2011

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Citation Details

Wells, Steve W.; Counihan, Timothy D.; Puls, Amy; Sytsma, Mark; and Adair, Brian, "Prioritizing Zebra and Quagga Mussel Monitoring in the Columbia River Basin" (2011). *Center for Lakes and Reservoirs Publications and Presentations.* Paper 10.
http://pdxscholar.library.pdx.edu/centerforlakes_pub/10

Prioritizing Zebra and Quagga Mussel Monitoring in the Columbia River Basin

Prepared for

Bonneville Power Administration and the Pacific States Marine Fisheries Commission

BPA Contract Number: 00003373
TI Project Number: 152

by

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April 2010

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Foreword

The purpose of this report is to provide a framework for the prioritization of water bodies in the Columbia River Basin and the Greater Northwest region (surrounding areas in Oregon, Washington, California, Nevada, Idaho, Utah, and Wyoming) for early detection monitoring for dreissenid mussels. Our ability to assess the relative risk of establishment and introduction of dreissenid mussels was confounded by significant gaps in the data necessary to rigorously predict where dreissenid mussels will become introduced and subsequently established. Consequently, local jurisdictions should evaluate the prioritized lists provided critically and make adjustments where local knowledge and additional information dictates. Further, since invasive species can be introduced and become established in areas identified with low to very low risk of establishment and introduction, monitoring these areas will increase the probability of detecting mussels before they become locally established.

Introduction

In 2007 dreissenid mussels (*Dreissena polymorpha*, zebra and *D. rostriformis bugensis*, quagga mussels) established populations west of the Rocky Mountains. The proximity of these new infestations increased the risk of introduction of dreissenid mussels to the Pacific Northwest. In response to the threat of dreissenid mussel invasion, the Columbia River Basin (CRB) Team of the 100th Meridian Initiative developed and tested a rapid response protocol that can be implemented if mussels are detected, but its efficacy is dependent upon effective detection of new infestations, which requires an effective monitoring strategy. Invasions by non-native species that eventually become invasive typically include a period of slow population growth, followed by an exponential increase in coverage. Control of invasive species is less costly in the early stages of infestations when population sizes are relatively small.

The inherent rarity of newly established populations, clumped distribution, environmental influences on spawning, and difficulty of observing underwater habitats complicates early detection of dreissenid mussels. When searching for any species at low densities there is a high likelihood of false negative results (i.e. failing to detect them when they are present); this will also be true for early detection efforts for dreissenid mussels. Because early detection monitoring is inherently difficult and resources are limited, early detection efforts should focus on water bodies that are at high risk for introduction and establishment.

Recreational boating is the primary vector for overland transport of mussels and increases the risk of inter-basin dreissenid introduction (Lucy, Buchan and Padilla 1999; Johnson, Ricciardi, and Carlton 2001, Karatayev, Padilla, Minchin, Boltovskoy, Burlakova 2007). The continued discovery of recreational trailered-watercraft with attached mussels in the Columbia Basin, and throughout the western US, corroborate the importance of this vector. Thus, total day use of a water body, presence of boat ramps and marinas, water body size and access, motorized boating, fishing, and angling tournaments are important determinants of risk of introduction.

The risk of dreissenid establishment is also influenced by environmental parameters such as dissolved calcium, pH, water temperature, salinity, dissolved oxygen, and substrate. Veliger survivorship increased from 3% at 12 mg Ca^{2+}/L to 20-25% at 47 mg Ca^{2+}/L (Sprung 1987). North American dreissenid juveniles show initial growth at calcium concentrations between 8.5 and 11 mg Ca^{2+}/L (Hincks and Mackie 1997; McMahon 1996) and moderate shell growth between 25 and 26 mg Ca^{2+}/L (McMahon 1996). In general, dreissenid adults inhabit waters with calcium concentrations greater than or equal to 15 mg Ca^{2+}/L, and populations become dense at concentrations greater than or equal to 21 mg Ca^{2+}/L (McMahon 1996). Dreissenid veligers are found in North America at pHs between 7.4 and 9.4; pH 8.4 is optimal (McMahon 1996). Adult dreissenid mussel growth is generally limited at pH less than 6.5 to 6.9, because dreissenids lose calcium to the external environment, and at pH greater than 10 (Hincks and Mackie 1997; McMahon 1996).

Dissolved calcium concentrations and pH are expected to be the most limiting environmental parameter to dreissenid establishment in the CRB and Greater Northwest (Hincks and Mackie 1997; McMahon 1996). Water temperature is not expected to limit growth as dreissenids inhabit a wide range of temperatures in North America. They are found in the Great Lakes at temperatures less than 5°C, and in the lower Mississippi where temperatures reach and exceed 30°C (McMahon 1996). North American freshwater dreissenids generally tolerate salinities up to 4‰ (McMahon 1996). Although both species of freshwater dreissenids are highly intolerant of oxygen deprivation (McMahon 1996), most water bodies in the CRB and surrounding areas are expected to maintain oxygenated areas that would support a source population during periods of low dissolved oxygen. Dreissenid mussels colonize multiple types of substrate (sand, silt, mud, shells, rock, wood, PVC, plants, etc.) and *D. r. bugensis* forms extensive populations on both soft and hard substrates (Roe and MacIsaac 1997).

Wells, Sytsma, and Draheim (2008, unpublished data) created a dreissenid risk matrix for the CRB and used it to develop a prioritized list of dreissenid mussel monitoring sites. The scope of that effort, however, was limited by data availability and constrained in geographic scope. Water bodies were prioritized from highest to lowest risk using the sum of ranks for calcium, pH and boater day use parameters. Although multiple data sources were evaluated, data were not available for many water bodies and parameters. Since the absence of data resulted in risk being ranked as zero, the relative risk for these water bodies was inaccurate. Obtaining water quality data on these lakes was necessary for a more comprehensive risk assessment for dreissenid introduction and establishment.

Further, long-distance transport of dreissenid mussels attached to trailered boats into the CRB is a major concern, and the geographic scope of the previous assessment needed to be expanded to high-risk water bodies outside the CRB boundary (e.g. Bear Lake, UT). The Sacramento-San Joaquin River Delta in California was the second most visited water body in all the 100th Meridian Initiative surveys conducted in the CRB, second only to the Columbia River. Sixty-two percent (*n*=1,314) of the total day-use reported by boaters surveyed within the CRB occurred outside the CRB, and 12% of total day-use (*n*=246) occurred in states with known dreissenid mussel populations.

This report provides a prioritized listing of water bodies for dreissenid monitoring in the CRB and the Greater Northwest region (surrounding areas in Oregon, Washington, California, Nevada, Idaho, Utah, and Wyoming). The prioritization is based on an assessment of the relative risk of introduction and establishment of *D. polymorpha* and *D. r. bugensis* into individual lakes, reservoirs, and rivers. This report also identifies some additional research needed to better characterize the suitability of water bodies in the Pacific Northwest for dreissenid mussel introduction and establishment.

Methods

Water Body Identification

We evaluated the relative risk of introduction and establishment of dreissenid mussels in individual water bodies in the CRB and Greater Northwest region. Earlier risk assessments for dreissenid mussels that included the CRB and Greater Northwest have occurred at larger scales. For instance, Drake and Bossenbroek (2004), Strayer (1991), and Whittier et al. (2008) conducted risk assessments at the hydrologic unit code and Level III ecoregion scales. Drake and Bossenbroek (2004) and Whittier, Ringold, Herlihy, Pierson (2008) reported a highly variable risk for the CRB, indicating the need for an assessment at a smaller scale. Assessment of dreissenid mussel risk at the water body scale has occurred in selected water bodies in some states within the CRB and the Greater Northwest Region (Cohen and Weinstein 1998; Colorado Division of Wildlife 2009, unpublished data; Idaho Department of Agriculture 2009, unpublished data; Utah Division of Water Resources 2007, unpublished data); however, these assessments were not regionally comprehensive.

We used a combination of expert judgment and available data to formulate an initial list of water bodies to be evaluated (*n*= 902). Water body types included lakes, reservoirs, rivers, and creeks. Water bodies of significant size and/or with high recreational use (boating and fishing) were selected using DeLorme Atlas and Gazetteer maps for California, Oregon, Washington, Nevada, Idaho, Montana, Wyoming, and Utah. A water body was considered of significant size when it was labeled on the map. Labels included water body name, and/or boating or angling symbols. Smaller water bodies that lacked labels on the maps were included if they were recognized for recreational use, e.g., if they're mentioned in fish and game reports. Water bodies that lacked public boat ramps were excluded from this prioritization. Despite our efforts to compile a comprehensive list, water bodies of significant size and/ or recreational use may have been excluded from this assessment. The omission of a water body from these assessments does not implicitly indicate a low likelihood of establishment and introduction.

Existing Water Quality and Boater Recreational Data

Our first step was to locate and assess the extent of existing pertinent water quality and boater recreational data for individual water bodies. We compiled data for a variety of parameters including dissolved calcium concentration, pH, conductivity, total visitor use days, total trip days, boater day use days, number of times a water body was mentioned in 100th Meridian Initiative boater surveys, presence of angling tournaments, surface area (lakes and reservoirs only), use of motorized boating, explicit indication that angling is a permitted recreational activity (e.g. Fish and Game angling regulations), presence of marinas and boat ramps, and presence of cold-water (e.g. trout, salmon, whitefish, etc.) and warm-water game fish (e.g. bass, crappie, walleye, etc).

Multiple sources were queried to compile water quality and boater recreational data. For water quality data, the US Environmental Protection Agency (EPA) STORET database (http://www.epa.gov/storet) and the USGS National Water Information System (NWIS) database (http://waterdata.usgs.gov) were the primary sources of data. Other sources of water quality data included state agencies, peer-reviewed literature, reports, and the Atlas of Oregon Lakes, Atlas of the Pacific Northwest, and the Hydrologic Investigations Atlas. We focused on water quality data collected within the last decade, but older data was used when no recent data were available. The compiling of existing water quality data was limited to data collected during the months of April through October to capture the dreissenid reproductive period. Boater-use data were gathered from surveys of registered boaters conducted by state agencies such as the Oregon State Marine Board, 100th Meridian Initiative boater survey, angling and regatta registration records, state park attendance records, DeLorme Atlas and Gazetteer maps, online maps, US Bureau of Reclamation's website for projects and facilities (http://www.usbr.gov/projects), US Army Corps of Engineers Corps Lake Getaway website (http://corpslakes.usace.army.mil/visitors/), the Recreation.gov website (http://www.recreation.gov), and angling websites.

Development of Kriging Model of Calcium Concentrations

After we obtained all existing water quality data, water bodies that lacked data were identified. To prioritize field collection efforts, we developed a kriging model (e.g., fitted surface models, universal kriging maps) to predict regional trends in calcium based on the existing geo-referenced water quality data compiled from STORET, NWIS and other sources (Figure 1). Kriging is a geostatistical technique used to generate predictions of a parameter value at a given location based on interpolations of the parameter using data from nearby locations. Universal kriging was used in order to remove trends; universal kriging assumes a general linear trend model, meaning the model assumes the mean calcium concentration varies over a given region. The kriging model predictions were used to identify water bodies lacking data that had the highest likelihood of having water quality suitable for dreissenid mussel establishment. Conservative dissolved calcium concentration thresholds were used in the kriging model (e.g. 8.5 mg Ca^{2+}/L).

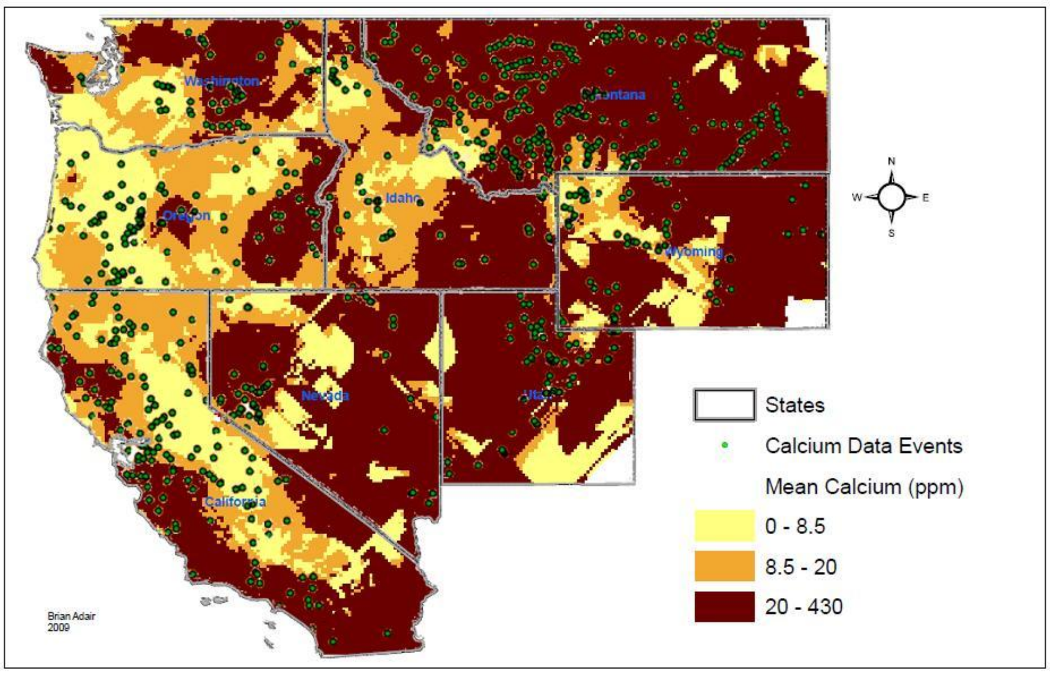

Figure 1. Universal Kriging map of the CRB and Greater Northwest showing predicted calcium concentrations as regional contours. The locations of measured dissolved calcium concentrations used to interpolate the calcium concentration contours are shown as green dots.

Field Data Collection

Field data collection was only feasible for a small subset of the water bodies lacking water quality data due to budgetary constraints. Thus, water bodies with the greatest perceived dreissenid introduction and establishment risk were selected for field collection of water quality data. The water bodies chosen were selected using the available recreational boater and water quality data, universal kriging model maps, and input from local agencies. The available water quality data were summarized to identify water bodies lacking data or with limited water quality data due to small sample size, old data, etc. These water bodies were then plotted on the predicted calcium contour map generated from the Kriging exercise (Figure 2). Since there were too many water bodies lacking water quality data to sample (*n*= 459), the available boater recreational data for these water bodies were summarized in order to identify those with the highest use. Only water bodies within the CRB boundary were considered for field data collection because prioritizing CRB water bodies was our primary objective. The largest and most used water bodies within the CRB lacking water quality data that were located in areas predicted to have medium to high concentrations of dissolved calcium or those located in areas lacking existing water quality data (see Figure 1) were selected for the initial list of water bodies for field data collection.

This initial list of water bodies to sample was then sent to local fish and game agencies to solicit their expert opinions on the list. We solicited their help in the acquisition of data not identified during the compiling of existing water quality data and, if no additional data were available, to help with the field collection of water quality data. Montana Fish Wildlife and Parks and the US Bureau of Reclamation (USBOR) collected water quality samples for a subset of this initial field collection list. The remaining list was further prioritized by selecting the water bodies that were hydrologically separate or spatially distal to locations with existing data. Opportunities to coordinate water quality sample collection with other projects were also identified. The final field data-collection list included 88 water bodies (Table 1).

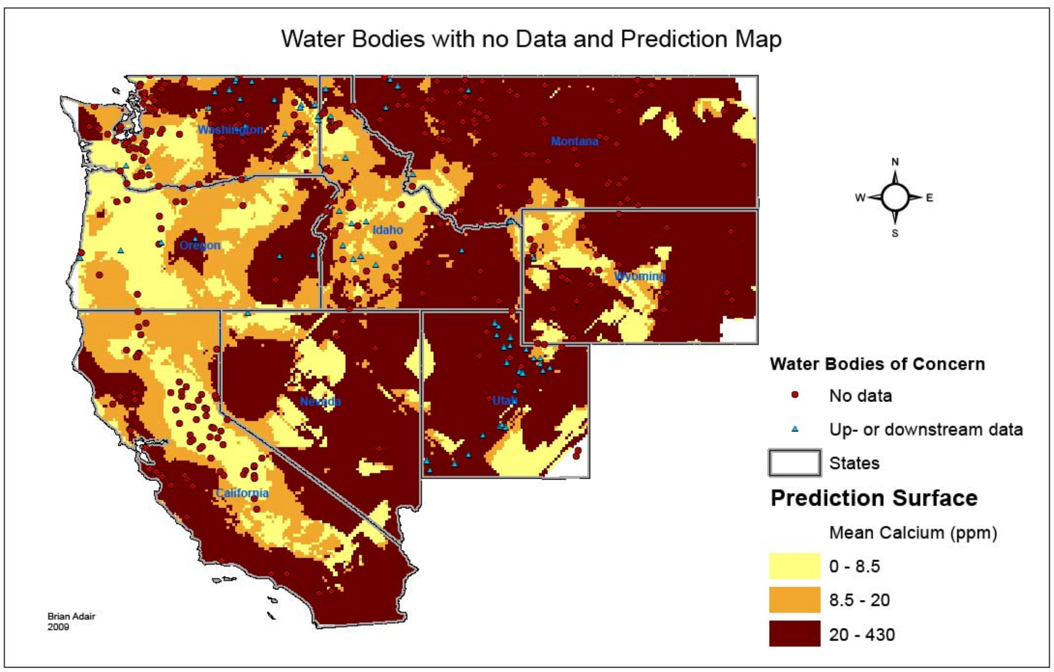

Figure 2. Universal Kriging map of the CRB and Greater Northwest showing the locations of water bodies lacking water quality data relative to the predicted calcium concentration contours. Water bodies lacking data were identified as those with data found either upstream or downstream the water body in question, as well as those completely lacking data.

Table 1. Water bodies selected for field data collection of dissolved calcium and pH and the agency designated for sample collection.

Water Body	State	Collector	Water Body	State	Collector
Bethany Reservoir	CA	PSU	Hungry Horse Reservoir	MT	MTFWP
Black Butte Lake	CA	PSU	Swan River	MT	MTFWP
Clear Lake	CA	PSU	Thompson Chain of Lakes	MT	MTFWP
Iron Gate Reservoir	CA	PSU	Whitefish Lake	MT	MTFWP
Lake Don Pedro	CA	PSU	Topaz Lake	NV	PSU
Lake McClure	CA	PSU	Wild Horse Reservoir	NV	PSU
Lake Nacimiento	CA	PSU	Brownlee Reservoir	OR	PSU
Lake New Melones	CA	PSU	Buckeye Lake	OR	PSU
Lake San Antonio	CA	PSU	Cliff Lake	OR	PSU
Lake Turlock	CA	PSU	Columbia River, John Day	OR	PSU
Mendocino Lake	CA	PSU	Columbia River, Lake Celilo	OR	USGS
Mokelumne River, B&W Resort	CA	PSU	Columbia River, Lake Umatilla	OR	USGS
Old River, Rivers End Marina	CA	PSU	Columbia River, McCormack Sl	OR	USGS
Sacramento River, Brannan Is	CA	PSU	Deschutes River	OR	USGS
San Joaquin River, Paradise Pt	CA	PSU	Fish Lake	OR	PSU
San Luis Reservoir	CA	PSU	Hemlock Lake	OR	PSU
Shasta Reservoir	CA	PSU	John Day River	OR	PSU
Alexander Reservoir	ID	PSU	Malheur River	OR	PSU
Alturas Lake	ID	PSU	Umatilla River	OR	USGS
Benewah Lake	ID	USGS	Alder Reservoir	WA	PSU
Black Canyon Reservoir	ID	USBOR	Banks Lake	WA	USGS
Black Lake	ID	USGS	Billy Clapp Lake	WA	USGS
Blackfoot Reservoir	ID	PSU	Black Lake	WA	USGS
Bliss Lake	ID	PSU	Blue Lake	WA	USGS
Cascade Reservoir	ID	USBOR	Clear Lake	WA	USGS
Chesterfield Reservoir	ID	PSU	Columbia River, Rowland Lake	WA	USGS
CJ Strike Reservoir	ID	PSU	Cowlitz River	WA	PSU
Clark Fork River	ID	USGS	Deer Lake	WA	USGS
Crane Creek Reservoir	ID	PSU	Diamond Lake	WA	USGS
Dworshak Reservoir	ID	USGS	Lake Chelan	WA	USGS
Hauser Lake	ID	USGS	Columbia River, Lake Wallula	WA	PSU
Horsethief Reservoir	ID	PSU	Liberty Lake	WA	USGS
Killarney Lake	ID	USGS	Loon Lake	WA	USGS
Lucky Peak Reservoir	ID	PSU	Newman Lake	WA	USGS
Medicine Lake	ID	USGS	Riffe Reservoir	WA	PSU
Mormon Reservoir	ID	PSU	Silver Lake	WA	USGS
Oneida Narrows Reservoir	ID	PSU	Silver Lake	WA	PSU
Paddock Valley Reservoir	ID	PSU	Sprague Lake	WA	USGS
Pend Oreille River	ID	USGS	Swift Creek Reservoir	WA	PSU
Petit Lake	ID	PSU	Waitts Lake	WA	USGS
Salmon Falls Reservoir	ID	PSU	Williams Lake	WA	USGS
Spirit Lake	ID	USGS	Yale Reservoir	WA	PSU
Stone Reservoir	ID	PSU	Fremont Lake	WY	PSU
Georgetown Lake	MT	MTFWP	Halfmoon Lake	WY	PSU

Standard operating procedures were developed for the field collection, preservation, and handling of water quality samples. Field collection occurred between June and early-October, 2009. Field collection was performed from a boat at an anchor site in the middle of the water body or near the dam in reservoirs. In a few limited cases sampling was done from surface structures such as navigational arms and docks.

At the anchor site, Secchi depth was measured by taking the average of two readings, each consisting of the depth of disk disappearance and the reappearance; sunglasses were removed when taking Secchi measurements. A multiprobe unit was deployed to collect a depth profile for water temperature, dissolved oxygen, conductivity, and pH. The multiprobe unit was lowered to the 1-m depth and allowed to stabilize. Multiprobe unit measurements were made at 1-m intervals to a depth of 1 m off the bottom or to the end of the cable. The depth of anchor site was determined by anchor line or using a depth sounder. Plankton samples were collected at the anchor site, and opportunistically throughout the water body, for the presence/nondetect determination of veligers using PSU protocols (Sytsma and Wells 2009, unpublished report).

A minimum of 250 mL of water was collected in an acid washed polyethylene bottle from approximately 0.7-m depth for the determination of dissolved calcium concentration. The unfiltered sample was immediately placed on ice. Onshore, the 250 mL water sample was filtered using a 0.45-µm filter, preserved with nitric acid and held on ice for a maximum of 30 days prior to cation analysis. Cation analyses were done by the Cooperative Chemical Analytical Laboratory using atomic absorption spectrophotometry. Equipment used for the collection and filtering of calcium samples was acid washed in 4% hydrochloric acid, and rinsed with distilled water. In order to reduce contamination of calcium samples, filtering equipment was isolated in plastic containers, and gloves were worn during sample and equipment handling.

Field and laboratory data accuracy and precision were maintained through quality control efforts. One duplicate cation sample was collected for every ten cation samples to assess precision. One field blank consisting of distilled water was filtered, preserved, and held on ice prior to analysis to assess field contamination and handling issues. The two meter depth was measured again after completing a depth profile with the multiprobe unit to check for instrument drift. Multiprobe units were calibrated at each water body for dissolved oxygen as percent saturated air. Multiprobe units were calibrated for pH 7 and 10 at the beginning of each day. The calibration was tested against pH 7 buffers later in the day and recalibrated if the measurement was not within ±0.2 pH units of the standard. Conductivity was calibrated in the laboratory prior to field deployment and recalibrated in the field if the calibration check was not within ±7% of the standard. Dissolved oxygen was recalibrated if not within ±0.2 mg/L of 100% saturated air. Quality control for cation analyses via atomic absorption spectrophotometry was done according to the standard operating procedures for the Cooperative Chemical Analytical Laboratory (CCAL) (Motter and Jones 2008). The CCAL quality control efforts included blanks, check standards to monitor instrument drift, MDL based on a one-sided 99% confidence interval (t-value) from at least seven repeated measurements of a low concentration standard, analytical duplicates, quality control check samples (QCCS), and the tracking of standard recoveries and QCCS results.

Prioritization

For this prioritization we characterized the relative risk of dreissenid establishment in individual water bodies in the CRB and Greater Northwest region using dissolved calcium, and characterized the relative risk of dreissenid introduction to individual water bodies using boater recreational data. The risk of establishment was given greater consideration in the relative prioritization of water bodies compared to the risk of introduction. Although the detection of veligers (but not adults) in lakes with calcium concentrations less than 12 mg Ca^{2+}/L (e.g. Granby Lake, CO) suggests that our ability to predict the risk of establishment is confounded by an incomplete knowledge of dreissenid biology, the physiological importance of calcium and its association with the distribution of established populations is well documented. Water quality data was more objective and more consistent in the methods of collection and availability among states compared to boater recreational data. Trailered boats are an important vector, especially for overland dispersal, but boater use data cannot be compared between states, there are large gaps, and other vectors for mussel introduction, such as barge traffic, are not reflected in boater recreational data.

Many environmental parameters, and combinations of parameters, have been used in prior dreissenid risk assessments including calcium, pH, salinity, dissolved oxygen, phosphate and nitrate, air temperature, water hardness, river geomorphology, and substrate type (Table 2) (Cohen and Weinstein 1998; Drake and Bossenbroek 2004; Jones and Ricciardi 2005; Karatayev 1995; Strayer 1991; Whittier et al. 2008); dissolved calcium and pH are physiologically important for metabolic functions and shell-building in dreissenid mussels (Hincks and Mackie 1997, McMahon 1996). Ramcharan, Padilla, and Dodson (1992) distinguished lakes with established dreissenid populations from those without using dissolved calcium concentration and pH at an accuracy of 92.7% (cross-validation error rate). Other environmental parameters Ramcharan et al. (1992) evaluated, but excluded from model selection, included maximum summer bottom temperature, maximum summer surface temperature, minimum summer bottom dissolved oxygen concentration, Secchi depth, and concentrations of magnesium, chlorine, bicarbonate, phosphate, total phosphorus, and nitrate. Neary and Leach (1992) used calcium, pH, and road access data to evaluate the potential for introduction and establishment in Ontario lakes. Cohen and Weinstein (1998) used calcium, pH, water temperature, dissolved oxygen, and salinity to predict dreissenid occurrence in California water bodies, but weighted calcium and pH over the other environmental parameters. The range of calcium and pH values used in other western studies to rank water bodies regarding the risk of dreissenid establishment is presented in Table 3.

Table 2. Dreissenid mussel responses to a) dissolved calcium concentrations and b) pH as reported in European and North American literature. Most studies were done with *D. polymorpha*.

a)

$[Ca^{2+}]$	Life stage	Type	Results	Author
<20	veliger	Lab	Absent	Hincks and Mackie 1997
12	veliger	Field	lower limit	McMahon 1996
12	veliger	Lab	3% survival	Sprung 1987
10 - 11	veliger	Field	initiation of shell growth	McMahon 1996
>34	veliger	Field	Optimum	McMahon 1996
47 - 106	veliger	Lab	20 - 25% survival	Sprung 1987
>8.5	adult	Lab	positive juvenile growth (pH >8.3)	Hincks and Mackie 1997
<12	adult	Model	spread unlikely	Neary and Leach 1992
15	adult	Field	lower limit	McMahon 1996
12 - 20	adult	Model	spread possible	Neary and Leach 1992
>20	adult	Model	spread probable	Neary and Leach 1992
21	adult	Field	dense populations	McMahon 1996
>25	adult	Lab	large populations	Hincks and Mackie 1997
25 - 26	adult	Field	moderate shell growth	McMahon 1996
32	adult	Lab	max growth	Hincks and Mackie 1997
>34	adult	Field	Optimum	McMahon 1996

b)

pH	Life stage	Type	Results	Author
< 8.5	veliger	Lab	Absent	Hincks and Mackie 1997
7.4 - 9.4	veliger	Field	successful development	McMahon 1996
8.4	veliger	Field	max growth	McMahon 1996
< 7.4	adult	Review	Absent	Karatayev 1995
< 7.3	adult	Model	Absent	Ramcharan et al. 1992
6.5	adult	Field	Minimum	McMahon 1996
7.4	adult	Field	moderate growth	McMahon 1996
> 8.3	adult	Lab	positive growth	Hincks and Mackie 1997
> 8.0	adult	Field	max growth	McMahon 1996

Table 3. The range of calcium and pH values used in other western studies to score water bodies regarding the risk of dreissenid establishment.

