has been isolated from Dreissenid mussels.

- Life cycle
    - Females generally reproduce in their second year. Eggs are expelled by the females and fertilized outside the body by the males; this process usually occurs in the spring or summer, depending on water temperature.
    - Optimal temperature for spawning is 14-16 ^{o}C.(57.2 to 60.8 ^{o}F) Over 40,000 eggs can be laid in a reproductive cycle.
    - After the eggs are fertilized, the larvae (veligers) emerge within 3 to 5 days and are free-swimming for up to a month.
    - Optimal temperature for larval development is 20-22^{o}C (68 to 71.6^{o}F.
    - The larvae begin their juvenile adult stage by settling on suitable substrate or other submerged structures where they crawl about by means of a foot. They then attach themselves by means of a byssus, an "organ" outside the body near the foot consisting of many threads.
    - Although the juveniles prefer a hard or rocky substrate/structures, they have been known to attach to vegetation.

- Means of overland dispersal
    - Generally attributed to watercraft so far.
    - Adult Dreissenids can survive in cool, humid conditions for days without being submerged.
    - Sub-microscopic veligers can survive in bilge/ballast water and in outboard shafts for days or weeks in cool weather.
    - Other means of moving mussels or veligers such as aquaculture or fish stocking and transportation are possible if transport water is not treated to kill adults or veligers.

APPENDIX M:
Risk Factors (for Mussels and Other ANS)

WATERCRAFT USES AND ACTIVITIES	
ACTIVITY	RISK FROM ACTIVITY
Barges, Dredging	High Biological Risk
Fishing Tournaments	High Biological Risk
Power Boat Races	High Biological Risk
Water Skiing Clubs	High Biological Risk
Sail Boat Regattas	High Biological Risk
Out of State Use	High Biological Risk
Marina Slipped Boats, Particularly Commercially Hauled	High Biological Risk
Work Boats (agency boats going to several reservoirs)	Medium to High Biological Risk
Boats Moored overnight	Medium to High Biological Risk
Day use boats	Low Biological Risk on Hulls, Medium Risk in Ballast or Bilge or plants hanging off

WATERCRAFT RISK TYPES	
ACTIVITY	RISK FROM ACTIVITY
All Trailered Watercraft	
House Boats	High Biological Risk - give very thorough inspection
Cabin Cruiser	
Ski Boats with Ballast Tanks	Medium to High Biological Risk, risk of mussels on hulls or larvae in bilge/live bait well. Verify no mussels on hull, engine, trailer and verify Ballast, Bilge, Live Well are dry. Verify no plants hanging off.
Large Open Boat	
Sail Boat	
Smaller Open Boats with outboard motors (no live wells, no bilge tanks)	Low Risk - just verify no mussels on trailer and no live bait and no plants.
Personal Watercraft (PWC, jetskis)	Low Biological Risk - verify no mussels on trailer and no ballast and engine water kicked out.
All Handlaunch Craft	
Canoes, Kayaks	Very Low Biological Risk, Educate public to dry.
Belly Boat, Inflatables	
Equipment	
Waders, Gear	Very Low Biological Risk, Educate public to dry.
Pets, Decoys	

APPENDIX N:

Possible Treatment/Eradication Approaches

identified by Dr. Andy Cohen, January 30, 2007

Excerpt from the 2007 NPS Quagga/Zebra Mussel Infestation Prevention and Response Planning Guide

