

S. HRG. 116–366

THE IMPACT OF INVASIVE SPECIES ON BUREAU  
OF RECLAMATION FACILITIES AND MANAGE-  
MENT OF WATER RESOURCES IN THE WEST

---

HEARING  
BEFORE THE  
SUBCOMMITTEE ON  
WATER AND POWER  
OF THE  
COMMITTEE ON  
ENERGY AND NATURAL RESOURCES  
UNITED STATES SENATE  
ONE HUNDRED SIXTEENTH CONGRESS

SECOND SESSION

MARCH 4, 2020



Printed for the use of the  
Committee on Energy and Natural Resources

Available via the World Wide Web: <http://www.govinfo.gov>

U.S. GOVERNMENT PUBLISHING OFFICE

40–912

WASHINGTON : 2021



COMMITTEE ON ENERGY AND NATURAL RESOURCES

LISA MURKOWSKI, Alaska, *Chairman*

|                               |                                |
|-------------------------------|--------------------------------|
| JOHN BARRASSO, Wyoming        | JOE MANCHIN III, West Virginia |
| JAMES E. RISCH, Idaho         | RON WYDEN, Oregon              |
| MIKE LEE, Utah                | MARIA CANTWELL, Washington     |
| STEVE DAINES, Montana         | BERNARD SANDERS, Vermont       |
| BILL CASSIDY, Louisiana       | DEBBIE STABENOW, Michigan      |
| CORY GARDNER, Colorado        | MARTIN HEINRICH, New Mexico    |
| CINDY HYDE-SMITH, Mississippi | MAZIE K. HIRONO, Hawaii        |
| MARTHA McSALLY, Arizona       | ANGUS S. KING, JR., Maine      |
| LAMAR ALEXANDER, Tennessee    | CATHERINE CORTEZ MASTO, Nevada |
| JOHN HOEVEN, North Dakota     |                                |

---

SUBCOMMITTEE ON WATER AND POWER

MARTHA McSALLY, *Chairman*

|                 |                        |
|-----------------|------------------------|
| JOHN BARRASSO   | CATHERINE CORTEZ MASTO |
| JAMES E. RISCH  | RON WYDEN              |
| BILL CASSIDY    | MARIA CANTWELL         |
| CORY GARDNER    | BERNARD SANDERS        |
| LAMAR ALEXANDER |                        |

BRIAN HUGHES, *Staff Director*  
KELLIE DONNELLY, *Chief Counsel*  
LANE DICKSON, *Senior Professional Staff Member*  
RENAE BLACK, *Democratic Staff Director*  
SAM E. FOWLER, *Democratic Chief Counsel*  
MELANIE THORNTON, *Democratic Professional Staff Member*  
DARLA RIPCHENSKY, *Chief Clerk*

# CONTENTS

## OPENING STATEMENTS

|                                                                                                | Page |
|------------------------------------------------------------------------------------------------|------|
| McSally, Hon. Martha, Subcommittee Chairman and a U.S. Senator from Arizona .....              | 1    |
| Cortez Masto, Hon. Catherine, Subcommittee Ranking Member and a U.S. Senator from Nevada ..... | 2    |
| Daines, Hon. Steve, a U.S. Senator from Montana .....                                          | 45   |

## WITNESSES

|                                                                                                                                                                                      |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Cameron, Scott, Principal Deputy Assistant Secretary for Policy, Management and Budget, U.S. Department of the Interior .....                                                        | 5  |
| Meck, Hon. Jackie A., Mayor, City of Buckeye, Arizona .....                                                                                                                          | 38 |
| Criswell, Stephanie, Vice Chair, Western Invasive Species Council, and Coordinator, Montana Invasive Species Council, Montana Department of Natural Resources and Conservation ..... | 45 |
| Preston, Michael, External Relations, Dolores Water Conservancy District, and Chair, Southwest Basin Roundtable .....                                                                | 52 |
| Regan, Julie W., Chief of External Affairs & Deputy Director, Tahoe Regional Planning Agency .....                                                                                   | 63 |

## ALPHABETICAL LISTING AND APPENDIX MATERIAL SUBMITTED

|                                                                                                                          |     |
|--------------------------------------------------------------------------------------------------------------------------|-----|
| Cameron, Scott:                                                                                                          |     |
| Opening Statement .....                                                                                                  | 5   |
| Map entitled "12 Interior Region Names Based on Watersheds" produced by the U.S. Geological Survey dated 10/18/19 .....  | 6   |
| Map entitled "Zebra and Quagga Mussel Sightings Distribution" produced by the U.S. Geological Survey dated 2/29/20 ..... | 8   |
| Written Testimony .....                                                                                                  | 10  |
| Photo of a Beach in the Great Lakes with Quagga Mussel Shells .....                                                      | 143 |
| Responses to Questions for the Record .....                                                                              | 199 |
| Criswell, Stephanie:                                                                                                     |     |
| Opening Statement .....                                                                                                  | 45  |
| Written Testimony .....                                                                                                  | 48  |
| Cortez Masto, Hon. Catherine:                                                                                            |     |
| Opening Statement .....                                                                                                  | 2   |
| Daines, Hon. Steve:                                                                                                      |     |
| Introduction .....                                                                                                       | 45  |
| McSally, Hon. Martha:                                                                                                    |     |
| Opening Statement .....                                                                                                  | 1   |
| Meck, Hon. Jackie A.:                                                                                                    |     |
| Opening Statement .....                                                                                                  | 38  |
| Written Testimony .....                                                                                                  | 40  |
| Preston, Michael:                                                                                                        |     |
| Opening Statement .....                                                                                                  | 52  |
| Written Testimony .....                                                                                                  | 54  |
| Regan, Julie W.:                                                                                                         |     |
| Opening Statement .....                                                                                                  | 63  |
| Written Testimony .....                                                                                                  | 65  |
| Western Governors' Association:                                                                                          |     |
| Statement for the Record .....                                                                                           | 150 |



# **THE IMPACT OF INVASIVE SPECIES ON BUREAU OF RECLAMATION FACILITIES AND MANAGEMENT OF WATER RESOURCES IN THE WEST**

---

**WEDNESDAY, MARCH 4, 2020**

U.S. SENATE,  
SUBCOMMITTEE ON WATER AND POWER,  
COMMITTEE ON ENERGY AND NATURAL RESOURCES,  
*Washington, DC.*

The Subcommittee met, pursuant to notice, at 10:48 a.m. in Room SD-366, Dirksen Senate Office Building, Hon. Martha McSally, presiding.

## **OPENING STATEMENT OF HON. MARTHA MCSALLY, U.S. SENATOR FROM ARIZONA**

Senator MCSALLY [presiding]. The hearing of the Senate Energy and Natural Resources Subcommittee on Water and Power will come to order. Thanks for your patience. We had a 10:30 vote, so I appreciate all of you for being here and your patience about getting started a little bit late.

The purpose of today's hearing is to discuss the impact of invasive species, specifically salt cedar and mussels, on the water resources in the West and what more we need to be doing to address this problem. Invasive species cost billions of dollars in direct costs and economic impact every year. These invaders can be devastating and the impacts to our water resources range from loss of supply to expensive infrastructure damage. They also have significant indirect impacts like increased wildfire risk or pressure on endangered species that affect water operations.

Like many damaging invasive species, salt cedar was initially introduced in America as an ornamental plant and was later used for erosion control all around the West. Unfortunately, we now know it also consumes massive amounts of water. This plant has now infested millions of acres across the Southwest and continues to spread causing hundreds of thousands of acre-feet of water losses each year.

In Arizona, our desert rivers like the Verde, Salt, and Gila have been hit particularly hard. In their healthy state, these landscapes should have a handful of native trees like willows, cottonwoods, and mesquite, but right now these riverbeds are choked with up to 4,000 salt cedars per acre. This not only puts incredible strain on the water supply, it also causes serious flooding and fire hazards.

The City of Buckeye is unfortunately more familiar with these challenges than anywhere. So I am grateful to have the perspective of Mayor Jackie Meck on the panel today. He has been a leader in bringing stakeholders together to tackle the problem of invasive salt cedars, getting buy-in and support from other municipal leaders as well as private industry, local, county, state and federal partners. For example, the Cities of Buckeye, Avondale and Good-year are partnering with Maricopa County and the Flood Control District of Maricopa County to take a comprehensive approach to restoring a stretch of the Gila River to eradicate salt cedars and make sure native plants and trees return to the river. This will create a balanced and healthy ecosystem and could lead to an additional 50,000 acre-feet of water being left in the river. These collaborative approaches are essential, and I look forward to hearing what the Subcommittee could do to ensure more on-the-ground solutions like this occur.

The quagga and zebra mussels are also a huge and growing problem out West. They were first discovered in the Lower Colorado River in 2007 and have since spread throughout the Basin including numerous locations in Arizona. These mussels attach on to nearly any surface causing severe damage to infrastructure by clogging water intakes and affecting operations. This costs water and power users millions of dollars annually and creates a host of other economic impacts. Once these mussels make their way into a river system, they spread rapidly and it has proven nearly impossible to get them out. So preventing their spread is especially important.

Combating the impacts and spread of salt cedars, mussels and other invasive species requires a multifaceted approach that includes public outreach and education, monitoring, eradication, restoration programs and development of new treatments and technologies. That is why it is so critical for a coordinated effort that includes federal, state, local and tribal entities. To that end, I am pleased to be co-sponsoring S. 2862, Drought Relief through Innovative Projects Act of 2019, with my colleague from Arizona, Senator Sinema. This bill will establish a competitive grant program to remove and replace non-native plants like salt cedar and ensure state and local governments have additional resources to address this problem.

I look forward to hearing from our witnesses about the challenge and what more this Subcommittee can do to ensure our federal agencies are a meaningful partner on this issue. With that, I now turn to our Ranking Member, Senator Cortez Masto.

**STATEMENT OF HON. CATHERINE CORTEZ MASTO,  
U.S. SENATOR FROM NEVADA**

Senator CORTEZ MASTO. Thank you. Thank you, Chairman McSally, for holding this hearing on an issue that, as we know, is so important for the Western states. I would like to welcome our panel of expert witnesses. I also want to welcome Julie Regan from the Tahoe Regional Planning Agency, who I have the opportunity to work with on a regular basis. It is an agency that works tirelessly to prevent and control aquatic invasive species in Lake Tahoe, in my home State of Nevada.

As the Chairwoman mentioned, we will hear a range of viewpoints today on the impact of invasive species on our water resources and how management of these species must take a comprehensive and collaborative approach. Invasive species affect the health of our ecosystems and pose a significant threat to our national economy and public health. Invasive species cost the United States billions of dollars in damages every year. Some research suggests over \$120 billion and are often remarkably persistent and difficult to keep in check. Many of these invasive species spread at a rate that far outpaces our ability to contain them, a problem compounded by our limited resources to fight back.

This is an issue that crosses state and jurisdictional boundaries and requires coordination at the highest level. I want to recognize the Administration for the work they are doing with the National Invasive Species Council and the Aquatic Nuisance Species Task Force to improve federal response and regional coordination on this issue. As many of you know, addressing invasive species becomes difficult as that species becomes more established or widespread. Leveraging our resources to prevent and combat invasive species is critical to long-term management and control.

In Nevada, invasive species continue to threaten the health of our desert and aquatic environments. Species such as a quagga mussel—which we brought props and I see one over there. This is a shoe infested by quagga mussels. That shows you the impact they have. Now unfortunately in some of our areas, including Lake Mead, we see these invasive quagga mussels.

Along with the quagga mussels we have seen, as the Chairwoman mentioned, salt cedar. We have cheatgrass and watermilfoil that are becoming increasingly pervasive and costly to manage. These species have spread quickly, damaging both my state's natural resources and economy. And I want to take some time and talk about one of the most devastating invasive species in Nevada which is the quagga mussel. They were first discovered in Lake Mead in 2007, and they catapulted the West and Nevada into action. Watercraft are the largest vectors for spreading these invasive mussels into new waterways, making boat inspections and decontamination a vital aspect of protecting Lake Tahoe and other nearby water bodies. In Lake Tahoe, the Tahoe Regional Planning Agency (TRPA) is leading a collaborative effort to prevent new aquatic invasive species and control existing invasive species.

The TRPA has a strong watercraft inspection and decontamination program, and this program inspected and certified over 8,000 watercraft before launching into Lake Tahoe in 2019. An introduction of non-native species could devastate Lake Tahoe's fragile ecosystem and native fisheries, impact boats and recreation areas, and could cost the Tahoe Basin about \$20 million annually according to the Army Corps of Engineers.

In Congress, we worked very hard, thanks to so many of our incredible Senators and folks on the ground between Nevada and California. We authorized the Lake Tahoe Restoration Act in 2016. This bill has dedicated \$415 million in federal dollars to improve water quality, fight against aquatic invasive species, and invest in smart technology to better inform our scientists and create a more sustainable Lake Tahoe for its residents and visitors. Today this

federal investment has supported the aquatic invasive species program in the region. To date, invasive quagga or zebra mussels have not entered Lake Tahoe. I call that a success story, and I think we can learn from that collaborative effort and the commitment to ensure that we are protecting our pristine waterways.

I also want to discuss salt cedar which is another invasive species that impacts water resources in Nevada. In Nevada, salt cedar is actually one of 54 classified noxious weeds in the Nevada State Statute. The Statute requires every landowner, including private, city, county or federal, to eradicate the species. Salt cedar management in Nevada also includes education and outreach, focusing on how to effectively remove salt cedar with the ultimate goal of preventing the spread of the species.

So preventing invasive species from being introduced or established is really the most cost-effective strategy for dealing with invasive species. We know that once they are established, these intruders are nearly impossible to eradicate and wreak havoc on crucial water infrastructure. They limit recreation opportunities and harm ecosystems and our local economies. Collaboration between the local and state partners with the Federal Government is critical to our ability to prevent, contain, and manage these invasive species.

I am so pleased to be here. Chairwoman, thank you again for holding this important hearing. I think the opportunity for us to learn from one another and collaborate is the key to our success in combating these invasive species. So I look forward to the testimony today.

Thank you.

Senator MCSALLY. Thank you.

Well, we have a great panel here today that will highlight local and national efforts to prevent and control these invasive species.

First, we will have Mr. Scott Cameron, Principal Deputy Assistant Secretary for Policy Management and Budget at the Department of the Interior.

Next, I am very pleased to have the Honorable Jackie Meck, Mayor of Buckeye, Arizona. As I mentioned, Mayor Meck has been a leader on the salt cedar challenge his community is facing and has brought a lot of important attention to this issue. He came and advocated to me when I was in the House and didn't represent anywhere near that district. And he was like, we have to get everybody on board. So I can personally attest to his passion on this issue. Thank you so much for being here, Jackie, and for your years and years of service to Buckeye and the State of Arizona. I understand you announced you were retiring at the end of the year. Who approved that?

Mr. MECK. It's been 23 years. That's enough.

Senator MCSALLY. Alright.

Mr. MECK. For younger people to take over so I can work on the salt cedar.

Senator MCSALLY. Alright, well your leadership will be missed. Congratulations and thanks again for all you have done for our state.

Mr. MECK. Thank you.

Senator MCSALLY. After that, we have Ms. Stephanie Criswell, Invasive Species Program Manager at the Montana Department of Natural Resources and Vice Chair of Western Invasive Species Council. Then Mr. Mike Preston, Manager of External Relations and former General Manager of Dolores Water Conservancy District in Colorado. Lastly, we will hear from Ms. Julie Regan, Deputy Director of the Tahoe Regional Planning Agency in Nevada.

Thank you all for being here. I ask that you please limit your verbal testimony to five minutes. Your full remarks will be submitted to the record.

With that, the Subcommittee recognizes Mr. Cameron.

**STATEMENT OF SCOTT CAMERON, PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR POLICY, MANAGEMENT AND BUDGET, U.S. DEPARTMENT OF THE INTERIOR**

Mr. CAMERON. Chairwoman McSally, Ranking Member Cortez Masto and members of the Subcommittee, thank you for the opportunity to testify about invasive species affecting Reclamation facilities. I'd like to spend the next five minutes talking about what Interior is doing about this problem. Given the limited time this morning, I'll focus on zebra and quagga mussels.

Invasive mussels cannot be addressed by the Bureau of Reclamation acting alone, nor by Interior alone, nor by the Federal Government alone. Instead, as you've both alluded to this morning, we need to work across all the affected bureaus of Interior with our sister federal agencies and, most importantly, partner with state and local governments and Indian tribes. I'll briefly describe five steps we have taken during this Administration to try to make some progress in this area.

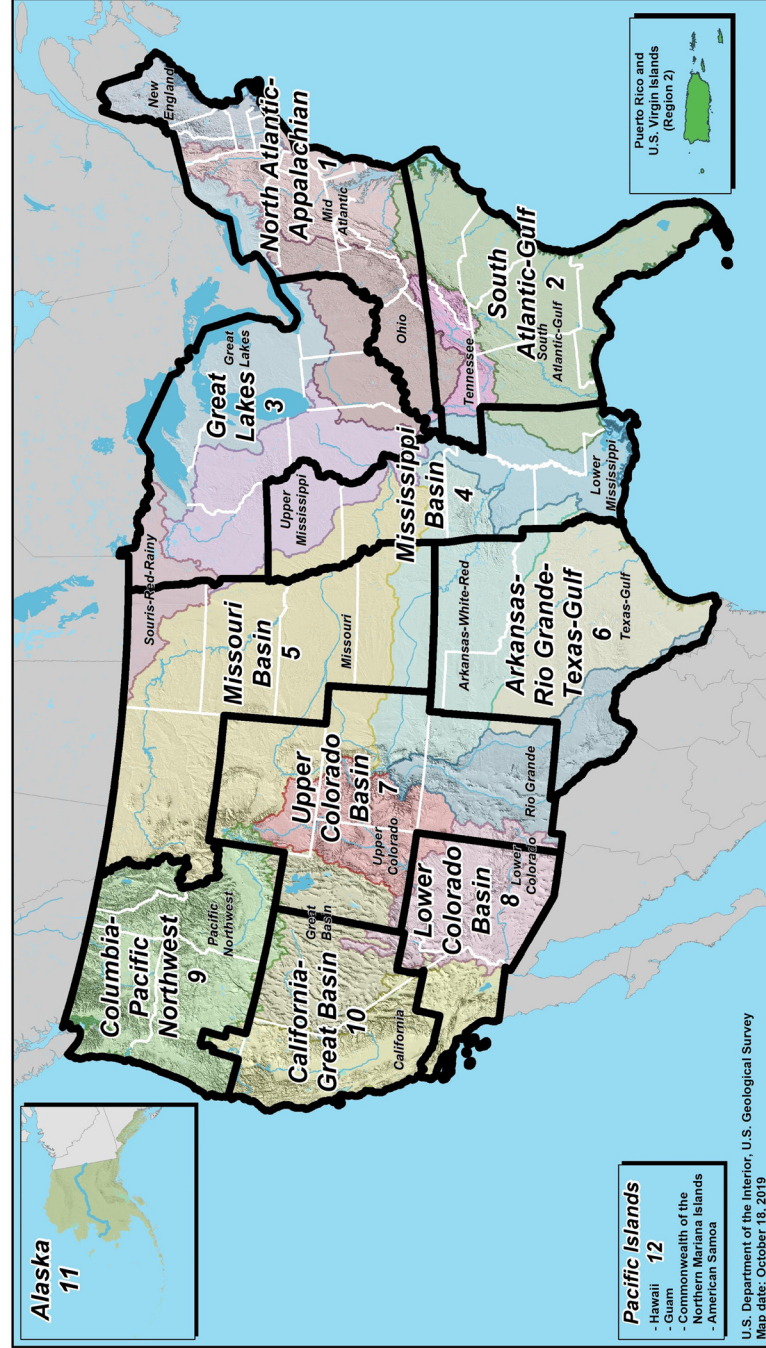
First, in 2017 at the urging of then-Governor Otter of Idaho, Interior began working closely with the Western Governors' Association, states, tribes and other federal agencies on a project called "Safeguarding the West from Invasive Species." An initiative of that includes dozens of activities that Interior bureaus are undertaking in collaboration with others to prevent, contain and control invasive mussels.

Second, to improve inter-bureau cooperation and coordination at a regional level inside Interior, in 2018 then-Secretary Zinke acted to ensure that our regional executives are focused on the same geography. Instead of our bureaus having a confusing hodgepodge of 49 different regional office boundaries across the country, we now are working from 12 standard Interior regions. Here's a map that shows the location of those regions.

[The map referred to follows:]



## 12 Interior Region Names Based on Watersheds

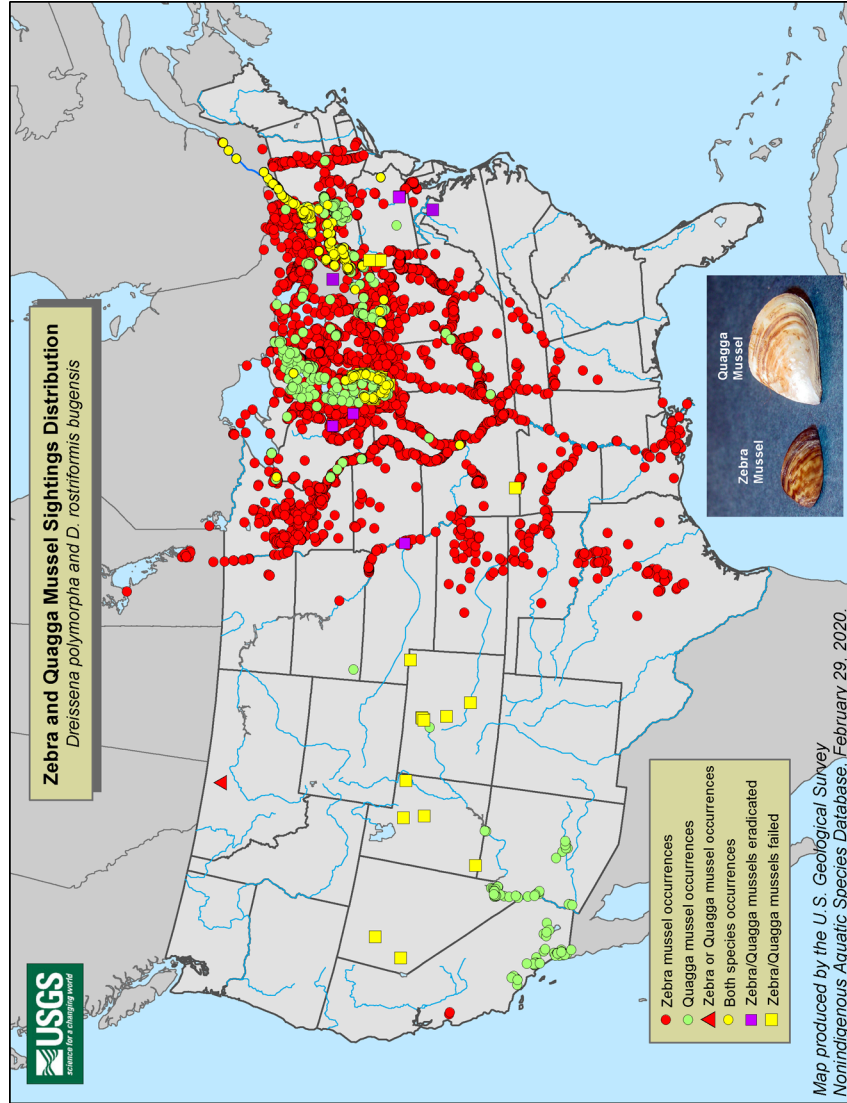


Mr. CAMERON. They generally follow watershed lines which is consistent with the Bureau of Reclamation's approach.