Rankings	$[Ca^{2+}]$	pH	Authors
High	>25	7.5 - 8.7	Cohen and Weinstein 1998
Med	15-25	7.3 - 7.5, 8.7 - 9.0	
Low-to-no	<15	<7.3, >9.0	
4	>25	>7.8 - 8.3*	Colorado Division of Wildlife 2009
3	15-25*	>7.4 - 7.8, >8.4*	
2	10 - 14*	>7.1 - 7.4*	
1	<10*	<7.1*	
High	>25		Idaho Department of Agriculture 2009
Med	11 - 25		
Low	0 - 10		
High	>28		Whittier et al. 2008
Moderate	20 - 28		
Low	12 - 20		
Very Low	<12		
High	>20	>7.4	Neary and Leach 1992
Med	12 - 20		
Low	<12	<7.4	
High	>25	7.5 - 8.7	Utah Division of Water Resources 2007
Moderate	20 - 25	7.2 - 7.5, 8.7 - 8.9	
Low	9 - 20	6.5 - 7.2, 9.0	
Very Low	<9	<6.5, >9.0	

* Value ranges were estimated from raw data and assigned rankings.

In this assessment, the risk of establishment was based on mean calcium concentration. The mean pH values of the water bodies in the CRB and Greater Northwest were generally greater than the lower thresholds limiting survival and growth. The mean pH values were greater than 6.9 and less than 10 for 96% of the 542 water bodies with pH data in the CRB and Greater Northwest. Although, pH values of 7.3 and 7.4 are reported by some authors as the lower pH threshold for dreissenid mussel growth and survival, we chose to use a more conservative lower pH threshold, surface mean pH value of 6.9, to account for diurnal and seasonal variability in pH, data collection timing, and a general lack of metadata for the pH data we compiled. Incidentally, 83% of the 542 water bodies in the CRB and Greater Northwest with pH data had mean pH values greater than 7.3.

The range in dissolved calcium concentration used to rank individual water bodies for dreissenid establishment in this prioritization (Table 4) was more conservative than others (Table 2 and Table 3). We chose to adopt a more conservative approach in part based on the recent detections of veligers in water bodies with low calcium concentrations (e.g. less than 10 mg/L) such as Lake Granby, CO and Grand Lake, CO, the spatial and temporal variability in calcium concentrations, and because of the uncertainty associated with our current knowledge of the ecological factors limiting *D. r. bugensis* populations. For example, although approximately 80%

of calcium deposited in the *D. polymorpha* shell is actively taken up from the water (Hincks and Mackie 1997), dreissenid mussels can also obtain calcium from food (Nichols 1996). Additionally, calcium concentrations collected upstream or downstream of a reservoir were evaluated separately (e.g. Flaming Gorge Reservoir versus Flaming Gorge Res inflow).

Table 4. Values of dissolved calcium (mg/L) used to assign a risk category to individual water bodies for determining the likelihood of dreissenid mussel establishment.

Risk Category	$[Ca^{2+}]$ (mg/L)
High	> 25
Medium	> 15 - 25
Low	12 - 15
Very Low	< 12
Indeterminate	No Data

Mean values for water quality parameters were used in this analysis. When water quality data were limited to one data point per water body, the one data point was used in lieu of the mean value. When only one or two data points were used to evaluate the likelihood of dreissenid establishment, the risk category was flagged with an asterisk. In the event of missing data, the field was left blank and the relative risk of establishment was indeterminate. Statistical Analysis System software (version 9.1, SAS Institute Inc., Cary, North Carolina, USA) was used to calculate summary statistics (mean, standard deviation, min, max, etc.) from the raw water quality data, and to write programs for data manipulation and risk category assignment. Ten percent of water bodies were randomly chosen for examination to ensure that the program was correctly assigning categories. The dissolved calcium concentration and pH data are summarized in Appendix I.

In addition to the assigned ranking of risk for dreissenid establishment based on calcium alone, we also used the mean values for dissolved calcium and pH to predict dreissenid presence/absence as per Ramcharan et al. (1992) and compared our results with the model as well as the risk assessments conducted by California (Cohen and Weinstein 1998) and Utah (Utah Division of Wildlife, unpublished data) state agencies and the earlier assessment by Wells et al. (2008). The Ramcharan et al. (1992) model was based on water quality and biological data collected from lakes in England, Scotland, France, The Netherlands, Denmark, Germany, Switzerland, Austria, Poland, Hungary, Yugoslavia, Italy, Russia, Sweden, and the Laurentian Great Lakes. This model correctly predicted the presence or absence of *D. polymorpha* with 92.7% accuracy in these areas. The Ramcharan et al. (1992) model is a discriminant function:

$$A = 1.246*\text{pH} + 0.045*[Ca^{2+} \text{ as mg/L}] - 11.696$$

Mussels present if $A > -0.638$

The relative risk of introduction for each water body was determined by boater recreational data. Recreational boating use was determined from annual boating and angling pressure (i.e. use days, trips), angling tournaments, and state assessments of recreational use. Use days represent the total number of days that registered boaters spent boating on a water body per year. Trips represent the number of days spent traveling away from home to go boating per year. Recreational use was also determined from state assessments that identified the most used water bodies in Washington and Utah. The two parameters representing recreational boating that were considered most applicable and had the broadest spatial coverage were used to assess the risk of introduction for each state. One parameter was weighted more than the other during the relative ranking of water bodies in order to combine results obtained using different methods. The parameters varied by state, and not all states had multiple parameters. Total pressure (e.g. total use days) and the number of registered angling tournaments were the most commonly used parameters to assess recreational boating; the greatest weight was given to total use days.

Categories for the relative risk of introduction were assigned to individual water bodies using the quartiles of the boater recreational data according to Table 5. Boater recreational data collection was not consistent between states, and was not available for many water bodies within each state. The risk categories for the risk of dreissenid mussel introduction into a given water body are therefore specific to each state and those water bodies containing recreational data.

Table 5. Value ranges of Recreational Boater Use data assigned to risk categories for the introduction of dreissenid mussels to a water body relative to other water bodies in a given state. Recreational boater use data were not consistent between states, and risk is assigned relative to those water bodies with data in each state. Risk categories were assigned to water bodies depending upon the quartiles of the recreational data.

Risk Category	Recreational Use Data
High	> Q_3
Medium	> median - Q_3
Low	> Q_1 - Q_3
Very Low	0 - Q_1
Indeterminate	No Data

Results

Relative Risk of Mussel Establishment

The relative risk of dreissenid mussel establishment was highest in the U.S. Upper Columbia River Basin and decreased downriver towards the mouth at the Pacific Ocean (Tables 6 through 9 and Figure 3). Water bodies in the Upper Columbia River sub-basin range from high (e.g. Moses Lake, WA) to very low risk of establishment (e.g. Wenatchee River, WA). Relative risk of establishment in the Mid-Columbia River sub-basin also ranged from high (e.g. Umatilla River, OR) to very low (e.g. Deschutes River, OR). Water bodies in the Upper Snake River sub-basin fell mostly in the high relative risk category (e.g. Lake Walcott, American Falls Reservoir, and Ririe Lake). The Central Snake River sub-basin had water bodies ranging from high (e.g. Milner Reservoir, Salmon Falls Reservoir, Owyhee River, Brownlee Reservoir) to very low (e.g. Cascade Reservoir, Lucky Peak Lake) relative risk of establishment. Water bodies in the Lower Snake River sub-basin ranged from medium (e.g. Salmon River) to very low relative risk (e.g. Clearwater River).

Variability in the relative risk of establishment was apparent in other major river basins as well (Figure 3). Water bodies in the Colorado River Basin had a high relative risk for dreissenid establishment. The relative risk for dreissenid establishment in the Sacramento-San Joaquin River Rivers Basin increased towards the river mouth, but water bodies in this basin had a generally very low relative risk of establishment, especially those in the upper sub-basin (e.g. Lake Don Pedro, New Melones Lake, Lake McClure, Camanche Reservoir, Lake Almanor, Folsom Lake); although some water bodies had a higher relative risk of dreissenid establishment (e.g. Black Butte Reservoir, Lake Berryessa, Clear Lake). Water bodies in the upper Missouri

River Basin ranged from high to very low, but most water bodies had a high to medium relative risk of establishment.

There were patterns in the relative risk of establishment on larger spatial scales than river basin. Concentrations of dissolved ions were generally higher in semiarid areas characterized by high evaporation and low precipitation. Utah was dominated by water bodies with a high relative risk for dreissenid establishment. Most areas of Nevada had a mixture of high and medium relative risk water bodies, except for water bodies near the Sierra Nevada Mountains, which were generally at low-risk for dreissenid establishment. The central and southern parts of Wyoming typically had high and medium-risk water bodies; however, the Yellowstone and Teton areas had water bodies that were very low risk for establishment. The mountains in the western part of Montana had variable likelihood of dreissenid establishment. Water bodies in the areas near Ravalli, Deer Lodge, and Granite Montana were typically very low risk for dreissenid establishment, while water bodies in northwestern Montana near Flathead and Lincoln areas range from high to low risk. The lowland areas in southern Idaho associated with the Snake River generally had high-risk water bodies, while the mountainous parts of Idaho such as the panhandle and areas around Idaho City generally had water bodies that were very low risk for dreissenid establishment. Most water bodies in Washington located in the western and central areas outside the Upper Columbia River Basin were very low risk for establishment. Water bodies in southeastern Oregon are typically medium risk, while water bodies in northeastern Oregon range from low to medium risk. Water bodies in central Oregon near the Bend area were medium risk and water bodies in the Willamette Valley and western Oregon were very low risk for dreissenid mussel establishment.

Table 6. Water bodies determined to have a high relative risk for dreissenid mussel establishment. Risk category was determined by mean dissolved [Ca^{2+}], mg/L. Presence or absence of dreissenid mussels was predicted for the water bodies using mean calcium and pH data in the model developed by Ramcharan et al. (1992). The results of risk assessments done by state agencies and others are also presented. Blanks indicate no data were available. ([1]= Cohen and Weinstein (1998), [2]= Utah Division of Wildlife Resources, and [3]= Wells et al. (2008)). Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can establish in areas identified with low to very low risk of establishment.

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Virgin River	NV	290	8.11	High	Presence	
Great Salt Lake	UT	268	7.60	High	Presence	
Cheyenne River	WY	249	7.82	High	Presence	
Wannacut Lake	WA	225	8.25	High*	Presence	High[3]
Powder River	MT	153	8.03	High	Presence	
Big Sandy Rv., Big Sandy Res. outflow	WY	141	8.20	High*	Presence	
Keyhole Reservoir outflow	WY	135	8.20	High	Presence	
Humboldt Lake	NV	123	7.83	High	Presence	
Seminoe Reservoir outflow	WY	120	8.23	High	Presence	
Musselshell River	MT	115	8.08	High	Presence	
Gunnison Reservoir	UT	94.2	8.06	High	Presence	
Bighorn River	MT	89.9	8.08	High	Presence	
Colorado River, Lake Mead	NV	87.6	7.74	High	Presence	
Salmon Falls Creek Reservoir	ID	83.2	8.15	High	Presence	High[3]
Clark Fork Muddy Creek	MT	83.2	8.12	High*	Presence	

Table 6 (continued).

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Quail Creek Reservoir	UT	83.0	8.20	High*	Presence	88 [2]
Kolob Reservoir	UT	82.0	8.30	High*	Presence	
Sparks Marina	NV	76.7	7.67	High	Presence	
Utah Lake	UT	76.1	8.11	High	Presence	100 [2]
Colorado River, Lake Havasu	CA	75.0	7.80	High	Presence	Low-to-no[1]
Porcupine Reservoir	UT	74.0	8.12	High*	Presence	
Teton River	MT	73.5	7.32	High	Presence	
Ruby River	MT	73.3	8.24	High	Presence	
Colorado River, Lake Powell	UT	72.1	8.0	High	Presence	
Beaverhead River	MT	71.5	7.92	High	Presence	
Soldier Creek Reservoir	UT	71.0	8.20	High	Presence	
East Canyon Reservoir	UT	69.0	8.28	High	Presence	88 [2]
San Juan River	UT	67.3		High	Presence	
Colorado River	NV	65.9	7.83	High	Presence	
Flaming Gorge Reservoir	UT	65.6	8.10	High	Presence	86 [2]
Judith River	MT	64.2	8.01	High	Presence	
Salt River, Palisades Reservoir inflow	WY	64.1	8.00	High*	Presence	High[3]
N.F. Musselshell River	MT	64.0	8.09	High	Presence	
Bighorn River	WY	62.9	8.17	High	Presence	
Big Spring Reservoir	NV	60.8	7.60	High	Presence	
Escalante River	UT	60.2		High	Presence	
Oneida Narrows Reservoir	ID	59.7	7.76	High*	Presence	
Sun River	MT	59.5	8.21	High	Presence	
Lost Creek Reservoir	UT	58.8	8.00	High	Presence	
Echo Reservoir	UT	58.3	8.19	High	Presence	
Starvation Reservoir	UT	57.9	8.24	High	Presence	88 [2]
Scofield Reservoir	UT	57.9	8.23	High	Presence	88 [2]
Snake River	ID	57.5	8.03	High	Presence	High[3]
Smith River	MT	56.5	8.16	High	Presence	
Warm Springs Reservoir	OR	56.0	8.08	High*	Presence	
Newton Reservoir	UT	55.0	8.01	High	Presence	
Boysen Reservoir	WY	54.1	8.31	High	Presence	
Ruby River Reservoir	MT	53.5		High*		
Red Lodge Creek	MT	53.3	7.35	High*	Presence	
Blackfoot River	ID	53.0	8.10	High*	Presence	High[3]
Bighorn Lake inflow	WY	52.6	8.31	High	Presence	
Flaming Gorge Reservoir	WY	52.4	8.34	High	Presence	
Alexander Reservoir	ID	52.1	7.97	High*	Presence	
North Platte River	WY	50.9	8.79	High	Presence	
Eagle Valley Reservoir	NV	50.5	8.18	High*	Presence	
Willow Creek	ID	50.2	8.18	High	Presence	
Carson Lake	NV	50.0	8.05	High	Presence	

Table 6 (continued).

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Magic Reservoir, outflow	ID	49.8	7.85	High	Presence	High[3]
Huntington North Reservoir	UT	49.7	8.26	High	Presence	
Rockport/Wanship Reservoir	UT	49.4	8.20	High	Presence	88 [2]
Marias River	MT	49.2	7.83	High	Presence	
Strawberry Reservoir	UT	48.4	8.01	High	Presence	75 [2]
Hyrum Reservoir	UT	48.3	7.87	High	Presence	88 [2]
Snake River, American Falls Res.	ID	47.5	8.19	High	Presence	High[3]
Lake Fort Peck	MT	47.0	8.59	High*	Presence	
Ririe Reservoir	ID	46.9	7.96	High	Presence	
Gunlock Reservoir	UT	46.9	8.05	High	Presence	88 [2]
Tongue River Reservoir	MT	46.9	7.43	High	Presence	
Snake River, Lake Walcott	ID	46.2	8.27	High	Presence	High[3]
Deer Creek Reservoir	UT	46.0	7.48	High	Presence	88 [2]
Huntington Reservoir	UT	45.9	8.17	High	Presence	88 [2]
Garden Creek	MT	45.9	8.34	High*	Presence	
Snake River, Milner Lake	ID	45.7	8.49	High	Presence	
Washoe Lake	NV	45.0	8.65	High	Presence	
Little Washoe Lake	NV	44.7	8.52	High	Presence	
Malheur Reservoir	OR	44.6	8.37	High	Presence	High[3]
Stillwater Point Reservoir	NV	44.4	8.17	High	Presence	
Sulphur Creek Reservoir outflow	WY	44.3	8.51	High*	Presence	
Woodruff Narrows Reservoir inflow	WY	44.2	8.48	High	Presence	
Piute Reservoir	UT	44.1	8.21	High	Presence	100 [2]
Milk River	MT	43.8	8.13	High	Presence	
Blackfoot Reservoir	ID	43.7	8.38	High	Presence	High[3]
Cave Lake	NV	43.6	8.41	High	Presence	
Green River, Fontenelle Reservoir	WY	43.6	8.06	High	Presence	
Bear River, Woodruff Reservoir	WY	43.5	8.30	High	Presence	
Snake River, Bliss Reservoir	ID	43.3	8.21	High	Presence	
Tiber Reservoir	MT	43.0	8.17	High	Presence	
Owyhee River	OR	43.0	7.97	High	Presence	
Joes Valley Reservoir	UT	42.7	7.91	High	Presence	88 [2]
Mission Lake	MT	42.4	8.05	High	Presence	High[3]
Gallatin River	MT	42.2	7.94	High	Presence	
Whitney Reservoir	UT	42.0	8.05	High*	Presence	
Bully Creek Reservoir	OR	41.7	7.76	High	Presence	High[3]
Pearrygin Lake	WA	41.5	8.35	High*	Presence	High[3]
Rye Patch Reservoir	NV	40.7	8.53	High	Presence	
Jefferson River	MT	40.5	8.18	High	Presence	
Snake River, Upper Salmon Falls Res.	ID	40.3	8.23	High	Presence	High[3]
Missouri River	MT	39.8	8.16	High	Presence	
Murtaugh Lake	ID	39.8	8.14	High	Presence	High[3]

Table 6 (continued).

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Malheur River	OR	39.6	8.36	High*	Presence	High[3]
Douglas Creek	MT	39.6	8.11	High*	Presence	
Ruby Lake Marsh	NV	39.4	8.00	High*	Presence	
Cooney Reservoir	MT	38.7		High*		
Pelican Lake	UT	38.6	8.35	High	Presence	
Panguitch Lake	UT	38.5	8.43	High	Presence	88 [2]
Mary's River	NV	38.4	8.16	High	Presence	
Enterprise Reservoir	UT	38.0	8.60	High*	Presence	
Hay Meadows Reservoir	NV	38.0	8.51	High*	Presence	
Spectacle Lake	WA	37.8	8.75	High	Presence	High[3]
Snake River, Gem State Reservoir	ID	37.4	8.09	High	Presence	
Snake River, Palisades Reservoir	ID	37.3	7.99	High	Presence	
Wind River	WY	37.2	8.18	High	Presence	
Otter Creek Reservoir	UT	37.0	8.42	High*	Presence	100 [2]
Beaver Creek	MT	37.0	8.02	High*	Presence	
Battle Creek	MT	37.0	7.91	High*	Presence	
Jocko River	MT	37.0		High*		
Pineview Reservoir	UT	37.0	8.04	High	Presence	88 [2]
North Platte Rv., Pathfinder Res. inflow	WY	36.5	8.16	High	Presence	
Palmer Lake	WA	36.0	8.35	High	Presence	High[3]
Lexington Reservoir	CA	36.0	7.90	High	Presence	High[1]
Bear Lake	ID	47.7	8.11	High	Presence	
Lodge Creek	MT	35.8	9.03	High*	Presence	
Tenmile Creek	MT	35.5	7.65	High	Presence	
Spokane River inflow	WA	35.3	8.43	High	Presence	High[3]
Helena Valley Regulating Reservoir	MT	35.0		High*		
Clarks Fork of Yellowstone River	MT	34.9	7.50	High	Absence	
Steinaker Reservoir	UT	34.8	7.80	High	Presence	88 [2]
Umatilla River	OR	34.6		High*		
Owyhee River, East	NV	34.6	8.36	High	Presence	High[3]
Stone Reservoir	ID	34.4	8.25	High*	Presence	
Holter Lake	MT	34.0		High*		
Nelson Reservoir	MT	34.0		High*		

Table 6 (continued).

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Lower Crab Creek	WA	33.9	8.33	High	Presence	
Ashley Lake	MT	33.8	8.16	High*	Presence	High[3]
Prineville Reservoir	OR	33.4	7.72	High	Presence	
North Platte Rv., Seminoe Res. inflow	WY	33.2	8.14	High*	Presence	
Clark Fork River	MT	33.2	7.91	High	Presence	High[3]
Kootenai River	ID	33.1	7.79	High	Presence	High[3]
Lake Koocanusa	MT	33.0	7.74	High*	Presence	High[3]
Anderson Lake	CA	33.0	7.70	High	Presence	High[1]
Lake San Antonio	CA	32.8	7.51	High*	Absence	High[1]
Owyhee River	ID	32.6	8.21	High	Presence	
Red Fleet Reservoir	UT	32.4	8.23	High*	Presence	88 [2]
Lake Del Valle	CA	32.0	8.50	High	Presence	High[1]
Hauser Reservoir	MT	32.0		High*		
Post Creek	MT	32.0		High*		
Mud Lake	ID	31.9	7.96	High	Presence	High[3]
Sprague Lake	WA	31.8	8.68	High	Presence	High[3]
S.F. Sun River	MT	31.7	8.33	High*	Presence	
Black Butte Lake	CA	31.5	8.06	High*	Presence	High[1]
Snake River, Brownlee Reservoir	ID	31.3	8.13	High	Presence	
Lake Nacimiento	CA	31.3	8.18	High*	Presence	High[1]
Owyhee River, South	NV	31.0	8.37	High	Presence	
Snake River, Hells Canyon Reservoir	OR	31.0	8.20	High*	Presence	
Moses Lake	WA	30.5	8.18	High	Presence	
Waitts Lake	WA	30.2	7.38	High	Absence	
Gates of the Mountain Reservoir	MT	30.0		High*		
Weber Reservoir	NV	29.3	8.12	High*	Presence	
S.F. Flathead River	MT	29.0	7.87	High	Presence	High[3]
Lake Helena	MT	29.0		High*		
Kootenai River	MT	28.6	8.10	High*	Presence	High[3]
Nevada Creek	MT	28.5	8.10	High*	Presence	
Canyon Ferry Reservoir	MT	28.3		High		
Potholes Reservoir outflow	WA	28.3	8.14	High	Presence	
Owyhee Reservoir	OR	28.2	7.55	High	Absence	High[3]
Lake Alva	MT	28.0		High*		
Paulina Lake	OR	28.0	8.25	High	Presence	
Bruneau River, West	NV	27.9	8.34	High	Presence	High[3]
Big Sand Wash Reservoir	UT	27.9	8.01	High	Presence	
Chesterfield Reservoir	ID	27.4	8.63	High*	Presence	High[3]
South Fork Reservoir	NV	27.3	8.38	High	Presence	
Sheckler Reservoir	NV	27.0	8.74	High	Presence	
Thompson Falls Reservoir	MT	27.0	8.33	High*		

Table 6 (continued).

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Echo Lake	MT	27.0		High*		
Yellowstone River	MT	26.8	8.14	High	Presence	High[3]
Rock Creek	MT	26.7	7.30	High	Absence	
Cold Springs Reservoir	NV	26.0	8.97	High*	Presence	
Lake Perris	CA	26.0	8.50	High	Presence	High[1]
Calero Reservoir	CA	26.0	8.10	High	Presence	High[1]
Mann Lake, inflow	ID	26.0	7.95	High*	Presence	High[3]
Noxon Reservoir	MT	26.0		High*		High[3]
Soda Butte Creek	MT	25.6	7.99	High	Presence	High[3]
Comins Reservoir	NV	25.4	8.76	High	Presence	
Powder River	OR	25.2	7.73	High	Absence	High[3]
East Lake	OR	25.5	7.25	High	Absence	High[3]
Norwegian Creek	MT	50.1	7.22	High	Presence	
Deadwood Reservoir	ID	33.7	7.21	High	Absence	
Pyramid Lake	NV	77.0	7.20	High*	Presence	
Birch Creek	MT	29.2	7.17	High	Absence	
Blackfoot River	MT	28.1	7.09	High	Absence	High[3]
Willow Creek	MT	29.4	7.03	High	Absence	
Coldwater Lake	WA	40.3	6.87	High	Absence	High[3]

Table 7. Water bodies determined to have a medium relative risk of dreissenid mussel establishment. Risk category was determined by mean dissolved [Ca^{2+}], mg/L. Presence or absence of dreissenid mussels was predicted for the water bodies using mean calcium and pH data in the model developed by Ramcharan et al. (1992). The results of risk assessments done by state agencies and others are also presented. Blanks indicate no data were available. ([1]= Cohen and Weinstein (1998), [2]= Utah Division of Wildlife Resources, and [3]= Wells et al. (2008)). Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can establish in areas identified with low to very low risk of establishment.

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Dacey Reservoir	NV	25.0	8.12	Medium*	Presence	
Upper Marsh Ck, Flaming Gorge Res. inflow	MT	25.0		Medium*		
Illipah Creek Reservoir	NV	24.7	8.55	Medium	Presence	
Crooked River	OR	24.3	7.90	Medium	Presence	High[3]
Mann Lake	OR	24.3	8.70	Medium*	Presence	High[3]
Snake River, C.J. Strike Reservoir	ID	24.2	8.39	Medium	Presence	
San Luis Reservoir	CA	24.2	8.30	Medium*	Presence	High[1]
Fresno Reservoir	MT	24.1		Medium		
Flathead River	MT	24.0	8.21	Medium*	Presence	
Cabinet Gorge Reservoir	MT	24.0	8.21	Medium*	Presence	High[3]
Lahontan Reservoir	NV	23.9	7.78	Medium	Absence	
Little Wood Reservoir	ID	23.8	7.91	Medium	Absence	High[3]
Clark Fork River	ID	23.6		Medium*		
Butte Creek	MT	23.5	8.37	Medium*	Presence	
Mormon Reservoir	ID	23.5	8.21	Medium*	Presence	
Clear Lake	CA	23.4	8.40	Medium	Presence	High[1]
Lake Pend Oreille	ID	23.4		Medium	Absence	High[3]
Little Wood River	ID	23.4	7.93	Medium	Absence	
Whitefish Lake	MT	23.0	7.58	Medium*	Absence	High[3]
Wild Horse Reservoir	NV	22.2	8.32	Medium	Presence	
Big Lost River	ID	22.0	8.18	Medium	Presence	High[3]
Harrison Lake	MT	22.0		Medium*		
Sophie Lake	MT	22.0		Medium*		
Swan Lake	MT	22.0		Medium*		High[3]
Flathead Lake	MT	21.6	8.02	Medium	Absence	High[3]
Forsyth Reservoir	UT	21.5	7.92	Medium	Absence	
Methow River	WA	21.5	7.99	Medium	Absence	High[3]
Carson River	NV	21.4	8.05	Medium	Presence	
Hungry Horse Reservoir	MT	21.2	8.01	Medium*	Absence	Medium[3]
Echo Canyon Reservoir	NV	21.0	8.68	Medium	Presence	
Ennis Lake	MT	21.0		Medium*		
Columbia River, FDR Lake	WA	20.9	7.93	Medium	Absence	High[3]
Priest Rapids Lake, outflow	WA	20.9	7.69	Medium	Absence	High[3]
Bilk Creek Reservoir	NV	20.8	7.95	Medium	Absence	
Lake Mendocino	CA	20.5	8.05	Medium*	Absence	
Yakima River inflow	WA	20.5	7.88	Medium	Absence	

Table 7 (continued).