APPROACH	DESCRIPTION	COMMENT
Batch Treatment with Biocide	Release sufficient biocide to raise the concentration throughout the water body to a lethal level.	Batch treatment was successfully used to eradicate the Black-striped Mussel *Mytilopsis sallei* from 3 boat basins in Darwin, Australia, and to eradicate zebra mussels from a quarry pond in Virginia.
Biocontrol	Release live organisms to control the target population through predation, parasitism, interference with reproduction, or other mechanisms.	There is no demonstrated biocontrol treatment for *Dreissenid* mussels, but a bacterial agent is under development by Dr. Dan Malloy of the New York State Museum.
Isolate & Treat with Biocide	Isolate the infested area with curtains, inflatable Barriers, earth berms, etc. and treat the isolated water volume with biocide.	Isolation curtains have been used for the herbicidal treatment of aquatic plants. Large inflatable barriers are being installed to protect the City of Venice from flood waters. Corrugated metal bulkheads have been used to contain construction sediment. Isolation/barrier technologies developed for containing chemical spills or sediments raised by dredging might be applicable.
Wrap & Treat with Biocide	Isolate the infested surfaces by wrapping or covering them, and inject biocide under the wrap or cover.	Two infestations of the seaweed *Caulerpa taxifolia* in southern California lagoons were eradicated by covering with PVC tarps held down by sandbags around the edges, and pumping chlorine underneath through valves in the tarps.
Wrap	Wrap or cover the infested surfaces.	Experimental covering of zebra mussels with large plastic tarps in Lake Saratoga, New York, killed 99.9% of the mussels, apparently by the combined stress of no food, low oxygen, high ammonia concentrations, etc.
Remove	Remove the mussels by hand, suction, scraping or hydroblasting combined with suction, or other methods.	The initial removal of 19,000 zebra mussels by hand from Lake George, New York in 2000, with annual follow-up collections of smaller numbers has progressively reduced the population, which appears to be dying out. Removal of 1.6 million intertidal snails by hand from a southern California cove eradicated an infestation of a parasite that used the snail as one of its hosts. Suction dredges of various sizes have been used for biological sampling of benthos, underwater archaeological excavation, and dredging sediment.
Bury	Bury with uninfested sediment using dredges.	
Coat	Spray with an underwater polymer or other suitable coating.	Smothers mussels.
Heat	Apply heated water, steam or flame to infested surfaces.	In 2001, the exotic seaweed *Undaria pinnatifida* was eradicated from the hull of a sunken vessel 2 km off Chatham Island, New Zealand, using electric heating elements inside a plywood box attached to the hull with magnets, which heated the water to 70°C within 10 -15 minutes. Small inaccessible areas were treated with a modified cutting torch. Superheated steam has been applied to benthic populations of *Undaria*.

APPENDIX O:

Mussel Control Options for Piped Systems

as presented by Black and Veatch at the Quagga Mussel Symposium on March 16, 2007
Excerpt from the 2007 NPS Quagga/Zebra Mussel Infestation Prevention and Response Planning Guide

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

APPENDIX P:
Decontamination Protocol
For Boats and Other Recreational Equipment Potentially Contaminated with Zebra/Quagga Mussels

Step 1: DRAIN
Bilges, wet wells, live wells, and any other compartments that could hold water from an infested field collection site should be drained of water at the boat ramp before leaving the area. If a boat has carried water from another location, remove all water and treat it with household bleach (> 5% sodium hypochlorite) at a concentration of 3 oz of bleach per 5 gallons (88 cc /18.9 liters) of water for a minimum of 1 hour before disposing in wastewater drain. Never dump water to the ground.

Step 2: PURGE
In order to kill and purge larvae that may be in the engine's cooling system, run disinfecting water through the motor for at least 1 minute. Disinfecting water should be either: 1) a bleach solution using household bleach (>5% sodium hypochlorite) at a concentration of 3 oz of bleach per 5 gallons (88 cc /18.9 liters)of water, or 2) tap water heated to >140 degrees F (60 degrees C). Running bleach through an engine may violate the terms of the engine's warranty, so hot water is recommended.

Step 2: SCRUB
Scrub all the surfaces with soapy water to remove any clinging material (plants, animals, mud, etc.), then visually inspect and remove anything remaining. Pay special attention to cracks and crevices in which mussels may become trapped, and aquatic plants harboring juvenile mussels may be present on trailers and propellers. Since adult zebra/ quagga mussels can close up and survive for extended periods of time under toxic external conditions, chemical disinfecting as a means to kill adult mussels may require a contact time of several days. Thus, chemical disinfectants are not recommended for killing adult mussels. At this step, the goal is to remove any and all living organisms as well as mud and other debris.