Thirdly, in 2019, Secretary Bernhardt designated a senior executive in each one of these 12 Interior regions to serve as, what we call, a Field Special Assistant, or FSA. The FSA serves as a catalyst, bringing together leaders from all the Interior bureaus in a given region to help them work together on shared missions and issues of mutual concern, such as invasive species.

Fourth, Interior is teaming much more closely with state governments. For instance, the National Park Service recently got OMB approval to participate in critical information sharing with the states about the movements of potentially mussel-infested recreational boats. As you can see from the next map, thank you, large portions of the West do not yet have invasive mussel infestations.

[The Mussel Distribution Map referred to follows:]



Mr. CAMERON. States rely on information about boat movement to keep infested boats from damaging their waters. Interior is now supporting states in this information collection effort. So as you can see, the Pacific Northwest and large portions of the Upper Colorado Basin are free from mussels at this point.

Finally, the Administration's regulatory reform initiative allows us to be much more responsive to state governments. We need to be able to respond quickly to the first detection of invasive mussels in a reservoir or a river. If bureaucracy delays us for weeks or even months, we may lose the opportunity to eradicate a new population of invasive mussels whether it's in Lake Tahoe or reservoirs in Arizona that, so far, are unaffected. Accordingly, career civil servants in the U.S. Fish and Wildlife Service in the Pacific Northwest recently developed a manual to expedite Endangered Species Act, Section 7 consultations. Now we can move more quickly if invasive mussels are detected and rapid response actions are needed to be taken that could potentially impact other endangered species.

In addition, Interior is working to develop categorical exclusions under the National Environmental Policy Act. Categorical exclusions enable managers to promptly act to control invasive species without preparing time-consuming documents like an EIS, or an environmental assessment. We are now identifying what appropriate actions might be categorically excluded, actions that have been proven to not cause harm to the environment in the past.

In summary, Interior recognizes that invasive species are among the top threats facing the lands and waters of the nation. We are committed to working with our sister federal agencies, states, tribes and local governments and, of course, the Congress, to cost-effectively combat invasive species in effective and lasting ways. I'd be delighted to answer any questions and really appreciate the Subcommittee's attention to this issue this morning.

[The prepared statement of Mr. Cameron follows:]

**Statement of Scott Cameron,  
Principal Deputy Assistant Secretary for Policy, Management and Budget  
U.S. Department of the Interior  
before the Senate Energy and Natural Resources Committee  
Subcommittee on Water and Power  
on  
Invasive Species**

Chairman McSally, Ranking Member Cortez Masto, and Members of the Subcommittee, I am Scott Cameron, Principal Deputy Assistant Secretary for Policy, Management and Budget, within the U.S. Department of the Interior (Interior). Thank you for the opportunity to talk about invasive species at Reclamation facilities.

***History and Background***

Quagga and zebra mussels (also known as Dreissenids) arrived in the Great Lakes from Europe in the 1980s and spread to many eastern waterways, rivers, and lakes. Quagga mussels were discovered in Lake Mead, Lake Mojave, and Lake Havasu on the Colorado River in 2007, and zebra mussels were confirmed in San Justo Reservoir in California in 2008. Quagga mussels were later confirmed in Lake Powell in Utah and Arizona in 2013. Invasive mussels have since spread to reservoirs in southern Arizona and California, and the threat of expansion continues.

The primary way mussels are spread from one water body to another is on recreational boats that are used in infested water and then transported to another water body. The mussel larvae, called veligers, are microscopic and can survive in small amounts of water left on the boat and the juvenile and adult mussels can attach themselves to the boat and survive transport. Veligers can also be moved within connected waters by natural currents. Not all mussel introductions will lead to an infestation, as mussels require certain conditions and water quality to survive and reproduce. Once populations become established, mussels are difficult to eradicate, therefore efforts to prevent, contain, and control infestations are paramount. Meanwhile significant resources are being utilized to research new technologies that may eradicate infestations in the future.

Invasive species affect multiple sectors of society. Invasive species are accelerating degradation of infrastructure in every region of the country, creating tens of billions of dollars of unfunded liabilities for state and local governments. In the West, invasive quagga and zebra mussels pose serious economic and ecological threats. Invasive mussels clog hydroelectric facilities and irrigation systems, as well as damage aquatic ecosystems, threatening Americans' ability to experience the full benefits of hydropower and enjoy their rivers, lakes and streams for recreation. Mussel infestations threaten agriculture, navigation locks, and the biodiversity that supports much of the Western outdoor recreation industry. Invasive mussels also may disrupt ecosystems to the degree that they may cause new listings under the Endangered Species Act (ESA).

Rural communities and those dependent on tourism are especially vulnerable. The already economically challenging job of providing clean drinking water to small rural communities will be complicated by higher annual operating costs necessary to protect the water infrastructure from mussels. Rural communities dependent on irrigated agriculture experience higher maintenance costs on farms from mussels clogging pumps, expensive pivot and drip irrigation systems, and canals. Experience in some areas has shown that a hydroelectric dam infested with invasive mussels may need to spend \$500,000 a year in extra maintenance to control the damage posed by these pests, costs that then get passed on to consumers and businesses.

### ***Impact of Mussels on Bureau of Reclamation Infrastructure***

Invasive species represent a growing threat to Bureau of Reclamation infrastructure. The spread of invasive mussels has become a major concern as quagga and zebra mussels have continued to spread throughout the West, infesting Reclamation reservoirs and water intakes, power plants, and facilities of other water providers. The Columbia River Basin is the last major uninfected watershed in the United States, where regional estimates suggest a full-blown infestation would cost its citizens \$500 million annually in lost economic production, higher electric rates, and risk more endangered species complications. As a result, Reclamation's FY 2021 budget includes \$7.8 million to combat and prevent the spread of invasive species throughout Reclamation facilities and structures, including \$5.6 million directed towards the prevention, early detection and monitoring, containment and control of quagga and zebra mussels at existing facilities.

Invasive mussels pose significant challenges for Reclamation because they are prolific breeders that permanently settle on or within water and power facility infrastructure. Maintaining and operating power and water supply and delivery facilities, water recreation, and other water-dependent industries in mussel-infested water bodies is significantly more complex and expensive. Mussels also affect public recreation, aquatic ecosystems, and water quality. Shell fragments degrade swim beaches, watercraft inspection and decontamination requirements increase time and cost for boaters, and populations of game and ESA-listed fish can be affected. A single adult dreissenid mussel can filter approximately a liter of water each day, reducing the availability of algae and zooplankton for native and endangered mollusks and other aquatic organisms, including fish. Extensive filtration has also increased water clarity, leading to the proliferation of aquatic weeds that can further affect the ecosystem.

### ***Reclamation's Response***

Reclamation is utilizing a variety of strategies to help reduce the spread and impacts caused by mussels to Reclamation facilities and structures. Efforts include partnerships for watercraft inspection and decontamination; early detection and monitoring; facility vulnerability assessments; research on mussel control and monitoring technologies; and public outreach and education.

Reclamation created an invasive mussel corporate task force to coordinate a Reclamation-wide approach to managing quagga and zebra mussels. By developing a corporate strategy, Reclamation integrates the various strategies to meet its needs and facilitates communication and

dialogue within Reclamation. Additionally, Reclamation established a mussel monitoring and detection program in 2009. Their aim is to detect the first stages of mussel exposure at Reclamation reservoirs, and to develop protective measures to prevent a full infestation or mussel spread.

***Department of the Interior and Reclamation Investment***

In 2017, the Department of the Interior announced its initiative, *Safeguarding the West from Invasive Species*. This is a set of actions developed through collaboration with the Western Governors' Association and Federal, State, and Tribal representatives to protect areas in the West from the economic and ecological threats posed by quagga and zebra mussels. It includes dozens of actions that Interior bureaus are undertaking to prevent, contain, and control invasive mussels in collaboration with other partners.

Interior's accomplishments under *Safeguarding the West* are described in two progress reports, one in 2018 and a second in 2019. Another report will be released this year. Interior will continue to fulfill its commitments in *Safeguarding the West* and work with partners to meet the most pressing needs to protect western waters from invasive mussels and other aquatic invasive species.

Through the *Safeguarding the West* initiative, Interior strengthened partnerships, improved communication, leveraged existing investments, and brought additional resources to bear in Fiscal Years (FY) 2017 through 2020. Interior spent \$9.0 million in FY2017 to prevent, contain, and control invasive mussels nationwide, including \$4.2 million for the Bureau of Reclamation. Interior spent \$13.7 million in FY2018; this included \$7.8 million for Reclamation. Reclamation's increase supported a variety of activities that emphasized containment of mussels in the Lower Colorado Region and prevention in the Pacific Northwest.

In FY2019, Interior spent \$17 million on mussels and nearly \$16 million was specifically appropriated for FY2020. Of those amounts, \$8.2 million and \$4.1 million were identified for Reclamation activities, respectively. Reclamation allocated an additional \$1.35 million in its FY2020 spend plan to prevent the spread of invasive mussels.

Reclamation's FY2021 budget request to combat and prevent the spread of invasive mussel species falls under extraordinary maintenance activities. The FY2021 budget includes \$5.6 million for the prevention, early detection and monitoring, containment, and control of invasive mussels at Reclamation facilities, in conjunction with other Federal and State partners. Quagga and zebra mussel infestations are highly destructive to water and power infrastructure and directly affect operating costs and costs to water and power consumers, and they also impair recreational opportunities. The FY2021 budget request for invasive species increased approximately \$1.4 million over FY2020 enacted amounts.

In addition to financial investments, in 2017, Reclamation launched a prize competition seeking innovative solutions for the 100-percent eradication of invasive quagga and zebra mussels from large reservoirs, lakes, and rivers in a cost-effective and environmentally sound manner. Reclamation continues to work with the winner of the Prize Challenge to develop the proposed control solution.

***Conclusion***

The spread of invasive species, particularly mussels, at Reclamation facilities as mentioned, represents a growing risk to Reclamation infrastructure. Invasive mussel infestations pose significant logistical and economic challenges for local communities, recreationists, and water managers by potentially disrupting water deliveries, increasing facility maintenance cost, and impacting the local ecosystem. Thank you for the opportunity to share Reclamation's views and work on invasive species.



# State of the Infrastructure

A Joint Report by the Bureau of Reclamation  
and the U.S. Army Corps of Engineers



US Army Corps  
of Engineers ®



— BUREAU OF —  
RECLAMATION

December 2019



On the cover and this page: the Joint Federal Project at Folsom Dam (photographs: Reclamation, December 2016).

The U.S. Army Corps of Engineers (Army Corps) and the Bureau of Reclamation (Reclamation) collaborated on a critical infrastructure project to construct the Folsom Dam auxiliary spillway, also known as the Joint Federal Project. Reclamation and the Army Corps, along with other cooperating agencies, formed an unprecedented partnership to address dam safety issues associated with extreme floods and to provide enhanced flood risk reduction for the Sacramento area – one of the most at-risk communities in the Nation. The auxiliary spillway was constructed adjacent to Folsom's main concrete dam, 23 miles northeast of Sacramento. It includes a 1,100-foot-long approach channel beginning in Folsom Reservoir, a concrete control structure with six bulkheads and six radial gates, a 3,100-foot-long auxiliary spillway chute, and a stilling basin that acts as an energy dissipation structure as water discharges and enters the American River. With the ability to operate the new spillway, large floods can be better managed by safely releasing more water from Folsom Reservoir earlier in a storm through both the spillway gates on Folsom Dam and the new control structure's radial gates, thereby reducing hydrologic risk and leaving more storage capacity in the reservoir.

## Executive Statement

The Army Corps and Reclamation have a long history of collaboration in evaluating, constructing, operating, and maintaining water infrastructure projects, in addition to sharing management responsibilities at major facilities. Reclamation and the Army Corps Civil Works Program receive funding through annual Energy and Water Development Act appropriations, supplemental appropriations, and from non-Federal cost-sharing partners and other receipts. In an ongoing effort to return the highest overall value to the Nation from available funds, the Army Corps and Reclamation seek opportunities to work with their partners to develop planning study solutions in a timely and cost-effective manner, to manage the cost, schedule, and scope of ongoing construction projects, and

to use risk analysis to prioritize capital investment and maintenance needs.

The Army Corps and Reclamation are committed to working with Tribal Governments, other Federal agencies, states, local governments, the private sector, and the public to manage, maintain, and enhance infrastructure. This report provides a high-level overview of the infrastructure asset portfolio and related asset management practices, collaboration efforts, and future strategies. Additional detail can be found on the respective agency websites. Our work is part of the broader effort at all levels of government to manage the Nation's water resources in a responsible manner.



**James Dalton**  
Director of Civil Works  
U.S. Army Corps of Engineers

The mission of the U.S. Army Corps of Engineers is to provide engineering services in collaboration with our partners to achieve technically thorough, environmentally sustainable, and economically-driven solutions to our nation's water resource needs.



**Brenda Burman**  
Commissioner  
Bureau of Reclamation

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

## Water-Related Infrastructure

Decades of Federal investment have yielded a robust national portfolio of water-related infrastructure, which represents a diverse and vast inventory of mission-critical, legacy, and strategically-developed assets for the benefit of the American people.

This enormous physical infrastructure is one of our Nation's most valuable assets, providing ongoing power generation, water supply, navigation, flood risk reduction, recreation, and other benefits. The importance, extent, and impacts of water-related infrastructure managed and maintained by the Army Corps and Reclamation are large and broad, impacting the Nation's economy daily.

The agencies will continue to efficiently manage funds and will pursue opportunities to respond to evolving influences on water-related infrastructure, such as infrastructure that is reaching or, in some cases, exceeding its design life, resulting in continuing and increasing needs for maintenance, repair, and replacement projects. Many Army Corps and Reclamation dams are more than 50 years old and most were built well before modern state-of-the-art design and construction practices were in use.



4 Grand Coulee Dam, Washington (photograph: Reclamation, June 2011)



The U.S. Army Corps of Engineers' &  
the Bureau of Reclamation's Combined



## WATER-RELATED INFRASTRUCTURE

**1,200+**  
Dams



**5,000+**  
Recreation Areas



**153**  
Hydroelectric  
Powerplants

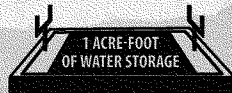


Powering



**10**  
Million  
Homes

**150 Million** acre-feet  
Serves ▶



**130 Million People**



**10 Million Acres**

**Tens of Thousands**  
of Miles of Canals



**25,000 Miles of**  
Navigable Waterways





## Reliable Systems Dams

Dams are major components of a comprehensive strategy to address water resource challenges posed by drought, flooding, depleted aquifers, environmental needs, energy demands, and population increase and movement in the United States. The Army Corps and Reclamation evaluate the condition of dams, dikes, and levees, and monitor the performance of facilities to manage the risks posed to the public due to these facilities. This is done through common Federal public protection guidelines which provide a framework for managing risk for life loss, economic, cultural, and environmental consequences. The guidelines also help maintain the ability of dams and related facilities to provide reliable water, power, and flood risk management benefits.

One of the Army Corps' primary missions is flood risk management and reducing risk from flood events. Reclamation's dams also provide flood control benefits in many cases, but the agency's mission is focused on water storage to irrigate farms and ranches, supply drinking water, enhance fish and wildlife habitats, and create public recreational opportunities. Dams managed by both the Army Corps and Reclamation provide water for generating a major portion of the United States' hydroelectric power.

### Strengths

- Systematic and rigorous inspection and maintenance programs assure the continued provision of benefits from the Army Corps' 716 dams and Reclamation's 491 dams.
- State-of-the-art dam safety programs use risk-informed evaluations to identify, analyze, and address hazards. These programs assure that the safety and welfare of the public is prioritized and reduce risks to property and the environment.
- Both the Army Corps and Reclamation have developed programs to reduce the required Federal investment for many projects by accounting for cost sharing with stakeholders in Federal dam projects, as directed by Congress.
- Reclamation has new authority to consider title transfers that can reduce the Federal inventory and focus resources on assets having national significance and benefit.



J. Strom Thurmond Dam and Lake. The lake is the third-largest artificial lake east of the Mississippi River, behind Kentucky Lake on the Tennessee River and Lake Marion on the Santee River, Clarks Hills, South Carolina. Completed in 1952 (photograph: Army Corps, November 2011).

### Challenges

- Some Army Corps and Reclamation dams operate at reduced capacity for flood storage, water supply, recreation, and other purposes because of measures implemented to address safety challenges informed by state-of-the-art design and construction standards. Most Army Corps and Reclamation dams were built 50 or more years ago.
- Water storage capacity in some reservoirs has decreased due to sediment accumulation, requiring evaluation of sediment removal and management options to reduce risk to water supply, power generation, and other uses.
- Competing infrastructure demands require balancing of water supply, flood risk management, agricultural demand versus municipal and industrial needs, urban encroachment, and storm magnitudes and frequencies.
- Dam safety repairs are sometimes needed in areas of dense population.
- Innovative investment decisions are needed to improve the technical capabilities and financial capacities of non-Federal operating entities responsible for operations and maintenance of Federal facilities.



## Reliable Systems Hydropower Facilities

The Army Corps is the largest producer of hydroelectric power in the United States and owns 75 hydropower facilities with a total generating capacity of approximately 24,000 megawatts. Reclamation is the second largest producer of hydroelectric power in the Nation and owns 78 facilities; Reclamation directly operates and maintains 53 of these facilities, which have a total generating capacity of approximately 15,000 megawatts. Reclamation and Army Corps facilities generate more than 100 million megawatt-hours of electricity each year, the equivalent annual demand of more than 10 million U.S. homes.



John Keys Pumping Plant, Grand Coulee Dam, Grand Coulee, Washington. Construction 1967-1974 (photograph: Reclamation, October 2019).

Over the past century, Federal hydropower generated at Reclamation projects has enabled the conveyance of water across the arid western U.S. In addition, power that is surplus to project requirements is marketed by Department of Energy Power Marketing Administrations. Surplus power has provided Reclamation a steady source of funding for project repayment and investment. Reliable, low-cost hydropower generated at Reclamation and Army Corps projects has provided tremendous value to the Nation, including spurring the development of the western United States through the provision of reliable electric power to rural communities as well as supporting western interconnected grid reliability.

### Strengths

- Hydropower is a source of clean and renewable energy.
- Systematic Power Review programs provide audit-like evaluations of the status of power programs relative to policy requirements.
- The Army Corps and Reclamation conduct regular condition assessments to strategically plan capital investments at hydropower facilities.
- Army Corps and Reclamation power is to be generated in a safe, reliable, and cost-effective manner. To that end, both programs seek out efficiencies while protecting against threats such as cyber and other attacks.
- Reclamation and Army Corps hydropower programs support domestic energy security initiatives by optimizing existing hydropower resources and facilitating the development of untapped resource potential through collaborative regulatory reform, operational and technological innovation, and stakeholder outreach. Collectively, these activities add to the value and revenue realized from existing public infrastructure.
- Additional hydropower can be developed by non-Federal entities at non-powered Reclamation and Army Corps assets via Federal Energy Regulatory Commission licensing or Reclamation Lease of Power Privilege authorizations, dependent upon the nature of the underlying Federal asset.

### Challenges

- Recapitalizing Federal hydropower assets is difficult when energy prices are low, requiring an investment strategy that balances trade-offs among performance, reliability, and increased energy costs.
- Hydropower must remain competitive and derive maximum value in an evolving energy market, one marked by low energy prices and availability of other energy generation resources.
- Competing water demands require a balance among hydroelectric power generation and flood risk management, water supply, ecosystem restoration, and species enhancement activities.



## Reliable Systems

# Navigation – Ports, Locks, and Dredging

The Army Corps' primary navigation responsibility is to provide safe, reliable, efficient, effective, and environmentally sustainable waterborne transportation systems for the movement of commerce, national security needs, and recreation. The Army Corps operates and maintains 25,000 miles of navigable waterways, channels and harbors, including 239 lock chambers at 193 sites and 1,067 coastal, Great Lakes, and inland harbors that directly serve 40 states. Coastal channels and inland and intracoastal waterways maintained by the Army Corps support the Nation's economy and security and contribute to state and local government economic development.

### Strengths

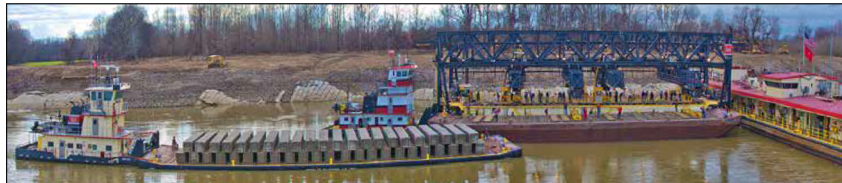
- The U.S. marine transportation industry supports approximately \$2 trillion in commerce annually. Army Corps maintenance dredging avoided at least \$1 billion in additional shipping costs in coastal channels in 2017.
- The Army Corps dredges over 210 million cubic yards of material each year to keep the Nation's waterways navigable. Much of the dredged material is reused beneficially for environmental restoration projects including the creation and restoration of wetlands and other valuable habitat.
- More than 48 percent of consumer goods bought by Americans passes through harbors maintained by the Army Corps.
- The Nation's harbors, channels, and waterways handle almost 2.4 billion tons of commerce annually. Approximately 600 million tons of cargo or 15 percent of domestic freight moves on inland waterways: 52 percent of the Nation's grains, 22 percent of domestic petroleum/products, and 20 percent of coal used for electricity.



A six barge tow tied off on the downstream side of Markland Lock & Dam's 600-foot lock on the Ohio River, 531.5 river miles below Pittsburgh. Towboats push up to 15 barges when navigating the inland waterway system, but a lock can accommodate only six to nine barges at a time. One barge has the capacity to safely transport 1,500 tons of products (photograph: Army Corps, November 2009).