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Williams Lake	WA	20.5	7.39	Medium	Absence	
Ochoco Reservoir	OR	20.1	8.40	Medium*	Presence	
Pend Oreille River	ID	20.1	7.92	Medium		
Lake Lowell	ID	19.8	8.17	Medium	Presence	High[3]
Loon Lake	WA	19.4		Medium*		High[3]
Walker River, East	NV	19.3	8.13	Medium	Absence	
Buckeye Lake	OR	19.2		Medium*		
Salmon River	ID	19.1	8.62	Medium*	Presence	High[3]
Contra Loma Reservoir	CA	19.0	7.50	Medium	Absence	High[1]
Thompson Lake, inflow	MT	19.0		Medium	Presence	High[3]
Lamar River	WY	18.8	7.90	Medium	Absence	
Lake Washington, inflow	WA	18.8	7.77	Medium	Absence	
Yakima River	WA	18.6	7.91	Medium	Absence	High[3]
Columbia River, Lake Wallula	WA	18.6	7.87	Medium	Absence	
Columbia River, Lake Wanapum	WA	18.1	8.02	Medium	Absence	
Applegate Reservoir	OR	18.1	7.75	Medium	Absence	
Johnson Valley Reservoir	UT	18.0	7.59	Medium*	Absence	
Billy Clapp Lake	WA	17.9		Medium*		High[3]
Columbia River, Lake Umatilla	OR	17.8		Medium		
Paddock Valley Reservoir	ID	17.8		Medium*		
Banks Lake	WA	17.8	7.90	Medium	Absence	
Columbia River, Lake Wallula	OR	17.4		Medium*		
John Day River	OR	17.3	7.79	Medium	Absence	High[3]
Snake River, Jackson Lake	WY	17.3	7.71	Medium	Absence	
Hart Lake	OR	17.2	8.00	Medium*	Absence	
Columbia River, Hanford Reach	WA	17.1	8.05	Medium	Absence	
Unity Reservoir	OR	17.1	9.60	Medium*	Presence	
Indian Valley Reservoir	CA	17.0	7.80	Medium	Absence	High[1]
Lake Berryessa	CA	17.0	7.30	Medium*	Absence	Moderate[1]
Salmon Lake	MT	17.0		Medium*		
Columbia River, Lake Celilo	OR	17.0	8.07	Medium	Absence	
Mann Creek Reservoir	ID	16.9	7.68	Medium	Absence	
Columbia River, Lake Celilo	WA	16.8		Medium*		
Mann Creek	ID	16.7	7.77	Medium	Absence	
Columbia River, Lake Bonneville	WA	16.5	8.11	Medium*		
Clear Lake	WA	16.4	8.47	Medium	Presence	
Buffalo Bill Reservoir inflow	WY	16.4	7.78	Medium	Absence	

Table 7 (continued).

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Horsetheif Lake	WA	16.2		Medium*		
Big Hole River	MT	16.1	7.46	Medium	Absence	
Placid Lake	MT	16.0		Medium*		
Lake Mary Ronan	MT	15.9	7.38	Medium*	Absence	
Island Park Reservoir	ID	15.8	8.09	Medium	Absence	High[3]
Thief Valley Reservoir	OR	15.6	7.31	Medium	Absence	High[3]
Rolland Lake	WA	15.6		Medium*		
Blue Lake	WA	15.6	8.00	Medium	Absence	
Lake McDonald, outflow	MT	15.2		Medium	Absence	High[3]
Boulder River	MT	18.9	7.01	Medium	Absence	
Lake Crescent	WA	15.9	6.94	Medium	Absence	
E.F. Rock Creek	MT	21.0	6.16	Medium*	Absence	

Table 8. Water bodies determined to have a low relative risk of dreissenid mussel establishment. Risk category was determined by mean dissolved [Ca^{2+}], mg/L. Presence or absence of dreissenid mussels was predicted for the water bodies using mean calcium and pH data in the model developed by Ramcharan et al. (1992). The results of risk assessments done by state agencies and others are also presented. Blanks indicate no data were available. ([1]= Cohen and Weinstein (1998), [2]= Utah Division of Wildlife Resources, and [3]= Wells et al. (2008)). Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can establish in areas identified with low to very low risk of establishment.

Water Body Name	State	Mean [Ca2+] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Harney Lake	OR	15.0	8.93	Low	Presence	High[3]
Knott Creek Reservoir	NV	14.2	8.08	Low	Absence	
Magone Lake	OR	14.0	8.70	Low*	Presence	Medium[3]
Wallowa Lake	OR	14.0	8.09	Low*	Absence	Medium[3]
Lake Sonoma	CA	14.0	7.50	Low*	Absence	
Walker River, West	NV	13.8	8.20	Low	Absence	
Upper Cow Lake	OR	13.8	7.80	Low*	Absence	Medium[3]
Sacramento River	CA	13.7	7.68	Low*	Absence	Low-to-no[1]
Bruneau River	ID	13.6	7.96	Low	Absence	High[3]
Antelope Flat Reservoir	OR	13.6		Low*		Medium[3]
Snake River, Lake Wallula	WA	13.6	7.95	Low	Absence	Medium[3]
Madison River	MT	13.5	7.91	Low	Absence	
Cold Springs Reservoir	OR	13.2	7.41	Low	Absence	Medium[3]
McCloud River	CA	13.0	7.80	Low	Absence	
South Twin Lake	WA	13.0	7.45	Low*	Absence	Medium[3]
Bethany Reservoir	CA	12.9	8.66	Low*	Presence	
Old River	CA	12.9	8.01	Low*	Absence	High[1]
Beulah Reservoir	OR	12.8	7.90	Low*	Absence	Medium[3]
Buffalo Lake	WA	12.5	8.55	Low*	Presence	High[3]
Henry's Fork, N.F. Snake River	ID	12.3	7.87	Low	Absence	
Nooksack River	WA	12.0	7.57	Low*	Absence	
Topaz Lake	NV	12.0	8.00	Low	Absence	
Fish Lake	UT	12.0	8.40	Low*	Absence	63 [2]
Seeley Lake	MT	12.0		Low*		
Platt 1 Reservoir	OR	14.3	7.29	Low*	Absence	
Blue Lake	OR	13.3	7.14	Low*	Absence	Medium[3]
Emigrant Lake	OR	12.6	7.02	Low	Absence	
Bitterroot River	MT	14.8	6.77	Low	Absence	Medium[3]

Table 9. Water bodies determined to have a very low relative risk of dreissenid mussel establishment. Risk category was determined by mean dissolved [Ca^{2+}], mg/L. Presence or absence of dreissenid mussels was predicted for the water bodies using mean calcium and pH data in the model developed by Ramcharan et al. (1992). The results of risk assessments done by state agencies and others are also presented. Blanks indicate no data were available. ([1]= Cohen and Weinstein (1998), [2]= Utah Division of Wildlife Resources, and [3]= Wells et al. (2008)). Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can establish in areas identified with low to very low risk of establishment.

Water Body Name	State	Mean [Ca^{2+}] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Anderson Ranch Reservoir	ID	10.3	7.68	Very Low	Absence	High[3]
Walker Lake	NV	11.8	9.02	Very Low	Presence	
W.F. Clearwater River	MT	11.7	7.4	Very Low*	Absence	
Lake Cushman	WA	11.6	7.55	Very Low	Absence	
San Joaquin River	CA	11.6	7.3	Very Low*	Absence	High[1]
Mountain Home Reservoir, outflow	ID	11.4	7.42	Very Low	Absence	High[3]
Walton Lake	OR	11.2	8.30	Very Low*	Absence	
Payette Lake	ID	11.0	8.3	Very Low*	Absence	Medium[3]
Lake Billy Chinook	OR	11.0	9.00	Very Low*	Presence	High[3]
Boise River	ID	10.9	7.67	Very Low	Absence	Medium[3]
Touchet River	WA	10.8	7.7	Very Low	Absence	High[3]
Iron Gate Reservoir	CA	10.7	8.3	Very Low*	Absence	
Delintment Lake	OR	10.6	8.00	Very Low*	Absence	Medium[3]
SF Boise River	ID	10.6	8.10	Very Low*	Absence	
Silver Lake	WA	10.4	7.49	Very Low	Absence	Medium[3]
Simtustus Lake	OR	10.4	8.90	Very Low*	Presence	Medium[3]
Spokane River	WA	10.2	7.71	Very Low	Absence	
St Regis River	MT	10.0	7.5	Very Low*	Absence	Medium[3]
Lake Oswego	OR	10.0	7.80	Very Low*	Absence	Low[3]
Virginia Lake	NV	10.0	7.4	Very Low	Absence	
Hyatt Reservoir	OR	10.0	7.34	Very Low	Absence	
Lake Shasta	CA	9.9	8.0	Very Low*	Absence	
Cliff Lake	OR	9.9		Very Low*		
North Twin Lake	OR	9.7	8.20	Very Low	Absence	Medium[3]
Entiat River	WA	9.7	7.91	Very Low	Absence	Medium[3]
Meeks Cabin Reservoir	WY	9.6	7.45	Very Low	Absence	
Crane Creek Reservoir	ID	9.5	7.33	Very Low*	Absence	
Deer Lake	WA	9.3	7.50	Very Low*	Absence	Medium[3]
Antelope Reservoir	OR	9.3	8.00	Very Low*	Absence	Medium[3]
Mokelumne River	CA	9.1	7.8	Very Low*	Absence	Low-to-no[1]
McKay Reservoir	OR	9.0	7.78	Very Low	Absence	
Lucky Peak Reservoir	ID	9.0	7.36	Very Low*	Absence	High[3]
Antelope Lake	CA	9.0	7.6	Very Low	Absence	Low-to-no
Phillips Lake	OR	8.9	8.20	Very Low*	Absence	Medium[3]
Rock Creek Reservoir	OR	8.9	6.98	Very Low*	Absence	
Palouse River	WA	8.5	7.96	Very Low	Absence	High[3]
Bull Lake	MT	8.3	8.14	Very Low	Absence	High[3]

Table 9 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$ mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Summit Lake	NV	8.2	7.6	Very Low	Absence	
Chickahominy Reservoir	OR	8.1	7.70	Very Low*	Absence	Medium[3]
Cowlitz River	WA	8.1	7.47	Very Low*	Absence	Low[3]
Hayden Lake, inflow	ID	8.0	7.55	Very Low	Absence	High[3]
Iron Canyon Reservoir	CA	8.0	7.8	Very Low	Absence	Low-to-no[1]
Lake Almanor	CA	8.0	7.8	Very Low*	Absence	Low-to-no[1]
McCloud Reservoir	CA	8.0	7.6	Very Low	Absence	Low-to-no[1]
Skagit River	WA	7.8	7.5	Very Low	Absence	Medium[3]
Cottonwood Reservoir	OR	7.8	7.80	Very Low*	Absence	Low[3]
Priest Lake	ID	7.6	7.46	Very Low	Absence	Medium[3]
Diamond Lake	WA	7.5	7.90	Very Low	Absence	Medium[3]
Rimrock Reservoir	WA	7.4	7.59	Very Low*	Absence	
Klamath Lake	OR	7.3	7.57	Very Low	Absence	
Lake Wenatchee	WA	7.0	7.33	Very Low	Absence	Medium[3]
Painted Rocks Reservoir	MT	7.0	8.0	Very Low*	Absence	
Tieton River, outflow	WA	7.0	7.62	Very Low*	Absence	
Agency Lake	OR	7.0	7.46	Very Low*	Absence	
Lake Chelan	WA	6.9	7.73	Very Low	Absence	Medium[3]
Howard Prairie Lake	OR	6.9	7.56	Very Low	Absence	
Dorena Reservoir	OR	6.9	7.63	Very Low*	Absence	
South Twin Lake	OR	6.7	8.30	Very Low*	Absence	Medium[3]
Deschutes River	OR	6.5	7.91	Very Low	Absence	High[3]
New Melones Lake	CA	6.5	8.2	Very Low*	Absence	
Morgan Lake	OR	6.4	8.10	Very Low*	Absence	Medium[3]
Bull Lake	WY	6.4	7.54	Very Low	Absence	
Little N.F. Coeur d'Alene River	ID	6.3	7.50	Very Low*	Absence	
Deadwood Reservoir	ID	6.2		Very Low	Absence	
Kachess River	WA	6.2	7.53	Very Low*	Absence	
Penland Lake	OR	6.1	8.00	Very Low*	Absence	Low[3]
Kachess Reservoir	WA	6.1	7.53	Very Low*	Absence	
Wilson Creek	ID	5.8	7.32	Very Low*	Absence	
Mineral Lake, outflow	WA	5.8	7.64	Very Low*	Absence	
Black Canyon Reservoir	ID	5.7	7.55	Very Low*	Absence	Medium[3]
North Fork Reservoir	OR	5.7	7.48	Very Low*	Absence	
Benewah Lake	ID	5.6	8.42	Very Low	Absence	
Yellowstone River	WY	5.5	7.52	Very Low	Absence	
Clearwater River	ID	5.4	8.20	Very Low	Absence	Low[3]

Table 9 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$ mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Riffe Reservoir	WA	5.4	7.43	Very Low*	Absence	
Hills Creek Lake	OR	5.3	8.10	Very Low*	Absence	
Fern Ridge Reservoir	OR	5.2	7.80	Very Low*	Absence	Low[3]
Deadwood River	ID	5.2	7.30	Very Low	Absence	
Alder Lake	WA	5.1	7.45	Very Low*	Absence	
White River	OR	5.1	7.40	Very Low*	Absence	Low[3]
Whiskeytown Reservoir	CA	5.0	7.30	Very Low	Absence	Low-to-no[1]
Lost Creek Lake	OR	5.0	7.30	Very Low*	Absence	
Goose Lake	OR	4.9	9.30	Very Low*	Presence	
Hemlock Lake	OR	4.9		Very Low*		
Willow Lake	OR	4.8	7.70	Very Low*	Absence	
Gerber Reservoir	OR	4.8	7.30	Very Low	Absence	
Newman Lake	WA	4.8	7.80	Very Low*	Absence	Low[3]
Devils Lake (Lincoln)	OR	4.7	7.8	Very Low	Presence	
Dexter Lake	OR	4.7	7.60	Very Low*	Absence	Low[3]
Selmac Lake	OR	4.7		Very Low*	Absence	
Wenatchee River	WA	4.7	7.6	Very Low	Absence	Low[3]
Cle Elum River	WA	4.7	7.53	Very Low*	Absence	
Pine Hollow Reservoir	OR	4.5	7.40	Very Low*		Low[3]
Lookout Point Lake	OR	4.5	7.40	Very Low	Absence	
Timothy Lake	OR	4.5	7.64	Very Low	Absence	Low[3]
Thompson Valley Reservoir	OR	4.4	7.60	Very Low*	Absence	
Wolf Creek Reservoir	OR	4.4		Very Low*	Absence	
Sandy River	OR	4.3	7.50	Very Low	Absence	Low[3]
North Fork Sauk River	WA	4.3	7.36	Very Low*	Absence	
Keechelus Reservoir	WA	4.1	7.35	Very Low*	Absence	
Fall Creek Reservoir	OR	4.1	7.58	Very Low	Absence	
Trinity River	CA	4.0	7.60	Very Low	Absence	Low-to-no[1]
Green Peter Lake	OR	4.0	7.30	Very Low*	Absence	Low[3]
Suttle Lake	OR	4.0	8.08	Very Low*	Absence	Low[3]
Swift Creek Reservoir	WA	3.9	7.39	Very Low*	Absence	
Liberty Lake	WA	3.9	7.50	Very Low*	Absence	Medium[3]
Black Lake	WA	3.8		Very Low*		
Lake McClure	CA	3.8	8.2	Very Low*	Absence	
Bumping Reservoir	WA	3.8	7.55	Very Low*	Absence	
Lochsa River	ID	3.7	7.36	Very Low	Absence	Low[3]
Jenny Lake outflow	WY	3.7	7.87	Very Low	Absence	

Table 9 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$ mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Cascade Reservoir	ID	3.6	7.4	Very Low	Absence	Low[3]
Eel Lake	OR	3.6	7.40	Very Low*	Absence	
Wickiup Reservoir	OR	3.5	7.60	Very Low*	Absence	Low[3]
Fish Lake (Jackson)	OR	3.5		Very Low	Absence	
Omak Lake	WA	3.5	9.55	Very Low*	Presence	Low[3]
Lemolo Lake	OR	3.5	7.53	Very Low*	Absence	
Detroit Lake	OR	3.5	7.51	Very Low*	Absence	Low[3]
Siltcoos Lake	OR	3.4	7.48	Very Low	Absence	
Davis Lake	OR	3.3	7.87	Very Low*	Absence	Low[3]
Pettit Lake	ID	3.2	7.31	Very Low	Absence	
Gold Lake	OR	3.2	7.30	Very Low*	Absence	
Blue River Reservoir	OR	3.2	7.49	Very Low	Absence	
Lake Don Pedro	CA	3.1	7.4	Very Low	Absence	Low-to-no[1]
Payette River	ID	3.1	7.37	Very Low	Absence	
Mercer Lake	OR	3.0	7.87	Very Low*	Absence	
Pardee Lake	CA	3.0	7.6	Very Low	Absence	Low-to-no[1]
Odell Lake	OR	3.0	7.79	Very Low*	Absence	Low[3]
Grassy Lake Reservoir	WY	2.9	7.30	Very Low	Absence	
Shoshone Lake inflow	WY	2.9	7.44	Very Low*	Absence	
Upper Stillwater Reservoir	UT	2.6	7.80	Very Low*	Absence	
Diamond Lake	OR	2.5	7.36	Very Low	Absence	
Fremont Lake	WY	2.4		Very Low		
Halfmoon Lake	WY	2.3		Very Low*		
Craine Prairie Reservoir	OR	2.2	9.80	Very Low*	Presence	Low[3]
Elk Lake	OR	2.2	7.95	Very Low*	Absence	Low[3]
Lava Lake	OR	2.1	7.90	Very Low*	Absence	
Cultus Lake	OR	2.0	7.50	Very Low*	Absence	
N.F. Clearwater River	ID	1.8	8.39	Very Low*	Absence	
Soap Lake	WA	1.6	9.60	Very Low*	Presence	Low[3]
White River	WA	1.7	7.29	Very Low*	Absence	
Agate Reservoir	OR	11.2	7.28	Very Low	Absence	
St. Maries River	ID	4.3	7.27	Very Low	Absence	
Tenmile Lake	OR	5.1	7.26	Very Low*	Absence	
Yellowstone Lake	WY	11.6	7.25	Very Low	Absence	
Grays River	WA	4.3	7.24	Very Low	Absence	Low[3]
Yale Reservoir	WA	3.8	7.23	Very Low*	Absence	
Alturas Lake	ID	7.4	7.22	Very Low*	Absence	

Table 9 (continued).

Water Body Name	State	Mean [Ca^{2+}] mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Redfish Lake, outflow	ID	4.7	7.21	Very Low	Absence	Low[3]
Crescent Lake	OR	2.4	7.20	Very Low*	Absence	Low[3]
Fish Lake	OR	7.5	7.20	Very Low*		
Willow Valley Reservoir	OR	5.5	7.20	Very Low*	Absence	
Haystack Reservoir	OR	4.6	7.20	Very Low*	Absence	Low[3]
Foster Reservoir	OR	4.4	7.20	Very Low*	Absence	Low[3]
Smith Reservoir	OR	4.2	7.20	Very Low*	Absence	
Pine Flat Lake	CA	3.0	7.2	Very Low	Absence	Low-to-no[1]
Miller Lake	OR	2.1	7.20	Very Low*	Absence	
St. Joe River	ID	6.4	7.19	Very Low	Absence	Medium[3]
Lake of the Woods	OR	2.5	7.14	Very Low	Absence	
Willamette River	OR	6.8	7.12	Very Low	Absence	Medium[3]
Woahink Lake	OR	1.9	7.10	Very Low*	Absence	
North Tenmile Lake	OR	3.4	7.10	Very Low*	Absence	
Camanche Reservoir	CA	3.0	7.1	Very Low	Absence	Low-to-no[1]
Millerton Lake	CA	3.0	7.1	Very Low	Absence	Low-to-no[1]
Hosmer Lake	OR	1.2	7.10	Very Low*	Absence	
Cle Elum Reservoir	WA	4.7	7.08	Very Low	Absence	
N.F. Payette River	ID	2.2	7.07	Very Low	Absence	
Henry Hagg Lake	OR	5.6	7.07	Very Low	Absence	
North Twin Lake	WA	7.2	7.05	Very Low*	Absence	Low[3]
Munsel Lake	OR	2.1	7.05	Very Low*	Absence	
Black Lake	ID	5.8	7.05	Very Low	Absence	
Tahkenitch Lake	OR	3.0	7.01	Very Low	Absence	
Sparks Lake	OR	1.4	7.01	Very Low	Absence	
Loon Lake	OR	4.2	7.00	Very Low	Absence	
Folsom Lake	CA	4.0	7.0	Very Low	Absence	Low-to-no[1]
Triangle Lake	OR	2.4	7.00	Very Low*	Absence	
Clear Lake	OR	2.1	7.00	Very Low*	Absence	
Killarney Lake	ID	6.2	6.94	Very Low	Absence	
Spirit Lake	WA	5.3	6.93	Very Low	Absence	High[3]
Hauser Lake	ID	4.6	6.91	Very Low	Absence	
Moon Lake	UT	3.9	6.91	Very Low	Absence	
Turlock Lake	CA	3.0	6.89	Very Low*	Absence	
Cougar Reservoir	OR	3.5	6.84	Very Low	Absence	Low[3]
Horsetheif Lake	ID	3.9	6.83	Very Low*	Absence	
Cottage Grove Lake	OR	6.4	6.77	Very Low*	Absence	Low[3]

Table 9 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$ mg/L	Mean pH	Risk Category	Ramcharan Model	State Assessments
Coeur d'Alene Lake	ID	5.4	6.71	Very Low	Absence	High[3]
Summit Lake	OR	0.1	6.70	Very Low*	Absence	
Skookumchuck River	WA	5.7	6.7	Very Low*	Absence	
Spirit Lake	ID	1.9	6.50	Very Low	Absence	
Lake Como	MT	2.0	6.4	Very Low*	Absence	Low[3]
Upper Payette Lake	ID	1.3	6.40	Very Low	Absence	Low[3]
Fourmile Lake	OR	1.5	6.20	Very Low*	Absence	
Devils Lake (Deschutes)	OR	1.2		Very Low	Absence	
Olallie Lake	OR	0.5		Very Low*		Low[3]

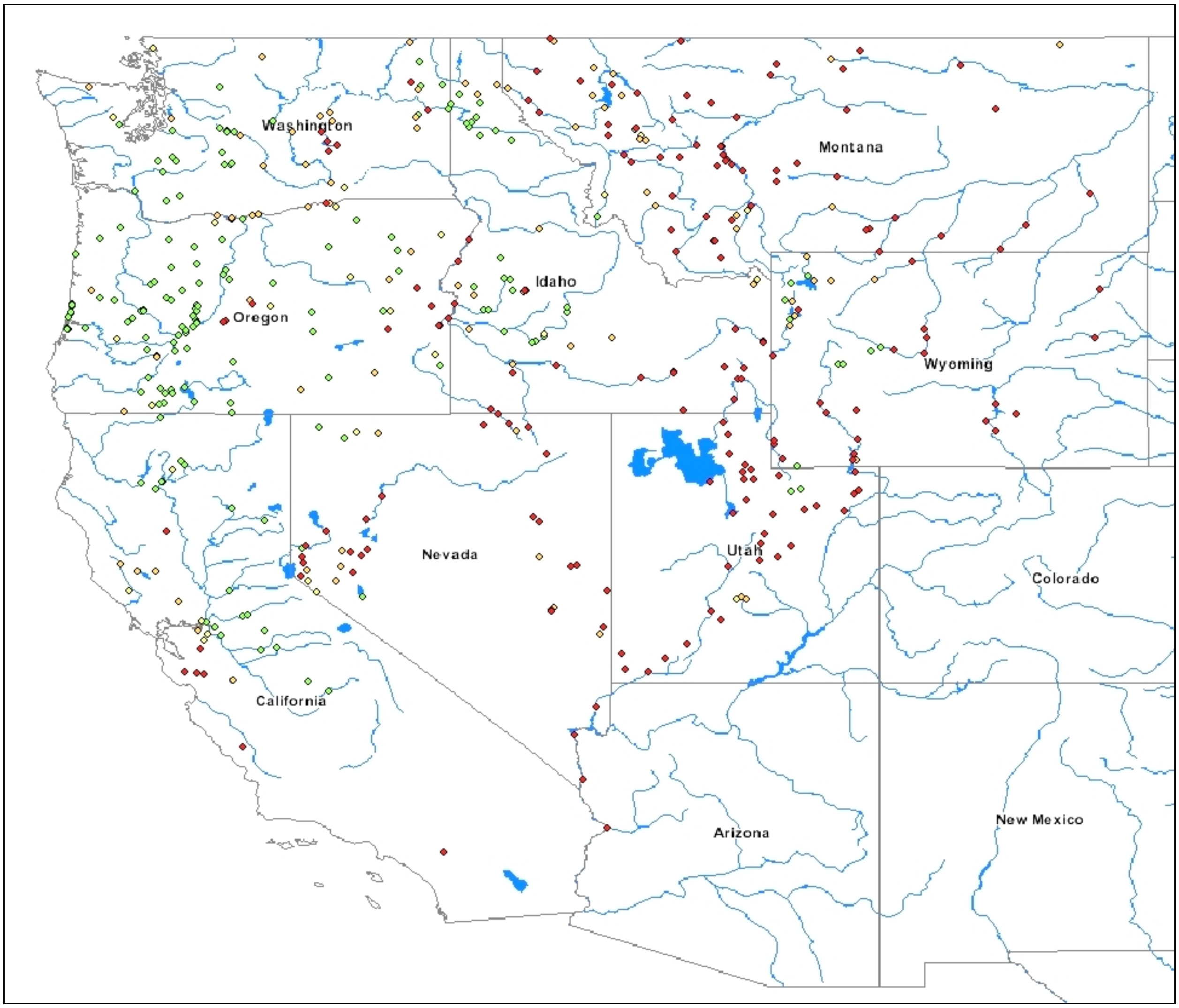

Figure 3. Map of water bodies showing risk categories for dreissenid mussel establishment. Risk category was determined by dissolved calcium concentration. High risk water bodies are shown with red dot, medium risk water bodies are orange, low risk are yellow, and very low risk water bodies are light green. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1. Dreissenids can establish in areas identified with low to very low risk of establishment.

This assessment made similar predictions for individual water bodies as the Ramcharan et al. (1992) model. The percent agreement of water bodies assigned to the high and medium risk categories and predicted presence was 94% (*n*=167), and 27% (*n*=67), respectively. Conversely, the percent agreement of water bodies assigned to the low, and very low risk categories and predicted absent was 92% (*n*=24), and 96% (*n*=159), respectively.

The assessments of the risk of establishment for water bodies in California were generally similar between Cohen and Weinstein (1998) and this prioritization. Fifty-seven percent of the 14 water bodies on both lists that were assigned to the high-risk category by Cohen and Weinstein (1998) were also assigned a high-risk category in our assessment. Two water bodies assigned a high risk by Cohen and Weinstein (1998) were just within the threshold for medium risk of establishment in this prioritization, and had calcium concentrations ranging between 23.0 and 25.0 mg Ca^{2+}/ L. Two rivers (Old River, CA and San Joaquin River, CA) assigned a high risk by Cohen and Weinstein (1998) were low to very low risk in our assessment, but calcium concentrations can vary depending upon the river reach where sampling occurs, especially in large rivers like the San Joaquin that drain into the Sacramento-San Joaquin Rivers Delta. Eighty-seven percent of the 15 water bodies assigned a low-to-no risk category by Cohen and Weinstein (1998) were assigned a very low risk category in this prioritization. The Colorado River, Lake Havasu was one of the two water bodies assigned a low risk by Cohen and Weinstein (1998) that was assigned a high risk of establishment in this prioritization.