Step 3: WASH
Hose down everything with hot pressure water, including boat, anchors, trailer, and anything else that came in contact with water. Pay particular attention to trailer pads made of carpet and foam rubber, which could trap tiny mussels. Temperature and exposure time determine the effectiveness of temperature treatments. Live stream, boiling, and hot (>140 degrees F) (>60 degrees C) power washing are all believed to be effective against all zebra/quagga mussel life stages. Work a small section at a time with a minimum of 3 minutes at full heat for each area.

Step 4: DRY
After thorough scrubbing, power washing and visual inspection, dry the boat and all equipment and keep everything out of the water for at least 2 weeks if temperature is below 70 degrees F (21 degrees C) or 1 week if the weather is warm(>70 F, >21 degrees C) and dry (<40% relative humidity). In winter, freezing may be used as an effective tool. Adult zebra/quagga mussels have a relatively low tolerance to freezing. Exposing boats and equipment to continually freezing temperatures for a recommended period of three days should produce 100% mortality.

APPENDIX Q:
Drying Times

This spreadsheet shows the recommended drying times for the State Parks in Colorado, by month. It is to be used to calculate drying times for boats at that Park. For more information, please see http://www.100thmeridian.org/Emersion.asp

Recommended Drying Time, In Days, for Colorado State Parks

Adapted from 100th Meridian Recommended Quarantine Time Web Application   Version 1, 8/15/08

	Month											
State Park	January	February	March	April	May	June	July	August	September	October	November	December
Arkansas Headwaters	73	73	73	46	29	19	12	19	19	29	73	115
Barr Lake	28	28	28	18	11	7	5	7	7	18	18	44
Boyd Lake	28	28	28	18	11	7	5	7	7	18	28	44
Chatfield	28	28	28	18	11	7	5	7	7	11	18	28
Cherry Creek	28	28	28	18	11	7	5	7	7	11	18	28
Colorado River	28	28	18	18	11	7	5	5	7	11	28	44
Crawford & Sweitzer	28	28	28	18	11	7	5	7	7	18	28	44
Eleven Mile/Spinney Mtn	51	51	32	32	13	13	8	8	13	21	32	51
Highline Lake	28	28	18	18	7	7	5	5	7	11	28	44
Jackson Lake	28	28	28	18	11	7	5	5	7	11	18	44
John Martin Reservoir	28	28	18	18	7	5	5	5	5	11	18	28
Lathrop	32	32	32	21	13	8	8	8	8	21	32	51
Mancos	28	28	18	18	11	7	5	5	7	11	18	28
Navajo	51	32	32	21	13	13	8	8	13	21	32	51
North Sterling	44	28	28	18	11	7	5	5	7	11	18	44
Paonia	28	28	28	18	11	7	5	7	11	18	28	44
Pearl Lake	73	73	46	29	29	19	12	12	19	29	46	73
Ridgway	73	73	46	29	19	12	12	12	19	29	46	73
Rifle Gap & Harvey	32	32	32	21	13	13	8	8	13	21	32	51
San Luis	44	44	28	18	11	11	7	7	11	18	28	44
St. Vrain	28	28	28	18	11	7	5	7	7	11	18	28
Stagecoach	73	73	46	29	19	19	12	12	19	29	46	73
State Forest	73	73	46	46	19	19	12	12	19	29	46	73
Steamboat	73	73	46	46	19	19	12	12	19	29	46	73
Sylvan Lake	44	44	44	28	18	11	7	11	11	18	28	44
Trinidad	32	32	32	21	13	8	5	8	8	21	32	51
Vega	51	51	32	21	13	13	8	8	13	21	32	51
Yampa/Elkhead	32	51	32	21	13	13	8	8	13	21	32	51
Average Days by Month	42.4	41.8	33.0	23.7	13.9	10.7	7.3	8.3	11.1	18.9	31.0	50.6
Denver Metro Area	28	28	28	18	11	7	5	7	7	11	18	28

For highlighted cells, use cell value or 3 days if continuous freezing temperatures

This table is for use in calculating drying time, in days, at State Parks in Colorado. Drying time is most frequently used in conjunction with yellow wire seals.