### Challenges

- Many U.S. coastal ports have limited ability to accept post-Panamax cargo vessels which drive international commerce.
- Many inland locks lack the capacity or redundancy for optimal industry barge traffic configuration.
- Continued focus is needed toward operating and maintaining the Nation's harbors, channels, waterways, and infrastructure by using asset management principles that target the greatest economic, environmental, and public safety returns to the Nation, and to reduce unscheduled lock and dam outages.
- An estimated 657 million tons of cargo could potentially be disrupted annually without regular maintenance dredging of major waterways.
- The cost of dredging has increased 12 percent in the last 10 years (adjusted for inflation); this is coupled with ongoing sediment accumulation in coastal navigation channels.
- Intermodal transportation needs require extensive coordination with other agencies and entities.



The Army Corps Vicksburg District's Mat Sinking Unit places articulated concrete mat on the west side of the Mississippi River near Newellton in Tensas Parish, Louisiana at Mile 413.5. This maintenance is done to preserve the Mississippi River's navigation channel, as well as to prevent erosion of levees and other critical flood control structures. The Mississippi Valley Division's Regional Channel Improvement Program completes revetment maintenance annually on critical portions of a 1,000-mile reach of the Mississippi River from Cairo, Illinois, to Head of Passes, Louisiana (photograph: Army Corps, January 2018).





## Reliable Systems Canals and Pipelines



Potholes Canal, Columbia Basin Project, Washington (photograph: Reclamation, September 2018).

Reclamation water conveyance facilities include approximately 8,000 miles of main line canals. Most are open channel and many are lined. Additionally, Reclamation owns inverted siphons and pressurized pipelines used for the conveyance of irrigation water to irrigation districts or water districts for direct delivery. Reclamation's water conveyance systems range in age from over 100 years old to newly-constructed.

- Implementation of Reclamation's new title transfer authority under Public Law 116-9 will streamline the process for water users to take title to canals and other water-related facilities, where appropriate. This will allow Reclamation to focus its operation and maintenance efforts on priority assets while providing water users with more flexibility to meet local or regional needs through operational changes.

### Strengths

- Reclamation conveyance facilities are inspected every three to six years, with the more frequent inspections focusing on canals in urban areas. These inspection programs are designed to ensure safe and reliable operation and to maximize cost-effectiveness by targeting priority maintenance and rehabilitation efforts.
- Nearly 90 percent of Reclamation conveyance facilities are transferred works, where operations, maintenance, and replacement are funded and executed by a non-Federal partner. Reclamation coordinates with the operating partners on inspections for these facilities.
- Specialized inspections are conducted for inaccessible features and specific asset types such as prestressed concrete cylinder pipe (PCCP). Risk analyses and planning scenarios inform proactive management actions.

### Challenges

- Over 1,000 miles of Reclamation's canal sections are classified as urbanized. Reclamation is in the second phase of a Bureau-wide canal condition analysis, an ongoing process using monitoring to prioritize action and enable informed decision making. Targeted risk reduction and investment will be required over the long term to maintain safe and reliable operations.
- Managing Reclamation's inventory of large diameter PCCP requires continued investment. This inventory has been in service for 25 to 60 years with over 40 installations totaling approximately 140 miles of pipe. Corrosion of this material has led to recent sudden failures. Reclamation is taking proactive measures to assess the condition of its full inventory of PCCP through electromagnetic inspection from inside the pipe, conducting associated risk analyses, and conducting planning scenarios for anticipated repairs and replacements.



## Reliable Systems Recreation Facilities

The range of recreation infrastructure includes boat launches, marinas, campground facilities, roads, parking lots, and numerous buildings and structures that require routine inspection, maintenance, repairs, and replacements. These assets provide safe access to recreation for hundreds of millions of visitors without impacting the dynamic multiple missions of the agencies' water-related infrastructure.

The Army Corps is one of the leading Federal providers of outdoor recreation with 270 million visits at more than 400 lake and river projects in 42 states. The Army Corps and non-Federal entities manage 4,865 developed recreation areas on more than 12 million acres.

Reclamation manages almost 8 million acres of land and water, most of which is available for public outdoor recreation. More than 240 developed recreation areas are managed by Reclamation or its non-Federal recreation partners.



Raystown Lake, Seven Points Beach, Labor Day 2018 (photograph: Army Corps, September 2018).



McKay Park/Bend Whitewater Park on the Deschutes River in Bend, Oregon (photograph: Reclamation, July 2018).

### Strengths

- The Army Corps' recreation program provides safe outdoor public access and recreation experiences to serve the needs of present and future generations. The program contributes to the quality of American life, while managing and conserving natural resources consistent with ecosystem management principles and protecting all project mission purposes. These recreation areas are located at existing water resource projects, increasing overall project benefits.
- Reclamation's recreation areas evolved from projects that originally focused on single-purpose agricultural objectives. The multipurpose approach to water resource development includes recreation as an important benefit. Reclamation's recreational infrastructure plays a major role in meeting the increasing public demands for water-based outdoor recreation facilities and opportunities.
- The Army Corps and Reclamation both work with Recreation.gov to share recreation opportunities across the country.

### Challenges

- Recreation facilities (many constructed 50 to 70 years ago) continue to degrade as public demand for recreational opportunities increase.
- Challenges are faced in maintaining boundaries to protect lands and natural resources, such as timber and cultural sites, due to pressure from increased population size, adjacent development, and adjacent private land ownership.
- Effective management requires balancing a range of competing interests, such as accommodating visitors, accommodating economic and commercial uses, conserving environmental and cultural resources, planning for natural resources management, allowing public access, performing trespass abatement and law enforcement, and remediating damage to land resources.



## Reliable Systems Bridges and Roads



Murray Lock and Dam Bridge, Little Rock, Arkansas (photograph: Army Corps, May 2007).

Transportation infrastructure is critical for supporting the range of missions associated with water-related infrastructure, including flood control, hydropower production, navigation, water supply, recreation and environmental protection. Public roads and bridges are key to allowing safe public access to Federal lands for recreation and for providing critical transportation corridors across or along the projects. Both the Army Corps and Reclamation have a significant quantity of bridge and road assets and participate in the Federal Land Transportation program under the Federal Lands Highways Office.

Bridges provide access to project features for maintenance and operations of mission infrastructure, visitation, and general transportation across the projects. The Army Corps has a total of 959 bridges in their inventory; 252 of these bridges are significant public vehicular bridges and are reportable to the National Bridge Inventory (NBI). The

Army Corps has some of the oldest bridges in the Federal inventory; the average age of Army Corps-owned NBI bridges is 55 years, and 21 percent of these bridges are over 75 years old and 5 percent are over 100 years old. Of the Army Corps' NBI inventory of bridges, 5 percent are in poor or worse condition and 17 percent are rated as being in fair or borderline poor condition.

Reclamation bridges provide access to high priority infrastructure, allow for efficient operation and maintenance of Reclamation infrastructure, and provide access to Federal land. Reclamation has a total of 1,436 bridges, of which 286 are significant public vehicular bridges that are reportable to the NBI. The average age of Reclamation's NBI bridges is 53 years; 16 percent are over 75 years old and 3 percent are over 100 years old. In addition, among Reclamation's NBI bridges, 7 percent are in poor or worse condition and 15 percent are in fair condition.



The Philadelphia District's Reedy Point Bridge at the Delaware River (Delaware Route 9), constructed in 1968, spans the Chesapeake and Delaware Canal connecting the Delaware River with the Chesapeake Bay in the states of Delaware and Maryland (photograph: Army Corps, August 2007).



Davis Dam Forebay Bridge at Davis Dam, Arizona. Construction 1949 (photograph: Reclamation, October 2018).

In addition to bridges, the Army Corps and Reclamation maintain more than 10 thousand miles of paved or unpaved public roads. The Army Corps submits an annual inventory on 7,976 miles of public roads that provide access to nearly 12 million acres of land and water, providing access for public use areas, project management offices, and crossings over bridges, dams, and levees. Of the Army Corps' paved road inventory, 30 percent is in fair or poor condition and 45 percent of the unpaved road condition is in fair or poor condition. Reclamation submits an annual public road inventory on 2,780 miles of roads. Reclamation roads provide public access to over 7.7 million acres of public land.

#### Strengths

- For bridges, both Reclamation and the Army Corps employ systematic programs that follow Federal Highway Administration and American Association of State Highway Transportation Officials rating methods. Routine inspections are generally completed every 24 months. Certain bridges also receive more advanced inspections such as fracture-critical inspections or underwater inspections.

- For roads, Reclamation and the Army Corps both use industry standard condition metrics such as Pavement Condition Rating and Pavement Surface Evaluation and Rating for condition assessments, performed on a five-year cycle. For roads within a recreation area, the Army Corps has integrated the manual visual assessment version into operational condition assessments.
- New road design, construction, maintenance, and management technologies and techniques are constantly being developed and both agencies incorporate new methods as possible. The Federal Highway Administration helps support innovations such as the use of 3D engineered models for more accurate and efficient planning and construction; new methods to determine how to best preserve pavement; and tools to make permitting reviews more efficient. New materials and technology, such as increasing the use of permeable paving materials to reduce storm runoff and using recycled materials in pavement, are also helping roads become more reliable and resilient.

#### Challenges

- Narrow roadways at project sites do not always safely accommodate recreational vehicles and pedestrians, especially roadways built on structures.
- Both agencies maintain a large inventory of aging bridges that ensure that mission requirements, public traffic requirements, and basic needs for project access are met. Funding needs are increasing as more bridges become structurally deficient due to the inventory nearing the end of its design life, and capital investments have not always kept pace with deteriorating conditions. Ongoing work also involves the need to fully inventory all bridges (agency-owned or owned by others) that cross project facilities.
- Reclamation is completing its first cycle of road condition assessments. The agency is currently about half way through the first comprehensive condition assessment of public roads as performed by the Federal Highway Administration. The Army Corps is integrating road condition assessments into the Operational Condition Assessment process.





## Keeping Communities Safe Levees



The Ceredo-Kenova Local Protection Project manages flood risk from the Ohio River and Big Sandy River to the cities of Kenova and Ceredo, Wayne County, West Virginia (photograph: Army Corps, circa 2001).



The Lawrenceburg levee system in Dearborn County, Indiana reduces flood risk from the Ohio River to the City of Lawrenceburg, Indiana (photograph: Army Corps, June 2010).

Levees are typically earthen embankments or concrete floodwalls, designed and constructed to contain, control, or divert the flow of water to reduce the risk of temporary flooding. The Army Corps Levee Safety Program portfolio is prioritized by a risk-informed decision making process. One of the Army Corps' primary missions is flood risk management, and levees have been successful in reducing flooding during many events. Although not all levee systems in the Army Corps portfolio are managed by the Army Corps, risk information is provided to local or regional levee managers to inform management improvements and resource prioritization. It is anticipated that this risk information can also be used by levee sponsors to demonstrate and communicate funding needs.

The Army Corps' levee portfolio includes about 2,220 levee systems totaling 14,287 miles in length. Levee sponsors operate and maintain over 2,000 levee systems that make up roughly 70 percent of the length contained in the entire portfolio; the remaining systems are operated and maintained by the Army Corps.

### Strengths

- The Army Corps' Levee Safety program mirrors its Dam Safety program, which prioritizes its portfolio through a risk-informed decision making process.
- The Army Corps is leading efforts to identify best practices in levee safety to help other agencies and the Nation develop procedures for levee safety programs and submit information to the national levee database.

### Challenges

- Changing flood conditions, magnitudes, frequencies, and increased population density can increase risk.
- Resources are increasingly focused on reacting to and recovering from significant natural catastrophic events.
- Challenges are faced in effectively communicating risk to the public.
- Maintenance and replacement needs and costs are increasing. If not addressed, deferred maintenance may result in additional levee safety issues.
- A careful balance is required to manage the safety of facilities while minimizing impacts to the environment.



## Keeping Communities Safe Dam Safety Programs



Anderson Ranch Dam, Idaho. Construction 1941-1950 (photograph: Reclamation, October 2018).

Water-related infrastructure and associated facilities produce a wide range of benefits across multiple business areas. For instance, while the original authorization for a given lock and dam may have focused purely on flood control, the pool created by these assets may also provide recreation and water supply opportunities that influence benefits such as economics, environmental conditions, and quality of life.

The condition of Army Corps and Reclamation infrastructure is regularly evaluated through several programs for the review of operation and maintenance of assets. The Army Corps and Reclamation use risk-informed evaluation methodologies to assess the current asset condition and the consequences of asset failure. Evaluation findings are used to establish a relative risk indicator to support portfolio investment decisions within an authorized project.

As an example of a key review, the Army Corps and Reclamation administer High- and Significant-Hazard Dam Examination programs. The detailed evaluations ensure that high- and significant-hazard dams are operated and maintained properly and effectively, that they will continue to provide project benefits, and that they will not create unacceptable risks to public safety and welfare, or to property and the environment.

Through maintenance management, operational condition assessments, risk assessment, and portfolio analytics, the Army Corps and Reclamation develop risk information that improves inputs to investment decisions. This philosophy ensures a uniform, consistent, and repeatable process to support risk-informed budget decisions that comply with law and appropriations.

Reclamation's world-class Dam Safety Program has established a risk-informed framework to meet the program objectives, requirements of the Reclamation Safety of Dams Act, and the Federal Guidelines for Dam Safety. Risk-informed procedures are used to assess the safety of structures, aid in making decisions to protect the public from the potential consequences of dam failure, assist in prioritizing the allocation of resources, and support justification for risk reduction actions where needed.

Similar to Reclamation, the Army Corps asset management approach makes use of risk evaluations involving determinations of likelihood developed from asset condition ratings and determinations of consequences developed from measures of performance and benefit. A consistent, risk-based approach lends clarity to investment choices.



## Keeping Communities Safe

# Protecting and Restoring the Environment

Water-related infrastructure plays an important role in managing and protecting the Nation's environment and natural resources. Functioning ecosystems serve as "natural infrastructure" that provides many services to our communities. The Army Corps and Reclamation protect and restore this natural infrastructure through several programs.

The Army Corps' Regulatory program evaluates permit applications for construction activities that occur in the Nation's waters, including wetlands. The program is committed to protecting the Nation's aquatic resources and navigation capacity while allowing reasonable development through fair and balanced decisions. The Army Corps' Natural Resource Management program's mission is to manage and conserve natural resources on Army Corps land and waters, consistent with ecosystem management principles, while providing quality public outdoor recreation experiences to serve the needs of present and future generations. The Army Corps promotes awareness of environmental values and incorporates sustainability into its decision processes and culture.

The Army Corps plays a key role in reducing the negative impacts of invasive species on ecosystems and infrastructure. As the primary Federal agency charged with researching invasive aquatic plants, the Army Corps conducts ground-breaking research to support efficient control while minimizing impacts to natural systems.

Reclamation has significant involvement in the protection of natural resources throughout the western United States. These larger efforts include significant portions of river basins, cover numerous fish and wildlife species and their habitats, and extend over the long term, with planning, implementation, and environmental compliance coverage as much as 50 years into the future.

Reclamation's restoration and enhancement activities are aligned with project purposes. Reclamation has identified nine major river restoration efforts that are tracked for various reporting requirements. In some cases, Reclamation projects have authorizing legislation that includes benefits to fish and wildlife as one of the project purposes, such as the construction of fish passage facilities, fish barrier removal, or river and stream-bank protection and enhancement.



Kissimmee River restoration in south Florida, an element of the Everglades Restoration project (photograph: Army Corps, October 2009).



Water hyacinth is an invasive plant that impedes commercial navigation on the McClellan-Kerr Arkansas River during peak summer growing months. The Army Corps manages water hyacinth across the country through integrated pest management to reduce impacts to all project purposes and minimize negative impacts on the environment (photograph: Army Corps, September 2018).

### Strengths

- Restoration activities by the Army Corps and Reclamation often support efforts to protect and recover species listed under the Endangered Species Act, such as salmon.
- Most of the Army Corps' and Reclamation's restoration, enhancement, and land management activities involve partnerships and cooperation with: Federal, state, and local agencies; Tribal Governments; and various non-profit environmental conservation organizations and stakeholders. Partnerships help ensure successful implementation through cost-sharing efforts that provide hundreds of millions of dollars in funding.
- The Army Corps constructs barriers to keep invasive Asian Carp out of the Great Lakes. Reclamation and the Army Corps both support invasive species control across service areas and collaborate with states and other partners to construct watercraft inspection stations to prevent the spread of zebra and quagga mussels, and to prevent infestations which could cause billions of dollars in damage to private and publicly-owned infrastructure such as power plants and water intakes.
- The Army Corps attempts to incorporate natural and nature-based features into its projects in all mission areas through its Engineering with Nature Program.



Fish ladder at John Day Lock and Dam, Columbia River near Rufus, Oregon (photograph: Army Corps, July 2002).



A Reclamation civil engineer with the San Joaquin River Restoration Program in California handles an adult spring-run Chinook salmon (photograph: Reclamation, May 2019).

### Challenges

- Changing landscapes, competing demands for water, and dynamic environmental conditions continue to create challenges in designing, prioritizing, and implementing restoration projects nationwide.
- The demand for restoration projects continues to increase and challenges limited Federal resources to complete, maintain, or initiate new projects.
- Invasive species will continue to threaten infrastructure and ecosystems throughout the United States. Preventing the spread of and early eradication of invasive species is critical to protection of our nation's infrastructure and economy.



River restoration to improve salmon and steelhead habitat. Yankee Fork, Idaho (photograph: Reclamation, November 2012).





Security Response Force members at Hoover Dam. Hoover Dam, Nevada (photograph: Reclamation, November 2017)



## Keeping Communities Safe Facility Security

To protect the public, and to protect the Nation's investment in critical infrastructure, Reclamation has actively integrated security into its facility management practices. By developing and implementing a comprehensive risk assessment program that encompasses infrastructure, information, and personnel, the Security Program supports the overall Reclamation mission to deliver water and power. Comprehensive facility assessments provide facility improvement recommendations which are then prioritized by risk. The Program has made significant facility and procedural improvements through the application of fortification funds. By design, these improvements are often invisible to the visiting public. Reclamation actively engages with the Army Corps in a variety of forums to ensure consistent policies and strategies for infrastructure protection. These forums also help support the greater

Dams Sector community to facilitate resilience of integrated water systems throughout the United States.

The Army Corps applies an integrated risk management approach to facility security. Risk-informed security strategies that address both physical and cyber security threats are provided to ensure the delivery of the Army Corps mission and to secure the Homeland. Through an integrated protection program, the Army Corps implements multiple security and mission assurance programs across the agency. This approach and associated Army Corps policies, along with accompanying U.S. Department of Homeland Security and Department of Defense policies, outline the risk management to integrate and coordinate security programs and facilitate risk-informed decision making in an all hazards environment.



Imperial Diversion Dam, Lower Colorado River. Construction 1936-1938 (photograph: Reclamation, March 2012).



## Protecting Investments and Planning for the Future Inspection and Asset Management Programs

Reliable performance of the Nation's water resources infrastructure is essential to the asset portfolio's ability to deliver safe and dependable service. The Army Corps and Reclamation operate, maintain, and manage more than \$232 billion and \$111 billion of the Nation's water-related infrastructure assets, respectively. From navigation locks and hydropower plants to dams and recreation areas, these assets are a vital part of the Nation's economy, safety, and security, and must be managed in an accountable and responsible manner.

Both agencies carry out this responsibility through a "structured asset management system," which is a risk-informed decision-making approach that assesses the life-cycle of a portfolio of projects within a watershed system. By consciously employing an asset management system, the Army Corps and Reclamation seek to optimize value derived from the portfolio for the benefit of the agencies and their stakeholders. The application of a performance-based, risk-informed lifecycle approach across all water infrastructure systems allows for prioritization of limited funding to make improved investment choices at key decision points throughout the complete life cycle of a project.

Both agencies must balance the competing demands of a single asset having multiple functions. Risk-informed evaluation methodologies are used to address the multi-purpose character of their assets, to include assessing the current condition of an asset and the consequences of its failure in order to establish a relative risk index supporting portfolio investment decisions within an authorized project.

The Army Corps and Reclamation Asset Management Programs use a strategic investment framework to optimize the delivery of benefits to the Nation. The framework allows the application of this same approach to planning for new infrastructure as well as the disposition of infrastructure no longer needed. This framework and the implementation of asset management within each agency is aligned with the Institute of Asset Management's (IAM) Conceptual Model to outline a path forward for the management of assets and the actions necessary to enable success. The IAM is a non-profit professional body of asset management experts that provides guidelines and processes that ensure a comprehensive asset management strategy for an organization. While Reclamation and the Army Corps have successfully managed their assets since inception, adopting a formal asset management approach consistent

with modern practices and techniques is necessary to continue that success and meet current challenges:

- Accurate asset information is needed to support budget requests with clear business cases to support infrastructure investments.
- Comprehensive, long-term planning strategies are needed to safely extend the useful lives of these assets, invest limited funds wisely, enhance public safety, and reduce or mitigate the consequences of infrastructure failure.
- Resources are limited for managing and maintaining assets that are reaching or exceeding their design lives.

Each agency's asset management approach provides common practices for inventorying, assessing, and categorizing assets to help determine each asset's strengths, weaknesses, and value to the system's mission in order to:

- Prioritize lifecycle value at all stages of the project (planning, design, procurement, construction, and operation & maintenance, etc.) to maximize portfolio benefits and minimize cost.
- Maintain asset information corporately so that condition, cost, and resource requirements will be consistently communicated to stakeholders at the national, regional, and local level.

- Systematically monitor and maintain asset condition to prevent, or to diminish to an acceptable degree, the consequences of operational (component or system) failure.
- Structure resource allocation decision-making to optimize value derived from assets, across all agency missions and geographic boundaries.
- Track the execution of the budget in context of the lifecycle plans to ensure planned benefits are realized to the maximum extent possible.
- Provide a strategy for operations, maintenance, capital investment, and disposition decision-making at all levels.
- "Right-size" the asset inventory and balance benefits, consequences of failure, and risk against lifecycle costs.
- Help improve reliability, minimize risk, and meet projected infrastructure demands.
- Formalize business processes that standardize best practices, promote accountability, and predict work requirements.

Consistent asset management approaches throughout the agencies supports the Army Corps and Reclamation in working with Tribal Governments, other Federal agencies, states, local governments, the private sector, and the public to manage infrastructure in a responsible and cost-effective manner.



Arrowrock Dam, Idaho. Construction 1911-1915 (photograph: Reclamation, April 2013).