There was good agreement between the assessment done by the Utah Division of Water Resources and this risk prioritization regarding risk of establishment. The Utah Division of Water Resources evaluated the risk of establishment by calculating a "likelihood percent" using the mean, minimum and maximum data values for eight parameters. The mean likelihood percent for Utah water bodies with high risk of establishment in this prioritization was 89 (SD= 5.7, n= 19). The Utah water body with a likelihood percent of 63 was a low risk of establishment in this prioritization.

The greatest divergence between this prioritization and other assessments was between Wells et al. (2008). There was agreement between these assessments, and 52% percent of the 75 water bodies assigned a high risk category by Wells et al. (2008) was also assigned a high-risk category by our prioritization. Conversely, one hundred percent (n=36) of the water bodies assigned a low risk category by Wells et al. 2008 were assigned a very low risk category in this assessment. Twenty-nine percent of the water bodies assigned a high risk by Wells et al. (2008), however, were characterized with medium risk of establishment in this prioritization. Out of the thirty-three water bodies assigned a medium risk by Wells et al. (2008), 27% and 70% were considered in this prioritization as low- and very low risk, respectively.

Relative Risk of Mussel Introduction

The relative risk of dreissenid introduction into a water body within the Columbia River Basin was highly variable (Tables 10 through 15). Most river sections and run-of-the-river reservoirs within the Columbia River Basin were medium to high risk for dreissenid mussel introduction due to the amount of recreational pressure on those water bodies, but the total recreational pressure is generally highest in the Upper Columbia River sub-basin (e.g. Banks Lake, Moses Lake, Potholes Reservoir, Pend Oreille River), and Lower Columbia River sub-basin (e.g. Willamette River, Lake Bonneville, Cowlitz River). The Snake River Basin was generally high risk for dreissenid introduction based on recreational pressure. Recreational use was high in some water bodies in the Upper Snake River sub-basin (e.g. American Falls Reservoir, Lake Walcott) in the Central Snake River sub-basin (e.g. Milner Lake, CJ Strike Reservoir, Brownlee Reservoir, Cascade Reservoir, Lake Lowell), and in the Lower Snake River sub-basin water bodies (e.g. Salmon River, Clearwater River).

Patterns in the relative risk of dreissenid introduction into water bodies outside the CRB were evident (Tables 10 through 15). Water bodies in the Colorado River Basin receive a large amount of recreational pressure and were therefore at high risk for dreissenid mussel introduction. Use patterns in the upper Missouri River Basin were variable, but many water bodies receive high recreational pressure from both Montana residents and nonresidents (e.g. Canyon Ferry Reservoir, Gallatin River, Lake Fort Peck, and Madison River). Patterns in recreational pressure in Montana from Montana residents were similar to non residents.

Table 10. Risk categories for dreissenid mussel introduction into Idaho based on boater recreational data. Water bodies presented are organized in decreasing risk based on # tournaments, then # boats/ tournament, and then by decreasing [Ca^{2+}] as mg/L. Risk categories were assigned to quartiles of raw data relative to each state. Blanks indicate no data was available. Some water bodies lacking calcium data were assessed for relative risk of introduction. Risk categories for mussel introduction were formulated using best professional judgment and relative to each state. Dreissenid mussels can be introduced into areas identified with low to very low risk of introduction.

Water Body Name	State	Mean [Ca^{2+}]	# Tourn.	# Boats/ Tourn.
Snake River, American Falls Res.	ID	47.5	High	High
Snake River, Milner Lake	ID	45.7	High	High
Snake River, Brownlee Res.	ID	31.3	High	High
Snake River, C.J. Strike Res.	ID	24.2	High	High
Lake Pend Oreille	ID	23.4	High	High
Lake Lowell	ID	19.8	High	High
Anderson Ranch Reservoir	ID	10.3	High	High
Coeur d'Alene Lake	ID	5.4	High	High
Cascade Reservoir	ID	3.8	High	High
Snake River, Lake Walcott	ID	46.2	High	Medium
Dworshak Reservoir	ID		High	Medium
Massacre Rocks	ID		High	Medium
Salmon River	ID	19.1	Medium	High
Clearwater River	ID	5.4	Medium	High
Snake River	ID	57.5	Medium	High
Hayden Lake	ID	8.0	Medium	Medium
Snake River, Hells Canyon Res.	ID		Medium	Medium
Spirit Lake	ID	1.9	Medium	Low
Magic Reservoir	ID	49.8	Medium	Low
Swan Falls Reservoir	ID		Medium	Low
Twin Lake, Lower	ID		Medium	Low
Deer Creek Reservoir	ID		Low	Medium
Devil Creek Reservoir	ID		Low	Medium
Salmon Falls Creek Reservoir	ID	83.2	Low	Medium
Ririe Reservoir	ID	46.9	Low	Low
Blackfoot Reservoir	ID	43.7	Low	Low
Rose Lake	ID		Low	Low
South Fork Boise River	ID		Low	Low
Lucky Peak Reservoir	ID	9.0	Low	Very Low
Black Canyon Reservoir	ID	5.7	Low	Very Low
Priest Lake	ID	7.6	Low	Very Low
Moose Creek Reservoir	ID		Very Low	Medium
Park Center Pond	ID		Very Low	Medium
Arrowrock Reservoir	ID		Very Low	Low
Elk Creek Reservoir	ID		Very Low	Low
Oxbow Reservoir	ID		Very Low	Low
Spring Valley Reservoir	ID		Very Low	Low
Oneida Narrows Reservoir	ID	59.7	Very Low	Very Low
Stone Reservoir	ID	34.4	Very Low	Very Low
Chesterfield Reservoir	ID	27.4	Very Low	Very Low
Little Wood Reservoir	ID	23.8	Very Low	Very Low
Island Park Reservoir	ID	15.8	Very Low	Very Low
Carey Lake	ID		Very Low	Very Low
Glendale Reservoir	ID		Very Low	Very Low
MacKay Reservoir	ID		Very Low	Very Low
Medicine Lake	ID		Very Low	Very Low
Winchester Lake State Park	ID		Very Low	Very Low

Table 11. Risk categories dreissenid mussel introduction into Montana based on recreational boater data. Water bodies are organized in decreasing risk based on total pressure, then non resident pressure, and then by decreasing [Ca^{2+}] as mg/L. Risk categories were assigned to quartiles of raw data relative to each state. Blanks indicate no data was available. Some water bodies lacking calcium data were assessed for introduction. Risk categories for mussel introduction were formulated using best professional judgment and relative to each state. Dreissenid mussels can be introduced into areas identified with low to very low risk of introduction.

Water Body Name	State	Mean [Ca^{2+}]	Total Pressure	NonRes. Pressure
Bighorn River	MT	89.9	High	High
Beaverhead River	MT	71.5	High	High
Fort Peck Lake	MT	47.0	High	High
Tongue River Reservoir	MT	46.9	High	High
Gallatin River	MT	42.2	High	High
Clark Fork River	MT	33.2	High	High
Lake Koocanusa	MT	33.0	High	High
Hauser Reservoir	MT	32.0	High	High
Kootenai River	MT	28.6	High	High
Canyon Ferry Reservoir	MT	28.3	High	High
Noxon Reservoir	MT	26.0	High	High
Flathead River	MT	24.0	High	High
Flathead Lake	MT	21.6	High	High
Big Hole River	MT	16.1	High	High
Lake Mary Ronan	MT	15.9	High	High
Bitterroot River	MT	14.8	High	High
Madison River	MT	13.5	High	High
Clark Canyon Reservoir	MT		High	High
Georgetown Lake	MT		High	High
Hebgen Lake	MT		High	High
Stillwater River	MT		High	High
Ruby River	MT	73.3	Medium	High
Missouri River	MT	39.8	Medium	High
Yellowstone River	MT	26.8	Medium	High
Boulder River	MT	18.9	Medium	High
Smith Lake	MT		Low	High
Ruby River Reservoir	MT	53.5	High	Medium
Holter Lake	MT	34.0	High	Medium
Fresno Reservoir	MT	24.1	High	Medium
Lake Elwell	MT		High	Medium
Smith River	MT	56.5	Medium	Medium
Jefferson River	MT	40.5	Medium	Medium
Helena Valley Regulating Res.	MT	35.0	Medium	Medium
Nelson Reservoir	MT	34.0	Medium	Medium
Ashley Lake	MT	33.8	Medium	Medium
Blackfoot River	MT	28.1	Medium	Medium
Rock Creek	MT	26.7	Medium	Medium

Table 11 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$	Total Pressure	NonRes. Pressure
Swan Lake	MT	22.0	Medium	Medium
Ennis Lake	MT	21.0	Medium	Medium
Bull Lake	MT	8.3	Medium	Medium
Lake Como	MT	2.0	Medium	Medium
Ackley Lake	MT		Medium	Medium
Bighorn Lake	MT		Medium	Medium
Browns Lake	MT		Medium	Medium
Dailey Lake	MT		Medium	Medium
Little Bitterroot Lake	MT		Medium	Medium
McGregor Lake	MT		Medium	Medium
Whitefish Lake	MT	23.0	Low	Medium
Placid Lake	MT	16.0	Low	Medium
Seeley Lake	MT	12.0	Low	Medium
Yellowtail Afterbay	MT		Low	Medium
Cooney Reservoir	MT	38.7	High	Low
Lake Helena	MT	29.0	Medium	Low
Hungry Horse Reservoir	MT	21.2	Medium	Low
Middle Thompson Lake	MT		Medium	Low
Newlan Creek Reservoir	MT		Medium	Low
Musselshell River	MT	115.3	Low	Low
Sun River	MT	59.5	Low	Low
Tongue River	MT	53.0	Low	Low
Sophie Lake	MT	22.0	Low	Low
Beaver Lake	MT		Low	Low
Deadmans Basin Reservoir	MT		Low	Low
Foys Lake	MT		Low	Low
Lake Elmo	MT		Low	Low
Nilan Reservoir	MT		Low	Low
Petrolia Reservoir	MT		Low	Low
Tetrault Lake	MT		Low	Low
Willow Creek Reservoir	MT		Low	Low
Judith River	MT	64.2	Very Low	Low
Willow Creek	MT	29.4	Very Low	Low
Echo Lake	MT	27.0	Very Low	Low
Lake McDonald	MT	15.2	Very Low	Low
Painted Rocks Reservoir	MT	7.0	Very Low	Low
Horseshoe Lake	MT		Very Low	Low

Table 11 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$	Total Pressure	NonRes. Pressure
Mystic Lake	MT		Very Low	Low
Tally Lake	MT		Very Low	Low
Marias River	MT	49.2	Low	Very Low
Cabinet Gorge Reservoir	MT	24.0	Low	Very Low
Salmon Lake	MT	17.0	Low	Very Low
Blanchard Lake	MT		Low	Very Low
Clearwater River	MT		Low	Very Low
Crystal Lake	MT		Low	Very Low
Glen Lake	MT		Low	Very Low
Pishkun Reservoir	MT		Low	Very Low
Powder River	MT	153	Very Low	Very Low
Milk River	MT	43.8	Very Low	Very Low
Mission Lake	MT	42.4	Very Low	Very Low
Tenmile Creek	MT	35.5	Very Low	Very Low
Birch Creek	MT	29.2	Very Low	Very Low
Thompson Lake	MT	19.0	Very Low	Very Low
Anita Reservoir	MT		Very Low	Very Low
Arrowhead Lake	MT		Very Low	Very Low
Bean Lake	MT		Very Low	Very Low
Dickey Lake	MT		Very Low	Very Low
Eureka Reservoir	MT		Very Low	Very Low
Gibson Reservoir	MT		Very Low	Very Low
Lake Josephine	MT		Very Low	Very Low
Little McGregor Lake	MT		Very Low	Very Low
Lodge Grass Storage Res	MT		Very Low	Very Low
Martinsdale Reservoir	MT		Very Low	Very Low
Upsata Lake	MT		Very Low	Very Low

Table 12. Risk categories for dreissenid mussel introduction into Nevada based on recreational boater data. Water bodies are organized in decreasing risk based on total pressure, and then by decreasing [Ca^{2+}] as mg/L. Risk categories were assigned to quartiles of raw data relative to each state. Blanks indicate no data was available. Some water bodies lacking calcium data were assessed for introduction. Risk categories for mussel introduction were formulated using best professional judgment and relative to each state. Dreissenid mussels can be introduced into areas identified with low to very low risk of introduction.

Water Body Name	State	Mean [Ca^{2+}]	Total Pressure
Lahontan Reservoir	NV	23.9	High
Big Bend	NV		High
Lake Tahoe	NV		High
Rye Patch Reservoir	NV	40.7	Medium
South Fork Reservoir	NV	27.3	Medium
Washoe Lake	NV	45.0	Low
Cave Lake	NV	43.6	Low
Spring Valley	NV		Low
Wild Horse Reservoir	NV	22.2	Very Low
Echo Canyon Reservoir	NV	21.0	Very Low
Walker Lake	NV	11.8	Very Low

Table 13. Risk categories for dreissenid mussel introduction into Oregon based on recreational boater data. Water bodies are organized in decreasing risk based on total pressure, then number tournaments, and then by decreasing [Ca^{2+}] as mg/L. Risk categories were assigned to quartiles of raw data relative to each state. Blanks indicate no data was available. Some water bodies lacking calcium data were assessed for introduction. Risk categories for mussel introduction were formulated using best professional judgment and relative to each state. Dreissenid mussels can be introduced into areas identified with low to very low risk of introduction.

Water Body Name	State	Mean [Ca^{2+}]	Total Pressure	# Tourn.
Columbia River	OR		High	High
Willamette River	OR	5.5	High	High
Henry Hagg Lake	OR	5.6	High	Medium
Fern Ridge Reservoir	OR	5.2	High	Medium
Snake River, Brownlee Res.	OR		High	Medium
Emigrant Lake	OR	12.6	High	Low
Green Peter Lake	OR	4.0	High	Low
Applegate Reservoir	OR	18.1	High	Very Low
Lake Billy Chinook	OR	11.0	High	Very Low
Klamath Lake	OR	7.3	High	Very Low
Howard Praire Lake	OR	6.9	High	Very Low
Devils Lake (Lincoln)	OR	4.7	High	Very Low
Wickiup Reservoir	OR	3.5	High	Very Low
Diamond Lake	OR	2.5	High	Very Low
Craine Praire Reservoir	OR	2.2	High	Very Low
Snake River	OR		High	Very Low
Paulina Lake	OR	28.0	High	
East Lake	OR	25.5	High	
Prineville Reservoir	OR	17.5	High	
John Day River	OR	17.3	High	
Wallowa Lake	OR	14.0	High	
Deschutes River	OR	6.9	High	
North Fork Reservoir	OR	5.7	High	
Lost Creek Lake	OR	5.0	High	
Foster Reservoir	OR	4.4	High	
Loon Lake	OR	4.2	High	
Suttle Lake	OR	4.0	High	
Detroit Lake	OR	3.5	High	
Mercer Lake	OR	3.0	High	
Odell Lake	OR	3.0	High	
Lake of the Woods	OR	2.5	High	
Crescent Lake	OR	2.4	High	
Lava Lake	OR	2.1	High	
Owyhee Reservoir	OR	17.3	Medium	High
Dexter Lake	OR	4.7	Medium	High
Siltcoos Lake	OR	3.4	Medium	Low
Cultus Lake	OR	2.0	Medium	Low
Dorena Reservoir	OR	6.9	Medium	Very Low
Cottage Grove Lake	OR	6.4	Medium	Very Low
Pine Hollow Reservoir	OR	4.5	Medium	Very Low
Fall Creek Reservoir	OR	4.1	Medium	Very Low
Snake River, Hells Canyon Res.	OR	31.0	Medium	

Table 13 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$	Total Pressure	# Tourn.
Ochoco Reservoir	OR	20.1	Medium	
Simtustus Lake	OR	10.4	Medium	
Hyatt Reservoir	OR	10.0	Medium	
Phillips Lake	OR	8.9	Medium	
Chickahominy Reservoir	OR	8.1	Medium	
Agency Lake	OR	7.0	Medium	
Hills Creek Lake	OR	5.3	Medium	
Selmac Lake	OR	4.7	Medium	
Timothy Lake	OR	4.5	Medium	
Smith Reservoir	OR	4.2	Medium	
Eel Lake	OR	3.6	Medium	
Lemolo Lake	OR	3.5	Medium	
Blue River Reservoir	OR	3.2	Medium	
Triangle Lake	OR	2.4	Medium	
Munsel Lake	OR	2.1	Medium	
Woahink Lake	OR	1.9	Medium	
Olallie Lake	OR	0.5	Medium	
North Tenmile Lake	OR	3.4	Low	High
Umatilla River	OR	34.6	Low	Low
Haystack Reservoir	OR	4.6	Low	Very Low
Tahkenitch Lake	OR	3.0	Low	Very Low
Malheur Reservoir	OR	44.6	Low	
Bully Creek Reservoir	OR	41.7	Low	
Hart Lake	OR	17.2	Low	
Unity Reservoir	OR	17.1	Low	
Thief Valley Reservoir	OR	15.6	Low	
Agate Reservoir	OR	11.2	Low	
Delintment Lake	OR	10.6	Low	
North Twin Lake	OR	9.7	Low	
Cottonwood Reservoir	OR	7.8	Low	
Gerber Reservoir	OR	4.8	Low	
Lookout Point Lake	OR	4.5	Low	
Wolf Creek Reservoir	OR	4.4	Low	
Clear Lake	OR	2.1	Low	
Miller Lake	OR	2.1	Low	
Warm Springs Reservoir	OR	56.0	Very Low	
Owyhee River	OR	43.0	Very Low	
Magone Lake	OR	14.0	Very Low	
Upper Cow Lake	OR	13.8	Very Low	
Walton Lake	OR	11.2	Very Low	
Rock Creek Reservoir	OR	8.9	Very Low	
South Twin Lake	OR	6.7	Very Low	
Penland Lake	OR	6.1	Very Low	

Table 13 (continued).

Water Body Name	State	Mean $[Ca^{2+}]$	Total Pressure	# Tourn.
Willow Valley Reservoir	OR	5.5	Very Low	
Goose Lake	OR	4.9	Very Low	
Thompson Valley Reservoir	OR	4.4	Very Low	
Cougar Reservoir	OR	3.5	Very Low	
Davis Lake	OR	3.3	Very Low	
Gold Lake	OR	3.2	Very Low	
Elk Lake	OR	2.2	Very Low	
Fourmile Lake	OR	1.5	Very Low	
Fish Lake (Douglas)	OR		Very Low	
Columbia River, John Day Pool	OR			High
Columbia River, Lake Bonneville	OR			High
Platt 1 Reservoir	OR	14.3		Low
Columbia River, Lake Umatilla	OR	17.8		Very Low
Columbia River, Lake Celilo	OR	17.0		Very Low
Blue Lake	OR	13.3		Very Low

Table 5. Risk categories for dreissenid mussel introduction into Utah based on recreational boater data. Water bodies are organized in decreasing risk based on the top priority water bodies identified by the state of Utah, then the # tournaments, and then by decreasing $[Ca^{2+}]$ as mg/L. Risk categories were assigned to quartiles of raw data relative to each state. Blanks indicate no data was available. Some water bodies lacking calcium data were assessed for introduction. Risk categories for mussel introduction were formulated using best professional judgment and relative to each state. Dreissenid mussels can be introduced into areas identified with low to very low risk of introduction.

Water Body Name	State	Mean $[Ca^{2+}]$	Top 29 in Utah	# Tourn.
Lake Powell	UT	72.1	High	High
Flaming Gorge Reservoir	UT	65.6	High	Medium
Jordanelle Reservoir	UT		High	Medium
Starvation Reservoir	UT	57.9	High	Low
Pelican Lake	UT	38.6		Low
Steinaker Reservoir	UT	34.8	High	Low
Utah Lake	UT	76.1	High	Very Low
East Canyon Reservoir	UT	69.0	High	Very Low
Rockport/Wanship Reservoir	UT	49.4	High	Very Low
Hyrum Reservoir	UT	48.3	High	Very Low
Mantua Reservoir	UT			Very Low

Table 15. Risk categories for dreissenid mussel introduction into Washington based on recreational boater data. Water bodies are organized in decreasing risk based on the top priority water bodies identified by the state of Washington, then total pressure, and then by decreasing [Ca^{2+}] as mg/L. Risk categories were assigned to quartiles of raw data relative to each state. Blanks indicate no data was available. Some water bodies lacking calcium data were assessed for introduction. Risk categories for mussel introduction were formulated using best professional judgment and relative to each state. Dreissenid mussels can be introduced into areas identified with low to very low risk of introduction.

Water Body Name	State	Mean [Ca^{2+}]	Total Pressure	WA Most Visited
Moses Lake	WA	25.8	High	High
Lake Washington inflow	WA	18.8	High	High
Banks Lake	WA	17.8	High	High
Cowlitz River	WA	8.1	High	High
Columbia River	WA		High	High
Lake Sammamish inflow	WA		High	High
Snake River	WA		High	High
Clear Lake	WA	16.4	Medium	High
Silver Lake	WA	10.4	Medium	High
Long Lake inflow	WA		Medium	High
Pend Oreille River	WA		Medium	High
Snohomish River	WA		Medium	High
Deer Lake	WA	9.3	Low	High
Lake Tapps tailrace	WA		Low	High
Williams Lake	WA	20.5		Medium
Columbia River, Lake Wanapum	WA	18.1		Medium
Lake Cresent	WA	15.9		Medium
Lake Cushman inflow	WA	14.2		Medium
Nooksack River	WA	12.0		Medium
Diamond Lake	WA	8.0		Medium
Mineral Lake outflow	WA	5.8		Medium
Alder Lake	WA	5.1		Medium
Cle Elum Reservoir	WA	4.7		Medium
Bumping Reservoir	WA	3.8		Medium
Deep Creek	WA			Medium
Fishtrap Creek	WA			Medium
Lake Ozette outflow	WA			Medium
Skagit River	WA			Medium
Potholes Reservoir outflow	WA	28.3	High	
Abernathy Creek	WA		Medium	
Loon Lake	WA	19.4	Low	
Yakima River	WA	18.6	Low	
Blue Lake	WA	15.6	Low	
Riffe Reservoir	WA	5.4	Low	
Black Lake	WA	3.8	Low	
Yale Reservoir	WA	3.8	Low	
Ahtanum Creek	WA		Low	
Billy Clapp Lake	WA	17.9	Very Low	
Spokane River	WA	10.2	Very Low	
Rimrock Reservoir	WA	7.1	Very Low	
Swift Creek Reservoir	WA	3.9	Very Low	
Chehalis River	WA		Very Low	

Discussion

The CRB Team of the 100th Meridian Initiative has developed and tested a rapid response protocol that can be implemented if mussels are detected. Its implementation will benefit from effective early detection of new infestations, which requires improved monitoring. Resource limitations require that monitoring for dreissenid mussels in the CRB focuses on water bodies with the highest relative risk for dreissenid mussel introduction and establishment. Water bodies that rank high for both introduction and establishment could be considered at highest risk and should be the highest monitoring priority. These water bodies should, at minimum, be the focus of monitoring for early detection of dreissenid mussels.

The water bodies in each state containing portions of the CRB with medium to high relative risk of dreissenid mussel introduction and establishment were identified (Tables 16 through 20). Nine water bodies located on the Columbia and Snake Rivers had either a high or medium relative risk of establishment and introduction (American Falls Reservoir, Lake Walcott, Milner Lake, Brownlee Reservoir, Hells Canyon Reservoir, CJ Strike Reservoir, Lake Celilo/The Dalles Reservoir, Lake Bonneville/Bonneville Reservoir, and Lake Wanapum). Several tributaries to the Columbia and Snake Rivers had a high to medium relative risk of dreissenid establishment and introduction (e.g. Kootenai River, Salmon River, ID, Pend Oreille River, and John Day River, OR). There are many other high to medium risk water bodies within the CRB that were directly or indirectly connected to the Columbia and Snake Rivers (e.g. Magic Reservoir, ID, Lake Lowell, ID, Salmon Falls Creek Reservoir, ID, Lake Koocanusa, MT, Blackfoot River, MT, Flathead Lake, MT, Owyhee Reservoir, OR, Banks Lake, WA, and Moses Lake, WA).

If resources permit, monitoring of particular water bodies with a low to very low relative risk of dreissenid establishment or introduction could be beneficial. The risk of establishment was given greater consideration in this prioritization compared to the risk of introduction, but many water bodies were identified with a low to very low risk of establishment but a medium to high risk of introduction. A low risk of establishment does not preclude dreissenid mussel establishment, and greater recreational boater use could increase propagule pressure. Water bodies that had a low relative risk of dreissenid establishment but a high to medium relative risk of introduction included the Bitterroot River, MT; Madison River, MT; Seeley Lake, MT; Wallowa Lake, OR; Emigrant Lake, OR; and Lake Billy Chinook, OR; These water bodies had mean calcium concentrations ranging from 12.0 to 14.8 mg Ca^{2+}/ L. Although most established populations occur in waters with calcium concentrations greater than 15 mg Ca^{2+}/ L, veligers have been detected repeatedly in water bodies with calcium concentrations less than 10 mg Ca^{2+}/ L (e.g. Grand Lake, CO, and Lake Granby, CO).

Water bodies characterized as low to very low risk for both establishment and introduction (Tables 8 through 15) are not listed in Tables 16 through 21. The objective of this prioritization was to identify the highest priority water bodies to target for early detection monitoring using the available data. Dreissenid mussels can be introduced and establish in the water bodies identified with low to very low risk of both establishment and introduction. There is more uncertainty, however, associated with water bodies lacking either water quality or boater recreational data.

For some water bodies in the CRB and Greater Northwest region there was no calcium or boater use data for assessing the relative risk of establishment or introduction (Tables 22 through 29). Over 190 water bodies were identified with a high to medium risk of dreissenid establishment that lacked recreational boater data. Conversely, 35 water bodies were identified with a high to medium relative risk of dreissenid introduction but that lacked water quality data. These water bodies need further evaluation and states should obtain the missing data for these water bodies to allow more effective prioritization.

Some states bordering the CRB have established dreissenid mussel populations and are a source of recreational boaters, and potentially contaminated boats, coming to the CRB; or have water bodies with high to medium relative risk of establishment and introduction. The proximity of these water bodies increases the risk posed to the CRB. We identified water bodies in California, Nevada, Wyoming, Montana, and Utah with a medium to high relative risk of dreissenid mussel establishment or introduction that could be a source of contaminated boats if the water bodies had established populations (Tables 23, 24, 26, 28, and 29). Water bodies in this category included Rye Patch Reservoir, South Fork Reservoir, Lahontan Reservoir, Lake Fort Peck, Missouri River, Canyon Ferry Reservoir, Utah Lake, Lake Powell, East Canyon Reservoir, and Flaming Gorge Reservoir. We were unable to obtain recreational boater data for many of these water bodies, but boats entering the CRB from these potentially high-risk areas should receive a high level of scrutiny in the CRB.