This table is provided as a guide. Other factors such as local weather knowledge, unusual weather other factors may influence your application of these numbers.

APPENDIX R:
Infested Waters

Zebra/Quagga Mussels are known or suspected to be
in the following waters (as of August 2008):

COLORADO • Lake Pueblo • Granby Lake (Quagga) ARIZONA • Lake Mead • Lake Powell • Lake Mohave CALIFORNIA (mostly southern) • Copper Basin Reservoir • Dixon Reservoir • El Capitan Reservoir • Irvine Lake • Lake Havasu • Lake Hodges • Lake Jennings • Lake Mathews • Lake Miramar • Lake Skinner • Lower Otay Lake • Murray Reservoir • Olivenhain Reservoir • Rattlesnake Reservoir • San Vicente Reservoir • Sweetwater Reservoir KANSAS (mostly eastern) • Cheney, • El Dorado • Perry • Walnut River • Winfield City Lake	NEBRASKA (eastern) • Offutt Air Force Base • Missouri River below Ft. Randall Dam at Niobrara • Missouri River below Gavin Point Dam at St. Helena NEVADA • Lake Mead OKLAHOMA (mostly eastern) • Skiatook lake • Oologah lake • Kaw lake • Keystone lake • Grand Lake O' the Cherokees • Lynn Lane Reservoir [city water supply east side of Tulsa • Sooner Lake • Arkansas River (multiple locations) • Verdegris River UTAH • Lake Powell (conflicting/unclear information at this time)	ALABAMA, ARKANSAS, CONNECTICUT, IOWA, ILLINOIS, INDIANA, KENTUCKY, LOUISIANA, MICHIGAN, MINNESOTA, MISSOURI, MISSISSIPPI, NEW YORK, OHIO, PENNSYLVANIA, TENNESSEE, VERMONT, WEST VIRGINIA, WISCONSIN, • These states have too many infected water bodies to list so you should consider any water bodies in these states as potentially infested Also Ontario and Quebec Provinces in Canada

As of August 2008, no mussels known or reported in Wyoming or New Mexico.

Updates available at:
http://nas.er.usgs.gov/queries/collectioninfo.asp?NoCache=4%2F7%2F2008+7%3A00%3A29+AM&SpeciesID=5&State=&County=&HUCNumber=

APPENDIX S:
Model ANS Programs from Other States

Minnesota

- Early April to Late October each year, 50 inspectors inspected 42,000 trailered watercraft.
- 12 FTE, 45 seasonals.
- The inspections were focused mainly on lakes with ANS infestations.
- Non-infested lakes were also inspected based on level of boater usage, frequency the lakes were cited as destinations on boater surveys, and request for inspections by a lake program.
- The primary funding source for the Invasive Species Program is a $5 surcharge on all watercraft registered in Minnesota.
- Each boater is asked a series of standard questions
- Decals are given to boaters that have spoken with an inspector.
- Worked with citizen groups to hold eleven volunteer trainings.
- Increased hours of inspections at certain lakes through cooperation with lake groups.
- Approximately 200 people have participated annually in the volunteer zebra mussel monitoring program checking lakes across the state.
- Received from the State Water Recreation Account in FY07-$1,149,000
- Received from the General Fund in FY07-$260,000