## Protecting Investments and Planning for the Future

### Water Supply

Addressing future water supply needs will require effective actions for the maintenance, protection, and enhancement of water-related infrastructure. Careful management of the Nation's water supply is critical to limiting water shortages and lessening the impact of droughts.

Army Corps and Reclamation facilities store water to provide municipal and industrial and irrigation water which supports the health of communities, food supplies, and industry. Reclamation supplies water to 10 million acres of farmland and over 140,000 farmers in the western U.S.

The Army Corps has 136 multiple purpose projects that contain storage for water supply in 26 states. These projects provide nearly 10 million acre-feet of water supply storage for municipal and industrial use, sufficient to meet indoor household needs of 101 million people.



Department of the Interior officials visit a project in Reclamation's Southern California Area Office (photograph: Reclamation, April 2012).

The Army Corps and Reclamation foresee the following challenges in addressing water supply needs into the future:

- Increasing populations in the western U.S. have resulted in an increased need to access and use available water supply storage in reservoirs.
- For Reclamation, droughts have made water supply operations and revenues more variable, and resources are required to meet partner needs and maintain public health and safety.
- The availability of water storage can be limited by siltation issues and dam safety restrictions.
- It will be important to continue to expand coordination with partners and stakeholders in order to balance the costs associated with project rehabilitation and operation and maintenance of facilities.

Through programs such as WaterSMART and the Water Infrastructure Improvements for the Nation Act, Reclamation will continue to work cooperatively with Tribal Governments, states, and local entities to implement actions to increase water supply by modernizing existing facilities and building out new infrastructure. WaterSMART supports investments in existing infrastructure to increase water supply reliability by leveraging Federal and non-Federal funding. The WaterSMART Program includes funding for cost-shared grants for water management improvement projects; collaborative efforts in the Basin Study Program to address imbalances between supply and demand; Title XVI Water Reclamation and Reuse projects; collaborative watershed projects through the Cooperative Watershed Management Program; planning and design activities through the Water Conservation Field Services Program; and drought planning and implementation actions to proactively address water shortages. The programs included in WaterSMART are collaborative in nature and work is done in partnership and cooperation with non-Federal entities and other Federal agencies to reduce conflict, facilitate solutions to complex water issues, and stretch limited supplies.





## Protecting Investments and Planning for the Future

### How the Army Corps and Reclamation are Working Together



Hoover Dam, Boulder City, Nevada. Construction 1931-1936 (photograph: Reclamation, May 1996).

The Army Corps and Reclamation have a long history of collaborating on the evaluation, construction, and operation and maintenance of water infrastructure projects with a variety of asset types. The agencies have asset management responsibility for a diverse portfolio of water-related constructed assets. With a number of facilities now over 100 years old, both agencies are responsibly managing aging infrastructure issues.

The Army Corps and Reclamation have multi-purpose asset portfolios which include assets that range in size and complexity, span large geographic areas, and serve a variety of functions. Assets range from simple boat launches to massive dams, extensive levee systems, and locks as long as four football fields. These portfolios include structures

for river navigation, hydropower, irrigation, flood risk management, recreation areas, fish ladders, utility systems, and laboratories.

A Federal Asset Management Working Group was established to link asset management professionals from the Army Corps, Reclamation, the Western Area Power Administration, and the Bonneville Power Administration to collaborate on asset management best practices and solutions to asset management challenges, and to provide a forum to expand the group's knowledge in order for all agencies to maximize the value of the Federal assets.

The Army Corps and Reclamation also coordinate on dam safety programs. Dams must be operated and maintained

in a safe manner, ensured through inspections for safety deficiencies, analyses utilizing current technologies, and corrective actions, if needed, based on current engineering practices. The Army Corps and Reclamation Safety of Dams programs use similar approaches to evaluate and implement actions to resolve safety concerns at dams. Under these programs, the Army Corps and Reclamation complete studies and identify and accomplish needed corrective action on high- and significant-hazard dams. The selected course of action relies on assessments of risks and liabilities with environmental and public involvement input to the decision-making process.

An example of close collaboration on critical infrastructure needs is the Folsom Dam auxiliary spillway, also known as the Joint Federal Project (featured on the cover and on page 2).

The Army Corps and Reclamation also collaborate to address reservoir sedimentation issues. Federal reservoirs provide the largest percentage of water storage volumes in the United States. Monitoring sediment accumulation and changes in the rate of accumulation in these reservoirs is essential to understanding the magnitude and geographic extent of reduced storage volume due to sediment accumulation. Evaluating reservoir vulnerabilities to changes in sedimentation rates is critical to the long-term management and reliable performance of reservoirs. An interdisciplinary and interagency project team was established that utilizes Army Corps regional technical specialists and the Army Corps Committee on Channel Stabilization. The Army Corps developed a baseline report on reservoir sedimentation status and related efforts leverage existing information and maximize knowledge related to reservoir sedimentation and associated impacts. This work supports further interagency collaboration through the U.S. Geological Survey's interagency Reservoir Sedimentation Database.



More than 70 people attended the October 2015 Arrowrock Dam Centennial celebration in Idaho, including officials, senior leaders, and representatives from the Shoshone-Bannock Tribes, Reclamation, the Army Corps, Senator Jim Risch's office, Senator Mike Crapo's office, Representative Mike Simpson's office, and the State of Idaho (photograph: Reclamation, October 2015).

## Moving Forward



The three images above represent the inventory of water-related infrastructure managed by the Army Corps and Reclamation, providing mission-critical power generation, navigation, and water supply benefits to the Nation (photographs: Reclamation, September 2018, left; Army Corps, July 2016, center; Reclamation, September 2018, right).

Over the Nation's history, investments in water-related infrastructure have resulted in a robust inventory of vital, long-term assets. This infrastructure is one of the Nation's most valuable assets and the Army Corps and Reclamation are committed to maintaining, protecting, and improving the infrastructure to ensure continued delivery of power generation, water supply, navigation, public safety, recreation, and other benefits. The agencies will continue to efficiently manage taxpayer funds and will pursue opportunities to respond to evolving influences on water-related infrastructure such as:

- Increases and shifts in population that result in changing water supply and power needs, new recreational demands, changes in potential consequences that affect risk management strategies, and ongoing updates to facility security measures.
- Changes in the magnitudes and frequencies of hydrologic events, resulting in the potential for greater damages to exposed areas and a need for continued and improved monitoring and response capabilities so that water-related infrastructure can provide the Nation with vital benefits long into the future.

### List of Acronyms and Abbreviations:

| Acronym or Abbreviation | Definition                                          |
|-------------------------|-----------------------------------------------------|
| Army Corps              | U.S. Army Corps of Engineers                        |
| IAM                     | Institute of Asset Management                       |
| NBI                     | National Bridge Inventory                           |
| PCCP                    | Prestressed concrete cylinder pipe                  |
| Reclamation             | Bureau of Reclamation                               |
| WaterSMART              | Sustain and Manage America's Resources for Tomorrow |





Hoover Dam hydropower facilities (photograph: Reclamation, October 2011)

## State of the Infrastructure

A Joint Report by the Bureau of Reclamation and the  
U.S. Army Corps of Engineers



US Army Corps  
of Engineers®

[www.usace.army.mil](http://www.usace.army.mil)

EP-25-1-117



BUREAU OF  
RECLAMATION

[www.usbr.gov](http://www.usbr.gov)

Senator MCSALLY. Great, thank you, Mr. Cameron.  
Mayor Meck.

**STATEMENT OF HON. JACKIE A. MECK, MAYOR,  
CITY OF BUCKEYE, ARIZONA**

Mr. MECK. Thank you.

Madam Chair, for the record my name is Jackie Meck. I'm the Mayor of the City of Buckeye which is in central Arizona. I am a Buckeye native. When I was growing up, Buckeye's population was never more than 1,200 and that included every dog, chicken and cat in the community. We now expect over 100,000 people in this year's census count. According to the Census Bureau, Buckeye is the fastest growing city in the country, USA, with a population over 50,000.

As a child, my friends and I spent a lot of time in the Gila River hiking, fishing, and hunting. Back then the river was bordered by tall mesquite, willow and cottonwood trees. In those days we could get near—could not—we could get near the water. Today, we cannot. Salt cedars are invasive species that have proliferated the Gila River and many other rivers in Arizona. They were planted along banks in the 1800s to control erosion. Unfortunately, what was planned to help stabilize the banks of the river has actually put our community, wildlife, critical infrastructure, and important water resource to a growing community in danger.

Salt cedars have congested more than 15,000 acres in and along the Gila River inside the planning areas of the cities of Buckeye, Goodyear and Avondale. In the last 18-mile stretch of the Gila River that we're trying to restore, salt cedars have consumed hundreds of thousands of acre-feet of water, decimated wildlife habitat, fueled wildfires, congested the flow of the river expanding the floodplain and, in the process of all that, created an unsightly monoculture. Each salt cedar tree consumes 200 to 300 gallons a day. Eradicating salt cedars in the 15,000 acres that we are concerned with creates a water resource in the desert with a potential to save 50,000 acre-feet of water. That is enough water for 200,000 households or 600,000 people.

Salt cedars outcompete the native tree species that provide habitat to 150 species of birds. One of those species of birds is endangered, the southwest willow flycatcher. Compounding the problem of salt cedars eliminating wildlife habitat is the tamarisk beetle. The beetle was introduced in Colorado by the Federal Government as a biologic control for salt cedar trees. Unfortunately, the beetle defoliates the salt cedars during the hottest time of the year, exposing the flycatcher's eggs and hatchlings to the sun, killing them. We expect the arrival of the tamarisk beetle in Buckeye within the next two years.

Salt cedars are highly flammable putting surrounding homes and critical public facilities, like the State Route 85 Bridge, in jeopardy. On average, that bridge carries 12,000 vehicles daily traveling to and from San Diego, Yuma, and Rocky Point. The high density of salt cedars has congested the Gila River impeding flood flows and creating the potential for a backwater effect aggravating the impact of an already flood-prone area. Ending floodplain delineations to the Gila River will add 4,500 acres of floodplain in our community.

This will limit development and require costly flood insurance for those landowners who have already built and could threaten the operation and existence of Buckeye's \$40 million wastewater treatment plant which sits inside the floodplain expansion. In the event we lose that wastewater treatment plant, it is electrical, and we will be probably having to dump over 9,000 homes of sewage in the river, the floodwaters, which go to the Colorado River via Yuma and into Mexico.

Ladies and gentlemen, the only solution to this problem is to remove the salt cedars in the channel, restore the land with native vegetation creating habitat for threatened and endangered species before the beetle's arrival, and build levees to protect our homes, farmland, and critical infrastructure.

Members of the Committee, here's what the Federal Government can do: provide best practices and expert advice so we do not have to waste time and money learning from our mistakes; support the DRIP Act, 5100—House Rule 5100 and Senate 2862—the DRIP Act is a bipartisan bill establishing an annual \$10 million competitive grant program with the Department of Agriculture; increase funding for the Army Corps' Continuing Authorities Program under Sections 205 and 206; dedicate resources in the Army Corps; and support methods of expediting, streamlining access to the Nationwide #27 (404) permits so we can remove invasive species themselves.

Madam Chair, that concludes my comments. Thank you for the opportunity to be here this morning.

[The prepared statement of Mr. Meck follows:]

**Jackie A. Meck**  
**Mayor**  
**City of Buckeye**

Madam Chair, for the record my name is Jackie Meck. I am the Mayor of the City of Buckeye, which is in central Arizona. Thank you for having me here today to testify on a matter that is very important to our community.

I am a Buckeye native. When I was growing up, Buckeye's population was never more than 1,200 and that may have included cats, dogs and chickens. Now we expect to have over 100,000 people in this year's census count. According to the Census Bureau, Buckeye is the fastest growing city in the country with a population over 50,000.

As a child, my friends and I spent a lot of our free time in the Gila River hiking, fishing and hunting. Back then, the river was bordered by tall mesquite, willow and cottonwood trees. In those days we could get near the water without much effort. Now, getting to the water is a challenge as very little water remains, and the Salt Cedars are so dense, you cannot move more than a few feet into where they are growing.

Salt Cedars are an invasive species that have proliferated the Gila River and many other rivers in Arizona. They were planted along river banks in the late 1800's to control erosion.

Unfortunately, what was planned to help stabilize the banks of the river has actually put our community, wildlife, critical infrastructure and an important water source to a growing community, in danger.

Salt Cedar trees have congested more than 15,000 acres in and along the Gila River inside the planning areas of the Cities of Buckeye, Goodyear and Avondale. In the 18 mile stretch of the Gila River that we are trying to restore, Salt Cedars have consumed hundreds of thousands of acre feet of water, decimated wildlife habitat, fueled wildfires, congested the flow of the river expanding the floodplain, and in the process of all that created an unsightly monoculture.

Each Salt Cedar tree consumes 200 to 300 gallons of water a day. Eradicating Salt Cedars in the 15,000 acres that we are concerned with, creates a water resource in the desert with the potential to save 50,000 acre-feet of water annually. That is enough water for 200,000 homes or 600,000 people.

Salt Cedars out-compete the native tree species that provide habitat to over 150 species of birds. One of those species of birds is endangered, the Southwest Willow Flycatcher.

Compounding the problem of Salt Cedars eliminating wildlife habitat, is the Tamarisk Beetle. The Tamarisk Beetle was introduced in Colorado by the federal government as a biological control for Salt Cedar trees. Unfortunately the beetle defoliates the Salt Cedars during the hottest time of the year exposing the Flycatcher's eggs and hatchlings to the sun, killing them. Buckeye expects the arrival of the Tamarisk Beetle within the next two years.

Salt Cedars are highly flammable (Figures B & C), putting surrounding homes and critical public facilities, like the State Route 85 Bridge, in jeopardy. On average, that bridge carries 12,000 vehicles daily traveling to and from San Diego, Yuma, and Rocky Point.

The high density of Salt Cedars has congested the Gila River, impeding flood flows and creating the potential for a backwater effect aggravating the impact of an already flood-prone area.

Pending floodplain delineations (Figure A) to the Gila River will add 4,500 acres of floodplain in our community. This will limit development and require costly flood insurance for those land owners who have already built, and could threaten the operation and existence of Buckeye's \$40 million waste water treatment plant (Figure D) which sits inside the floodplain expansion.

Ladies and gentlemen, the only solution to this problem is to -

1. remove the Salt Cedars,
2. restore the land with native vegetation creating habitat for threatened and endangered species before the beetle's arrival, and
3. build levees to protect our homes, farmland, and critical infrastructure.

Members of the committee, here is what the federal government can do to help us -

1. Provide best practices and expert advice so we do not have to learn from our mistakes.
2. Support the DRIP Act (H.R. 5100 & S.2862).  
**The DRIP Act** is a bipartisan bill establishing an annual \$10 million competitive grant program within the Department of Agriculture to alleviate challenges posed by salt cedars and other nonnative plants in riparian areas.
3. Increase funding for the Army Corps' Continuing Authorities Program under Sections 205 and 206 so we can protect our critical infrastructure.
4. Dedicate resources in the Army Corps of Engineers, the Natural Resources Conservation Service, the Bureau of Land Management, and the US Fish and Wildlife Service to support and track projects and assist local agencies through the process; and finally,
5. Support methods of expediting and streamlining access to the Nationwide #27 (404) permits so we can remove invasive species ourselves.

Madam Chair that concludes my comments. Thank you again for the opportunity to be here today.

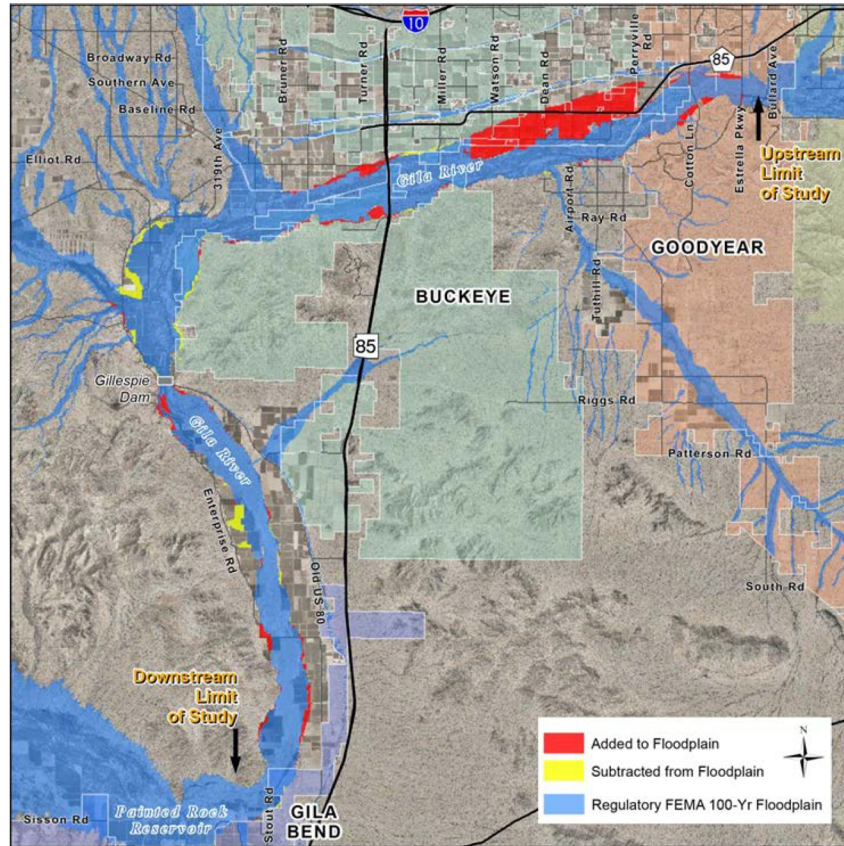


Figure A – Expansion of the Floodplain





Figure B – Salt Cedars burning in the Gila River



Figure C – What's left of the Salt Cedars after a fire and before they rejuvenate.

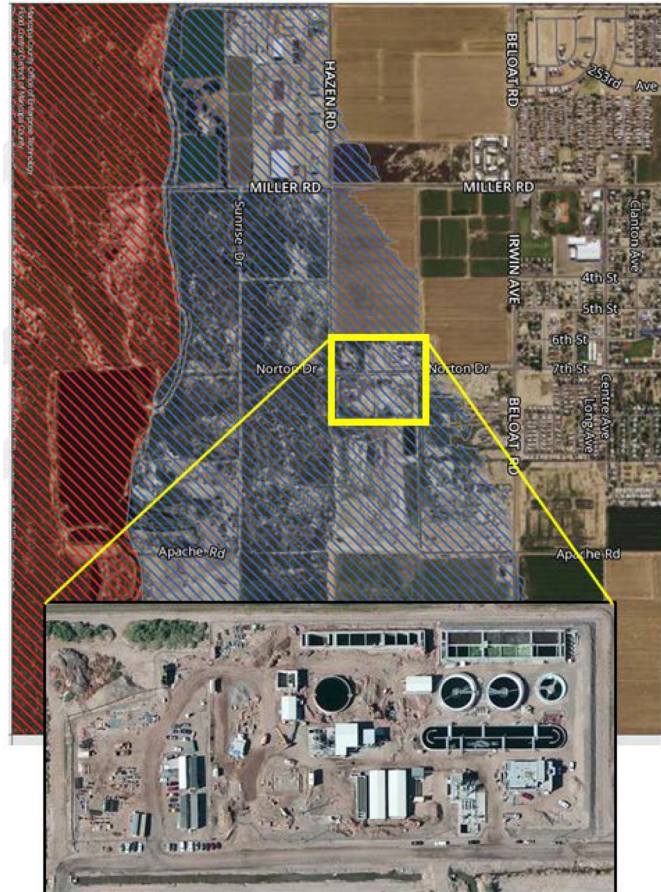


Figure D – Buckeye's \$40M waste water treatment plant inside the new floodplain

Senator MCSALLY. Thank you, Mayor Meck.  
I now want to recognize my colleague, Senator Daines, to introduce Ms. Criswell.

**STATEMENT OF HON. STEVE DAINES,  
U.S. SENATOR FROM MONTANA**

Senator DAINES. Thank you, Chair McSally. It is an honor to have a fellow Montanan here today testifying in front of this Committee.

Ms. Stephanie Criswell serves as the Vice Chair of the Western Invasive Species Council and the Coordinator of the Montana Invasive Species Council. I know this is a very important issue back home. I want to thank you for making the trip from Helena to Washington, DC. In both roles she is working hard to mitigate the threat of invasive aquatic species as well as to enhance the coordination between our communities as well as the state and our neighboring states.

Ms. Criswell, welcome to Washington, DC. I look forward to hearing from you on this important topic. Thank you for coming today.

**STATEMENT OF STEPHANIE CRISWELL, VICE CHAIR, WESTERN INVASIVE SPECIES COUNCIL, AND COORDINATOR, MONTANA INVASIVE SPECIES COUNCIL, MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION**

Ms. CRISWELL. Thank you.

Good morning, Chairwoman McSally, Ranking Member Cortez Masto and members of the Subcommittee. As mentioned, I am Stephanie Criswell, Vice Chair of the Western Invasive Species Council, as well I work for the Montana Department of Natural Resources and Conservation as the Coordinator of the Montana Invasive Species Council. I thank you for the opportunity to testify before you today on the critically important topic of the threat of invasive species to water resources in the West.

Invasive species can harm native aquatic ecosystems as well as the economic sectors that depend upon them, including recreation, agriculture, and hydropower. Three species of particular concern are, again, tamarisk or salt cedar and invasive quagga and zebra mussels. Salt cedars form dense stands in riparian areas blocking access and limiting human use of the waterways for recreation and agriculture. It is poor habitat for many types of wildlife, has minimal forage value for livestock and can increase soil salinity and the frequency and severity of wildfires. The species also consumes large amounts of water which is of concern since so much of the West is already impacted by drought.

Invasive quagga and zebra mussels arrived in North America in the 1980s and have since spread to nearly every major waterway in the U.S. They have caused substantial damage to water delivery systems, hydroelectric facilities, agriculture, recreational boating and fishing, and native wildlife. Once established, invasive mussels are expensive to control and virtually impossible to eradicate. If mussels spread to the Columbia River Basin, the last major uninfested water system in the continental U.S., the control and

mitigation costs to hydropower facilities in that basin alone could reach \$500 million annually.

To help address the threat of aquatic invasive species to Western water resources, the Western Governors' Association, WGA, created the Western Invasive Species Council. The Council's purpose is to enhance coordination between existing state invasive species councils to improve communication and collaboration on regional biosecurity and invasive species control efforts and to advocate for regional needs at the federal level. The Council is an outgrowth of the WGA's Biosecurity and Invasive Species Initiative which focused on the impacts that nuisance species, pests, and pathogens have on ecosystems, forests, rangelands, watersheds, and infrastructure in the West.