Table 16. Water bodies in Idaho that have a high to medium relative risk of dreissenid mussel establishment and/or introduction. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction#
Snake River, American Falls Reservoir	47.5	8.19	High	High
Snake River, Lake Walcott	46.2	8.27	High	High
Snake River, Milner Lake	45.7	8.49	High	High
Snake River, Brownlee Reservoir	31.3	8.13	High	High
Kootenai River	33.1	7.79	High	High+
Salmon Falls Creek Reservoir	83.2	8.15	High	Medium
Magic Reservior, outflow	49.8	7.85	High	Medium
Snake River, Hells Canyon Reservoir	31.0	8.20	High	Medium
Snake River, C.J. Strike Reservoir	24.2	8.39	Medium	High
Lake Pend Oreille	23.4		Medium	High
Lake Lowell	19.8	8.17	Medium	High
Salmon River	19.1	8.62	Medium	High
Pend Oreille River	20.1	7.92	Medium	High*
Anderson Ranch Reservoir	12.0	7.68	Very Low	High
Coeur d'Alene Lake	5.4	6.71	Very Low	High
Clearwater River	5.4	8.20	Very Low	High
Cascade Reservoir	3.6	7.4	Very Low	High
Hayden Lake	8.0	7.55	Very Low	Medium
Spirit Lake	1.9	6.50	Very Low	Medium

+ Water body had high relative risk of introduction in Montana.
* Water body had high relative risk of introduction in Washington.
# When there were multiple measures of boater use, the measure with the highest risk category was used.

Table 17. Water bodies in Nevada that have a high to medium relative risk of dreissenid mussel establishment and/or introduction. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction[#]
Rye Patch Reservoir	40.7	8.53	High	Medium
South Fork Reservoir	27.3	8.38	High	Medium
Lahontan Reservoir	23.9	7.78	Medium	High

[#] When there were multiple measures of boater use, the measure with the highest risk category was used.

Table 18. Water bodies in Montana that have a high to medium relative risk of dreissenid mussel establishment and/or introduction. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction[#]
Bighorn River	89.9	8.08	High	High
Ruby River	73.3	8.24	High	High
Beaverhead River	71.5	7.92	High	High
Ruby River Reservoir	53.5		High	High
Lake Fort Peck	47.0	8.59	High	High
Tongue River Reservoir	46.9	7.43	High	High
Gallatin River	42.2	7.94	High	High
Missouri River	39.8	8.16	High	High
Cooney Reservoir	38.7		High	High
Holter Lake	34.0		High	High
Clark Fork River	33.2	7.91	High	High
Lake Koocanusa	33.0	7.74	High	High
Hauser Reservoir	32.0		High	High
Kootenai River	28.6	8.10	High	High
Canyon Ferry Reservoir	28.3		High	High
Yellowstone River	26.8	8.14	High	High
Noxon Reservoir	26.0		High	High
Smith River	56.5	8.16	High	Medium
Jefferson River	40.5	8.18	High	Medium
Helena Valley Regulating Reservoir	35.0		High	Medium
Nelson Reservoir	34.0		High	Medium
Ashley Lake	33.8	8.16	High	Medium
Lake Helena	29.0		High	Medium
Blackfoot River	28.1	7.09	High	Medium
Rock Creek	26.7	7.30	High	Medium
Fresno Reservoir	24.1		Medium	High
Flathead River	24.0	8.21	Medium	High
Flathead Lake	21.6	8.02	Medium	High
Boulder River	18.9	7.01	Medium	High
Big Hole River	16.1	7.46	Medium	High
Lake Mary Ronan	15.9	7.38	Medium	High
Whitefish Lake	23.0	7.58	Medium	Medium
Swan Lake	22.0		Medium	Medium
Hungry Horse Reservoir	21.2	8.01	Medium	Medium
Ennis Lake	21.0		Medium	Medium
Placid Lake	16.0		Medium	Medium
Bitterroot River	14.8	6.77	Low	High
Madison River	13.5	7.91	Low	High
Seeley Lake	12.0		Low	Medium
Bull Lake	8.3	8.14	Very Low	Medium
Lake Como	2.0	6.4	Very Low	Medium

[#] When there were multiple measures of boater use, the measure with the highest risk category was used.

Table 19. Water bodies in Oregon that have a high to medium relative risk of dreissenid mussel establishment and/or introduction. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction#
Prineville Reservoir	33.4	7.72	High	High
Owyhee Reservoir	28.2	7.55	High	High
Paulina Lake	28.0	8.25	High	High
East Lake	25.5	7.25	High	High
Snake River, Brownlee Reservoir	31.3	8.13	High	High**
Snake River, Hells Canyon Reservoir	31.0	8.20	High	Medium
Applegate Reservoir	18.1	7.75	Medium	High
John Day River	17.3	7.79	Medium	High
Columbia River, Lake Celilo	17.0	8.07	Medium	High
Columbia River, Lake Bonneville	16.5	8.11	Medium	High
Ochoco Reservoir	20.1	8.40	Medium	Medium
Wallowa Lake	14.0	8.09	Low	High
Emigrant Lake	12.6	7.02	Low	High
Lake Billy Chinook	11.0	9.00	Very Low	High
Klamath Lake	7.3	7.57	Very Low	High
Howard Praire Lake	6.9	7.56	Very Low	High
Willamette River	6.8	7.12	Very Low	High
Deschutes River	6.5	7.91	Very Low	High
North Fork Reservoir	5.7	7.48	Very Low	High
Henry Hagg Lake	5.6	7.07	Very Low	High
Fern Ridge Reservoir	5.2	7.80	Very Low	High
Lost Creek Lake	5.0	7.30	Very Low	High
Devils Lake (Lincoln)	4.7	7.8	Very Low	High
Dexter Lake	4.7	7.60	Very Low	High
Foster Reservoir	4.4	7.20	Very Low	High
Loon Lake	4.2	7.00	Very Low	High
Green Peter Lake	4.0	7.30	Very Low	High
Wickiup Reservoir	3.5	7.60	Very Low	High
Detroit Lake	3.5	7.51	Very Low	High
North Tenmile Lake	3.4	7.10	Very Low	High
Mercer Lake	3.0	7.87	Very Low	High
Odell Lake	3.0	7.79	Very Low	High
Lake of the Woods	2.5	7.14	Very Low	High
Diamond Lake	2.5	7.36	Very Low	High
Crescent Lake	2.4	7.20	Very Low	High
Craine Praire Reservoir	2.2	9.80	Very Low	High
Lava Lake	2.1	7.90	Very Low	High

[#] When there were multiple measures of boater use, the measure with the highest risk category was used.

Table 19 (continued).

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction#
Simtustus Lake	10.4	8.90	Very Low	Medium
Hyatt Reservoir	10.0	7.34	Very Low	Medium
Phillips Lake	8.9	8.20	Very Low	Medium
Chickahominy Reservoir	8.1	7.70	Very Low	Medium
Agency Lake	7.0	7.46	Very Low	Medium
Dorena Reservoir	6.9	7.63	Very Low	Medium
Cottage Grove Lake	6.4	6.77	Very Low	Medium
Hills Creek Lake	5.3	8.10	Very Low	Medium
Selmac Lake	4.7		Very Low	Medium
Pine Hollow Reservoir	4.5	7.40	Very Low	Medium
Timothy Lake	4.5	7.64	Very Low	Medium
Smith Reservoir	4.2	7.20	Very Low	Medium
Fall Creek Reservoir	4.1	7.58	Very Low	Medium
Eel Lake	3.6	7.40	Very Low	Medium
Lemolo Lake	3.5	7.53	Very Low	Medium
Siltcoos Lake	3.4	7.48	Very Low	Medium
Blue River Reservoir	3.2	7.49	Very Low	Medium
Triangle Lake	2.4	7.00	Very Low	Medium
Munsel Lake	2.1	7.05	Very Low	Medium
Cultus Lake	2.0	7.50	Very Low	Medium
Woahink Lake	1.9	7.10	Very Low	Medium
Olallie Lake	0.5		Very Low	Medium

** Water body had high relative risk of introduction in Idaho.
# When there were multiple measures of boater use, the measure with the highest risk category was used.

Table 20. Water bodies in Utah that have a high to medium relative risk of dreissenid mussel establishment and/or introduction. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction#
Utah Lake	76.1	8.11	High	High
Colorado River, Lake Powell	72.1	8.0	High	High
East Canyon Reservoir	69.0	8.28	High	High
Flaming Gorge Reservoir	65.6	8.10	High	High
Starvation Reservoir	57.9	8.24	High	High
Rockport/Wanship Reservoir	49.4	8.20	High	High
Hyrum Reservoir	48.3	7.87	High	High
Steinaker Reservoir	34.8	7.80	High	High
Pelican Lake	38.6	8.35	High	Low

When there were multiple measures of boater use, the measure with the highest risk category was used.

Table 21. Water bodies in Washington that have a high to medium relative risk of dreissenid mussel establishment and/or introduction. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction#
Moses Lake	30.5	8.18	High	High
Potholes Reservoir outflow	28.3	8.14	High	High
Pend Oreille River	20.1		Medium	High
Lake Washington, inflow	18.8	7.77	Medium	High
Banks Lake	17.8	7.90	Medium	High
Columbia River, Lake Celilo	16.8		Medium	High
Columbia River, Lake Bonneville	16.5	8.11	Medium	High
Clear Lake	16.4	8.47	Medium	High
Williams Lake	20.5	7.39	Medium	Medium
Columbia River, Lake Wanapum	18.1	8.02	Medium	Medium
Lake Cresent	15.9	6.94	Medium	Medium
Nooksack River	12.0	7.57	Low	Medium
Silver Lake	10.4	7.49	Very Low	High
Deer Lake	9.3	7.50	Very Low	High
Cowlitz River	8.1	7.47	Very Low	High
Lake Cushman	11.6	7.55	Very Low	Medium
Diamond Lake	7.5	7.90	Very Low	Medium
Mineral Lake, outflow	5.8	7.64	Very Low	Medium
Alder Lake	5.1	7.45	Very Low	Medium
Cle Elum Reservoir	4.7	7.08	Very Low	Medium
Bumping Reservoir	3.8	7.55	Very Low	Medium

When there were multiple measures of boater use, the measure with the highest risk category was used.

Table 22. Water bodies in Idaho with either a high to medium relative risk of dreissenid mussel establishment or introduction, but that lack data for one of the risk factors. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Oneida Narrows Reservoir	59.7	7.76	High	
Blackfoot River	53.0	8.10	High	
Alexander Reservoir	52.1	7.97	High	
Willow Creek	50.2	8.18	High	
Ririe Reservoir	46.9	7.96	High	
Blackfoot Reservoir	43.7	8.38	High	
Snake River, Bliss Reservoir	43.3	8.21	High	
Snake River, Upper Salmon Falls Reservoir	40.3	8.23	High	
Murtaugh Lake	39.8	8.14	High	
Snake River, Gem State Reservoir	37.4	8.09	High	
Snake River, Palisades Reservoir	37.3	7.99	High	
Bear Lake	35.9	7.87	High	
Stone Reservoir	34.4	8.25	High	
Deadwood Reservoir	33.7	7.21	High	
Owyhee River	32.6	8.21	High	
Mud Lake	31.9	7.96	High	

Table 22 (continued).

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Chesterfield Reservoir	27.4	8.63	High	
Mann Lake, inflow	26.0	7.95	High	
Little Wood Reservoir	23.8	7.91	Medium	
Clark Fork River	23.6		Medium	
Mormon Reservoir	23.5	8.21	Medium	
Little Wood River	23.4	7.93	Medium	
Big Lost River	22.0	8.18	Medium	
Paddock Valley Reservoir	17.8		Medium	
Mann Creek Reservoir	16.9	7.68	Medium	
Mann Creek	16.7	7.77	Medium	
Island Park Reservoir	15.8	8.09	Medium	
Dworshak Reservoir				High
Massacre Rocks				High
Deer Creek Reservoir				Medium
Devil Creek Reservoir				Medium
Swan Falls Reservoir				Medium
Twin Lake, Lower				Medium
Moose Creek Reservoir				Medium
Park Center Pond				Medium

Table 23. Water bodies in Montana with either a high to medium relative risk of dreissenid mussel establishment or introduction, but that lack data for one of the risk factors. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Powder River	153	8.03	High	
Musselshell River	115	8.08	High	
Clark Fork Muddy Creek	83.2	8.12	High	
Teton River	73.5	7.32	High	
Judith River	64.2	8.01	High	
N.F. Musselshell River	64.0	8.09	High	
Sun River	59.5	8.21	High	
Red Lodge Creek	53.3	7.35	High	
Norwegian Creek	50.1	7.22	High	
Marias River	49.2	7.83	High	
Garden Creek	45.9	8.34	High	
Milk River	43.8	8.13	High	
Tiber Reservoir	43.0	8.17	High	
Mission Lake	42.4	8.05	High	
Douglas Creek	39.6	8.11	High	
Battle Creek	37.0	7.91	High	
Beaver Creek	37.0	8.02	High	
Jocko River	37.0		High	
Lodge Creek	35.8	9.03	High	
Tenmile Creek	35.5	7.65	High	
Clarks Fork of Yellowstone River	34.9	7.50	High	

Table 23 (continued).

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Post Creek	32.0		High	
S.F. Sun River	31.7	8.33	High	
Gates of the Mountain Reservoir	30.0		High	
Willow Creek	29.4	7.03	High	
Birch Creek	29.2	7.17	High	
S.F. Flathead River	29.0	7.87	High	
Nevada Creek	28.5	8.10	High	
Lake Alva	28.0		High	
Echo Lake	27.0		High	
Thompson Falls Reservoir	27.0	8.33	High	
Soda Butte Creek	25.6	7.99	High	
Upper Marsh Creek, Flaming Gorge Res. Inflow	25.0		Medium	
Cabinet Gorge Reservoir	24.0	8.21	Medium	
Butte Creek	23.5	8.37	Medium	
Harrison Lake	22.0		Medium	
Sophie Lake	22.0		Medium	
E.F. Rock Creek	21.0	6.16	Medium	
Thompson Lake, inflow	19.0		Medium	
Salmon Lake	17.0		Medium	
Lake McDonald, outflow	15.2		Medium	
Clark Canyon Reservoir				High
Georgetown Lake				High
Hebgen Lake				High
Lake Elwell				High
Smith Lake				High
Stillwater River				High
Dailey Lake				Medium
Ackley Lake				Medium
Bighorn Lake				Medium
Browns Lake				Medium
Little Bitterroot Lake				Medium
McGregor Lake				Medium
Middle Thompson Lake				Medium
Newlan Creek Reservoir				Medium
Yellowtail Afterbay				Medium

Table 24. Water bodies in Nevada with either a high to medium relative risk of dreissenid mussel establishment or introduction, but that lack data for one of the risk factors. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Virgin River	290	8.11	High	
Humboldt Lake	123	7.83	High	
Colorado River, Lake Mead	87.6	7.74	High	
Pyramid Lake	77.0	7.20	High	
Sparks Marina	76.7	7.67	High	
Colorado River, Lake Havasu	75.0	7.80	High	
Big Spring Reservoir	60.8	7.60	High	
Eagle Valley Reservoir	50.5	8.18	High	
Carson Lake	50.0	8.05	High	
Washoe Lake	45.0	8.65	High	
Little Washoe Lake	44.7	8.52	High	
Stillwater Point Reservoir	44.4	8.17	High	
Cave Lake	43.6	8.41	High	
Ruby Lake Marsh	39.4	8.00	High	
Mary's River	38.4	8.16	High	
Hay Meadows Reservoir	38.0	8.51	High	
Owyhee River, East	34.6	8.36	High	
Owyhee River, South	31.0	8.37	High	
Weber Reservoir	29.3	8.12	High	
Bruneau River, West	27.9	8.34	High	
Sheckler Reservoir	27.0	8.74	High	
Cold Springs Reservoir	26.0	8.97	High	
Comins Reservoir	25.4	8.76	High	
Dacey Reservoir	25.0	8.12	Medium	
Illipah Creek Reservoir	24.7	8.55	Medium	
Wild Horse Reservoir	22.2	8.32	Medium	
Carson River	21.4	8.05	Medium	
Echo Canyon Reservoir	21.0	8.68	Medium	
Bilk Creek Reservoir	20.8	7.95	Medium	
Walker River, East	19.3	8.13	Medium	
Big Bend				High
Lake Tahoe				High

Table 25. Water bodies in Oregon with either a high to medium relative risk of dreissenid mussel establishment or introduction, but that lack data for one of the risk factors. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Warm Springs Reservoir	56.0	8.08	High	
Malheur Reservoir	44.6	8.37	High	
Owyhee River	43.0	7.97	High	
Bully Creek Reservoir	41.7	7.76	High	
Malheur River	39.6	8.36	High	
Umatilla River	34.6		High	
Powder River	25.2	7.73	High	
Crooked River	24.3	7.90	Medium	
Mann Lake	24.3	8.70	Medium	
Buckeye Lake	19.2		Medium	
Columbia River, Lake Umatilla	17.8		Medium	
Columbia River, Lake Wallula	17.4		Medium	
Hart Lake	17.2	8.00	Medium	
Unity Reservoir	17.1	9.60	Medium	
Thief Valley Reservoir	15.6	7.31	Medium	
Suttle Lake	4.0	8.08	Very Low	

Table 26. Water bodies in Utah with either a high to medium relative risk of dreissenid mussel establishment or introduction, but that lack data for one of the risk factors. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Gunnison Reservoir	94.2	8.06	High	
Quail Creek Reservoir	83.0	8.20	High	
Kolob Reservoir	82.0	8.30	High	
Porcupine Reservoir	74.0	8.12	High	
Soldier Creek Reservoir	71.0	8.20	High	
San Juan River	67.3		High	
Escalante River	60.2		High	
Lost Creek Reservoir	58.8	8.00	High	
Echo Reservoir	58.3	8.19	High	
Scofield Reservoir	57.9	8.23	High	
Newton Reservoir	55.0	8.01	High	
Huntington North Reservoir	49.7	8.26	High	
Strawberry Reservoir	48.4	8.01	High	
Gunlock Reservoir	46.9	8.05	High	
Deer Creek Reservoir	46.0	7.48	High	
Huntington Reservoir	45.9	8.17	High	
Piute Reservoir	44.1	8.21	High	

Table 26 (continued).

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Joes Valley Reservoir	42.7	7.91	High	
Whitney Reservoir	42.0	8.05	High	
Panguitch Lake	38.5	8.43	High	
Enterprise Reservoir	38.0	8.60	High	
Otter Creek Reservoir	37.0	8.42	High	
Pineview Reservoir	37.0	8.04	High	
Red Fleet Reservoir	32.4	8.23	High	
Big Sand Wash Reservoir	27.9	8.01	High	
Forsyth Reservoir	21.5	7.92	Medium	
Johnson Valley Reservoir	18.0	7.59	Medium	
Jordanelle Reservoir				High

Table 27. Water bodies in Washington with either a high to medium relative risk of dreissenid mussel establishment or introduction, but that lack data for one of the risk factors. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Wannacut Lake	225	8.25	High	
Pearrygin Lake	41.5	8.35	High	
Coldwater Lake	40.3	6.87	High	
Spectacle Lake	37.8	8.75	High	
Palmer Lake	36.0	8.35	High	
Spokane River inflow	35.3	8.43	High	
Lower Crab Creek	33.9	8.33	High	
Sprague Lake	31.8	8.68	High	
Waitts Lake	30.2	7.38	High	
Methow River	21.5	7.99	Medium	
Columbia River, FDR Lake	20.9	7.93	Medium	
Priest Rapids Lake, outflow	20.9	7.69	Medium	
Yakima River inflow	20.5	7.88	Medium	
Loon Lake	19.4		Medium	
Yakima River	18.6	7.91	Medium	
Columbia River, Lake Wallula	18.6	7.87	Medium	
Billy Clapp Lake	17.9		Medium	
Columbia River, Lake Umatilla	17.8		Medium	
Columbia River, Hanford Reach	17.1	8.05	Medium	
Horsetheif Lake	16.2		Medium	
Rolland Lake	15.6		Medium	
Blue Lake	15.6	8.00	Medium	
Lake Sammamish inflow				High
Lake Tapps tailrace				High
Long Lake inflow				High

Table 27 (continued.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment	Relative Risk Introduction
Snohomish River				High
Abernathy Creek				Medium
Deep Creek				Medium
Fishtrap Creek				Medium
Lake Ozette				Medium
Skagit River				Medium

Table 28. Water bodies in Wyoming with either a high to medium relative risk of dreissenid mussel establishment or introduction, but that lack boater use data. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment
Cheyenne River	249	7.82	High
Big Sandy River, Big Sandy Reservoir outflow	141	8.20	High
Keyhole Reservoir outflow	135	8.20	High
Seminoe Reservoir outflow	120	8.23	High
Salt River, Palisades Reservoir inflow	64.1	8.00	High
Bighorn River	62.9	8.17	High
Boysen Reservoir	54.1	8.31	High
Bighorn Lake inflow	52.6	8.31	High
Flaming Gorge Reservoir	52.4	8.34	High
North Platte River	50.9	8.79	High
Sulphur Creek Reservoir outflow	44.3	8.51	High
Woodruff Narrows Reservoir inflow	44.2	8.48	High
Green River, Fontenelle Reservoir	43.6	8.06	High
Bear River, Woodruff Reservoir	43.5	8.30	High
Wind River	37.2	8.18	High
North Platte River, Pathfinder Res. Inflow	36.5	8.16	High
North Platte River, Seminoe Reservoir inflow	33.2	8.14	High
Lamar River	18.8	7.90	Medium
Snake River, Jackson Lake	17.3	7.71	Medium
Buffalo Bill Reservoir inflow	16.4	7.78	Medium

Table 29. Water bodies in California with a high to medium relative risk of dreissenid mussel establishment that lack boater use data. Risk categories were formulated using best professional judgment. The amount of data used to assign risk categories varied for each water body. Data is summarized in Appendix 1 and II, and risk categories based on one or two data points are flagged with an asterisk. Dreissenids can also establish in areas identified with low to very low risk of establishment.

Water Body Name	$[Ca^{2+}]$ mg/L	pH	Relative Risk Establishment
Colorado River, Lake Mead	87.6	7.74	High
Colorado River, Lake Havasu	75.0	7.80	High
Lexington Reservoir	36.0	7.90	High
Anderson Lake	33.0	7.70	High
Lake San Antonio	32.8	7.51	High
Lake Del Valle	32.0	8.50	High
Black Butte Lake	31.5	8.06	High
Lake Nacimiento	31.3	8.18	High
Lake Perris	26.0	8.50	High
Calero Reservoir	26.0	8.10	High
San Luis Reservoir	24.2	8.30	Medium
Clear Lake	23.4	8.40	Medium
Lake Mendocino	20.5	8.05	Medium
Contra Loma Reservoir	19.0	7.50	Medium
Indian Valley Reservoir	17.0	7.80	Medium
Lake Berryessa	17.0	7.30	Medium

Dreissenid mussel surveys of the water bodies with the greatest risk of introduction and establishment should employ standardized protocols for the examination of solid surfaces and sediment samples for adult mussel detection, plankton samples for veliger analysis, and shoreline walks to search for mussel shells, particularly in reservoirs that have been drawn down. Monitoring should be coordinated regionally.

Regional prioritization of monitoring for dreissenid mussels at the individual water body scale presented many challenges. False negatives (e.g., not identifying a high risk water body when it is at high risk) caused by a lack of data are a major concern in prioritizing risk at the individual water body scale. We started with a large initial list of water bodies in the CRB including lakes, reservoirs, rivers, and creeks (*n*= 902). We reduced the size of the list by focusing on water bodies with public boat ramps and large rivers. Information on presence of boat ramps and other indicators of use was incomplete, difficult to obtain, and differed between states. As a consequence, some water bodies with boat ramps and use levels that would result in a medium to high relative risk of introduction may have been dropped from the list. States should evaluate the prioritized lists provided and make adjustments where local knowledge dictates.

Many water bodies lacked water quality and/or boater recreation data, and much of the existing water quality data is not stored electronically. Additionally, because data were obtained from multiple agencies, the sampling and analytical protocols may have differed. Metadata for water quality data were often either not available or inaccessible, and the number of years of data and time of year that the data were collected was highly variable between water bodies. The development of a suite of water quality characteristics to measure, standardization of the data collection methods, and the development of metadata that is accessible would facilitate a more thorough assessment of the risk of establishment of AIS in the future.

Standardization of boat use and angling metrics collected across jurisdictional boundaries would also facilitate a more thorough assessment of AIS risk. Lack of standardized data collection methods required a state-by-state assessment of the relative risk of introduction; no regional assessment was possible. For example boater-use surveys and record keeping regarding angling tournaments varied from state to state, likely due to the fact that each individual state has its own goals for collecting the data. Boating and angling data were not available for some states and most states did not collect out-of-state boater recreational use. Only angling day-use data were available for Montana, and the data included angling from both the shoreline and watercraft. Boater use-day data were only available for state parks in Nevada. Some states did not maintain angling tournament data, and the level of detail varied between states that did have data. For example, some states recorded the water bodies where tournaments were held as well as the number of boats and fishermen, while other states simply recorded the location.

Our efforts to perform a new mailed-boater survey to obtain more uniform recreational use data were unsuccessful because of difficulties in attaining mailing lists for registered boaters. Lastly, recreational boating was used in this prioritization, but other vectors transport dreissenid mussel adults and larvae between basins as well (e.g. oil spill response equipment, dredges, barges, ballast water, transport of hatchery reared sport fish, etc.). Availability of data on these vectors of introduction was similarly difficult. Boater surveys conducted by the 100th Meridian Initiative provided boater recreational data that was relatively consistent across the numerous states within the CRB and Greater Northwest area, but these data were biased by the collection methods and were not used in this prioritization.

Research that better defines the tolerance thresholds of dreissenid mussels, and other high priority AIS, will help refine the assessment of establishment risk. The thresholds used to rank raw water quality and recreational data were based on previous tolerance studies, and other dreissenid mussel risk evaluations, but there is much uncertainty regarding the thresholds reported in the literature. Additionally, there is a paucity of information on environmental tolerances of *D. r. bugensis*.

Using only dissolved calcium concentration to predict risk of dreissenid mussel establishment may be inappropriate in some cases. Calcium concentrations can vary spatially and temporally, and these effects are exacerbated in regulated systems (Petts 1986). The relative proportion of major ions is relatively constant in well-watered North American temperate zones, and calcium is the dominant cation in lakes and rivers within this zone (Kalff 2002). The relative proportion of major ions, however, can vary due to differences in geology (e.g. mineral weathering), climate (e.g. evaporative precipitation) (Gorham, Dean, Sanger 1983), and other processes like groundwater, and pollution (Chapman 1992). The mean values for calcium concentration were calculated from data representing the April through October period, and efforts were focused on the last decade. The amount of calcium data in terms of data points and the number of years, however, varied between water bodies. Forty four percent (n= 219) of all water bodies assigned a risk category for establishment had less than three data points. The low and very low risk category for establishment had the greatest number of water bodies with less than three data points (57%, n=16, and 56%, n=109, respectively). Thirty percent (n=59) of the water bodies in the high, and 41% (n=35) of the water bodies in the medium risk category for establishment had less than three data points. Habitat suitability was overestimated for hypersaline, inland water bodies that were assigned a high-risk category for dreissenid establishment based upon dissolved calcium (e.g. Great Salt Lake, UT, Cheyenne River, WY, and Humboldt Lake, NV). Similarly, the risk for establishment may be overestimated in other water bodies with high ion concentrations (conductivity greater than 1,800 μS/ cm) such as the Virgin River, NV (>2,000 μS/cm), Powder River, MT (2,000 μS/cm), Big Sandy River, WY (>2,800 μS/cm), and Keyhole Reservoir, WY (2,200 μS/cm). Thus, when prioritizing water bodies for monitoring the estimated risk of establishment presented in this report needs to be tempered by expert knowledge of unusual water quality conditions that may exist.