Wisconsin

- Financial impacts of zebra mussels on Wisconsin residents have been significant because of new maintenance costs for Wisconsin's water utilities (about $4 million based on 1993 figures) and power plants (approximately $1 million in 1993).
- DNR has 12 seasonal watercraft inspectors. They can issue violations, but they have no law enforcement capability.
- Since 2004, the Clean Boats, Clean Waters volunteer program has trained 1,000 volunteer inspectors. They can issue violations, but they have no law enforcement capability.
- Volunteers are trained to organize and conduct a boater education program in their community.
- Adults and youth teams educate boaters on how and where invasive species are most likely to hitch a ride into water bodies.
- Volunteers perform boat and trailer checks for invasive species, distribute informational brochures and collect and report any new water body infestations.
- As of October 2006, there were 448 waters with watercraft inspectors.
- 2007-96 zebra mussel infested waters, 471 Eurasian Watermilfoil infested waters
- They are starting a Boat Ambassador program to train people that have law enforcement background how to do inspections so they have the authority to stop boats.
- There was a boater registration fee increase of 29-33% depending on boat length. This fund is tapped for hiring 10 part time wardens (Boat Ambassadors) to assist with boater education, boat/trailer inspection and AIS law enforcement.

Washington State

- With no occurrences of mussels yet, they have responded aggressively through the following measures:
- $558,000/yr for prevention and enforcement through a $2 raise in rec. boat registration fees.
- WDFW recommends that the state legislature and the governor be prepared to consider declaring a state of emergency if there is an invasion of zebra or quagga mussels into state waters that cannot be quickly contained.
- 4 biologists, 1 state patrol officer completely dedicated to ANS, 2 ballast water inspectors, 1 database person, 5 seasonals.
- 180 monitoring sites across the state to implement an early detection plan.
- All 66 Washington State Patrol staff (commercial vehicle inspectors) at the five Port of Entry Weigh Stations have been trained in AIS identification.
- Cleaning stations are portable systems that they take with them to Ports of Entry– high pressure rinse and bleach mix
- ANS Program funded by mix of soft money, state general fund, federal grant money, tax on boater registrations.

California

- California is responding to their mussel infestation seriously, incorporating many state agencies as well as federal agencies through the following processes.
- Zebra or quagga mussels in 6 lakes/reservoirs and Colorado River aqueduct.
- CA Fish and Game is the lead agency for CA zebra mussel response. Full ICS response to new infestations.
- $2 million-06/07 for quagga, $2.7million-07/08 for quagga, website estimates impact in 'hundreds of millions.
- They already had a very large ANS program in place which would mean that they have probably spent over $10 million in the past few years.
- Providing funding for mussel educational material and signage.
- Provided 10 statewide zebra/quagga trainings for regional personnel.
- Allocated $2.7 million in 07/08 to CA Dept. of Food and Ag to intensify boat inspections at Border Patrol Stations.
- Passed new legislation for stronger enforcement of inspections/quarantines.
- Game wardens are employing 8 dogs that have zebra/quagga training, 8 more dogs in training.
- 5 of 6 regions have hired new environmental scientists to focus specifically on mussels.
- Provided 10 statewide zebra/quagga trainings for regional personnel.
- Lake Casitas and San Justo Reservoir have been shut down to boating.
- Metropolitan Water District has already spent $5.9 million to purchase new sampling equipment, step up sampling, initiate boat inspections, education and decontamination.
- They estimate spending a total of $10 million by July of 2008.

Utah

- Utah Division of Wildlife Resources (UDWR) is responding strongly to the zebra mussel threat by requesting funds for the following activities:
- Implementing inspections at some ports of entry
- UDWR is providing staff to State Parks and others for inspections/ decontamination/ education
- Implementing at 27 water bodies, 3 ports of entry (15 state parks this summer
    - High risk – 20 lakes, 3 ports of entry with 1-4 inspectors and boat washing facilities
    - Medium risk – 5 lakes, 1-2 inspectors and boat washing
    - Low risk – 1 lake with 1 inspector, and boat washing
- UDWR hiring 12 new full time employees, 22 wildlife techs for this response
- UDWR requested $1.6 million (did not include all the FTE, some being phased in the next year)
- Estimated state maintenance costs for water industry of $15 million/year. Overall impact not yet estimated.
- National Park Service has permanent, high pressure, hot water decontamination stations available at all marinas within Glen Canyon National Recreation Area.
- National Park Service is requiring any boats that are slipped or moored in Lake Powell to receive a decontaminating wash before they exit the park if they are being moved to a non-infested lake.