Prior to the establishment of the Western Invasive Species Council, state level invasive species coordinators in the West had already been meeting to collaborate on invasive species issues and to develop and implement education and outreach campaigns to inform the public about these threats and how—what they can do to prevent them. Examples of campaigns that have been adopted widely across the West include “Clean. Drain. Dry.” to prevent aquatic invasive species introductions and a new one, “Squeal on Pigs,” the campaign to encourage the public to report feral swine sightings, an emerging threat in the northern part of the Western U.S. The group now formalized as the Western Invasive Species Council will continue and expand its work. The Council will meet in April and plans to discuss ways we can work together to protect our waters from aquatic invasive species.

At the state level, Montana has been working diligently to prevent and manage invasive species. The Montana Invasive Species Council was established in 2014 to serve as a coordinating body and also as part of the Incident Command Team that responded to Montana's 2016 invasive mussel detections. The response team dealt with the immediate threat and developed a long-term plan that resulted in an increase in the program's state budget appropriation from \$1 million per year to \$6 million per year. I'm happy to report that more than three years later, we have not had any additional detections; however, our work's not done. Continued vigilance is necessary.

The Montana Invasive Species Council commissioned a study to estimate economic damages if invasive mussels were to become established in the state. That study estimated damages for direct mitigation and revenue lost to affected stakeholders at \$234 million per year which is roughly just three percent of the current level of Montana's aquatic invasive species funding and not a full accounting of the impacts.

Salt cedar is another threat to Montana because of its impacts on water resources and semi-arid conditions. Montana formed a Salt Cedar Team in 2014 to promote strategic cooperative management and consisted of more than 50 public and private partners. The team began coordinated treatments in 2015 and has been working ever since to manage known infestations on the Bighorn, Yellowstone, Missouri, Musselshell, Judith, and Marias Rivers. The extent of Montana's salt cedar infestation is not known and this will require sustained management efforts.

Thank you for the opportunity to testify on preventing the spread and introduction of all aquatic invasive species as a priority for Western states. It will take coordination, actions, and sustained funding at the local, state, regional, and federal level to continue minimizing and preventing the threat.

Thank you again for having me. I'm happy to respond to any questions you or the Subcommittee members may have.

[The prepared statement of Ms. Criswell follows:]

**Testimony of Stephanie Criswell  
On behalf of the  
Western Invasive Species Council  
and  
Montana Department of Natural Resources and Conservation**

**Before the  
Senate Committee on Energy and Natural Resources**

**Subcommittee on Water and Power**

**Hearing to Examine the Impact of Invasive Species on Bureau of Reclamation Facilities and  
Management of Water Resources in the West**

**March 4, 2020**

**Introduction**

Good morning, Madam Chairwoman McSally, Ranking Member Cortez Masto and Members of the Subcommittee. I am Stephanie Criswell, Vice Chair of the Western Invasive Species Council. As well, I work for the Montana Department of Natural Resources and Conservation as the coordinator of the Montana Invasive Species Council. I thank you for the opportunity to testify before you today on the critically important topic of the threat of invasive species to water resources in the West.

**Water Resources and Invasive Species in the West**

The spread of invasive species affects many aspects of western ecosystems and economies, including western water resources. Invasive species can harm native aquatic ecosystems, as well as the economic sectors they depend upon them, including recreation, agriculture, and hydropower. Three species of particular concern are tamarisk, also known as salt cedar and two species of invasive mussels called quagga and zebra mussels.

Salt cedar forms dense stands in riparian areas, blocking access and limiting human use of the waterways for recreation and agriculture. It is poor habitat for many types of wildlife, has minimal forage value for livestock, and can increase soil salinity and the frequency and severity of wildfires. The extensive root system of salt cedar increases sediment deposition, which narrows the water channel and increases water velocity during flooding. This species also consumes large amounts of water, which is of concern since so much of the West is impacted by drought.



Invasive quagga and zebra mussels arrived in North America in the 1980s, and have since spread to nearly every major waterway in the U.S. They have caused substantial damage to water delivery systems, hydroelectric facilities, agriculture, recreational boating and fishing, and native wildlife. Once established in a waterbody the mussels are expensive to control and virtually impossible to eradicate. The damage to North American power plants and municipal drinking water systems can reach as high as \$1 billion per year. If the mussels spread to the Columbia River Basin — the last major uninfested water system in the continental U.S. — the control and mitigation costs to hydropower facilities in the Basin alone could reach \$500 million annually.

#### **Western Invasive Species Council/Western Governors' Association**

To help address the threat of aquatic invasive species to western water resources, the Western Governors' Association (WGA) comprised of the Governors of the 22 westernmost states and territories, recently created the Western Invasive Species Council. The Council's purpose is to enhance coordination between existing state invasive species councils, to improve communication and collaboration on regional biosecurity and invasive species control efforts, and to advocate for regional needs at the federal level.

The Council is an outgrowth of the WGA's Biosecurity and Invasive Species initiative led by Hawaii Governor, and previous-WGA Chair, David Ige. This year-long Initiative focused on the impacts that nuisance species, pests and pathogens have on ecosystems, forests, rangelands, watersheds and infrastructure in the West, and examined the role that biosecurity plays in addressing these risks.

The outcomes of the Initiative are captured in the Initiative Special Report, which was released in June 2019, and Western Governors' policies on the issue are articulated in WGA Policy Resolution 2019-06, Biosecurity and Invasive Species Management. In these documents, Western Governors identify next steps to improve invasive species management in the West, including:

- New efforts to encourage cross-boundary projects to control invasive annual grasses;
- The launching of a new Invasive Species Data Mobilization Campaign;
- An Invasive Mussel Leadership Forum which was hosted by WGA in Las Vegas, Nevada in August 2019; and
- The creation of the Western Invasive Species Council.

Prior to the establishment of the Western Invasive Species Council, state-level invasive species council coordinators in the West had already been meeting monthly to share information about emerging threats, best practices regarding detections and managing established invasive species, and to develop and implement education and outreach campaigns to inform the public about these threats in a consistent manner across the West. Examples of campaigns that have been adopted across the West include "Clean.Drain.Dry" to prevent aquatic invasive species introductions, "Don't Let it Loose" regarding the release of aquarium pets, "Don't Move

Firewood” regarding forest pests and disease, and “Squeal on Pigs” a campaign to encourage the public to report feral swine sightings, an emerging threat in the West.

While this group has been effective in coordinating on invasive species issues and particularly messaging, there was a general sentiment that states could do more to address invasive species issues in the West if the group formalized and was able to increase capacity. This idea was expressed through panel discussions at the Pacific Northwest Economic Region Summit, the Western Plant Board 100<sup>th</sup> Annual Conference, and through other informal discussions and venues. Through the Western Governors’ Association Invasive Species and Biosecurity Initiative, Governors and state invasive species coordinators saw an opportunity to formalize the group under the auspices of WGA.

That opportunity became a reality in 2019 and the Western Invasive Species Council was established. To date, the Council includes 17 governor-appointed members. Since officially launching in late December, the Council has met twice and has adopted four projects that address specific species and improved data management on a regional level.

The Council will meet in Denver, Colorado, in April 2020 and plans to discuss ways this group can work together to protect our waters from aquatic invasive species.

#### **Montana and Invasive Species**

Western states are economically reliant on water for many sectors including agriculture, tourism, and hydropower. As such, western states have coordinated on preventing and managing aquatic and terrestrial invasive species for years. These partnerships have been key to working to prevent aquatic invasive species introductions into our waters and were important to Montana’s response to invasive quagga and zebra mussel detections in two waterbodies in the fall of 2016.

At the state level, Montana has been working diligently to prevent and manage invasive species. The Montana Invasive Species Council was established in 2014 to serve as a statewide coordinating body to combat invasive species. The Council’s first undertaking was to develop a framework for how Montana manages invasive species. In 2016 that guiding document was critical in Montana’s response to invasive mussel detections.

An objective of the framework was to respond to invasive species using the Incident Command System. The response team dealt with the immediate threat and developed a long-term plan that resulted in an increase in the program’s legislative budget appropriation from \$1 million/year to \$6 million/year. That funding was used to add watercraft inspection stations and increase hours of operation and the operating season, increase early detection monitoring three-fold, and increase overall capacity of the program. I am happy to report that more than three years later, we have not had another detection, and one of the waterbodies impacted has been delisted for containment.

The Montana Invasive Species Council commissioned a study to estimate economic damages if invasive mussels were to become established in the state. That study estimated damages for direct mitigation and revenue lost to affected stakeholders at \$234 million per year. A full accounting of the direct and indirect costs would far exceed that number. The current level of Montana's AIS funding, approximately \$6.5 million annually, is roughly 3 percent of the estimated \$234 million annual mitigation and lost-revenue costs.

In addition to state funding, Montana has relied on federal funding from the Bureau of Reclamation for education and outreach prevention efforts and from the Water Resource and Development Act to enhance Montana's watercraft inspection program.

Salt cedar is a serious threat to Montana because of its impacts on water resources in semi-arid conditions. It is a ferocious consumer of water and can lower the water levels in reservoirs and is often found by springs on old homesteads. It is difficult and expensive to manage on rivers, in part, because access is difficult reaching steep banks requiring a boat or aerial services. The extent of Montana's salt cedar infestation is not known but may be contained with consistent management.

Montana formed a Salt Cedar Team in 2014 to promote strategic, cooperative management of salt cedar. The team consists of more than 50 public and private partners. The team's treatment plan is a cooperative effort between the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the Natural Resources Conservation Service, the Bureau of Land Management, the Missouri River Conservation Districts Council, the Garfield County Conservation District, and private landowners. The team began coordinated treatments in 2015 and is working to manage known infestations on the Bighorn, Yellowstone, Missouri, Musselshell, Judith and Marias rivers.

### **Conclusion**

Thank you for the opportunity to testify. Preventing the spread and introduction of all aquatic invasive species is a priority for western states, and it will take coordination and actions at the local, state, regional, and federal level to continue minimizing and preventing the threat.

Madam Chairwoman McSally, this concludes my prepared remarks. I am happy to respond to any questions you or the other Subcommittee members may have.

Senator MCSALLY. Thanks, Ms. Criswell.  
Mr. Preston, you are up.

**STATEMENT OF MICHAEL PRESTON, EXTERNAL RELATIONS,  
DOLORES WATER CONSERVANCY DISTRICT, AND CHAIR,  
SOUTHWEST BASIN ROUNDTABLE**

Mr. PRESTON. Good morning, Chairman McSally and Ranking Member Cortez Masto. My name is Mike Preston. I manage external relations for the Dolores Water Conservancy District and just came off of 12 years as General Manager. I'm also Chair of the Southwest Basin Roundtable. I'm here to enthusiastically support the Stop the Spread of Mussels Act of 2019.

I'm happy to say that Colorado set up a mandatory inspection program in 2008 and, as of today, there have been no adult mussels detected in Colorado. As Manager of the Water Conservancy District, I think one of the most important things I did over those 12 years was to take decisive action to cooperate with the opportunity to address the quagga mussel problem which is the problem in our reservoir. We have a lot at stake. Seventy thousand irrigated acres, irrigated out of our reservoir. Multiple towns are supplied by water. McPhee Reservoir is center piece of the Colorado Ute Indian Water Rights Settlement which brought drinking water to the tribe for the first time in their history and provided them with water for a very successful 7,600-acre farm. All of this was at risk from mussels.

As I think it's been pretty well laid out, it clogs, you know, pipes, grates, all the kind of infrastructure, driving up maintenance costs by the millions of dollars. It would kill all the aquatic life in McPhee Reservoir and diminish the fishing and all the enjoyment there.

We manage two power plants totaling about 15 megawatts. It would have been very damaging, possibly made them unviable, but certainly drove up the cost. And as it's been stated, there's no real cure.

So when the state set up the program in 2008, we jumped on it right away and what happened over time, originally the state was funding the program, but that became unfeasible. They were using energy severance taxes. Those taxes took a dive, and so we needed—we were in, you know, a situation where we needed to figure out how we were going to move forward. So we formed a four-way cost share agreement. It involved the Bureau of Reclamation who owns the reservoir, the Dolores Water Conservancy District who operates it, the Forest Service who is the recreation manager in the area, and the Parks and Wildlife that do their program.

So, and I've got the—we actually ended up with an MOU in 2017 amongst the four managers of these entities. I have submitted that with my testimony for the record. And once we had kind of a stable cost share arrangement, then we've been trying to turn our attention to helping, protecting from incoming boats and also helping other states that are trying to advance their program.

I guess I would say that one of the important things about the legislation, the Bureau of Reclamation needs to be at the center of these cost share arrangements. I mean, they own these reservoirs. And in our case, we were fortunate to have a manager that was

willing to step forward and take that responsibility kind of in a timely fashion. So this should become standard, although it's very important that partnerships be formed and these are cost share arrangements that allow a sustainable funding on the part of all parties. We spend about \$100,000 a year, \$25,000 per entity. We can all absorb that. Had that fallen to one of us, I don't know if we would have been successful.

I guess the other—I guess in closing, what I would just emphasize, or again, are the stakes. You know, the tourism and recreation economy is really big in our rural part of Colorado and in the enjoyment of people that kind of live in our area. Maintaining our irrigation delivery systems and keeping agriculture economically viable is a constant struggle to any water manager and to any water conservancy district, and we can't afford to risk driving up maintenance costs on our facilities. The water treatment plants, this would devastate water treatment plants, potentially. We had, you know, the degradation of the fishery in the reservoir and the potential risk downstream could lead to ESA intervention at some point.

And then the other thing is Colorado is a headwater state. There our river systems go to, you know, 17 states and so it's really important to everybody downstream as well.

So on behalf of the water users in Colorado and the West, I really urge the passage of the Stop the Spread of Mussels Act of 2019 and appreciate this opportunity to testify.

[The prepared statement of Mr. Preston follows:]

**Testimony of Michael Preston  
External Relations, Dolores Water Conservancy District  
Chair, Southwest Basin Roundtable  
Before the Senate Subcommittee on Water and Power  
Stop the Spread of Invasive Mussels Act of 2019  
March 4, 2020, 10:30AM, Room 366, Dirksen Senate Office Building**

**Honorable Chairman Murkowski, Senator Gardner and Members of the Subcommittee:**

The intent of the adoption of regulations by the State of Colorado requiring mandatory watercraft inspections in 2008 has been validated by the fact that there has never been an adult zebra or quagga mussel found in Colorado to this day. In the end, the inspection and decontamination programs set up by the State of Colorado have been effective because of the partnerships and matching fund arrangements that have taken root across Colorado.

As General Manager of the Dolores Water Conservancy District (DWCD) for twelve years the establishment of a tight mussel inspection and decontamination program is one of the most important steps we have taken to protect McPhee Reservoir. McPhee is the third largest reservoir in Colorado providing irrigation water over 70,000 acres, domestic supplies to multiple towns, and a key element in the fulfillment of the Colorado Ute Indian Water Rights Settlement which brought potable water to the Ute Mountain Ute Tribe, for the first time in their history, while supporting the Tribe's highly successful 7,600 acre Farm and Ranch Enterprise. McPhee also provides flatwater recreation on the lake, boating releases and fish pool releases downstream for sport and native fish.

All of the benefits described above would have been destroyed, damaged and exponentially more costly to maintain, had DWCD not joined with partners to establish a rigorous inspection and decontamination program at McPhee Reservoir.

- We learned that pipes, gates and water infrastructure would clog with mussels that would have cost millions of dollars in a perpetual maintenance fight to keep water flowing.
- We learned that if mussels got in our reservoir, it would kill all of the aquatic life in the lake and put at risk aquatic life in the Dolores River below McPhee, which joins the Colorado River in Utah.
- DWCD operates two power plants totaling 15MW. The power generation capacity of these plants would have cost millions of additional dollars to keep running and could become infeasible.
- We learned that once a reservoir becomes infested, there is no known cure. The mussel affliction and resulting impacts are permanent.



In the early years of the McPhee inspection program, Colorado Parks and Wildlife (CPW) used legislative appropriations of energy severance tax funds as the only funding source. As awareness grew in Colorado that there were pressing needs all over the state, it became clear that funding sources needed to be diversified to meet ever increasing demand. The steps outlined below may be useful to other states and water districts that are stepping forward to protect their reservoirs from mussels:

- A four party MOU was signed in 2017 by the four responsible partners who agreed to equally share the annual cost of inspections, and to adopt a budget and work plan annually to be implemented by a collaborative “technical team.” The signatories include: Dolores Water Conservancy District (reservoir operator), Colorado Parks and Wildlife (inspection program lead), Bureau of Reclamation (reservoir owner), and the San Juan National Forest (recreation manager at McPhee). The program costs about \$100,000 annually and each party has been able to absorb their \$25,000 annual share. A copy of the MOU is included for the record with this testimony. None of the partners could have done this alone.
- As severance tax revenues decreased, Colorado Parks and Wildlife was not in a position to share their portion of the funding. Water users around the state joined CPW in support of the Mussel Free Colorado Act of 2018 passed by the Colorado General Assembly (HB 18-1008). The Act added \$25 to annual boating registration fees and an out-of-state stamp at \$50 a year to raise approximately \$2.4 million a year for the inspection and decontamination program. The Act also stiffened fines for violation, and allowed the State to recoup costs for decontamination of quarantined and impounded boats.

As mussel prevention activities expanded and become more stable in Colorado, we have turned our attention to the need to support mussel control inspections in neighboring states. McPhee Reservoir is a few hours from Lake Powell which is so badly infested, the dead shells cut the feet of those walking the beach and the iconic canyons have a “bathtub ring” of mussel shells clinging to the walls. “Hot boats” coming out of Lake Powell and other States, without adequate mussel protections, are a large and growing threat to the entire State of Colorado, and other states that are trying to keep their reservoirs clean.

The Stop the Spread of Mussels Act of 2019 it vitally needed based on the following lessons learned from the McPhee Reservoir inspection program:

- McPhee Reservoir is owned by the Bureau of Reclamation. The four-way cost share agreement to protect McPhee Reservoir would not have happened if not for a Reclamation Area Manager that understood the threat and was willing to join with the other four partners in addressing the mussel threat. Participation by

Reclamation in these inspection programs should be the standard, so long as other responsible parties are willing to join the effort.

- Partnerships and cost share arrangements are vital. Participation by Reclamation when they own the reservoir is a lynch pin, but other responsible parties need to share in the effort. Mussel prevention calls for an ‘all hands on deck’ approach.
- The need for mussel inspection programs is always going to bump up against resource limits. All parties must work together to expand the funding pie. The Mussel Free Colorado Act passed because it was broadly advocated and got a big push from Colorado Water Congress. Each state and conservancy district needs to apply their own local institutions to this challenge while working together to expand capacity. The Stop the Spread of Mussels Act of 2019 can provide vital leverage for Reclamation to play a supporting role, and in some cases, a convening role.

I would like to close my testimony by imagining what life would be like in Colorado had we not taken the decisive actions that have resulted in not a single adult mussel being found in Colorado.

- Our tourism and recreation economy and the enjoyment of people who live in our communities for recreational opportunities would be greatly diminished, had we not made this effort.
- Maintaining our water storage and irrigation delivery systems, while keeping agriculture economically viable, is an ongoing challenge. The added costs of a mussel infestation would have been devastating for DWCD and the farmers we supply water to.
- With regard to domestic water supplies, a mussel infestation would have dramatically driven up the cost of operating and maintaining water treatment plants, while degrading water quality and availability.
- The degradation of the sports fishery would have been compounded by impacts on sensitive native fish which could have driven ESA intervention.
- Colorado is a headwaters state. The damage done to the river systems originating in the Great Lakes region foreshadow the potential impacts on the river systems that flow out of Colorado.

On behalf of water users in Colorado and the West, I urge passage by the United States Senate and the House of Representatives of the Stop the Spread of Mussels Act of 2019.

**MEMORANDUM OF UNDERSTANDING**

**Between the  
Dolores Water Conservancy District,**

**And  
Colorado Parks and Wildlife, Southwest Region,**

**And The  
U. S. Bureau of Reclamation, Western Colorado Area Office,**

**And the  
USDA Forest Service, San Juan National Forest  
Forest Service #16-MU-11021300-056**

This MEMORANDUM OF UNDERSTANDING (MOU) is hereby made and entered into by and between the Dolores Water Conservancy District, hereinafter referred to as "the District", Colorado Parks and Wildlife, Southwest Region, hereinafter referred to as "CPW", the U.S. Bureau of Reclamation, hereinafter referred to as "Reclamation", and the United States Department of Agriculture (USDA), Forest Service, San Juan National Forest, hereinafter referred to as the "U.S. Forest Service".

Title: Memorandum of Understanding for the Prevention of Aquatic Nuisance Species at McPhee Reservoir in Southwest Colorado.

- I. PURPOSE:** The purpose of this MOU is to document the cooperation between the parties in the prevention of aquatic nuisance species infection at McPhee Reservoir, in accordance with the following provisions.
- II. STATEMENT OF MUTUAL BENEFITS AND INTERESTS:**

The Dolores Water Conservancy District (District) was created under the laws of Colorado to support, organize, and manage the Dolores Project (Project) to develop local water resources under contract with the United States through the Bureau of Reclamation. These District responsibilities include the operation and maintenance of all Project facilities appurtenant to McPhee Reservoir. Those facilities are at risk to the detrimental effects of invasive aquatic nuisance species.

Colorado Parks and Wildlife (CPW) was created under the laws of the State of Colorado and is responsible to perpetuate the fish and wildlife populations of the State and to provide enjoyable and sustainable outdoor recreation opportunities. Aquatic nuisance species are deemed detrimental to aquatic wildlife and their habitats and to water-based recreation across the state. CPW carries out the policies and programs of its Commission.

The U.S. Forest Service under the laws of the United States and the regulations of the Secretary of Agriculture is responsible for managing recreation and the natural resources on federal lands under U.S. Forest Service jurisdiction, including wildlife and fish habitat, and in a manner that is sustainable and will not impair the productivity of the land. Aquatic nuisance species would be detrimental to aquatic life that are an important component in McPhee Reservoir recreation management, and could damage aquatic life and U.S. Forest Service natural and recreational resources below McPhee Reservoir.

The U.S. Bureau of Reclamation (Reclamation) investigated, planned, constructed and contracted for the operation and maintenance of the Dolores Project under the Act of Congress of June 17, 1902 (32 Stat. 388), and acts amendatory thereof or supplementary thereto, particularly the Colorado River Basin Act of April 11, 1956 (P.L. 90-537). The Dolores Project includes two hydropower facilities providing power to the Colorado River Storage Project that both operate appurtenant to McPhee Reservoir and therefore at risk from the detrimental effects of invasive aquatic nuisance species.