Validating our monitoring prioritization was not possible because dreissenid mussel populations are known to occur in only a few western water bodies and direct comparisons between different assessments is difficult. Some of these western dreissenid populations are in waters that were traditionally viewed as low-risk due to elevation, water temperature, and dissolved calcium concentration (Grand Lake, CO, and Lake Granby CO). The direct comparison of assessments is complicated by differing parameters, and the relative weighting of those parameters. There were some disagreements between the risk categories assigned to water bodies in our prioritization, the presence/absence predictions using the Ramcharan et al. (1992) model, and other assessments. It appears, however, the divergence between water bodies assigned a high risk of establishment in our assessment, but were predicted to have mussels absent by the Ramcharan model, was due to pH. The mean calcium and pH concentrations of the water bodies classified as high risk in this assessment but predicted to have mussels absent by the Ramcharan et al. (1992) model were 32.4 mg Ca^{2+}/L (SD= 7.854, *n*= 10), and 7.3 (SD= 0.179, *n*= 9). Several authors consider a pH 7.3 as the lower limiting pH value for dreissenid establishment. The divergence between this prioritization and the previous assessment by Wells et al. (2008) was likely due to the fact that Wells et al. (2008) used more conservative calcium thresholds for the risk categories (i.e. erring on the side of caution), used the upper range values for calcium and pH versus mean values, and the risk categories presented by Wells et al. (2008) combined ranks for water quality and recreational boater data, and therefore represented the risk of establishment and introduction. The consideration of multiple assessments, although difficult, is important and increases the likelihood of capturing natural variability, and identifying patterns within relative risk rankings. Again, local knowledge and additional information on use and water chemistry are required to reconcile these discrepancies and provide the necessary focus for an effective early-detection monitoring program for dreissenid mussels in the CRB.

Recommendations and Next Steps

1. Water bodies that are high risk for both dreissenid establishment and introduction are the highest priority for monitoring, however, many water bodies lacked data and we could not accurately assess the relative risk of either introduction of establishment.

2. Collecting water quality and recreational data for water bodies lacking data will allow a more rigorous assessment of the risk of establishment and introduction. These water bodies are identified in Tables 22-29.

3. Collecting regional boater recreational data collected using survey methods that are standardized across states will better define risk patterns associated with recreational boating. For example, a mailed survey to a sub-set of registered boaters in western states could evaluate travel patterns such as routes, destinations, and trip duration.

4. Incorporating Canadian water bodies and recreational pressure will increase the utility of this and future assessments of risk. The Columbia River Basin is trans-boundary, and at least

one case of a trailered watercraft found to be transporting attached adult dreissenid mussels involved a Canadian who purchased a used boat from the lower Colorado River.

5. As is true with any modeling exercise, this assessment should be validated and updated as new information becomes available. Occurrences of new populations can be used to check accuracy. New experimental findings from growth and survival experiments should be incorporated into our understanding of these mussels' environmental tolerances, and used to improve this prioritization.

6. Standardize a suite of pertinent water quality parameters to be monitored and protocols for collecting them. Protocols should include collection methods, metadata requirements, quality control/quality assurance, storage and sharing (e.g. online interactive databases), and publishing.

7. Standardization of early detection sampling protocols and research that verifies the effectiveness of various sampling techniques in detecting dreissenid mussels at low densities would ensure consistency and cost-effectiveness of dreissenid mussel monitoring programs.

8. Expanding this prioritization effort to include *Limnoperna fortunei* (Golden lake mussel) will allow as assessment of the potential for this mussel to become established in the study area. This invasive freshwater mussel, currently in South America, Japan, and Korea, has similar life history traits as dreissenids (e.g. planktonic larvae, byssal-attachment), and appears to have broader environmental tolerances.

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Appendix I

Appendix I – Table A. Summary of water quality data for California including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Anderson Lake	33.0		33.0	33.0	1	1	7.7	7.7	7.7	1	1
Antelope Lake	9.0		9.0	9.0	1	1	7.6	7.6	7.6	1	1
Bethany Reservoir	12.9		12.9	12.9	1	1	8.7	8.5	8.8	14	1
Black Butte Lake	31.5	0.7	31.0	32.0	2	2	8.1	7.5	8.9	15	2
Calero Reservoir	26.0		26.0	26.0	1	1	8.1	8.1	8.1	1	1
Camanche Reservoir	3.0		3.0	3.0	1	1	7.1	7.1	7.1	1	1
Clear Lake	23.4	3.4	20.0	26.3	4	2	8.4	7.7	9.1	11	2
Contra Loma Reservoir	19.0		19.0	19.0	1	1	7.5	7.5	7.5	1	1
Folsom Lake	4.0		4.0	4.0	1	1	7.0	7.0	7.0	1	1
Indian Valley Reservoir	17.0		17.0	17.0	1	1	7.8	7.8	7.8	1	1
Iron Canyon Reservoir	8.0		8.0	8.0	1	1	7.8	7.8	7.8	1	1
Iron Gate Reservoir	10.7		10.7	10.7	1	1	8.3	7.7	9.8	12	1
Lake Almanor	8.0		8.0	8.0	1	1	7.8	7.8	7.8	1	1
Lake Berryessa	17.0		17.0	17.0	1	1	7.3	7.3	7.3	1	1
Lake Del Valle	32.0		32.0	32.0	1	1	8.5	8.5	8.5	1	1
Lake Don Pedro	3.1	0.1	3.0	3.2	3	2	7.4	6.5	7.8	15	2
Lake Havasu	75.0		75.0	75.0	1	1	7.8	7.8	7.8	1	1
Lake McClure	3.8		3.8	3.8	1	1	8.2	8.0	8.9	9	1
Lake Mendocino	20.5		20.5	20.5	1	1	8.1	7.5	8.9	14	1
Lake Nacimiento	31.3		31.3	31.3	1	1	8.2	7.8	8.5	13	1
Lake Perris	26.0		26.0	26.0	1	1	8.5	8.5	8.5	1	1
Lake San Antonio	32.8		32.8	32.8	1	1	7.5	7.0	8.9	14	1
Lake Shasta	9.9		9.9	9.9	1	1	8.0	7.7	8.2	12	1
Lake Sonoma	14.0		14.0	14.0	1	1	7.5	7.5	7.5	1	1
Lexington Reservoir	36.0		36.0	36.0	1	1	7.9	7.9	7.9	1	1
McCloud River	13.0		13.0	13.0	1	1	7.8	7.8	7.8	1	1
McCloud Reservoir	8.0		8.0	8.0	1	1	7.6	7.6	7.6	1	1
Millerton Lake	3.0		3.0	3.0	1	1	7.1	7.1	7.1	1	1
Mokelumne River	9.1	4.9	5.6	12.5	2	1	7.8	7.7	7.9	15	1
New Melones Lake	6.5		6.5	6.5	1	1	8.2	7.7	8.7	12	1
Old River	12.9		12.9	12.9	1	1	8.0	8.0	8.1	7	1
Pardee Lake	3.0		3.0	3.0	1	1	7.6	7.6	7.6	1	1
Pine Flat Lake	3.0		3.0	3.0	1	1	7.2	7.2	7.2	1	1
Sacramento River	13.7		13.7	13.7	1	1	7.7	7.6	7.8	6	1
San Joaquin River	11.6	0.2	11.4	11.7	2	1	7.3	7.2	7.3	4	1
San Luis Reservoir	24.2	0.2	24.0	24.3	2	2	8.3	8.3	8.3	1	1
Trinity River	4.0		4.0	4.0	1	1	7.6	7.6	7.6	1	1
Turlock Lake	3.0		3.0	3.0	1	1	6.9	6.8	7.2	7	1
Whiskeytown Reservoir	5.0		5.0	5.0	1	1	7.3	7.3	7.3	1	1

Appendix I - Table B. Summary of water quality data for Idaho including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Alexander Reservoir, west end	52.1	1.0	51.3	52.8	2	1	8.0	7.7	8.1	16	1
Alturas Lake	7.4	0.3	7.2	7.8	3	1	7.2	6.8	8.3	43	1
Anderson Ranch Reservoir	10.3	3.0	1.3	13.6	29	4	7.6	6.7	8.7	202	5
A.R.Res. inflow, SF Boise Rv	14.9		14.9	14.9	1	1	7.9	7.6	8.3	13	2
A.R.Res. outflow, SF Boise Rv	10.7	1.0	9.9	11.8	3	3	7.6	7.4	7.9	18	4
Arrowrock Reservoir							7.5	7.0	10.2	124	3
Arrowrock Res inflow, MF Boise							7.7	7.3	8.3	28	2
Arrowrock Res inflow, SF Boise							7.9	7.6	8.2	27	2
Bear Lake	47.7	13.1	18	83	64	11	8.11	7.3	8.9	63	11
Bear Rv, inflow Alexander Res	35.9		35.9	35.9	1	1	8.7	8.7	8.7	1	1
Benewah Lake	5.6	0.3	5.2	5.9	6	1	8.4	7.7	9.2	6	1
Big Lost River	22.0	5.6	15.0	29.0	16		8.2	6.9	8.5	16	
Black Canyon Reservoir	5.7	0.1	5.6	5.8	2	1	7.5	7.3	7.9	8	2
Black Lake	5.8	0.3	5.5	6.1	6	1	7.0	6.6	7.4	7	1
Blackfoot Reservoir	43.7	1.9	41.6	45.2	3	1	8.4	7.7	9.4	14	1
Blackfoot River	53.0	0.1	52.9	53.0	2		8.1	8.1	8.1	2	
Boise River							7.7	7.0	8.5	39	4
Boise River	10.9	1.6	7.5	12.0	15		7.3	7.0	7.6	15	
Bruneau River	13.6	4.7	9.0	28.0	9		8.0	7.4	8.7	9	
Cascade Res							7.6	6.9	9.5	106	9
Cascade Reservoir, inflow	3.8	0.4	3.2	4.5	14		7.4	6.6	8.4	14	
Chesterfield Reservoir	27.4	8.1	21.6	33.1	2	1	8.6	8.1	9.3	24	1
Clark Fork River	23.6	1.8	22.3	24.8	2	1					
Clearwater River	5.4	0.5	4.7	6.1	7		8.2	7.8	8.8	7	
Coeur d'Alene Lake	5.4	0.8	4.0	9.5	69	5	6.7	6.1	7.7	206	5
Crane Creek Reservoir	9.5	0.5	9.1	9.9	2	1	7.3	6.9	8.1	18	1
Deadwood Reservoir	33.7	19.3	4.8	53.0	14	4	7.1	6.6	8.5	109	3
Deadwood Reservoir inflow	6.2		6.2	6.2	1	1	7.3	6.4	8.1	33	2
Deadwood River	5.2	1.9	3.9	8.9	6	3	7.3	5.9	8.5	121	6
Hauser Lake	4.6	0.1	4.4	4.7	4	1	6.9	6.5	8.9	12	1
Hayden Lake, inflow	8.0	2.0	4.8	11.0	21		7.6	6.8	8.3	21	
Henery's Fork, N.F. Snake Rv	12.3	3.8	7.4	17.8	6	6	7.9	7.7	8.0	6	6
Horsetheif Lake	3.9	0.2	3.8	4.0	2	1	6.8	6.5	8.2	24	1
Island Park Reservoir	15.8	3.3	1.2	20.5	51	7	8.1	7.0	9.7	88	7
Killarney Lake	6.2	0.6	5.5	6.8	5	1	6.9	6.9	7.1	6	1
Kootenai River	33.1	6.5	20.0	41.0	18		7.8	6.8	8.5	18	
Lake Cascade outflow	3.3	0.3	2.1	4.1	64	10	7.1	6.3	8.6	71	10
Lake Lowell	19.8	0.8	18.5	20.9	7	2	8.2	7.7	8.8	20	2
Little N.F. Coeur d'Alene River	6.3		6.3	6.3	1	1	7.5	7.5	7.5	1	1
Little Wood Reservoir	23.8	1.4	22.3	28.0	18	4	7.9	7.2	9.1	68	3
Little Wood River	23.4	0.3	23.2	23.8	7	3	7.9	7.8	8.2	11	3
Lochsa River	3.7	1.2	1.4	5.8	10		7.4	6.5	8.7	10	
Lucky Peak Reservoir	9.0	0.6	8.6	9.5	2	1	7.4	7.0	8.0	65	2
Magic Reservior, outflow	49.8	10.4	33.0	62.0	10		7.9	6.6	8.6	10	
Mann Creek	16.7	2.3	15.4	19.4	3	3	7.8	7.7	7.9	3	3

Appendix I - Table B (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Mann Creek Reservoir	16.9	1.8	15.3	19.9	6	3	7.7	7.4	8.4	31	2
Mann Lake, inflow	26.0	1.4	25.0	27.0	2		8.0	7.6	8.3	2	
Mormon Reservoir	23.5	1.6	22.4	24.6	2	1	8.2	8.1	10.1	16	1
Mountain Home Res, outflow	11.4	7.2	8.0	30.5	9		7.4	7.1	8.1	9	
Mud Lake	31.9	2.4	28.0	38.0	15		8.0	7.6	9.0	15	
Murtaugh Lake	39.8	5.2	32.0	46.0	5		8.1	7.8	8.4	5	
N.F. Clearwater River	1.8		1.8	1.8	1	1	8.4	8.4	8.4	1	1
N.F. Payette River	2.2	0.3	1.8	3.2	61	10	7.1	6.5	7.9	61	10
Oneida Narrows Reservoir	59.7	1.2	58.8	60.6	2	1	7.8	7.2	8.2	34	1
Owyhee River	32.6	7.9	16.9	46.1	20	5	8.2	8.0	8.7	20	5
Paddock Valley Reservoir	17.8	4.5	14.6	21.0	2	1					
Payette Lake							6.4	5.9	7.5	202	1
Payette Lake	11.0				1		8.3			1	
Payette River	3.1	0.8	2.0	6.0	65	9	7.4	6.5	13.1	167	10
Pend Oreille L	23.4	1.9	19.0	25.0	12	1	7.9	7.5	8.5	181	2
Pend Oreille River	20.1	0.9	19.2	21.0	4	1					
Pettit Lake	3.2	0.1	3.1	3.3	4	1	7.3	7.0	7.8	20	1
Priest Lake	7.6	2.4	4.3	13.0	16		7.5	6.2	8.4	16	
Redfish Lake, outflow	4.7	1.1	3.6	6.8	8		7.2	6.7	8.0	8	
Ririe Reservoir	46.9	6.1	32.3	53.3	30	7	8.0	7.3	8.8	120	7
Salmon Falls Creek Reservoir	83.2	3.5	77.0	88.0	15		8.2	7.9	8.4	15	
Salmon River	19.1	0.8	18.5	19.6	2	2	8.6	8.6	8.7	2	2
SF Boise River	10.6		10.6	10.6	1	1	8.1	8.1	8.1	1	1
Snake River	57.5	11.2	38.0	74.0	24		8.0	7.3	8.7	24	
Snake River, American Falls Res	47.5	2.1	44.9	50.7	8	4	8.2	7.4	8.8	29	5
Snake River, Bliss Reservoir	43.3	0.6	42.6	44.0	4	1	8.2	8.1	8.6	27	1
Snake River, Brownlee Reservoir	31.3	5.0	26.0	35.9	5	3	8.1	7.7	8.6	27	4
Snake River, C.J. Strike Res	24.2	13.9	9.1	36.4	3	1	8.4	7.7	9.3	33	1
Snake River, Gem State Res	37.4	3.1	32.5	40.7	6	6	8.1	7.9	8.4	6	6
Snake River, Lake Walcott	46.2	2.3	39.4	50.9	33	10	8.3	7.6	8.8	65	10
Snake River, Milner Lake	45.7	3.4	40.1	50.5	9	9	8.5	8.3	8.7	9	9
Snake River, Palisades Reservoir	37.3	2.9	32.9	43.1	19	7	8.0	7.3	8.5	19	7
Snake R, Upper Salmon Falls Res	40.3	6.4	29.6	46.0	5	1	8.2	8.1	8.6	13	3
Spirit Lake	1.9	0.0	1.8	1.9	4	1	6.5	6.2	8.0	22	1
St. Joe River	6.4	1.7	3.4	9.6	29	7	7.2	6.5	7.9	45	8
St. Maries River	4.3	1.2	3.3	6.0	6	1	7.3	6.6	9.8	18	4
Stone Reservoir	34.4	4.9	31.0	37.9	2	1	8.2	8.2	8.4	6	1
Upper Payette Lake	1.3	0.1	1.2	1.3	4		6.4	5.9	6.7	4	
Warm Springs Creek							7.8	7.6	8.5	2	1
Willow Creek	50.2	2.1	47.7	52.9	6	6	8.2	8.1	8.3	6	6
Wilson Creek	5.8		5.8	5.8	1	1	7.3	6.5	8.0	30	3

Appendix IC. Summary of water quality data for Montana including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Ashley Lake	33.8		33.8	33.8	1	1	8.2	7.8	8.6	39	1
Battle Creek	37.0		37.0	37.0	1	1	7.9	7.9	7.9	1	1
Beaver Creek	37.0		37.0	37.0	1	1	8.0	8.0	8.0	1	1
Beaverhead River	71.5	8.9	60.0	82.4	5	3	7.9	7.7	8.3	7	4
Big Hole River	16.1	9.2	5.4	33.8	21	5	7.5	6.6	9.5	24	5
Bighorn River	89.9	8.2	83.6	102.0	5	3	8.1	7.9	8.4	8	4
Birch Creek	29.2	30.9	5.0	103.0	13	4	7.2	6.7	9.0	18	5
Bitterroot River	14.8	8.4	8.2	25.7	5	3	6.8	6.0	7.8	9	5
Blackfoot River	28.1	6.4	19.0	35.0	6	4	7.1	6.2	8.5	9	5
Boulder River	18.9	12.5	7.0	54.0	28	5	7.0	5.5	8.6	36	7
Bull Lake	8.3	1.3	7.0	9.8	5		8.1	7.8	8.5	5	
Butte Creek	23.5		23.5	23.5	1	1	8.4	8.4	8.4	1	1
Cabinet Gorge Reservoir	24.0	0.0	24.0	24.0	2	2	8.2	8.2	8.2	2	1
Camp Creek							7.9	7.9	7.9	1	1
Canyon Ferry Reservoir	28.3	1.5	27.0	30.0	3	1					
Clark Fork Muddy Creek	83.2		83.2	83.2	1	1	8.1	8.1	8.1	1	1
Clark Fork River	33.2	5.6	28.0	41.6	7	3	7.9	7.2	8.5	13	5
Clarks Fork of Yellowstone Rv	34.9	6.7	28.8	45.7	6	2	7.5	6.7	8.9	9	4
Cooney Reservoir	38.7		38.7	38.7	1	1					
Douglas Creek	39.6		39.6	39.6	1	1	8.1	7.8	9.3	2	2
E.F. Rock Creek	21.0		21.0	21.0	1	1	6.2	6.2	6.2	1	1
Echo Lake	27.0		27.0	27.0	1	1					
Ennis Lake	21.0		21.0	21.0	1	1					
Flathead Lake	21.6	6.9	7.2	27.0	7	3	8.0	7.7	8.3	7	3
Flathead River	24.0		24.0	24.0	1	1	8.2	8.0	8.6	17	5
Fort Peck Lake	47.0		47.0	47.0	1		8.6	8.5	8.8	12	1
Fresno Reservoir	24.1	0.9	23.2	25.0	3	2					
Gallatin River	42.2	3.9	36.0	53.0	26	4	7.9	7.4	8.8	10	6
Garden Creek	45.9		45.9	45.9	1	1	8.3	8.2	8.6	2	2
Gates of the Mountain Reservoir	30.0		30.0	30.0	1	1					
Gibson Reservoir							8.1	7.9	8.3	38	2
Harrison Lake	22.0		22.0	22.0	1	1					
Hauser Lake	32.0	0.0	32.0	32.0	2	1					
Helena Valley Regulating Res	35.0		35.0	35.0	1	1					
Holter Lake	34.0		34.0	34.0	1	1					
Hungry Horse Reservoir	21.2	0.1	21.1	21.2	2	1	8.0	8.0	8.0	1	1
Jefferson River	40.5	6.8	31.8	56.8	23	3	8.2	7.8	8.9	31	6
Jocko River	37.0		37.0	37.0	1	1					
Josephine Lake							8.0	7.9	8.1	12	1
Judith River	64.2	20.6	43.2	86.6	5	3	8.0	7.8	8.3	8	5
Koocanusa Lake	33.3	4.0	28.0	40.1	24	3	7.7	7.0	8.8	275	2
Kootenai River	28.6	0.5	28.3	29.0	2	2	8.1	7.9	8.5	2	2
Lake Alva	28.0		28.0	28.0	1	1					
Lake Como	2.0				1		6.4			1	
Lake Helena	29.0		29.0	29.0	1	1					

Appendix IC (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Lake Kookanusa	30.0	1.4	29.0	31.0	2	1					
Lake McDonald, outflow	15.2	1.8	10.2	18.6	13						
Lodge Creek	35.8		35.8	35.8	1	1	9.0	9.0	9.0	1	1
Lower Twin Lake							6.5	6.4	6.6	8	1
Madison River	13.5	6.0	5.0	23.0	63	6	7.9	7.4	8.9	117	8
Marias River	49.2	2.9	41.0	52.0	12	1	7.8	7.1	8.5	12	1
Mary Ronan Lake	15.9		15.9	15.9	1	1	7.4	6.6	8.4	32	1
Milk River	43.8	14.6	23.0	67.0	25	3	8.1	7.4	8.9	29	5
Mission Lake	42.4	5.6	36.0	53.0	15		8.0	7.5	8.6	15	
Missouri River	39.8	5.3	10.0	49.5	125	9	8.2	7.3	8.9	165	9
Musselshell River	115.3	45.7	73.0	209.0	12	3	8.1	7.9	8.6	9	6
N.F. Musselshell River	64.0	5.9	57.3	69.2	4	1	8.1	8.0	8.2	4	1
Nelson Reservoir	34.0		34.0	34.0	1	1					
Nevada Creek	28.5	9.2	22.0	35.0	2	1	8.1	8.0	8.2	2	1
Norwegian Creek	50.1	17.9	34.8	69.7	3	1	7.2	7.1	7.8	3	1
Noxon Reservoir	26.0		26.0	26.0	1	1					
Painted Rocks Lake	7.0		7.0	7.0	1	1	8.0	8.0	8.0	1	1
Placid Lake	16.0		16.0	16.0	1	1					
Post Creek	32.0		32.0	32.0	1	1					
Powder River	152.8	33.1	81.9	248.0	38	5	8.0	7.3	8.8	73	6
Red Lodge Creek	53.3		53.3	53.3	1	1	7.4	7.4	7.4	1	1
Rock Creek	26.7	14.8	3.0	48.9	27	6	7.3	6.0	8.9	33	8
Ruby River	73.3	9.8	45.0	84.0	22	2	8.2	7.8	8.7	33	2
Ruby River Reservoir	53.5	4.9	50.0	57.0	2	1					
S.F. Flathead River	29.0	5.0	23.4	33.0	3	2	7.9	7.2	8.5	21	7
S.F. Sun River	31.7		31.7	31.7	1	1	8.3	8.3	8.3	1	1
Salmon Lake	17.0		17.0	17.0	1	1					
Seeley Lake	12.0		12.0	12.0	1	1					
Smith River	56.5	12.6	43.1	71.9	5	2	8.2	8.0	8.5	6	3
Soda Butte Creek	25.6	9.0	9.6	34.3	15		8.0	7.7	8.3	15	
Sophie Lake	22.0		22.0	22.0	1	1					
St Regis River	10.0	2.9	8.0	12.1	2		7.5	7.3	7.7	2	
Stoner Creek							8.1	8.0	8.3	7	2
Sullivan Creek							8.0	7.8	8.5	7	2
Sun River	59.5	10.5	44.3	74.4	9	3	8.2	7.7	8.8	57	6
Swan Creek							8.1	8.1	8.3	7	2
Swan Lake	22.0		22.0	22.0	1	1					
Tenmile Creek	35.5	21.1	6.0	58.4	7	2	7.6	7.2	8.9	7	2
Teton River	73.5	10.8	50.4	95.8	22	3	7.3	5.9	10.9	28	4
Thompson Falls Reservoir	27.0		27.0	27.0	1	1					
Thompson Lake, inflow	19.0	6.5	13.0	26.0	4		8.3	8.2	8.4	4	
Tiber Reservoir	43.0	0.0	43.0	43.0	2	1	8.2	7.5	8.5	117	1
Tongue River	53.0	9.8	31.0	68.0	34	6	2.1	0.4	8.9	45	7
Tongue River Reservior	46.9	1.5	45.0	50.0	9	1	7.4	6.7	8.1	27	1
Upper Marsh Creek, Flaming Gorge Reservoir inflow	25.0		25.0	25.0	1	1					

Appendix I - Table C (continued).