The District, CPW, Reclamation, and the U.S. Forest Service, acknowledge that all parties have important management responsibilities outside of and related to the management of aquatic nuisance species. These agencies will endeavor to work cooperatively to fulfill these responsibilities for the benefit and enjoyment of the people of Colorado and the United States.

In consideration of the above premises:

### **III. THE PARTIES SHALL:**

- A. Maintain close cooperation as needed in matters of mutual interest, including management of flat water recreation and aquatic nuisance species at McPhee Reservoir for the benefit of irrigation; municipal and industrial water use; fish and wildlife; and production of hydroelectric power, all in keeping with the needs of the District, U.S. Forest Service multiple use principles and the mission of CPW.
- B. Recognize the needs of the other parties and coordinate with and provide information regarding policies, plans, programs, and projects that affect flat water recreation and aquatic nuisance species management at McPhee Reservoir in a timely manner.
- C. Consult and confer with the other parties, by providing input to the development of plans, management strategies, objectives, and standards and guidelines, where they might affect flat water recreation and aquatic nuisance species management at McPhee Reservoir.
- D. Explore cost-effective methods of managing flat water recreation and aquatic nuisance species during peak and off-peak seasons and hours.

- E. Recognize the need for and convey cohesive messages to the public about the potential damages caused by aquatic nuisance species to water infrastructure, natural resources and recreation and the value of sound management techniques that prevent the spread of aquatic nuisance species.

**IV. IT IS MUTALLY AGREED BY THE PARTIES THAT:**

- A. INTERAGENCY COORDINATION MEETINGS. Local coordination meetings will be held periodically (typically annually) between the signatories and appropriate staff to exchange information, discuss projects, and coordinate activities of mutual interest. Each agency shall appoint an individual and alternate to coordinate on routine matters at the annual coordination meetings.
- B. TECHNICAL GROUP. Each party may appoint representative(s) to serve on a technical group to collaborate on issues of concern in regards to Aquatic Nuisance Species Management at McPhee Reservoir.
- C. TERMINATION. Any of the parties, in writing, may terminate this MOU in whole, or in part, at any time before the date of expiration.
- D. NONBINDING AGREEMENT. This MOU creates no right, benefit, or trust responsibility, substantive or procedural, enforceable by law or equity. The parties shall manage their respective resources and activities in a separate, coordinated and mutually beneficial manner to meet the purpose(s) of this MOU. Nothing in this MOU authorizes any of the parties to obligate or transfer anything of value.

Specific, prospective projects or activities that involve the transfer of funds, services, property, and/or anything of value to a party requires the execution of separate agreements and are contingent upon numerous factors, including, as applicable, but not limited to: agency availability of appropriated funds and other resources; cooperator availability of funds and other resources; agency and cooperator administrative and legal requirements (including agency authorization by statute); etc. This MOU neither provides, nor meets these criteria. If the parties elect to enter into an obligation agreement that involves the transfer of funds, services, property, and/or anything of value to a party, then the applicable criteria must be met. Additionally, under a prospective agreement, each party operates under its own laws, regulations, and/or policies, and any Forest Service obligation is subject to the availability of appropriated funds and other resources. The negotiation, execution, and administration of these prospective agreements must comply with all applicable law.

Nothing in this MOU is intended to alter, limit, or expand the agencies' statutory and regulatory authority.

E. PRINCIPAL CONTACTS. Individuals listed below are authorized to act in their respective areas for matters related to this MOU.

| <b>Dolores Water Conservancy District</b>                                                                                                                                          | <b>Colorado Parks and Wildlife</b>                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name: Michael Preston, General Manager<br>Address: 80 South Cactus<br>City, State, Zip: Cortez, CO<br>Telephone: 970-565-7562<br>FAX: 970-565-0870<br>Email: mpreston@frontier.net | Name: Patricia D. Dorsey<br>Address: 415 Turner Drive<br>City, State, Zip: Durango, CO 81303<br>Telephone: 970-375-6702<br>FAX:<br>Email: patt.dorsey@state.co.us |

| <b>Bureau of Reclamation</b>                                                                                                                                                        | <b>U.S. Forest Service</b>                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name: Ed Warner, Area Manager<br>Address: 185 Suttle St., Suite 2<br>City, State, Zip: Durango, CO 81303<br>Telephone: 970-385-6500<br>FAX: 970-385-6539<br>Email: lwarner@usbr.gov | Name: Mark Lambert, Program Manager<br>Address: 15 Burnett Court<br>City, State, Zip: Durango, CO 81301<br>Telephone: 970-385-1240<br>FAX: 970-375-2331<br>Email: mblambert@fs.fed.us<br><br>Name: Beth Redmond,<br>Grants Management Specialist Address: 15<br>Burnett Court<br>City, State, Zip: Durango, CO 81301<br>Telephone: 970-385-1259<br>FAX: 970-385-1243<br>Email: bredmond@fs.fed.us |

- F. NOTICES. Any communications affecting the operations covered by this MOU given by the "the Parties" is sufficient only if in writing and delivered in person, mailed, or transmitted electronically by e-mail or fax, as follows:

To the Parties, at all of the Parties' addresses shown in the MOU or such other address designated within the MOU.

Notices are effective when delivered in accordance with this provision, or on the effective date of the notice, whichever is later.

- G. PARTICIPATION IN SIMILAR ACTIVITIES. This MOU in no way restricts the "the Parties" from participating in similar activities with other public or private agencies, organizations, and individuals.
- H. ENDORSEMENT. Any of the cooperator's contributions made under this MOU do not by direct reference or implication convey U.S. Forest Service endorsement of the cooperator's products or activities.
- I. MEMBERS OF U.S. CONGRESS. Pursuant to 41 U.S.C. 22, no U.S. member of, or U.S. delegate to, Congress shall be admitted to any share or part of this agreement, or benefits that may arise therefrom, either directly or indirectly.
- J. FREEDOM OF INFORMATION ACT (FOIA). Public access to MOU or agreement records must not be limited, except when such records must be kept confidential and would have been exempted from disclosure pursuant to Freedom of Information regulations (5 U.S.C. 552).
- K. TEXT MESSAGING WHILE DRIVING. In accordance with Executive Order (EO) 13513, "Federal Leadership on Reducing Text Messaging While Driving," any and all text messaging by Federal employees is banned: a) while driving a Government owned vehicle (GOV) or driving a privately owned vehicle (POV) while on official Government business; or b) using any electronic equipment supplied by the Government when driving any vehicle at any time. All cooperators, their employees, volunteers, and contractors are encouraged to adopt and enforce policies that ban text messaging when driving company owned, leased or rented vehicles, POVs or GOVs when driving while on official Government business or when performing any work for or on behalf of the Government.
- L. DEBARMENT AND SUSPENSION. The Cooperator shall immediately inform the U.S. Forest Service if they or any of their principals are presently excluded, debarred, or suspended from entering into covered transactions with the federal government according to the terms of 2 CFR Part 180. Additionally, should the cooperator or any of their principals receive a transmittal letter or other official Federal notice of debarment or suspension, then they shall notify the U.S. Forest Service without undue delay. This applies whether the exclusion, debarment, or suspension is voluntary or involuntary



M. **MODIFICATIONS.** Modifications within the scope of this MOU must be made by mutual consent of the parties, by the issuance of a written modification signed and dated by all properly authorized, signatory officials, prior to any changes being performed. Requests for modification should be made, in writing, at least 30 days prior to implementation of the requested change.

N. **COMMENCEMENT/EXPIRATION DATE.** This MOU is executed as of the date of the last signature and is effective through 12/31/2020 at which time it will expire.

O. **AUTHORIZED REPRESENTATIVES.** By signature below, each party certifies that the individuals listed in this document as representatives of the individual parties are authorized to act in their respective areas for matters related to this MOU.

In witness thereof, the parties hereto have executed this MOU as of the last date written below.

V. **SIGNATURES**

  
 PATRICIA D. DORSEY, Southwest Regional  
 Manager, Colorado Division of Parks and Wildlife  
 Date 22 Sept 16

  
 MICHAEL F. PRESTON, General Manager, Dolores  
 Water Conservancy District  
 Date 9/22/16

  
 ED WARNER, Area Manager, Western Colorado  
 Office, U.S. Bureau of Reclamation  
 Date 9/22/16

  
 RUSSELL M. BACON, Forest Supervisor  
 U.S. Forest Service, San Juan National Forest  
 Date 9/22/16

The authority and format of this agreement have been reviewed and approved for signature.

  
 BETH REDMOND  
 U.S. Forest Service, San Juan National Forest  
 Date 9/29/2016

Senator MCSALLY. Thank you, Mr. Preston.  
Ms. Regan, you are recognized.

**STATEMENT OF JULIE W. REGAN, CHIEF OF EXTERNAL AFFAIRS & DEPUTY DIRECTOR, TAHOE REGIONAL PLANNING AGENCY**

Ms. REGAN. Thank you.

Good morning, Chairwoman McSally, Ranking Member Cortez Masto, members of the Subcommittee. I am Julie Regan, Chief of External Affairs and Deputy Director of the Tahoe Regional Planning Agency. Our organization was formed by an interstate compact between California and Nevada and ratified by Congress 50 years ago. Our mission is to protect Lake Tahoe, the second deepest lake in the United States and one of the clearest large lakes in the world. I appreciate the opportunity to join this panel and address the Subcommittee on the pressing issue of invasive species.

Our spectacular lake faces serious threats from the spread of aquatic invasive species, and I'd like to share what we're doing to combat this environmental and economic hazard. Lake Tahoe straddles the States of California and Nevada high in the Sierra Nevada mountain range sitting at more than 6,200 feet of elevation. Nearly 80 percent of our land is owned by the Federal Government and managed by the U.S. Forest Service. Our year-round population of 60,000 swells by 15 million people annually. While we're a snow sports destination, summer is actually our peak season as visitors flock to our beaches and outdoor recreational opportunities. Boating and other water sports are a time-honored tradition at Lake Tahoe and play a vital role in our region's annual \$5 billion economy.

When quagga mussels were first detected in Lake Mead in 2007, our agency recognized the immediate threat to the lake, our drinking water supply, and economy. We mobilized to convene a 40-person organization to a partnership to create the boat inspection program. This program has grown to be a national model and, to date, has prevented quagga mussels from entering Lake Tahoe. We have held this line with our partners by conducting nearly 90,000 mandatory watercraft inspections over the last 12 years with an unprecedented level of support from the boating community. We are united around a common understanding should these invasive mussels take hold in Tahoe's waters, their impacts would be nothing short of catastrophic.

Invasive mussels starve native species of nutrients that they need to survive. Both quagga and zebra mussels are prolific procreators quickly encrusting docks, boats, sneakers, and drinking water infrastructure. Their razor-like shells can carpet shorelines making walking barefoot on the beach virtually impossible. We've had some close calls with quagga mussels over the years. One time our inspectors intercepted a boat infested with invasives. An undetected crack in the boat's pontoon was allowing water to seep in. Inspectors found quagga and zebra mussels and other aquatic plants and snails, a glaring example of how easy it is for an unsuspecting boater to introduce these invaders into an ecosystem.

While powerboats get much of the attention, local kayakers, paddleboarders and fishermen can also unintentionally introduce

invasives. A local non-profit, the League to Save Lake Tahoe, sponsors an “Eyes on the Lake” program which incorporates citizen-based science where paddlers can monitor while they recreate. The League, also known as “Keep Tahoe Blue,” has trained more than 3,000 people to help protect our clean waters.

While the comprehensive programs we have in place at Tahoe are keeping new invasives out of our waters, unfortunately, other aquatic invasives entered decades ago. Invasive plants such as watermilfoil and curly-leaf pondweed and the Asian clam also litter our beaches. We have projects underway to treat these existing invasives before they ruin our entire lake. Over the last ten years our basin-wide partnership has treated nearly 90 acres, fully eradicating invasive plants in some areas. One of the largest projects actively underway is in an area called the Tahoe Keys. This 1,100-acre waterfront community is infested with invasive milfoil and pondweed creating serious environmental and human health concerns.

All of the programs I’ve mentioned are crucial to preventing and controlling aquatic invasive species at Lake Tahoe. Through public-private partnership of our environmental improvement program, we’ve brought funds to bear in this fight from federal, state, local and private sources. A local non-profit called the Tahoe Fund has tapped private donors to support invasive species projects raising thousands of dollars to leverage public funds.

In 2016, Congress reauthorized the Lake Tahoe Restoration Act delivering crucial federal leadership and funding that has been fully leveraged to maximize project impact. The U.S. Fish and Wildlife Service is a key partner in the federal family serving as the lead agency along with my organization for federal investment under the Act.

Lake Tahoe continues to set records for warming temperatures making us even more vulnerable to invasive species. We will continue to rely on what we call “epic collaboration” to combat these threats in the future. As we like to say, we are all in this boat together. What we’ve accomplished thus far at Lake Tahoe demonstrates what is possible—a collaborative proving ground for sound science and commonsense policies. Realizing what is possible in the future demands that we continue to paddle in the same direction so that we can preserve Lake Tahoe—what Mark Twain once famously called, “the fairest picture the whole earth affords.”

Thank you.

[The prepared statement of Ms. Regan follows:]

**Testimony for Julie W. Regan,  
Chief of External Affairs & Deputy Director, Tahoe Regional Planning Agency**

Good morning Chairwoman McSally, Ranking Member Cortez Masto, and members of the subcommittee, I am Julie Regan, Chief of External Affairs and Deputy Director of the Tahoe Regional Planning Agency. Our organization was formed by an interstate Compact between California and Nevada and ratified by Congress 50 years ago. Our mission is to protect Lake Tahoe, the second deepest lake in the United States and one of the clearest large lakes in the world. For those of you who have visited, I'm sure you'd agree that Lake Tahoe induces a sense of majesty and is truly a national treasure.

I appreciate the opportunity to join this panel and address the subcommittee on the pressing issue of invasive species. Our spectacular lake faces serious threats from the spread of aquatic invasive species and in my brief time this morning, I'd like to share what we're doing to combat this environmental and economic hazard.

Lake Tahoe straddles the states of California and Nevada, high in the Sierra Nevada mountain range sitting at more than 6,200 feet of elevation. Nearly 80 percent of our land is owned by the federal government and managed by the U.S. Forest Service. Our small year-round population of 60,000 swells by 15 million people annually. While we're a snowsports destination, summer is actually our peak season as visitors flock to our beaches and outdoor recreational opportunities. Boating and other water sports are a time-honored tradition at Lake Tahoe and play a vital role in our region's \$5 billion annual economy.

When quagga mussels were first detected in Lake Mead, Nevada in 2007, our agency recognized the immediate threat to the lake, our drinking water supply, and economy. We mobilized to convene a 40-organization partnership to create a boat inspection program. This program has grown to be a national model, and to date, has prevented quagga mussels from entering Lake Tahoe. We have held this line by conducting nearly 90,000 mandatory watercraft inspections over the last 12 years with an unprecedented level of support from the boating community.

We are united around a common understanding: should these invasive mussels take hold in Tahoe's waters, their impacts would be nothing short of catastrophic.

Invasive mussels starve native species of nutrients they need to survive. Both quagga and zebra mussels are prolific procreators, quickly accumulating on underwater surfaces, encrusting docks, boats, and drinking water infrastructure. Their razor-like shells can carpet shorelines, making walking barefoot on the beach virtually impossible.

We've had some close calls with quagga mussels over the years. One time our inspectors intercepted a boat infested with multiple invasives. An undetected crack in the boat's pontoon was allowing water to seep in. Inspectors found adult quagga and zebra mussels, and other aquatic plants and snails – a glaring example of how easy it is for an unsuspecting boater to introduce these invaders into an ecosystem.

While powerboats get much of the attention, local kayakers, paddle boarders, and fishermen can also unintentionally introduce invasives. A local non-profit, the League to Save Lake Tahoe, sponsors an "Eyes on the Lake" program which incorporates citizen-based science, where paddlers can monitor while they recreate. The League, also known as "Keep Tahoe Blue" has trained more than 3,000 people to help protect our clear waters.

While the comprehensive programs we have in place at Tahoe are keeping new invasives out of our waters, unfortunately, other aquatic invaders entered decades ago. Invasive plants such as watermilfoil and curlyleaf pondweed are choking waterways in marinas and other shallow areas and a small bivalve called the Asian clam also litters our beaches. We have projects underway to treat these existing invasives before they ruin the entire lake. Over the last 10 years, our basin-wide partnership has treated nearly 90 acres, fully eradicating invasive plants in some areas. One of the largest projects actively underway is in an area called the Tahoe Keys. This 1,100 acre waterfront community is infested with invasive milfoil and curlyleaf pondweed creating serious environmental and human-health concerns. A collaborative stakeholder process is in the works to find solutions.

All of the programs I've mentioned are crucial to preventing and controlling aquatic invasive species at Lake Tahoe. Through the public-private partnership of our Environmental Improvement Program, we've brought funds to bear in this fight from federal, state, local, and private sources. A local non-profit called the Tahoe Fund has tapped private donors to support invasive species projects raising thousands of dollars to leverage public funds.

In 2016, Congress reauthorized the Lake Tahoe Restoration Act, delivering crucial federal leadership and funding that has been fully leveraged to maximize project impact. The U.S. Fish and Wildlife Service is a key partner in the federal family, serving as the lead agency along with my organization for federal investment under the Restoration Act.

Lake Tahoe continues to set records for warming temperatures, making us even more vulnerable to invasive species. We will continue to rely on what we call "epic collaboration" to combat these threats in the future. As we like to say, we are all in this boat together. What we've accomplished thus far at Lake Tahoe demonstrates what is possible -- a collaborative proving ground for sound science and common sense policies. Realizing what is possible in the future demands that we continue to paddle in the same direction so that we can preserve Lake Tahoe - what Mark Twain once famously called, "the fairest picture the whole world affords."

-END-

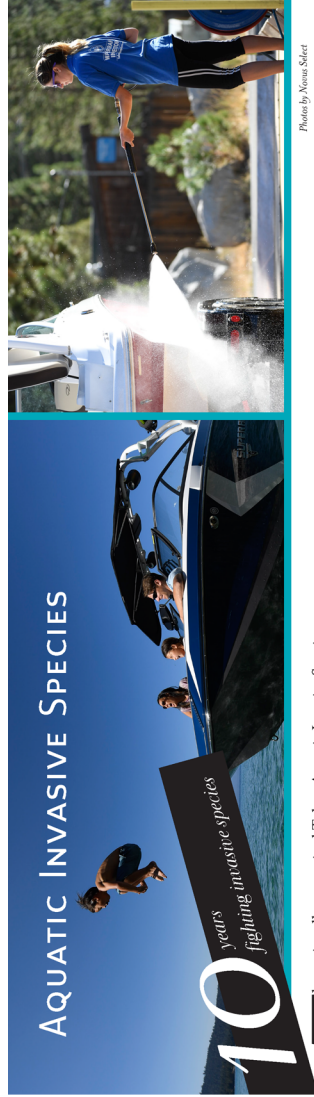


Photo by Nissa Selet

The nationally recognized Tahoe Aquatic Invasive Species (AIS) Program has prevented the introduction of quagga and zebra mussels and the spread of other harmful species into Lake Tahoe since 2008. The program, led by TRPA and the Tahoe Resource Conservation District, also implements projects to control and reduce populations of invasive plants, clams, and warm water fish through a science-based, prioritized plan. The treatment of these AIS populations helps to improve lake clarity and restore habitat for native species. Managers and scientists continue to work together to monitor lake conditions and complete research to prevent the introduction and spread of invasive species in Lake Tahoe.

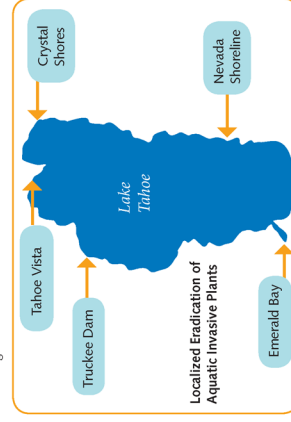
#### 10 YEAR PROGRAM ACCOMPLISHMENTS

- No new AIS invasions detected in Lake Tahoe.
- Inspected over 70,000 boats for AIS.
- Intercepted hundreds of boats carrying AIS.
- Treated over 60 acres of lake for aquatic invasive species.
- Over 50 private and public partners invested in preventing and treating AIS in Lake Tahoe.



#### FUTURE PRIORITIES

- Contain and treat invasive plants in the Tahoe Keys.
- Implement a lake-wide invasive species monitoring plan in partnership with nearshore water quality monitoring.
- Explore emerging techniques to treat existing invasive species such as Asian clams and Eurasian watermilfoil.
- Enhance implementation of the western regional AIS inspection mobile application.
- Continue to work with the boat industry to promote innovative boat design to lower the risk of AIS.





Implementation Plan for the  
Control of Aquatic Invasive Species within Lake Tahoe

by

Marion E. Wittmann, Ph.D. & Sudeep Chandra, Ph.D.

University of Nevada Reno  
Department of Biology



In collaboration with

The Lake Tahoe Aquatic Invasive Species Coordination Committee

June 2, 2015

*Suggested citation:* Wittmann, M.E. and Chandra, S. 2015. Implementation Plan for the Control of Aquatic Invasive Species within Lake Tahoe. Lake Tahoe AIS Coordination Committee, June 2, 2015. Reno, NV. 51 pp.

## TABLE OF CONTENTS

|                                                                                       |           |
|---------------------------------------------------------------------------------------|-----------|
| <b>Executive Summary .....</b>                                                        | <b>3</b>  |
| <b>Background and Aquatic Invasive Species Problem Statement .....</b>                | <b>5</b>  |
| <b>Current Efforts in the Tahoe Basin related to prevention .....</b>                 | <b>8</b>  |
| <b>The "Lake Tahoe AIS Management Plan": History and Status .....</b>                 | <b>8</b>  |
| <b>The need for a Lake Tahoe AIS "Implementation Plan" .....</b>                      | <b>9</b>  |
| Objectives and evaluation of the Implementation Plan .....                            | 9         |
| Identify invasive species that are candidates for control efforts in Lake Tahoe ..... | 10        |
| History of Tahoe invasions, control activities and management conclusions .....       | 11        |
| Aquatic Plants .....                                                                  | 11        |
| Eurasian watermilfoil .....                                                           | 11        |
| Curlyleaf pondweed .....                                                              | 17        |
| Invertebrates .....                                                                   | 19        |
| Asian clam .....                                                                      | 19        |
| Signal crayfish .....                                                                 | 23        |
| Mysid shrimp .....                                                                    | 26        |
| Warm water fish .....                                                                 | 27        |
| Amphibians .....                                                                      | 31        |
| American Bullfrog .....                                                               | 31        |
| <b>Prioritization of species, locations for control and recommended actions .....</b> | <b>34</b> |
| Introduction .....                                                                    | 34        |
| Aquatic invasive species management groupings .....                                   | 34        |
| Site prioritization for invasive aquatic plants and warm water fish removal .....     | 35        |
| Methods of the ecologically based site prioritization model .....                     | 36        |
| Recommendations for species in other management groups .....                          | 42        |
| Recommended efficacy monitoring .....                                                 | 43        |
| Knowledge Gaps .....                                                                  | 44        |
| Next steps .....                                                                      | 47        |
| <b>Acknowledgements .....</b>                                                         | <b>48</b> |
| <b>References .....</b>                                                               | <b>49</b> |

### Executive Summary

Substantial changes to the economy, water quality, aesthetic value, and recreational pursuits are currently occurring in part due to the unwanted impacts of aquatic invasive species (AIS). In 2009 and again in 2014, the Aquatic Nuisance Species Task Force (ANS Task Force), an inter-governmental organization dedicated to preventing and controlling aquatic nuisance species, approved a Lake Tahoe Region Aquatic Invasive Species Interstate Management Plan (LTAIS Management Plan). The LTAIS Management Plan identifies threats and quantifies economic damages posed by AIS, develops management strategies for AIS in the Tahoe Basin, and supports one of the nation's most rigorous recreational boat inspection programs.

This current document, referred to as "the implementation plan" is intended as an extension of the LTAIS Management Plan and should be used as a guide for resource managers at Lake Tahoe to identify and prioritize species, specific locations and strategies for the implementation of AIS removal and control. The information provided here is intended to guide the prioritization of control strategies and is not intended to be a comprehensive treatment of all issues related to AIS in the Lake Tahoe region. The implementation plan supports the goals of the LTAIS Management plan by providing the following:

1. An identification of AIS that are candidates for control in Lake Tahoe,
2. A comprehensive description of the history of aquatic invasions and control activities in Lake Tahoe or elsewhere. Based on this information, an assessment of feasible control or management options are identified by species group,
3. An ecologically based framework to prioritize (a) species and (b) specific sites for control or removal efforts in Lake Tahoe over 3-5 year period,
4. Efficacy monitoring recommendations,
5. Identification of key knowledge gaps, and
6. Next steps related to research and management of AIS.

This implementation plan was formally reviewed by an external expert panel comprised of individuals with extensive academic, management or regulatory backgrounds concerning AIS. This implementation plan was also reviewed by members of the Lake Tahoe Aquatic Invasive Species Coordination Committee (LTAISCC). The LTAISCC is a bi-state collaborative of local, state and federal agencies, research institutions and stakeholder groups which developed the LTAIS Management Plan and manages AIS issues in the Tahoe Basin.

Through the development of this implementation plan, seven aquatic invasive species groups were determined under guidance from the LTAIS Management Plan and the AISCC. These groups include: warm water fishes (various species), plants (Eurasian watermilfoil, curlyleaf pondweed), invertebrates (Asian clam, mysid shrimp, signal crayfish), and an amphibian (American Bullfrog). A comprehensive history of the invasion of each of these species and the control actions taken to date within the Tahoe Basin and elsewhere was provided. Using this information, as well as information from the peer-reviewed published literature, an assessment of the feasibility of management actions for each of species group was provided. Feasible management actions were qualified into three classifications:

**Feasible control actions**

- Eurasian watermilfoil
- Curlyleaf pondweed
- Warm water fish

**Potential control actions**

- Signal crayfish
- American bullfrog

**No feasible control options at this time**

- Mysis shrimp
- Asian clam

An ecologically based framework was used to determine a site prioritization for aquatic invasive plants and warm water fish in the Tahoe Basin. The metrics used in the prioritization model included: (1) fish-plant interactions, (2) size of infestation, (3) human use (by recreational boaters), and (4) location of infestation. Other factors of major significance concerning the control of AIS such as suitability of the receiving habitat, proximity to sensitive native species, or potential impact of control actions on the surrounding environment are vital components of site selection, but are not included in this model due to lack of available data.

Sites with the highest prioritization included the Tahoe Keys (East and West). These sites received the highest priority largely as a result of the immensity of nuisance aquatic plant infestations, as well as the intensity of recreational boater visitation. Other highly prioritized sites included Meeks Bay, Ski Run Marina and Channel, and Lakeside Marina and swim area. Emerald Bay was not highly prioritized for immediate control action because of recent successful efforts to remove all Eurasian watermilfoil biomass. This site is indicated as a priority for post-treatment surveillance monitoring.

At present, only non-chemical methods are recommended for the control of all AIS in Lake Tahoe. This is due to the special status designation for Lake Tahoe and States of California and Nevada rules prohibiting the use of chemical additions to the watershed. Suggestions are provided for all AIS considered in this document for immediate implementation actions, the development of future control strategies or technologies and the consideration of chemical control methods, where appropriate. Major knowledge gaps identified included the need for:

- A consistent lake wide surveillance program with central data storage,
- Efficacy monitoring associated with each management action taken,
- Development of specific metrics to quantify the success of the overall AIS management/implementation program at Tahoe, and
- As a majority of the AIS considered here are nearshore species, an integration of the Tahoe AIS management program with the Lake Tahoe Nearshore Management plan.

Recommendations for "next steps" included a call the development of: a nearshore surveillance and monitoring program, metrics to evaluate the progress of AIS control actions carried out in the lake, a research plan to address data gaps, the exploration or development of new strategies or technologies for the control of AIS in Lake Tahoe, and an alignment of available resources with the priorities recommended in this implementation plan.

### Background and Aquatic Invasive Species Problem Statement

Lake Tahoe is well known for its remarkable clarity and aesthetic beauty. Since the 1960s, the clarity has declined due to progressive cultural eutrophication and the loading of fine sediments from an increasingly urbanized and developed watershed. As a result of this clarity loss, a significant amount of public and private funding has been utilized to implement conservation programs to improve lake water quality.

Along with changes to Tahoe's clarity, there have been alterations to the lake's biological community over time (Figure 1). Biological organisms can play a very important role in maintaining ecosystem integrity and function. Lake Tahoe's biological organisms can live both in the open water, where clarity has been measured over time, but also in both the lake's deep and nearshore waters where there has been significant degradation measured in recent years (Heyvaert et al. 2013).

In the mid to late 1800's, Lake Tahoe had a relatively simple biological community containing 8 native fish taxa, 6 zooplankton species, 12 benthic invertebrate taxa, and 5-8 plant taxa including higher plants, algae, and mosses. The food web of the lake was relatively simple; the lake's native top fish predator, Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), fed mostly in the open water of the lake on zooplankton and fishes. As a result, smaller native fishes (e.g. reidside shiner, dace) likely had fewer predators when migrating to the nearshore to spawn during early summer periods.

Over the next 140 years there was a series of species introductions into Lake Tahoe (Figure 1). Some of the early introductions were intentional, sanctioned by federal and state agencies, while more recent introductions may have occurred intentionally or accidentally but are considered illegal. The sanctioned introductions of fishes from 1880 to 1940's included a number of trout species. Lake trout (*Salvelinus namaycush*), the lake's dominant fish predator today, was first introduced in 1888 and was considered established by 1912. Known to feed on prey half of its length, lake trout likely played a major role in eliminating the lake's native trout, Lahontan cutthroat trout. In the mid 1940's there was the accidental introduction of kokanee salmon (*Oncorhynchus nerka*), an important sport fish in the lake today. And by the mid-1930s the final introduction (of many introduction events) of the signal crayfish (*Pacifastacus leniusculus*) occurred.

By 1960, the food web of Lake Tahoe had changed substantially. In contrast to the native food web, it was comprised of two major fishes, kokanee salmon and lake trout, which are still the dominant sport fishes in the lake today. The lake trout fed on native fishes across habitats in the open, deeper waters similar to the native cutthroat trout but also in the deeper waters of the nearshore habitat. As a result the lake trout were able to further utilize native fishes and crayfish in the nearshore, unlike the native predatory cutthroat trout. Kokanee salmon fed largely on native zooplankton taxa (e.g. *Daphnia*) which are important grazers on algae particles in the open water. In addition, there were other trout species popular with recreational anglers that had established in the lake, rainbow and brown trout.

In the 1960s, resource managers from California and Nevada Fish and Game agencies believed the game fishes in Lake Tahoe were largely limited by food. As a result, the agencies introduced mysid shrimp (*Mysis diluviana*). This was the last sanctioned introduction of species into Lake Tahoe. The introduction of this species had profound changes to the food web and biological composition of Lake Tahoe. Mysids predatory nature resulted in the decline of two native pelagic taxa (*Daphnia* and *Bosmina* spp.) which are the preferred food resource for kokanee salmon. With the ability for larger mysids to migrate to deeper waters (~400 m), they can evade predation by kokanee salmon, which resulted in a decrease in fish size rather than an increase as intended by the introduction of the shrimp (Morgan 1978). In addition, mysids may be explanatory in the recently observed reduction of native, endemic invertebrate species (Caires et al. 2013, Chandra 2003). After the introduction of *Mysis* shrimp, the food web of Tahoe became increasingly reliant upon pelagic resources. This resulted in the development of two distinct, seasonal food webs; a nearshore food web with fewer top predators and offshore/ deep profundal food web.

After the introduction of mysid shrimp in the 1960s, there was a generally understanding by resource managers not to introduce additional species to the lake due to unintended consequences, which may result from the establishment of new species. In addition, evidence had emerged that the lake's clarity was in decline and an agency agencies had been created (e.g. Tahoe Regional Planning Agency) to address the decline in clarity. Existing state of California and Nevada agencies also developed objectives to maintain the lake's water quality, aesthetic beauty, and maintain the lake's "natural" characteristic. With the cultural changes occurring since the 1960s it would be approximately 20 more years before a series of new biological introductions were becoming noticeable in Lake Tahoe.

By the mid 1980s a series of unintentional fish, invertebrate and plant introductions occurred and resulted in another suite of changes to the lake's nearshore ecology. These include the two aquatic plants Eurasian watermilfoil (*Myriophyllum spicatum*) and curlyleaf pondweed (*Potamogeton crispus*), first observed in South Lake Tahoe and which are now established in more than 20 locations of the Lake Tahoe nearshore zone. These species are considered a nuisance in some locations (e.g. Tahoe Keys) since they foul boat propellers. These nuisance aquatic plants also increase habitat for invasive warm water fishes and have been shown to alter phosphorus cycling in the nearshore zone (Kamerath et al. 2008; Walter 2000). Asian clams (*Corbicula fluminea*) were first observed in the early 2000's in the Southeastern portion of Lake Tahoe at Nevada Beach. These bivalves have now established along most of the south shore, in Emerald Bay and potentially in Sand Harbor in the Northeastern region of the lake. Asian clams have been correlated with nuisance level growth of nearshore algal populations and have impacted the aesthetics of beaches through shell deposition along some locations in the south shore. Warm water fishes such as largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*) and other species were first discovered in Lake Tahoe in the 1970's & 80's. The population size of these fishes is increasing through time, with the majority of the populations concentrated in the Tahoe Keys area of the lake. Warm water fishes prey on native fishes, and have contributed to the ongoing decline in these native species. Native to eastern North America, the American bullfrog (*Rana catesbeiana*) is established in the Lake Tahoe Basin

and is of particular concern in sites that are targeted for restoration efforts such as Taylor Creek.

Today we have nearly 30 non-native aquatic species established in the Lake Tahoe watershed, including plants, fish, invertebrates, and an amphibian. An analysis of potential AIS economic impacts to both recreation/ tourism/property values, and increased boat/pier maintenance costs in the Lake Tahoe Region was estimated to be \$22.4 and \$78 million per year respectively (TRPA 2014). However, these estimates do not, and were not intended to capture the potential economic effects on ecological function for the sensitive and unique biological community in Lake Tahoe. Of particular recent concern, and the result of the development of this implementation plan, is the establishment and within-lake spread of a number of unintentionally introduced species. Lake Tahoe's water quality, aesthetic value, and recreational pursuits are currently threatened by the unwanted effects of non-native aquatic plants, fish, invertebrates, and other species. These non-native aquatic organisms are considered 'invasive' when they threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent upon such waters (ANSTF 2012).

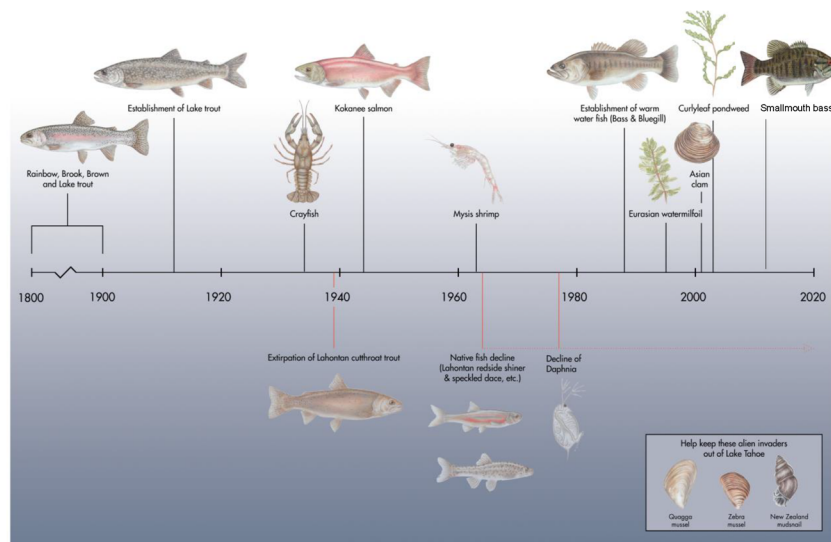


Figure 1. A timeline of species introductions and associated biological declines in Lake Tahoe. Initial introductions until the mid-1960s were sanctioned and legal by federal and state agencies. These introductions resulted in the loss (e.g. Lahontan cutthroat trout) or near elimination (e.g. *Daphnia* and *Bosmina*) of species. Introductions by the mid 1980s were not legal and resulted in the establishment in the lake's nearshore habitat.



#### Current Efforts in the Tahoe Basin related to prevention

Regulators, managers and scientists understand the ecological and economic threats posed by AIS in the Tahoe region and have established a formidable prevention program. The AIS prevention programming in the Tahoe Basin has been established using regulatory precedents. Namely, the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990 (P.L. 101-636) establishes federal authority to prevent the introduction of nuisance aquatic organisms and control their spread through coordinated research, control strategies, priorities, and education efforts. Under guidance provided by NANPCA, the Tahoe Regional Planning Agency (TRPA; a compact regulatory agency) developed a regional Code of Ordinances (Chapter 63.4.1) prohibiting the following actions in the Lake Tahoe region:

- The transport or introduction of aquatic invasive species into the Lake Tahoe region.
- The launching of any watercraft or landing of any seaplane contaminated with AIS into the waters of the Tahoe region.
- The provision of inaccurate or false information to the TRPA or persons designated to conduct inspections.

There are a number of AIS prevention efforts currently in place in the Lake Tahoe Basin which include outreach, education, voluntary action by the boating public, and governmental regulation (TRPA 2014). In addition to the numerous and ongoing outreach and education programs, one of the most significant prevention programs is the motorized and non-motorized watercraft inspection and decontamination program. This program, which began in 2008, is managed by the TRPA and its designee, the Tahoe Resource Conservation District (TRCD). Under this inspection and decontamination program, all motorized watercraft shall be inspected prior to launching into the waters of the Lake Tahoe region. The objective of inspection and decontamination is to completely eliminate all viable AIS life stages, and thereby prevent their introduction into waters of the Lake Tahoe Region. Inspections are mandatory and incur a vessel-size dependent fee to the boater. From 2009-2014, approximately 43,000 watercraft inspections and 17,000 decontaminations were conducted. The federal government has invested more than \$3 million each year for the last four years to support the entire AIS program; these funds are scheduled to be eliminated in 2015.

#### The "Lake Tahoe AIS Management Plan": History and Status

The Aquatic Nuisance Species Task Force (ANSTF) is an intergovernmental organization dedicated to preventing and controlling aquatic nuisance species, and implementing the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990. The ANSTF encourages state and interstate planning entities to develop management plans which describe detection and monitoring efforts for aquatic nuisance species, prevention efforts to stop their introduction and spread, and control efforts to reduce their impacts. Management plan approval by the ANSTF is required to obtain funding under Section 1204 of NANPCA.

In 2009, the first Lake Tahoe Interstate AIS Management Plan (hereafter referred to as the "LTAIS Management Plan") was approved by the ANSTF. In 2014 the first update of the original

2009 plan was approved by the ANSTF. This update revised the 2009 Plan taking into account developments in the implementation of AIS efforts in the Tahoe Region, and primarily focuses on changes needed to make the LTAIS Management Plan as useful as possible for management, policy and funding decisions related to AIS issues in the region. The Tahoe Regional Planning Agency provides oversight to the implementation of this plan, including acting as the fiscal agent, or pass through agency for funds associated with its implementation.

Generally, the goals of the LTAIS Management Plan are to: (1) Prevent new introductions of AIS to the Lake Tahoe Region (2) Limit the spread of existing AIS populations in the Lake Tahoe Region, by employing strategies that minimize threats to native species, and extirpate existing AIS populations when possible, (3) Abate harmful ecological, economic, social and public health impacts resulting from AIS (TRPA 2014). Summarized in the LTAIS Management Plan is the background information on the current non-native species in the Lake Tahoe Region, the introduction pathways for existing and potential AIS taxa, information on potential AIS in the Lake Tahoe Region, and a description of the goals and objectives of the plan. Also included (as appendices) is an overview of existing regulations and programs, prevention plans, control and eradication plans, monitoring and response plans, economic information including an estimate of potential monetary impacts the AIS may have on the Region, and an overview of existing and potential AIS life histories and distributions.

### **The need for a Lake Tahoe AIS "Implementation Plan"**

The LTAIS Management Plan provides a strong description of the available AIS detection and monitoring efforts, prevention activities to stop their introduction and spread, and control efforts to reduce their impacts. However, there remains the need to provide information concerning the *implementation* of the control efforts to reduce impacts of AIS in the Tahoe Basin. Specifically, this refers to target species selection, site selection and prioritization of species and sites given the current environmental conditions in the Tahoe Basin.

### **Objectives and evaluation of the Implementation Plan**

The goals of this implementation plan are to:

1. Identify AIS that are candidates for control efforts in Lake Tahoe,
2. Provide a comprehensive description of the history of aquatic invasions and control activities in Lake Tahoe, or elsewhere. Based on this information, an assessment of feasible control or management options are identified by species group, and
3. Provide an ecologically-based framework to prioritize (a) species and (b) specific sites for control or removal efforts in Lake Tahoe over 3-5 year period.

The implementation plan has been formally reviewed by (1) an external expert panel comprised of individuals from academic and management backgrounds with specialties in invasive species management and ecology (Table 1), and (2) the Lake Tahoe Aquatic Invasive Species Coordination Committee.

| Name                           | Affiliation                                                                                     | Expertise                                                                                                                                                                                                                                               |
|--------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lars Anderson, Ph.D.           | Waterweed Solutions, USDA Agricultural Research Service (Retired)                               | Control and eradication of invasive and detrimental aquatic plants, Integral to Bay Delta programs including the successful reduction of <i>Egeria densa</i> in over 3,000 acres of the Sacramento-San Joaquin Delta and 800 acres in Discovery Bay, CA |
| Meghan Brown, Ph.D.            | Associate Professor of Biology, Hobart and William Smith Colleges                               | Biological limnologist with a focus on zooplankton including mysid ecology, ecosystem dynamics, impacts of Asian clam on ecological dynamics                                                                                                            |
| Michael Hoff, M.S.             | Regional AIS Coordinator Great Lakes-Big Rivers Region, US Fish and Wildlife Service            | Use of risk assessment for regulatory and non-regulatory decision-making, AIS early detection and response planning, specialty in invasive warm water fish, plants, and other species                                                                   |
| Nicholas Mandrak, Ph.D.        | Associate Professor of Biological Sciences, University of Toronto Scarborough                   | Invasive species risk assessment, fish biology and ecology, invasion ecology, impacts of invasive species                                                                                                                                               |
| Michael Marchetti, Ph.D.       | Fletcher Jones Professor of Ecology, St Mary's College of California                            | Invasion ecology, fish ecology, invasive species risk assessment, impacts and establishment on non-native species                                                                                                                                       |
| Sandra Nierzwicki-Bauer, Ph.D. | Professor of Biology, Director of Darrin Freshwater Institute, Rensselaer Polytechnic Institute | Basic and applied studies of aquatic invasive species (zebra mussels and Asian clam), water resource management                                                                                                                                         |
| John Rothlisberger, Ph.D.      | Aquatic Ecologist, US Forest Service                                                            | Invasion ecology, invasive plants, fish and invertebrates, spread of invasive species by recreational boats, impacts of non-native species, risk assessment                                                                                             |

Table 1. Names, affiliation and expertise of external expert review panel which evaluated the Lake Tahoe Aquatic Invasive Species Implementation Plan.

#### Identify invasive species that are candidates for control efforts in Lake Tahoe

The selection of AIS species that qualify as candidates for control under this implementation plan was a result of a two-step process. First, the LTAIS Management Plan was used to identify nonindigenous species perceived to cause significant damage or harm in the Lake Tahoe Watershed and are therefore considered invasive and unwanted<sup>1</sup>. This includes species referenced under Type 2, 3 and 4 (Chapter 3, Table 5) in the LTAIS Management Plan (TRPA 2014). Second, by referencing the LTAIS Management Plan and through discussions with the Lake Tahoe AIS Coordination Committee in 2015, the species of concern were further refined to include those taxa for which control or management is feasible in the Lake Tahoe Basin, and/or those which have significant unwanted effects on restoration goals within the Basin. The following species groups will be considered in this Implementation Plan: (1) Two aquatic plant

<sup>1</sup> In the LTAIS Management Plan, this determination was made through the TRPA Code of Ordinances, Chapter 63.4 which contains regulations relating to the prevention of invasion by AIS. Invasive species are defined in the TRPA Code as:

"...species, both aquatic and terrestrial, that establish and reproduce rapidly outside of their native range and may threaten the diversity or abundance of native species through competition for resources, predation, parasitism, hybridization with native populations, introduction of pathogens, or physical or chemical alteration of the invaded habitat. Through their impacts on natural ecosystems, agricultural and other developed lands, water delivery and flood protection systems, invasive species may also negatively affect human health and/or the economy."

species: Eurasian watermilfoil, curlyleaf pondweed, (2) various warm water fish species, (3) three invertebrate species: signal crayfish, Asian clam, mysid shrimp, and (4) one amphibian, the American Bullfrog.