Water Body	Dissolved Calcium (mg/L) Mean	SD	Min	Max	*n*	# yrs	pH Mean	Min	Max	*n*	# yrs
Upper Twin Lake							6.4	6.0	6.7	15	1
W.F. Clearwater River	11.7	3.1	9.5	13.9	2	1	7.4	7.3	7.6	2	1
W.F. Gallatin River							7.6	7.3	8.1	13	3
Whitefish Lake	23.0	0.1	23.0	23.1	2	1	7.6	7.1	8.4	106	1
Willow Creek	29.4	58.5	2.0	303.0	33	3	7.0	6.3	8.6	31	3
Yellowstone River	26.8	18.0	8.1	61.9	28	6	8.1	7.5	9.0	53	7

Appendix I - Table D: Summary of water quality data for Nevada including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

Water Body	Dissolved Calcium (mg/L) Mean	SD	Min	Max	*n*	# yrs	pH Mean	Min	Max	*n*	# yrs
Bassett Lake							8.5	8.5	8.5	1	1
Big Spring Reservoir	60.8	10.4	46.6	78.0	7	5	7.6	7.0	8.1	7	5
Bilk Creek Reservoir	20.8	3.8	17.0	26.0	4	4	8.0	7.4	10.3	8	4
Bruneau River, West	27.9	8.3	18.0	38.0	9	7	8.3	8.0	8.8	13	11
Carson Lake	50.0	18.5	30.0	96.0	18	4	8.1	7.6	9.1	37	6
Carson River	24.6	14.1	8.0	56.0	36	7	8.1	7.5	8.8	88	8
Carson River, East	14.4	7.7	6.3	32.0	21	7					
Carson River, West	25.2	11.2	15.0	46.0	7	7					
Catnip Reservoir							9.3	9.3	9.3	1	1
Cave Lake	43.6	7.1	36.4	50.5	3	3	8.4	8.3	8.7	5	4
Chimney Reservoir							8.4	8.2	8.5	3	1
Cold Springs Reservoir	26.0	7.1	21.0	31.0	2	2	9.0	8.7	9.3	4	2
Colorado River	65.9	1.4	64.0	69.0	12	2	7.8	7.5	8.0	12	2
Comins Reservoir	25.4	12.9	10.7	46.0	8	6	8.8	8.4	10.2	15	7
Dacey Reservoir	25.0		25.0	25.0	1	1	8.1	7.8	8.6	3	2
Eagle Valley Reservoir	50.5	2.1	49.0	52.0	2	2	8.2	7.8	8.7	5	2
Echo Canyon Reservoir	21.0	12.7	7.0	40.0	6	5	8.7	8.3	10.4	9	5
Hay Meadows Reservoir	38.0	17.0	26.0	50.0	2	2	8.5	8.4	8.7	4	2
Hobart Creek Reservoir							8.5	8.5	8.5	1	1
Humboldt Lake	123	99.6	37.6	390	11	7	7.8	7.5	8.9	11	7
Illipah Creek Reservoir	24.7	17.6	14.1	45.0	3	3	8.6	8.3	9.2	4	3
Knott Creek Reservoir	14.2	4.5	5.0	18.0	11	2	8.1	7.5	8.8	12	3
Lahontan Reservoir	23.9	4.9	19.0	43.0	31	11	7.8	6.9	9.7	249	15
Lake Mead	87.6	13.5	50.0	169	516	32	7.7	7.4	8.5	120	4
Lake Tahoe							8.0	7.3	9.6	9	6
Little Washoe Lake	44.7	1.5	43.0	46.0	3	2	8.5	8.3	9.0	27	5
Marlette Lake							8.0	7.8	8.4	2	2
Mary's River	38.4	7.6	20.0	45.0	16	9	8.2	7.7	8.7	39	16
Nesbitt Lake							8.7	8.7	8.7	1	1
Onion Valley Reservoir							8.4	8.4	8.4	1	1
Owyhee River	27.6	4.8	20.0	35.1	19	8	8.4	8.0	9.0	26	11
Owyhee River, East	34.6	4.3	26.0	39.0	9	7	8.4	7.8	9.0	13	11
Owyhee River, South	31.0	14.5	15.0	52.0	5	4	8.4	7.9	8.7	9	8

Appendix I - Table D (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Pyramid Lake	77.0		77.0	77.0	1	1	7.2	7.2	7.2	1	1
Ruby Lake Marsh	39.4		39.4	39.4	1	1	8.0	8.0	8.0	1	1
Rye Patch Reservoir	40.7	3.6	35.5	49.0	17	6	8.5	8.3	8.8	40	10
Sheckler Reservoir	27.0	3.5	23.0	29.0	3	2	8.7	8.6	9.0	5	3
South Fork Reservoir	27.3	3.4	21.0	33.0	16	10	8.4	7.9	9.0	63	14
Sparks Marina	76.7	18.6	49.0	105	7	3	7.7	7.1	8.3	22	4
Spooner Lake							8.3	8.3	8.3	1	1
Stillwater Point Reservoir	44.4	6.9	29.0	55.0	11	3	8.2	7.7	10.0	29	6
Summit Lake	8.2	2.7	6.1	13.0	7	5	7.6	7.2	8.1	7	5
Topaz Lake	12.0	2.6	8.6	16.0	21	13	8.0	6.5	9.4	72	20
Topaz Reservoir	26.5	36.5	8.6	91.7	5	5	7.2	6.9	14.0	2	2
Upper Pahranagat Lake							7.7	7.5	7.9	4	3
Virgin River	290	159	52.0	570	25	17	8.1	7.5	8.5	37	10
Virginia Lake	10.0	0.0	10.0	10.0	3	2	7.4	6.9	8.5	4	2
Walker Lake	11.8	9.5	0.0	47.0	171	18	9.0	7.5	9.8	262	19
Walker River	18.0	5.4	9.0	30.0	20	7	8.2	7.5	8.6	81	14
Walker River, East	19.3	6.1	10.7	30.0	17	7	8.1	7.0	8.7	83	14
Walker River, West	13.8	5.2	1.0	24.0	17	7	8.2	7.4	8.7	85	14
Washoe Lake	45.0	0.0	45.0	45.0	4	1	8.6	8.1	9.0	49	4
Weber Reservoir	29.3	12.3	20.6	38.0	2	2	8.1	7.8	8.7	3	3
Wild Horse Reservoir	22.2	2.0	18.9	26.0	13	9	8.3	7.5	11.4	59	16
Wilson Reservoir							8.8	8.5	9.5	4	2

Appendix I - Table E. Summary of water quality data for Oregon including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Agate Reservoir	11.2	1.5	10.3	12.9	3	2	7.3	6.6	8.8	7	3
Agency Lake	7.0		7.0	7.0	1	1	7.5	6.8	9.6	10	5
Antelope Flat Reservoir	13.6		13.6	13.6	1	1					
Antelope Reservoir	9.3		9.3	9.3	1	1	8.0	8.0	8.0	1	1
Applegate Reservoir	18.1	7.8	8.5	29.0	11	4	7.8	7.3	8.6	30	5
Beulah Reservoir	12.8	3.1	10.6	15.0	2	2	7.9	7.8	8.1	5	3
Blue Lake	13.3	1.1	12.5	14.0	2	2	7.1	6.9	7.7	2	2
Blue River Reservoir	3.2	0.3	2.9	3.4	3	2	7.5	7.4	7.6	2	2
Buckeye Lake	19.2		19.2	19.2	1	1					
Bully Creek Reservoir	41.7	16.8	24.3	66.0	6	3	7.8	7.1	8.8	8	3
Chickahominy Reservoir	8.1		8.1	8.1	1	1	7.7	7.7	7.7	1	1
Clear Lake	2.1		2.1	2.1	1	1	7.0	7.0	7.0	1	1
Cliff Lake	9.9		9.9	9.9	1	1					
Cold Springs Reservoir	13.2	0.4	12.9	13.6	3	2	7.4	7.0	8.7	3	2
Columbia River, Lake Celilo	17.0	0.5	16.3	17.3	3	1	8.1	8.1	8.1	7	1
Columbia River, Lake Umatilla	17.8	1.3	16.9	19.7	4	1					
Columbia River, Lake Wallula	17.4		17.4	17.4	1	1					
Cottage Grove Lake	6.4		6.4	6.4	1	1	6.8	6.5	7.7	2	2
Cottonwood Reservoir	7.8		7.8	7.8	1	1	7.8	7.8	7.8	1	1
Cougar Reservoir	3.5	0.5	2.6	3.8	5	2	6.8	6.6	7.9	5	2
Craine Praire Reservoir	2.2		2.2	2.2	1	1	9.8	9.8	9.8	1	1
Crescent Lake	2.4	0.1	2.3	2.4	2	1	7.2	7.0	7.6	2	1
Crooked River	24.3	4.9	21.0	30.0	3		7.9	7.7	8.1	3	
Cultus Lake	2.0		2.0	2.0	1	1	7.5	7.5	7.5	1	1
Davis Lake	3.3	0.2	3.1	3.4	2	1	7.9	7.6	8.7	2	1
Delintment Lake	10.6		10.6	10.6	1	1	8.0	8.0	8.0	1	1
Deschutes River	6.9	1.5	4.0	8.0	9	1	7.9	7.4	8.4	9	
Deschutes River	6.1	1.5	4.0	8.0	9		7.9	7.4	8.4	9	
Detroit Lake	3.5	0.1	3.4	3.5	2	2	7.5	6.9	8.2	24	2
Devils Lake	2.4	2.0	1.0	4.7	3	2	7.8	7.5	8.9	2	1
Dexter Lake	4.7		4.7	4.7	1	1	7.6	7.6	7.6	1	1
Diamond Lake	2.5	0.2	2.3	2.6	3	2	7.4	7.1	9.5	3	2
Dorena Reservoir	6.9	1.9	5.5	8.2	2	2	7.6	7.2	8.1	4	4
East Lake	25.5	0.8	23.4	27.0	26	7	7.3	6.6	8.3	26	7
Eel Lake	3.6		3.6	3.6	1	1	7.4	7.4	7.4	1	1
Elk Lake	2.2	0.0	2.2	2.2	2	2	7.9	7.7	8.6	2	2
Emigrant Lake	12.6	0.3	12.3	12.8	3	2	7.0	6.6	7.9	3	2
Fall Creek Reservoir	4.1	0.4	3.7	4.5	3	2	7.6	7.3	7.9	3	2
Fern Ridge Reservoir	5.2		5.2	5.2	1	1	7.8	7.8	7.8	1	1
Fish Lake	5.5	2.9	3.5	7.5	2	2	7.2	7.2	7.2	1	1
Foster Reservoir	4.4		4.4	4.4	1	1	7.2	7.2	7.2	1	1
Fourmile Lake	1.5		1.5	1.5	1	1	6.2	6.2	6.2	1	1
Gerber Reservoir	4.8		4.8	4.8	1	1	7.3	7.3	7.3	1	1

Appendix I - Table E (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Gold Lake	3.2		3.2	3.2	1	1	7.3	7.3	7.3	1	1
Goose Lake	4.9		4.9	4.9	1	1	9.3	9.3	9.3	1	1
Green Peter Lake/ Reservoir	4.0		4.0	4.0	1	1	7.3	7.3	7.3	1	1
Harney Lake	15.0	0.8	14.0	16.0	4		8.9	8.8	9.1	4	
Harney Lake	15.0	0.8	14.0	16.0	4		8.9	8.8	9.1	4	
Hart Lake	17.2		17.2	17.2	1	1	8.0	8.0	8.0	1	1
Haystack Reservoir	4.6		4.6	4.6	1	1	7.2	7.2	7.2	1	1
Hemlock Lake	4.9		4.9	4.9	1	1					
Henry Hagg Lake	5.6	0.6	5.0	6.2	5	3	7.1	6.6	8.6	5	3
Hills Creek Lake/ Reservoir	5.3		5.3	5.3	1	1	8.1	8.1	8.1	1	1
Hosmer Lake	1.2		1.2	1.2	1	1	7.1	7.1	7.1	1	1
Howard Praire Lake	6.9	0.5	6.4	7.3	3	2	7.6	7.2	8.6	3	2
Hyatt Reservoir	10.0	1.0	9.4	11.4	4	2	7.3	7.1	8.3	3	2
John Day River	17.3	0.3	17.0	17.6	3	1	7.8	7.2	8.8	29	1
Klamath Lake	7.3	0.9	6.5	9.0	6	4	7.6	7.2	9.1	6	4
Lake Billy Chinook	11.0	1.5	9.9	12.0	2	1	9.0	8.8	9.4	2	1
Lake of the Woods	2.5	0.3	2.2	2.8	3	2	7.1	7.0	7.4	3	2
Lake Oswego	10.0				1		7.8			1	
Lava Lake	2.1		2.1	2.1	1	1	7.9	7.9	7.9	1	1
Lemolo Lake	3.5	0.2	3.3	3.6	2	2	7.5	7.2	9.5	16	5
Lookout Point Lake	4.5	0.4	4.2	4.9	3	2	7.4	7.0	8.0	3	2
Loon Lake	4.2	0.7	3.4	4.6	3	2	7.0	7.0	7.0	2	2
Lost Creek Lake/ Reservoir	5.0	1.1	4.2	5.7	2	2	7.3	7.1	7.7	2	2
Magone Lake	14.0		14.0	14.0	1	1	8.7	8.7	8.7	1	1
Malheur Reservoir	44.6	4.7	41.0	49.9	3	3	8.4	8.1	9.1	3	3
Malheur River	39.6	0.7	39.1	40.1	2	1	8.4	8.3	8.4	4	1
Mann Lake	24.3		24.3	24.3	1	1	8.7	8.7	8.7	1	1
McKay Reservoir	9.0	2.2	6.4	12.2	6	3	7.8	7.5	8.8	2	2
Mercer Lake	3.0	0.0	3.0	3.0	2	2	7.9	7.6	8.7	2	2
Miller Lake	2.1		2.1	2.1	1	1	7.2	7.2	7.2	1	1
Morgan Lake	6.4		6.4	6.4	1	1	8.1	8.1	8.1	1	1
Munsel Lake	2.1	0.1	2.0	2.2	2	2	7.0	7.0	7.1	2	2
North Fork Reservoir	5.7	0.4	5.4	5.9	2	2	7.5	7.2	7.8	3	2
North Tenmile Lake	3.4		3.4	3.4	1	1	7.1	7.1	7.1	1	1
North Twin Lake	9.7		9.7	9.7	1	1	8.2	8.2	8.2	1	1
Ochoco Reservoir	20.1		20.1	20.1	1	1	8.4	8.4	8.4	1	1
Odell Lake	3.0	0.2	2.8	3.1	2	1	7.8	7.5	9.3	2	1
Olallie Lake	0.5	0.1	0.4	0.5	2	2					
Owyhee Reservoir	17.3	3.6	12.6	21.5	4	2	7.4	7.0	8.4	3	2
Owyhee Reservoir outflow	39.0	32.5	16.0	62.0	2	2	7.7	7.5	8.0	2	2
Owyhee River	43.0	17.2	12.0	79.0	32	9	8.0	7.6	8.6	30	9
Paulina Lake	28.0	1.6	21.0	29.0	29	7	8.3	7.8	8.9	28	7
Penland Lake	6.1		6.1	6.1	1	1	8.0	8.0	8.0	1	1
Phillips Lake	8.9		8.9	8.9	1	1	8.2	8.2	8.2	1	1

Appendix I - Table E (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Pine Hollow Reservoir	4.5		4.5	4.5	1	1					
Platt 1 Reservoir	14.3		14.3	14.3	1	1	7.3	7.0	8.7	2	2
Powder River	25.2	8.4	16.0	38.0	9		7.7	6.8	8.2	9	
Prineville Reservoir	17.5	1.3	16.4	19.2	4	2	7.4	6.8	8.4	4	2
Prineville Reservoir inflow	49.3	2.2	47.0	52.0	4	3	8.1	7.7	8.8	4	3
Rock Creek Reservoir	8.9		8.9	8.9	1	1	7.4	7.4	7.4	1	1
Sandy River	4.3	1.0	3.0	5.5	13		7.0	6.3	7.5	13	
Sandy River	4.3	1.0	3.0	5.5	13		7.0	6.3	7.5	13	
Selmac Lake	4.7		4.7	4.7	1	1	7.5	7.5	7.5	1	1
Sheep Corral Reservoir							9.7	9.7	9.7	1	1
Siltcoos Lake	3.4	1.1	2.7	4.7	3	3	7.5	7.2	8.3	3	3
Simtustus Lake	10.4		10.4	10.4	1	1	8.9	8.9	8.9	1	1
Smith Lake	4.2		4.2	4.2	1	1	7.2	7.2	7.2	1	1
Snake River, Hells Canyon Reservoir	31.0		31.0	31.0	1	1	8.2	8.0	8.6	2	1
South Twin Lake	6.7		6.7	6.7	1	1	8.3	8.3	8.3	1	1
Sparks Lake	1.4	0.3	1.0	1.7	5	2	7.0	6.5	7.7	5	2
Summit Lake	0.1		0.1	0.1	1	1	6.7	6.7	6.7	1	1
Suttle Lake	4.0	0.1	3.9	4.0	2	1	8.1	7.9	8.4	2	1
Tahkenitch Lake	3.0	0.5	2.5	3.6	5	4	7.0	6.8	7.3	4	4
Tenmile Lake	5.1	2.6	3.2	6.9	2	2	7.3	7.1	7.5	2	2
Thief Valley Reservoir	15.6	2.3	13.9	18.3	3	2	7.3	7.1	8.4	3	2
Thompson Valley Reservoir	4.4		4.4	4.4	1	1	7.6	7.6	7.6	1	1
Timothy Lake	4.5	0.3	4.1	4.9	4	2	7.6	6.9	8.3	11	4
Triangle Lake	2.4		2.4	2.4	1	1	7.0	7.0	7.0	1	1
Umatilla River	34.6	0.1	34.6	34.7	2	1					
Unity Reservoir	17.1		17.1	17.1	1	1	9.6	9.6	9.6	1	1
Upper Cow Lake	13.8		13.8	13.8	1	1	7.8	7.8	7.8	1	1
Wallowa Lake	14.0	1.8	12.7	15.3	2	1	8.1	8.0	8.2	2	1
Walton Lake	11.2		11.2	11.2	1	1	8.3	8.3	8.3	1	1
Warm Springs Reservoir	56.0	50.9	20.0	92.0	2	2	8.1	7.9	8.2	3	2
White River	5.1				1		7.4			1	
Wickiup Reservoir	3.5		3.5	3.5	1	1	7.6	7.6	7.6	1	1
Willamette River	8.0	1.4	4.9	9.7	12		7.1	6.6	8	12	
Willow Lake/ Reservoir	4.8		4.8	4.8	1	1	7.7	7.7	7.7	1	1
Willow Valley Reservoir	5.5		5.5	5.5	1	1	7.2	7.2	7.2	1	1
Woahink Lake	1.9	0.3	1.7	2.1	2	2	7.1	6.9	7.5	2	2
Wolf Creek Reservoir	4.4		4.4	4.4	1	1	8.0	8.0	8.0	1	1

Appendix I - Table F: Summary of water quality data for Utah including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Big Sand Wash Reservoir	27.9	12.7	11.0	58.0	41	10	8.0	7.2	8.6	43	10
Currant Creek Reservoir							8.4	8.2	8.5	5	1
Deer Creek Reservoir	46.0	6.6	36.0	57.0	12	3	7.5	7.2	8.2	7	3
East Canyon Reservoir	69.0	9.4	50.0	79.0	8	2	8.3	8.1	8.6	7	2
Echo Reservoir	58.3	9.3	44.0	74.0	9	2	8.2	7.9	8.5	9	2
Electric Lake							8.5	8.5	8.5	1	1
Enterprise Reservoir	38.0		38.0	38.0	1	1	8.6	8.6	8.6	1	1
Fish Lake	12.0		12.0	12.0	1	1	8.4	8.4	8.4	1	1
Flaming Gorge Reservoir	65.6	6.9	43.0	80.0	101	4	8.1	7.4	9.1	100	4
Forsyth Reservoir	21.5	2.3	18.0	24.0	6	2	7.9	7.6	8.5	6	2
Goshen Reservoir							8.4	8.2	8.5	5	1
Great Salt Lake	267.7	67.2	140.0	343.0	18	2	7.6	7.4	7.8	10	1
Gunlock Reservoir	46.9	2.8	44.7	50.0	3	3	8.0	7.8	8.5	3	3
Gunnison Reservoir	94.2	4.3	91.0	99.0	3	2	8.1	8.0	8.1	3	2
Huntington North Reservoir	49.7	11.5	33.0	68.0	7	3	8.3	8.0	8.6	7	3
Huntington Reservoir	45.9	4.5	38.0	55.0	16	5	8.2	7.5	8.7	17	5
Hyrum Reservoir	48.3	9.3	33.0	68.0	15	5	7.9	7.4	8.5	15	5
Joes Valley Reservoir	42.7	8.9	27.0	58.0	11	3	7.9	7.6	8.5	11	3
Johnson Valley Reservoir	18.0	0.0	18.0	18.0	2	2	7.6	7.5	7.7	2	2
Kolob Reservoir	82.0		82.0	82.0	1	1	8.3	8.3	8.3	1	1
Lost Creek Reservoir	58.8	8.9	39.0	70.0	11	2	8.0	7.6	8.5	11	2
Moon Lake	3.9	1.7	1.9	7.2	9	3	6.9	6.5	8.3	9	3
Newton Reservoir	55.0	12.3	46.0	69.0	3	2	8.0	7.8	8.4	4	3
Otter Creek Reservoir	37.0		37.0	37.0	1	1	8.4	8.2	8.9	2	2
Panguitch Lake	38.5	11.4	26.7	54.0	5	2	8.4	8.1	8.8	5	2
Pelican Lake	38.6	16.0	15.0	78.0	41	6	8.4	7.6	9.7	45	6
Pineview Reservoir	37.0	7.4	27.0	43.0	4	3	8.0	7.9	8.3	4	3
Piute Reservoir	44.1	2.5	38.0	48.0	26	6	8.2	7.7	8.7	26	6
Porcupine Reservoir	74.0	26.9	55.0	93.0	2	1	8.1	8.0	8.3	2	1
Quail Creek Reservoir	83.0		83.0	83.0	1	1	8.2	8.2	8.2	1	1
Red Fleet Reservoir	32.4		32.4	32.4	1	1	8.2	7.6	8.8	16	5
Rockport/Wanship Reservoir	49.4	9.2	32.0	60.0	11	4	8.2	7.8	8.8	11	4
Scofield Reservoir	57.9	5.6	52.0	67.0	7	3	8.2	8.1	8.4	10	3
Soldier Creek Reservoir	71.0	64.9	32.0	210.0	8	4	8.2	8.1	8.4	5	3
Starvation Reservoir	57.9	10.7	40.7	79.0	21	6	8.2	8.1	8.5	20	6
Steinaker Reservoir	34.8	3.5	26.4	39.0	9	2	7.8	7.3	8.4	9	2
Strawberry Reservoir	48.4	13.5	32.0	81.0	16	6	8.0	7.3	8.6	15	5
Upper Stillwater Reservoir	2.6		2.6	2.6	1	1	7.8	7.8	7.8	1	1
Utah Lake	76.1	14.6	53.6	96.0	7	2	8.1	7.7	8.3	6	2
Whitney Reservoir	42.0	21.2	27.0	57.0	2	2	8.0	8.0	8.1	2	2

Appendix I - Table G. Summary of water quality data for Washington including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Abernathy Creek							7.3	6.9	7.7	43	4
Ahtanum Creek							7.9	7.9	7.9	1	1
Alder Lake	5.1	0.4	4.9	5.4	2	1					
Alder Reservoir							7.5	7.1	8.0	21	1
Alkali Flat Creek							8.3	7.7	9.2	22	2
Almota Creek							8.1	7.9	8.4	12	2
Banks Lake	17.8	0.2	17.5	18.3	8	1	7.9	7.3	8.4	12	1
Bertrand Creek							7.3	7.3	7.4	6	2
Big Beef Creek							7.3	6.7	7.8	20	4
Billy Clapp Lake	17.9	0.4	17.6	18.1	2	1					
Black Lake	3.8	0.1	3.8	3.9	2	1					
Black River							7.1	7.1	7.1	1	1
Blue Lake	15.6	1.0	14.7	16.9	4	1	8.0	7.4	9.0	20	1
Bonaparte Creek							8.5	8.3	8.7	12	1
Buffalo Lake	12.5	0.7	12.0	13.0	2		8.6	8.1	9.0	2	
Bumping Reservoir	3.8	0.7	3.3	4.3	2	2	7.5	7.5	7.6	3	2
Burnt Bridge Creek							7.9	7.7	8.1	8	2
Cedar River							7.6	6.9	9.0	45	4
Chehalis River							7.6	7.2	8.2	45	4
Chewuch River							8.0	7.5	8.3	7	2
Chico Creek							7.1	6.9	7.6	7	2
Cle Elum Reservoir	4.7	0.2	4.5	4.9	5	3	7.1	6.8	7.4	4	3
Cle Elum River	4.7	0.1	4.6	4.7	2	2	7.5	7.4	7.7	2	2
Clear Creek							7.6	7.4	7.8	7	2
Clear Lake	16.4	1.1	14.8	18.1	5	1	8.5	7.9	8.8	10	1
Coldwater Lake	40.3	8.3	31.0	47.0	3		6.9	6.7	7.0	3	
Columbia Rv inflow, Colockum Ck							7.9	7.8	8.0	2	1
Columbia Rv inflow, Rock Is Ck							8.0	8.0	8.1	2	1
Columbia Rv inflow, Salmon Ck							7.1	7.0	7.3	3	1
Columbia River, below Bonneville							8.1	8.0	8.2	7	2
Columbia Rv, FD Roosevelt Lake	20.9	4.1	15.5	29.6	33	4	7.9	7.0	8.6	170	10
Columbia River, Hanford Reach	17.1	1.8	13.4	20.1	29	10	8.1	7.6	8.6	49	10
Columbia River, Lake Bonneville	16.5	0.0	16.5	16.5	2	1					
Columbia River, Lake Celilo	16.8		16.8	16.8	1	1					
Columbia River, Lake Umatilla							8.1	7.9	8.5	21	4
Columbia River, Lake Wallula	18.6	2.8	13.4	24.5	34	11	7.9	7.4	8.6	48	11
Columbia River, Lake Wanapum	18.1	2.2	14.7	23.1	13	5	8.0	7.6	8.7	13	5
Columbia River, Rock Island Res							7.9	7.8	8.3	6	2
Columbia Rv, Rufus Woods Lake							8.1	7.8	8.4	21	4
Colville River							8.4	7.8	8.9	21	4
Cowiche Creek							8.1	7.8	8.8	7	2
Cowlitz River	8.1	0.0	8.1	8.1	2	1	7.5	7.1	7.9	29	4
Cowlitz River	6.3	1.0	4.6	7.9	14		7.2	6.9	7.4	14	
Crab Creek							8.4	8.2	8.6	22	4
Deep Creek							7.1	6.7	7.4	20	4

Appendix I - Table G (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Deer Lake	9.3	0.3	9.1	9.6	2	1					
Deer Lake	8.2	0.2	8.0	8.3	2		7.5	7.2	7.8	2	
Deschutes River							7.5	7.2	7.7	22	4
Dewatto River							7.4	7.4	7.6	7	2
Diamond Lake	8.0	0.1	8.0	8.1	2	1					
Diamond Lake	6.9	0.3	6.7	7.1	2		7.9	7.8	8.0	2	
Dry Creek							8.2	7.8	8.5	7	2
Duckabush River							7.0	6.4	7.5	20	4
Dungeness River							7.0	6.8	7.4	7	2
E.F. Lewis River							7.6	7.1	8.1	22	4
East Twin Reservoir							7.2	6.6	7.8	20	4
Elochoman River							7.5	7.5	7.5	1	1
Elwha River							7.2	6.5	7.7	19	4
Entiat River							7.9	7.3	8.8	22	4
Entiat River	9.7	3.4	4.2	14.0	19		7.3	6.9	8.0	14	
Fauntleroy Creek							8.2	8.1	8.3	7	2
Fishtrap Creek							7.5	7.4	7.7	7	2
Foster Creek							8.8	8.6	9.0	5	1
Germany Creek							7.4	7.2	7.9	22	4
Grays River	4.3	0.9	2.9	6.0	15		7.2	6.8	7.5	15	
Green River							7.4	7.0	7.9	44	4
Hangman Creek							8.2	7.8	9.4	21	4
Hawk Creek							8.2	8.2	8.2	1	1
Hoh River							7.0	6.5	7.4	20	4
Horsetheif Lake	16.2		16.2	16.2	1	1					
Humptulips River							6.9	6.4	8.0	20	4
Joe's Creek							8.1	8.0	8.3	7	2
Johns Creek							7.2	7.2	7.2	1	1
Kachess Reservoir	6.1	0.3	5.9	6.3	2	2	7.5	7.5	7.6	2	2
Kachess River	6.2	0.2	6.0	6.3	2	2	7.5	7.5	7.6	2	2
Kalama River							7.6	7.0	8.3	22	4
Keechelus Reservoir	4.1	0.0	4.1	4.1	2	1	7.4	7.4	7.4	2	1
Kettle River							8.1	7.3	8.8	21	4
Lacamas Creek							7.4	7.1	7.8	7	2
Lake Chelan	6.9	0.5	6.4	7.3	4		7.7	7.3	8.2	4	
Lake Cresent	15.9	0.2	15.7	16.1	4	1	6.9	6.8	7.1	4	1
Lake Cresent inflow											
Lake Cushman inflow	14.2	1.7	11.0	16.5	7	2	7.6	6.9	8.0	29	7
Lake Cushman outflow	8.9	0.7	8.5	9.4	2	1	7.5	7.5	7.5	2	1
Lake Ozette outflow							6.8	6.1	7.8	38	5
Lake Sammamish inflow							7.7	7.4	8.0	9	3
Lake Tapps tailrace							7.3	7.1	7.6	7	2
Lake Wahington inflow	18.8	4.2	12.7	25.4	6	1	7.8	7.3	8.6	87	9
Lake Wenatchee	7.0	6.2	2.3	14.0	3		7.3	7.2	7.4	3	
Leach Creek							7.6	7.4	7.8	7	2

Appendix I - Table G (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Liberty Lake	3.9	0.3	3.7	4.1	2		7.5	7.2	7.8	2	
Little Almota Creek							8.5	8.4	8.7	7	2
Little Anderson Creek							7.4	7.2	7.9	20	4
Little Klickitat River							8.3	7.7	9.3	12	2
Little Penewawa Creek							8.4	8.3	8.6	7	2
Little Spokane River							8.0	7.5	8.5	21	4
Little Washougal Creek							7.6	7.4	8.3	7	2
Little Wenatchee River							7.3	7.1	7.4	6	2
Long Lake inflow							7.1	7.0	7.2	4	1
Loon Lake	19.4	0.0	19.4	19.4	2	1					
Lower Crab Creek	33.9	6.3	22.3	44.3	98	9	8.3	7.9	8.9	100	9
M.F. Nooksack River							7.7	7.5	7.8	7	2
Methow River	21.5	3.7	17.9	28.6	7	3	8.0	7.0	8.6	54	7
Mill Creek							7.1	6.7	7.5	42	4
Miller Creek							8.1	7.8	8.6	7	2
Mineral Lake outflow	5.8		5.8	5.8	1	1	7.6	7.6	7.6	1	1
Missouri Flat Creek							7.9	7.5	8.8	7	2
Moses Lake	25.8	2.8	21.6	35.5	31	10	8.4	8.0	9.1	31	10
Moses Lake inflow	35.2	9.8	19.6	73.5	49	10	7.9	7.6	8.5	49	10
Moxee Drain							8.3	8.1	8.7	7	2
Mud Flat Creek							8.2	8.1	8.6	7	2
N.F. Stillaguamish River							7.5	6.8	9.0	44	4
Naches River							8.0	8.0	8.0	1	1
Naselle River							7.4	7.0	7.9	22	4
Nason Creek							7.1	6.9	7.3	6	1
Newman Lake	4.8	0.2	4.6	4.9	2		7.8	7.8	7.8	2	
Nisqually River							7.6	7.4	7.8	22	4
Nooksack River	12.0		12.0	12.0	1	1	7.6	7.2	10.6	61	5
North Creek							8.3	8.3	8.3	1	1
North Fork Sauk River	4.3		4.3	4.3	1	1	7.4	7.4	7.4	1	1
North Twin Lake	7.2	0.6	6.7	7.6	2		7.1	7.0	7.1	2	
Okanogan River							8.3	7.9	8.9	42	4
Olequa Creek							7.7	7.2	8.0	7	2
Omak Lake	3.5	0.1	3.4	3.5	2		9.6	9.5	9.6	2	
Palmer Lake	36.0	2.3	34.0	38.0	4		8.4	8.2	8.4	4	
Palouse River							8.0	7.0	9.7	43	4
Palouse River	8.5	3.1	4.5	14.0	16		7.4	7.0	8.1	16	
Paradise Creek							8.0	7.6	9.3	16	3
Pataha Creek							8.4	8.4	8.4	1	1
Pearrygin Lake	41.5	10.6	34.0	49.0	2		8.4	8.1	8.6	2	
Pend Oreille River							8.4	7.8	9.0	41	4
Penewawa Creek							8.3	7.9	8.8	21	2
Pilchuck River							7.5	7.3	8.2	14	2
Potholes Reservoir outflow	28.3	4.1	20.6	41.9	54	10	8.1	7.7	8.6	68	10
Priest Rapids Lake, outflow	20.9	1.4	19.0	24.0	16		7.7	7.5	7.9	16	

Appendix I - Table G (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Puyallup River							7.4	7.2	7.8	21	4
Rattlesnake Creek							7.9	7.8	7.9	7	2
Riffe Reservoir	5.4	0.3	5.2	5.6	2	1	7.4	7.2	7.7	38	1
Rimrock Reservoir	7.1		7.1	7.1	1	1	7.4	7.4	7.4	1	1
Rimrock Reservoir inflow	7.7		7.7	7.7	1	1	7.8	7.8	7.8	1	1
Rolland Lake	15.6		15.6	15.6	1	1					
S.F. Nooksack River							7.8	7.6	8.1	7	2
S.F. Palouse River							8.0	7.7	9.0	36	4
S.F. Snoqualmie River							7.4	7.1	7.5	7	2
S.F. Stillaguamish River							7.4	7.0	8.1	44	4
Samish Lake inflow											
Samish River							7.6	7.2	8.0	22	4
Sammamish Rv, Lk Washington							7.4	7.0	8.0	10	2
Seabeck Creek							7.2	6.8	7.5	20	4
Silver Lake	10.4	8.4	4.3	20.3	5	1	7.5	7.2	7.9	6	1
Similkameen River							7.8	7.2	8.5	21	4
Skagit River							7.5	7.0	8.1	43	4
Skagit River	7.8	1.4	6.0	10.0	15		7.4	6.9	8.0	15	
Skokomish River							7.0	6.6	7.4	20	4
Skookumchuck River	5.7		5.7	5.7	1	1	6.7	6.7	6.7	1	1
Skykomish River							7.2	6.8	7.6	22	4
Snake River, Lk Herbert G. West							8.0	8.0	8.1	2	1
Snake River, Lake Sacajawea							7.6	7.6	7.6	1	1
Snake River, Lake Wallula	13.6	3.6	7.4	23.3	17	2	8.0	7.6	8.5	38	6
Snake River, Lower Granite Res							8.3	7.9	8.6	25	5
Snohomish River							7.2	6.8	7.4	22	4
Snoqualmie River							7.2	6.7	7.5	44	4
Snoqualmie Rv inflow, Cherry Ck							7.3	7.1	7.6	4	1
Soap Lake	1.6	0.1	1.5	1.6	2		9.6	9.5	9.7	2	
South Twin Lake	13.0	0.0	13.0	13.0	2		7.5	7.4	7.5	2	
Spanaway Creek							7.5	7.5	7.5	1	1
Spectacle Lake	37.8	4.6	31.0	41.0	4		8.8	8.1	9.4	4	
Spirit Lake	5.3	2.0	3.5	7.4	3		6.9	6.4	7.2	3	
Spokane River	10.2	7.0	4.6	29.0	99	7	7.7	6.9	8.7	211	9
Spokane River inflow	35.3	16.9	7.9	49.0	6	1	8.4	8.4	8.5	3	1
Sprague Lake	31.8	2.2	29.0	34.0	4		8.7	8.2	9.1	4	
Stavis Creek							7.3	6.7	7.8	20	4
Steptoe Creek							8.3	8.0	8.8	18	2
Stillaguamish River							7.4	7.0	8.1	22	4
Sulphur Creek							8.4	8.1	8.8	6	2
Swift Creek Reservoir	3.9	0.4	3.6	4.2	2	1	7.4	7.1	7.7	34	1
Tahuya River							7.2	7.0	7.3	7	2
Tarboo Creek							7.5	7.4	7.5	5	1
Tieton Rv, Rim Rock Res outflow	7.0		7.0	7.0	1	1	7.6	7.6	7.6	1	1
Touchet River							7.7	7.7	7.7	1	1

Appendix I - Table G (continued).

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Touchet River	10.8	4.6	6.0	27.0	17		7.6	7.0	8.3	17	
Tucannon River							8.1	7.7	9.1	22	4
Twisp River							8.3	8.3	8.3	1	1
Waitts Lake	30.2	0.7	29.5	30.8	3	1	7.4	7.0	8.6	22	1
Walker Creek							8.1	8.1	8.1	1	1
Walla Walla River							8.1	7.7	9.2	22	4
Wannacut Lake	225	7.1	220	230	2		8.3	8.2	8.3	2	
Washougal River							7.6	7.2	8.0	7	2
Wawawai Creek							8.4	8.3	8.5	7	2
Wenatchee River	4.7	2.5	2.5	8.9	5	4	7.6	7.1	9.0	56	8
Wenatchee River	3.9	1.0	2.5	6.7	17		7.2	6.7	7.4	15	
West Twin River							7.1	6.7	7.5	20	4
White River	1.7	0.3	1.5	2.0	2	2	7.3	6.9	8.2	23	6
White Salmon River							7.6	7.5	7.7	7	2
Wide Hollow Creek							8.2	8.0	8.7	7	2
Willapa River							7.3	7.1	7.7	30	4
Williams Lake	20.5	0.7	19.5	21.1	4	1	7.4	7.1	8.9	22	1
Wilson Creek							7.9	7.8	8.0	7	2
Yakima River	18.6	6.6	4.4	24.7	21	4	7.9	7.1	9.1	167	9
Yakima River inflow	20.5	11.9	6.2	41.7	6	1	7.9	7.6	8.7	7	2
Yale Reservoir	3.8	0.1	3.7	3.9	2	1	7.2	7.0	9.9	34	1

Appendix I - Table H. Summary of water quality data for Wyoming including the mean, standard deviation, number of data points (*n*), as well as the number of years represented in data.

	Dissolved Calcium (mg/L)						pH				
Water Body	**Mean**	**SD**	**Min**	**Max**	***n***	**# yrs**	**Mean**	**Min**	**Max**	***n***	**# yrs**
Bear River, Woodruff Res inflow	37.4	10.2	20.1	54.3	19	8	8.1	7.3	8.8	19	8
Bear River, Woodruff Res outflow	49.5		49.5	49.5	1	1	8.5	8.5	8.5	1	1
Big Sandy Rv, Big Sandy Res out	141		141	141	1	1	8.2	8.2	8.2	1	1
Bighorn Lake inflow	52.6	12.1	32.2	67.4	11	2	8.3	7.8	8.8	35	10
Bighorn River	62.9	17.1	33.0	92.9	35	4	8.2	7.3	8.9	121	10
Boysen Reservoir inflow	52.9	3.2	50.6	55.1	2	1	8.4	8.2	8.6	6	2
Boysen Reservoir outflow	55.4	6.2	43.3	64.0	17	4	8.2	7.8	8.7	23	5
Buffalo Bill Reservoir inflow	16.9	16.6	5.2	28.7	2	2	8.1	7.9	8.3	2	2
Buffalo Bill Reservoir outflow	15.8	4.5	9.2	23.4	21	4	7.5	7.0	8.0	21	4
Bull Lake inflow	4.2		4.2	4.2	1	2	7.4	7.0	7.9	5	2
Bull Lake outflow	8.5		8.5	8.5	1	1	7.7	7.5	8.2	3	1
Cheyenne River	249	116	16.2	479	58	8	7.8	6.8	8.7	68	8
Flaming Gorge Reservoir	54.7	4.3	45.6	62.5	15	3	8.0	7.4	9.6	30	5
Flaming Gorge Reservoir inflow	60.6		60.6	60.6	1	1	8.5	8.5	8.5	1	1
Fremont Lake	2.4	0.1	2.4	2.5	4	1					
Grassy Lake Reservoir	1.9		1.9	1.9	1	1	7.3	7.3	7.3	1	1
Grassy Lake Reservoir outflow	3.8		3.8	3.8	1	1	7.3	7.3	7.3	1	1
Green Rv, Flaming Gorge Res inflow	41.9	5.2	34.1	52.1	15	4	8.5	8.2	9.3	37	9
Green Rv, Fontenelle Res inflow	48.2		48.2	48.2	1	1	8.2	8.2	8.2	1	1
Green Rv, Fontenelle Res outflow	38.9	6.7	31.3	51.2	14	3	7.9	6.7	9.0	58	10
Guernsey Reservoir outflow							8.3	8.0	8.4	30	2
Halfmoon Lake	2.3		2.3	2.3	1	1					
Jackson Lake inflow	32.0		32.0	32.0	1	1	7.8	7.4	8.5	21	3
Jenny Lake outflow	3.7	0.7	3.1	5.1	8	1	7.9	7.5	8.4	8	1
Keyhole Reservoir outflow	135	64.5	21.4	303	106	9	8.2	7.5	8.9	119	10
Lamar River	18.8	6.4	9.2	24.7	5	1	7.9	7.2	8.8	23	2
Meeks Cabin Reservoir	9.6	3.0	6.5	13.8	5	4	7.5	7.4	7.5	5	4
North Platte River	50.9	7.5	37.8	57.0	5	3	8.8	8.7	8.9	5	3
North Platte Rv, Glendo Res inflow							8.5	8.3	9.0	12	6
North Platte Rv, Pathfinder Res in	36.5	5.7	27.6	48.5	18	3	8.2	7.8	9.0	18	3
North Platte Rv, Seminoe Res inflow	33.2		33.2	33.2	1	1	8.1	7.6	8.8	31	10
Salt River, Palisades Res inflow	64.1		64.1	64.1	1	1	8.0	7.6	8.9	23	10
Seminoe Reservoir outflow	120	46.4	38.9	220	18	3	8.2	7.9	8.7	18	3
Shoshone Lake inflow	2.9	1.7	1.7	4.1	2	1	7.4	7.3	7.6	2	1
Snake River, Jackson Lake	15.0	0.8	13.8	16.1	5	4	7.5	6.9	8.1	6	5
Snake River, Jackson Lake inflow	17.7	4.7	9.0	25.1	29	7	7.7	6.9	8.4	28	7
Snake River, Jackson Lake outflow	19.2	4.0	14.4	26.1	34	8	8.0	7.1	8.9	33	8
Sulphur Creek Reservoir outflow	44.3	12.2	35.6	52.9	2	1	8.5	8.4	8.9	3	1
Wind River	37.2	12.0	22.9	57.2	8	2	8.2	7.4	9.1	38	3
Woodruff Narrows Res inflow	44.2	12.3	28.9	55.9	5	2	8.5	8.3	9.2	5	2
Yellowstone Lake	5.2	0.4	4.1	5.9	20	1	7.3	6.3	8.5	138	2
Yellowstone Lake inflow	18.0	2.1	14.3	19.4	5	2	7.2	6.8	8.2	22	3
Yellowstone River	5.5	0.3	5.2	6.0	5	1	7.5	7.1	8.5	25	2

Appendix II

Appendix II - Table A. Idaho recreational boater data from Idaho Department Fish and Game (2009, unpublished data). Blanks indicate no data was available.

Water Body Name	State	# Tourn.	# boats/ Tourn.
Anderson Ranch Reservoir	ID	25	453
Arrowrock Reservoir	ID	2	58
Black Canyon Reservoir	ID	3	22
Blackfoot Reservoir	ID	3	46
Carey Lake	ID	2	17
Cascade Reservoir	ID	26	693
Chesterfield Reservoir	ID	1	20
Clearwater River	ID	9	810
Coeur d'Alene Lake	ID	51	1,945
Deer Creek Reservoir	ID	3	115
Devil Creek Reservoir	ID	3	163
Dworshak Reservoir	ID	18	355
Elk Creek Reservoir	ID	1	25
Hayden Lake	ID	8	110
Island Park Reservoir	ID	1	8
Lake Lowell	ID	15	781
Lake Pend Oreille	ID	46	2,369
Little Wood Reservoir	ID	2	17
Lucky Peak Reservoir	ID	3	22
Magic Reservoir	ID	5	72
Massacre Rocks	ID	22	301
Moose Creek Reservoir	ID	1	100
Oneida Narrows Reservoir	ID	1	15
Oxbow Reservoir	ID	1	15
Park Center Pond	ID	1	100
Priest Lake	ID	3	17
Ririe Reservoir	ID	4	43
Rose Lake	ID	3	30
Salmon Falls Creek Reservoir	ID	4	215
Salmon River	ID	8	1,000
Snake River	ID	12	730
Snake River, American Falls Res.	ID	19	462
Snake River, Brownlee Res.	ID	50	1,716
Snake River, C.J. Strike Res.	ID	101	2,237
Snake River, Hells Canyon Res.	ID	9	116
Snake River, Lake Walcott	ID	16	212
Snake River, Milner Lake	ID	65	1,672
South Fork Boise River	ID	4	40
Spirit Lake	ID	6	76
Spring Valley Reservoir	ID	2	35
Stone Reservoir	ID	1	12
Swan Falls Reservoir	ID	8	78
Twin Lake, Lower	ID	7	78
Glendale Reservoir	ID	1	15
MacKay Reservoir	ID	1	10
Medicine Lake	ID	1	5
Winchester Lake State Park	ID	1	20

Appendix II - Table B: Montana recreational boater data from Montana Fish, Wildlife and Parks (2007, unpublished data). Blanks indicate no data was available.

Water Body Name	State	Total Pressure	Non Res Pressure
Ackley Lake	MT	5,761	731
Anita Reservoir	MT	345	0
Arrowhead Lake	MT	133	75
Ashley Lake	MT	4,962	805
Bean Lake	MT	95	0
Beaver Lake	MT	3,037	203
Beaverhead River	MT	28,005	13,649
Big Hole River	MT	17,533	6,377
Bighorn Lake	MT	8,475	2,051
Bighorn River	MT	35,838	25,064
Birch Creek	MT	233	0
Bitterroot River	MT	36,244	13,219
Blackfoot River	MT	8,433	1,867
Blanchard Lake	MT	1,570	0
Boulder River	MT	7,511	3,045
Browns Lake	MT	7,856	622
Bull Lake	MT	4,734	911
Cabinet Gorge Reservoir	MT	1,484	0
Canyon Ferry Reservoir	MT	83346	4,358
Clark Canyon Reservoir	MT	25254	4,189
Clark Fork River	MT	17,148	4,836
Clearwater River	MT	1,478	0
Cooney Reservoir	MT	11,850	298
Crystal Lake	MT	1,434	0
Dailey Lake	MT	4,804	619
Deadmans Basin Reservoir	MT	4,175	544
Dickey Lake	MT	383	0
Echo Lake	MT	737	114
Ennis Lake	MT	8,089	2,006
Eureka Reservoir	MT	346	0
Flathead Lake	MT	70,509	9,891
Flathead River	MT	18,842	4,082
Fort Peck Lake	MT	29,137	3,877
Foys Lake	MT	1,890	432
Fresno Reservoir	MT	14,584	973
Gallatin River	MT	28,070	13,004
Georgetown Lake	MT	54,837	8,370
Gibson Reservoir	MT	587	62
Glen Lake	MT	1,460	0
Hauser Reservoir	MT	47,696	7,167
Hebgen Lake	MT	24,742	16,434
Helena Valley Regulating Res.	MT	6,765	699
Holter Lake	MT	35,883	1,951
Horseshoe Lake	MT	85	85
Hungry Horse Reservoir	MT	7,401	490

Appendix II - Table B (continued).

Water Body Name	State	Total Pressure	Non Res Pressure
Jefferson River	MT	8,780	2,163
Judith River	MT	624	112
Kootenai River	MT	25,274	9,047
Lake Como	MT	4,736	804
Lake Elmo	MT	4,411	152
Lake Elwell	MT	14,968	698
Lake Helena	MT	5,435	222
Lake Josephine	MT	1,095	0
Lake Koocanusa	MT	38,082	13,135
Lake Mary Ronan	MT	15,760	5,307
Lake McDonald	MT	1,099	508
Little Bitterroot Lake	MT	6,685	794
Little McGregor Lake	MT	57	0
Lodge Grass Storage Res.	MT	190	0
Madison River	MT	55,575	36,835
Marias River	MT	1,964	10
Martinsdale Reservoir	MT	283	0
McGregor Lake	MT	11,321	829
Middle Thompson Lake	MT	7,017	106
Milk River	MT	809	8
Mission Lake	MT	62	62
Missouri River	MT	11,259	2,577
Musselshell River	MT	1,612	78
Mystic Lake	MT	187	130
Nelson Reservoir	MT	9,543	568
Newlan Creek Reservoir	MT	7,757	85
Nilan Reservoir	MT	3,970	451
Noxon Reservoir	MT	19,726	2,405
Painted Rocks Reservoir	MT	1,106	114
Petrolia Reservoir	MT	1,948	76
Pishkun Reservoir	MT	1,183	0
Placid Lake	MT	2,505	1,270
Powder River	MT	610	0
Rock Creek	MT	5,368	2,310
Ruby River	MT	8,239	5,125
Ruby River Reservoir	MT	11,487	727
Salmon Lake	MT	3,172	38
Seeley Lake	MT	4,386	1,004
Smith Lake	MT	4,298	2,736
Smith River	MT	6,731	2,289
Sophie Lake	MT	1,128	160
Stillwater River	MT	11,374	2,740
Sun River	MT	2,472	545
Swan Lake	MT	7,018	1,474
Tally Lake	MT	1,083	237

Appendix II - Table B (continued).

Water Body Name	State	Total Pressure	Non Res Pressure
Tenmile Creek	MT	124	43
Tetrault Lake	MT	2,187	350
Thompson Lake	MT	56	0
Tongue River	MT	2,949	389
Tongue River Reservoir	MT	17,303	7,475
Upsata Lake	MT	501	0
Whitefish Lake	MT	4,148	623
Willow Creek	MT	619	319
Willow Creek Reservoir	MT	1,912	541
Yellowstone River	MT	10,991	3,175
Yellowtail Afterbay	MT	3,761	973

Appendix II - Table C. Nevada recreational boater data from Nevada Division of State Parks (2009, unpublished data). Blanks indicate no data was available.

Water Body Name	State	Total Pressure
Big Bend	NV	53,626
Cave Lake	NV	9,790
Echo Canyon Reservoir	NV	3,884
Lahontan Reservoir	NV	243,866
Lake Tahoe	NV	81,895
Rye Patch Reservoir	NV	27,383
South Fork Reservoir	NV	51,342
Spring Valley	NV	11,314
Walker Lake	NV	5,952
Washoe Lake	NV	18,591
Wild Horse Reservoir	NV	7,879

Appendix II - Table D: Oregon recreational boater data from the Oregon State Marine Board, 2008. Blanks indicate no data was available.

Water Body Name	State	Total Pressure	# Tourn.
Agate Reservoir	OR	598	
Agency Lake	OR	7373	
Applegate Reservoir	OR	10,630	1
Blue Lake	OR		1
Blue River Reservoir	OR	3,447	
Bully Creek Reservoir	OR	439	
Chickahominy Reservoir	OR	439	
Clear Lake	OR	401	
Columbia River	OR	524,091	28
Columbia River, John Day Pool	OR		5
Columbia River, Lake Bonneville	OR		7
Columbia River, Lake Celilo	OR		1
Columbia River, Lake Umatilla	OR		1
Cottage Grove Lake	OR	5,352	1
Cottonwood Reservoir	OR	401	
Cougar Reservoir	OR	168	
Craine Praire Reservoir	OR	11,723	1
Crescent Lake	OR	9,705	
Cultus Lake	OR	7,135	2
Davis Lake	OR	168	
Delintment Lake	OR	734	
Deschutes River	OR	48,246	
Detroit Lake	OR	71,672	
Devils Lake (Lincoln)	OR	15,226	1
Dexter Lake	OR	7,597	7
Diamond Lake	OR	16,390	1
Dorena Reservoir	OR	16,390	1
East Lake	OR	10,913	
Eel Lake	OR	1,882	
Elk Lake	OR		
Emigrant Lake	OR	18,705	2
Fall Creek Reservoir	OR	5,757	1
Fern Ridge Reservoir	OR	45,712	3
Fish Lake (Douglas)	OR	18	
Foster Reservoir	OR	28,004	
Fourmile Lake	OR	176	
Gerber Reservoir	OR	449	
Gold Lake	OR	84	
Goose Lake	OR	6	
Green Peter Lake	OR	15,628	2
Hart Lake	OR	1,341	
Haystack Reservoir	OR	929	1
Henry Hagg Lake	OR	33,159	3
Hills Creek Lake	OR	3,022	
Howard Praire Lake	OR	26,642	1

Appendix II - Table D (continued).

Water Body Name	State	Total Pressure	# Tourn.
Hyatt Reservoir	OR	5,964	
John Day River	OR	12,366	
Klamath Lake	OR	823	1
Lake Billy Chinook	OR	58,591	1
Lake of the Woods	OR	32,625	
Lava Lake	OR	10,186	
Lemolo Lake	OR	4,128	
Lookout Point Lake	OR	1,345	
Loon Lake	OR	9,278	
Lost Creek Lake	OR	15,763	
Magone Lake	OR	103	
Malheur Reservoir	OR	747	
Mercer Lake	OR	9,468	
Miller Lake	OR	416	
Munsel Lake	OR	1,721	
North Fork Reservoir	OR	13,666	
North Tenmile Lake	OR	404	8
North Twin Lake	OR	508	
Ochoco Reservoir	OR	7,598	
Odell Lake	OR	29,637	
Olallie Lake	OR	1,739	
Owyhee Reservoir	OR	5,886	5
Owyhee River	OR	38	
Paulina Lake	OR	18,749	
Penland Lake	OR	76	
Phillips Lake	OR	2,590	
Pine Hollow Reservoir	OR	7,020	1
Platt 1 Reservoir	OR		2
Prineville Reservoir	OR	33,192	
Rock Creek Reservoir	OR	207	
Selmac Lake	OR	3,271	
Siltcoos Lake	OR	8,232	2
Simtustus Lake	OR	3,669	
Smith Reservoir	OR	1,601	
Snake River	OR	16,324	1
Snake River, Brownlee Res.	OR	19,285	3
Snake River, Hells Canyon Res.	OR	1,613	
South Twin Lake	OR	123	
Suttle Lake	OR	8,770	
Tahkenitch Lake	OR	1,298	1
Thief Valley Reservoir	OR	1,060	
Thompson Valley Reservoir	OR	266	
Timothy Lake	OR	7,842	
Triangle Lake	OR	7,235	
Umatilla River	OR	446	2

Appendix II - Table D (continued).

Water Body Name	State	Total Pressure	# Tourn.
Unity Reservoir	OR	1,416	
Upper Cow Lake	OR	331	
Wallowa Lake	OR	10,040	
Walton Lake	OR	203	
Warm Springs Reservoir	OR	251	
Wickiup Reservoir	OR	20,663	1
Willamette River	OR	281,176	30
Willow Valley Reservoir	OR	329	
Woahink Lake	OR	4,218	
Wolf Creek Reservoir	OR	579	

Appendix II - Table E. Utah recreational boater data from the Utah Division of Wildlife Resources (2009, unpublished data). Blanks indicate no data was available.

Water Body Name	State	Top 29 in Utah	# Tourn.
East Canyon Reservoir	UT	High	1
Flaming Gorge Reservoir	UT	High	5
Hyrum Reservoir	UT	High	1
Jordanelle Reservoir	UT	High	5
Lake Powell	UT	High	14
Mantua Reservoir	UT		1
Pelican Lake	UT		3
Rockport/Wanship Reservoir	UT	High	1
Starvation Reservoir	UT	High	3
Steinaker Reservoir	UT	High	3
Utah Lake	UT	High	1

Appendix II - Table F. Washington recreational boater data from the Washington State Parks and Recreation Commission (2007, unpublished data). Blanks indicate no data was available.

Water Body Name	State	Total Pressure	WA most Visited
Abernathy Creek	WA		
Ahtanum Creek	WA		
Alder Lake	WA		0.3
Banks Lake	WA	2.1	1.3
Billy Clapp Lake	WA	0.3	
Black Lake	WA	0.6	
Blue Lake	WA	0.6	
Bumping Reservoir	WA		0.3
Chehalis River	WA	0.4	
Cle Elum Reservoir	WA		0.3
Clear Lake	WA	1.0	0.6
Columbia River	WA	19.3	19.9
Columbia River, Lake Wanapum	WA		0.3
Cowlitz River	WA	1.3	0.9
Deep Creek	WA		0.3
Deer Lake	WA	0.6	0.5
Diamond Lake	WA		0.3
Fishtrap Creek	WA		0.3
Lake Cresent	WA		0.3
Lake Cushman inflow	WA		0.3
Lake Ozette outflow	WA		0.3
Lake Sammamish inflow	WA	1.6	0.9
Lake Tapps tailrace	WA	0.5	0.7
Lake Washington inflow	WA	6.1	3.9
Long Lake inflow	WA	1.0	0.9
Loon Lake	WA	0.6	
Mineral Lake outflow	WA		0.3
Moses Lake	WA	1.4	0.8
Nooksack River	WA		0.3
Pend Oreille River	WA	0.7	0.5
Potholes Reservoir outflow	WA	1.3	
Riffe Reservoir	WA	0.7	
Rimrock Reservoir	WA	0.3	
Silver Lake	WA	0.9	0.8
Skagit River	WA		0.3
Snake River	WA	4.7	2.6
Snohomish River	WA	1.1	0.5
Spokane River	WA	0.3	
Swift Creek Reservoir	WA	0.3	
Williams Lake	WA		0.3
Yakima River	WA	0.6	
Yale Reservoir	WA	0.6	