#### History of Tahoe invasions, control activities and management conclusions

The following section provides a comprehensive description of the history of aquatic invasions and associated control activities in Lake Tahoe and elsewhere for the species identified in the previous section. At the end of each species-specific invasion and management section, a recommendation concerning management actions to be implemented for each species grouping is provided.

#### Aquatic Plants

Currently there are two known species of nonindigenous aquatic plants in Lake Tahoe, Eurasian watermilfoil (*Myriophyllum spicatum*) and Curlyleaf pondweed (*Potamogeton crispus*). These species are considered invasive in Lake Tahoe due to their impacts to recreation, navigation and ecosystem dynamics. Additionally, despite its designation as a native plant, coontail (*C. demersum*) is considered a nuisance in some regions of Lake Tahoe (e.g., the Tahoe Keys) due to its excessive growth in these areas.

Prior to the establishment of non-native aquatic plants, Lake Tahoe's benthic zone was dominated by a number of Characeae, mosses, liverworts and filamentous algae species, which have been observed at depths up to 400 m (Frantz & Cordone 1967; Caires et al. 2013). The native macrophytes Andean milfoil (*M. quitense*), Canadian waterweed (*Elodea canadensis*), coontail (*Ceratophyllum demersum*), Richardson's pondweed (*Potamogeton richardsonii*) and leafy pondweed (*Potamogeton foliosus*) are also found in Lake Tahoe. It is important to note that information related to the historic distribution and densities of native plants in Tahoe is limited. This may be important when looking to retain Tahoe's natural setting or the inadvertent removal of native species during invasive species control work.

The following sections provide a brief description of both nonindigenous plant species' establishment history in Tahoe, and control options based on observed accounts in Tahoe and elsewhere. Based on these accounts, a brief recommendation concerning Lake Tahoe-specific management options for each species is provided.

#### Eurasian watermilfoil

Eurasian watermilfoil is thought to have been introduced to Lake Tahoe in the 1960's or 1970's and was formally identified along the south shore in the late 1980's and 1990's (Loeb & Hackley 1988; Anderson & Spencer 1996; Anderson 2003). In 1995, there were 13 nearshore sites in Tahoe that contained Eurasian watermilfoil. Since this time, the number of sites with Eurasian watermilfoil has increased, with 17 sites observed in 2000, 22 sites in 2003 and 26 sites in 2005 (Figure 2). In 2011, there were 23 sites with Eurasian watermilfoil, and in 2012 the number of occupied sites declined again, to 18, with a total coverage of approximately 500 km<sup>2</sup> (Figure 3). The decrease in number of sites in 2011 and 2012 relative to previous years is potentially a result of changes in surveillance strategies or the extirpation of localized populations due to management actions (K. Boyd pers. comm. 2015). A recently published assessment of the

potential spread of Eurasian watermilfoil in Lake Tahoe indicates that a number of sites currently without Eurasian watermilfoil may be designated as high risk for Eurasian watermilfoil establishment in Lake Tahoe (Wittmann et al. 2015). Some of the highest risk sites for future Eurasian milfoil establishment include the Lake Forest Boat Launch, Camp Richardson, Carnelian Bay and other areas that are generally protected from high wave action and contain appropriate habitat conditions such as suitable sediment substrates.

Eurasian milfoil in Lake Tahoe and in other systems can cause unwanted ecological and economic impacts. In North America, high density populations of Eurasian watermilfoil impact native species (Boylen et al. 1999) and can cause unwanted effects on water quality, recreation and other ecosystem services (Eiswerth et al. 2000; Halstead et al. 2003; CAST 2014). In the nearshore regions of Lake Tahoe, Eurasian milfoil has been found to alter phosphorus cycling in the water column, potentially leading to increased algae production (Walter 2000). In the Tahoe Keys, aquatic macrophytes, including Eurasian milfoil are present in very high abundance and provide habitat and protection from harmful ultra violet (UV) light exposure for invasive warm-water fishes (Kamerath et al. 2008; Tucker et al. 2010). Eurasian milfoil and other aquatic plant species are navigation and aesthetic nuisances to homeowners in the Tahoe Keys, who incur an annual harvesting cost of \$400,000 to control species solely within the Tahoe Keys property area (TKPOA 2015).

#### Control of Eurasian milfoil

A variety of mechanical, biological and chemical methods have been used to control Eurasian watermilfoil (Berent et al. 2015). Mechanical means to reduce plant biomass such as harvesting, cutting, hand removal or mowing are often used in localized regions such as marinas or swim areas to clear navigation or recreation use zones (Greenfield et al. 2004). Unfortunately these methods tend to promote the spread of the plant (Crowell et al. 1994) because milfoil can grow from broken off stems. Other mechanical means include gas permeable or impermeable barriers or blocking/shading light from infestations using dyes or fabric. Water drawdowns are often utilized in reservoir systems and are most effective when the plants are exposed to several weeks of drying and the root crowns are exposed to sub-freezing temperatures (Berent et al. 2015). Water level manipulation is often used conjunction with herbicides and/or shade barriers (Barger et al. 2003, Swearingen et al. 2002).

Biocontrol options include a fungus *Mycoleptodiscus terrestris*, a North American weevil (*Euhrychiopsis lecontei*), and a cyprinid fish, the Grass Carp (*Ctenopharyngodon idella*). Grass carp have been widely used as biocontrol agents for aquatic macrophytes including Eurasian watermilfoil. Unfortunately studies have found that Grass Carp will feed on Eurasian watermilfoil only after other macrophytes (including natives) have been consumed by this species. As a result grass carp are currently not recommended for Eurasian watermilfoil control by some agencies (Washington State Department of Ecology 2013). It is important to note that Grass Carp are not native to the Lake Tahoe region and are considered invasive in many regions of North America.

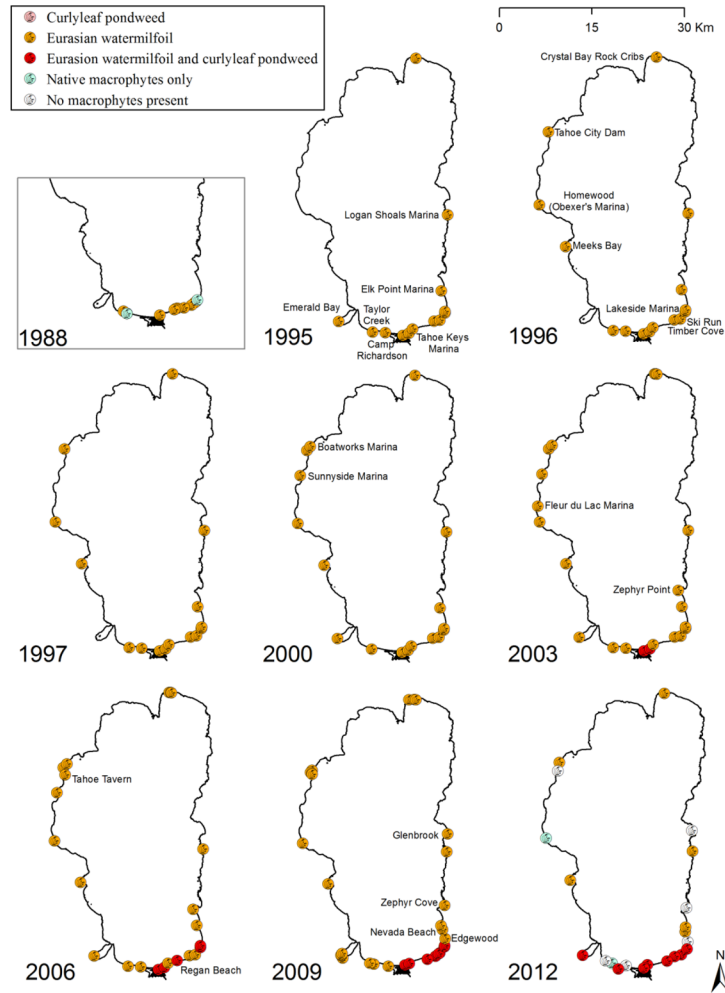


Figure 2. Distribution of Native and non-native aquatic plant presence and absence in Lake Tahoe, 1988 – 2012. Data from 1988 panel after Hackley and Loeb (1988). 1995 – 2006 surveys by L.W.J. Anderson, USDA-ARS, 2009 surveys by P. Caterino, 2012 surveys conducted by SEA, Inc. Note, only 2012 survey data contains native species information and absences, all other surveys only indicate only presence of non-native plant populations.

A number of herbicides are commonly employed to treat Eurasian watermilfoil infestations, including but not limited to triclopyr, 2,4-D, fluridone, imazamox and endothall. Triclopyr,

fluridone and 2,4-D have been used in small-plot and whole-lake management programs to control Eurasian watermilfoil and in many instances have shown considerable selectivity in removing Eurasian watermilfoil with little to no impact on native plant communities (Petty et al. 2001; Madsen et al. 2002; Siemering et al. 2008). Fluridone applied in the early stages of growth can result in season long control of Eurasian watermilfoil (USACE 2011; DNR 2012). Disadvantages of chemical control methods include restrictions to swimming, drinking water, and fishing and potential impacts to non-target plants. Additionally, the use of chemical controls may require extensive water quality monitoring that could increase overall program costs (TRPA 2014).

#### Control of Eurasian watermilfoil in Lake Tahoe

Efforts in Lake Tahoe to remove or control Eurasian milfoil or other aquatic plants began in the 1980's and included mechanical harvesting and raking in the Tahoe Keys as a means to keep navigation pathways clear for boating traffic (Greenfield et al. 2004). In agreement with other published accounts, managers at the Tahoe Keys Property Owners Association (TKPOA) found that this treatment was likely increasing Eurasian watermilfoil biomass (Tischler, pers comm 2002). In an effort to find different solutions, managers in the TKPOA also attempted other experimental efforts such as the unsuccessful use of a water circulator (e.g., "Solar Bee") (Anderson et al. 2005).

The Lake Tahoe Invasive Aquatic Plant Control Program began in 2005 with experimental removal of Eurasian milfoil using diver suction vacuum removal, hand pulling and light impermeable bottom barriers in Emerald Bay in 2005-2007 (Van Way 2005; Gillies & Van Way 2006). While integrated programs using hand pulling and bottom barrier application have been shown to be effective in other systems, it is uncertain whether these 2005-2007 efforts were successful in the lake. This is due to the lack of integration of these three methods as well as the absence of a comprehensive or directed removal program at this location. Further, no follow-up treatments or efficacy surveillance was conducted after these efforts, leaving no quantitative information to evaluate the effectiveness of these actions. Anecdotal evidence suggests that the Emerald Bay milfoil populations recovered in as little as two years after treatment.

In 2007 several bottom barriers and a pontoon work boat fitted with equipment to assist in invasive plant removal in Lake Tahoe were purchased. In 2008, 46 m<sup>2</sup> of bottom barriers were deployed at Parson's Rock in Emerald Bay. In 2009, 966 m<sup>2</sup> of barriers were placed at Parson's Rock and a 334 m<sup>2</sup> area was suctioned in Emerald Bay in the area of the Vikingsholm Swim Beach and Pier. Transect survey results from these efforts showed that Eurasian watermilfoil began recolonization of bottom barrier treatment sites within 15 months post-treatment and that the use of barriers alone was unlikely to provide an effective strategy for controlling this plant in Emerald Bay (Brockett et al. 2013).

In 2010, a comprehensive removal program using a combination of benthic barriers and diver hand removal was initiated at three sites in Emerald Bay which has continued through the present (Brockett et al. 2013, Shaw et al. in prep). The results of this effort indicate that by

using a combination of methods under a comprehensive framework that allows for rapid response and consistent surveillance efforts, it appears that successful removal of Eurasian watermilfoil can occur. In 2014, 12 Eurasian watermilfoil plants were found and removed from Emerald Bay in spring and no plants were found in a 2014 fall survey. Surveillance efforts are ongoing.

Between 2008 and 2014 a number of Eurasian watermilfoil removal efforts were carried out at other nearshore locations in Lake Tahoe. Removal treatments at Ski Run Marina and Channel first began in 2009. Due to interference with local concessionaires and concerns for diver safety, these control efforts were cut short. Another effort was initiated in 2012 at Ski Run where two removal methods were implemented: 1) gas-permeable, benthic bottom barriers and 2) diver-assisted hand removal. In the Ski Run Channel, 48% of the infestation was treated with bottom barriers and 52% with diver-assisted removal. Results from these experiments indicate that barriers typically need to be in place for 6-10 weeks to achieve plant mortality and removal of the barriers began in November 2012. Barrier removal was completed in late November and diver-assisted removal continued until December 2012. Complicating the removal efforts in Ski Run Marina was curlyleaf pondweed, which had significantly colonized at Ski Run Marina and Channel. There have been no control actions at Ski Run since 2012, however mechanical control is planned for 2015.

Prior to 2010, a private-public collaborative aquatic plant removal effort had been initiated with the Lakeside Homeowners Association. This effort carried out at Lakeside utilized a clam shell dredge and was completely unsuccessful due to the almost complete replacement of Eurasian watermilfoil by curlyleaf pondweed as a result of the clam shell dredge activity. Learning from this experience, the private-public collaboration continued, and in 2010-2012, 3716 m<sup>2</sup> of invasive aquatic plants were suction removed and 3318 m<sup>2</sup> of bottom barriers were deployed at Lakeside Marina and Swim Area. At Lakeside Beach 85% of the treatment was accomplished with bottom barriers and 15% with diver-assisted removal.

Conclusions based on Eurasian watermilfoil control research  
Successful control of Eurasian watermilfoil at Lake Tahoe requires integration and consistency of removal strategies, as well as post-treatment efficacy monitoring and rapid response capabilities. This recommendation is largely based on the results of the comprehensive and multi-year removal program (relative to a particular site) with post-treatment monitoring and rapid response capability in Emerald Bay, which has resulted in a significant decrease of Eurasian watermilfoil at this location. Further, where control efforts have been haphazard and without monitoring or rapid response capabilities, Eurasian watermilfoil recolonization has occurred. The use of multiple and integrated methods (e.g., bottom barriers, hand pulling, and suction removal) for plant removal is highly recommended, particularly in localized habitats that have variable characteristics. In systems other than Tahoe, chemical control has been successfully used for both seasonal and long-term reductions of Eurasian milfoil. While highly controversial and a number of years away from regulatory permission, herbicide treatments in Lake Tahoe, particularly in marina or other protected nearshore zones, may provide a cost-



effective means to reduce local infestation and limit the spread of Eurasian watermilfoil lake wide.

#### Aquatic Macrophytes Distribution and Composition 2012

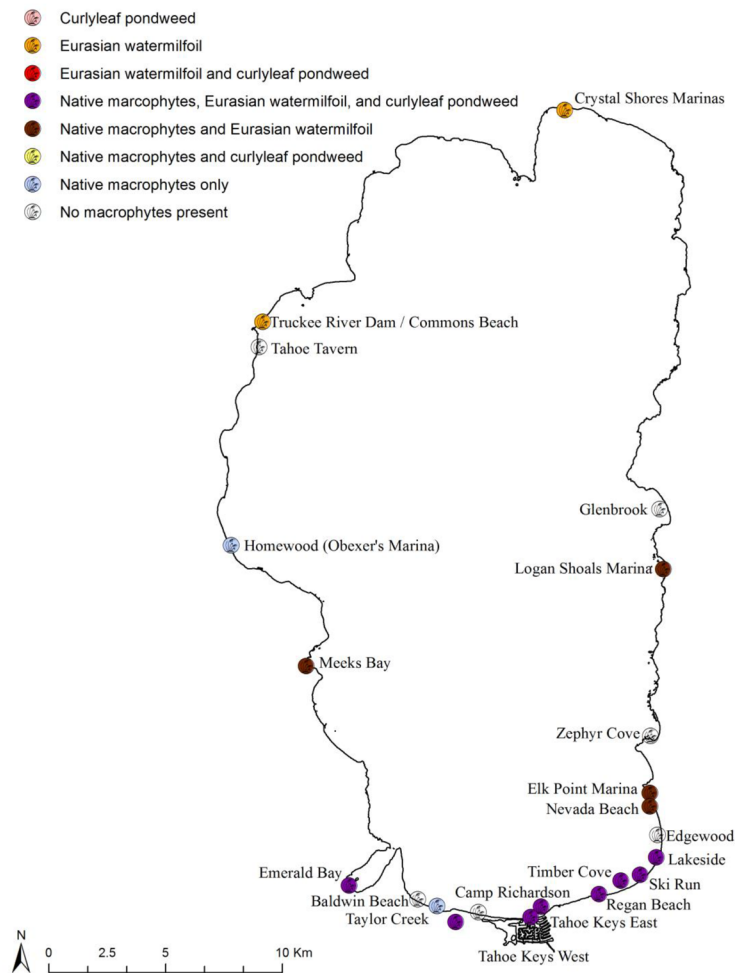


Figure 3. Detailed native and non-native aquatic plant distribution in Lake Tahoe. Data are a compilation of 2012 aquatic plant survey carried out by SEA, and observations made by other Tahoe surveillance efforts.

### *Curlyleaf pondweed*

Curlyleaf pondweed was first identified in the south shore of Lake Tahoe in 2003 (Anderson 2003). Since its discovery, this species has spread along the south shore and in some regions has outcompeted and replaced infestations of Eurasian watermilfoil (Figure 2). Curlyleaf pondweed has been called the most widely dispersed, nuisance invasive aquatic macrophytes in North American lakes. This pondweed can inhibit recreation, increase the phosphorus concentration across the water column and impair water quality (Bolduan et al. 1994, Woolf and Madsen 2003). Curlyleaf pondweed is tolerant of many ecological conditions (low/high nutrients, slow/fast water flow, low/high temperatures, low/high light) and can invade numerous aquatic ecosystems. Its ability to germinate in the fall and overwinter along with its wide environmental tolerances allows for this species to begin growing in the spring before native plant species. Large infestations of curlyleaf pondweed can impede water flow and can cause excess phosphorus release into the water column as a result of annual die-offs and subsequent decomposition of plant material.

### *Control of curlyleaf pondweed*

Similar to Eurasian watermilfoil, curlyleaf pondweed has a number of mechanical, biological and chemical treatments. Curly-leaf pondweed can be mechanically removed by raking or seining, but will likely reestablish from any remaining roots left behind. Traditional benthic barriers (i.e. gas permeable) have been used on curlyleaf pondweed with variable results. Mayhew and Runkel (1962) and Mayer (1978) reported that covering curlyleaf pondweed populations with benthic barriers (polyethylene and fiber glass coated sheeting) was effective at reducing biomass, but did not report on subsequent recolonization. Madsen and Crowell (2002) suggest that bottom barriers are effective in preventing the growth of rooted curly-leaf pondweed, however, long-term management would require the elimination of vegetative buds (i.e. turions) to fully interrupt the life cycle.

Biocontrol of curlyleaf pondweed can occur using the herbivorous Grass Carp, (*Ctenpharyngodon idella*). However, Grass Carp is not native to the Tahoe Region and is considered invasive in regions of North America (Wittmann et al. 2014).

Herbicide treatment using endothall or fluridone is effective at inhibiting turion production and can substantially reduce curlyleaf pondweed biomass and turion abundance during the initial 2-3 years of treatment. Unfortunately less substantial reductions have been observed in subsequent years (i.e. >3yrs) of treatment (Johnson et al. 2012). In another study, spring treatments of diquat or endothall were effective in reducing curlyleaf pondweed shoot and root biomass, as well as suppressing turion production (Poovey et al. 2002). In both studies, while herbicide treatment reduced turion production, viable turions remained in the sediments up to 5 years post treatment.

### *Integrated use of bottom barriers and acetic acid or high temperature treatments*

Recent experiments conducted at the bench and mesocosm scale, showed that using a gas impermeable rubber barrier and a 2-week exposure of turions to dilute acetic acid ( $C_2H_4O_2$ , tapioca starch pearls, which facilitated slow release of the compound) resulted in complete

inhibition of sprouting turions at and above acetic acid concentrations of 83.3 mmol (Barr & Ditomaso 2014). Similar results were found with treatments of hot water under bottom barriers (Barr and Ditomaso, *In Press*). These findings demonstrate the potential of acetic acid or hot water combined with impermeable benthic barriers as an effective method for the inhibition of curlyleaf pondweed turion sprouting.

#### Control of curlyleaf pondweed in Lake Tahoe

Experiments conducted both in the field in Lake Tahoe and in the laboratory between 2011-2013 tested whether bottom barriers could be an effective method to control curlyleaf pondweed (Gamble et al. 2013). Curlyleaf pondweed turions were collected from the Tahoe Keys, placed in mesh bags and placed under jute, polyethylene or rubber barriers that were deployed *in situ*. The results showed that turion sprouting was higher after 8-weeks under the barriers than the control conditions. Yet, benthic barriers were successful in reducing the existing biomass of curlyleaf pondweed populations, with jute being the most cost-effective and easily deployed bottom material. Examination of the test sites six and twelve months after application of the barriers suggests that pondweed populations were not primarily using turions for recolonization, but were instead spreading via rhizomes (Gamble et al. 2013).

Small laboratory experiments (without sediment) showed that using a rubber barrier treatment, 48% of the turions sprouted relative to 100 percent sprouting in the control condition. Turions in the jute and polyethylene treatments had 100% and 97% sprouting respectively. Larger mesocosm scale experiments (with sediment) also showed the rubber barrier treatment had a strong and highly significant effect on turion sprouting: 30% sprouting compared to 98% in the control condition. The jute barrier treatments had a 72% sprouting rate and polyethylene barriers, a 70% sprouting rate. Comparison among treatment means showed that rubber barriers were significantly more effective than either polyethylene or jute and that jute and polyethylene were not significantly different from each other. The authors of this study concluded that benthic barriers alone cannot eradicate 100 percent of the turions on their own, but that benthic barriers could be used in conjunction with other integrated methods for eradication of curlyleaf pondweed turions.

#### Conclusions based on curlyleaf pondweed control research

Control of curlyleaf pondweed likely requires multiple strategies to reduce plant biomass, destroy turions, and reduce rhizome growth. The integrated use of suction removal and bottom barriers to reduce both vegetative growth and rhizome spread is recommended. Exploration of dredging activities to remove turions from sediments is also warranted. Further, based on results from studies in systems outside of Lake Tahoe, the integration of either acetic acid (e.g., vinegar) or hot water application with the use of bottom barriers or other mechanical removal means may be effective to inhibit turion production and enhance in localized eradication efforts for this species. This integrated approach, applied particularly at the early stages of establishment, may provide significant reduction in turion production, vegetative growth and the spread of this species. In order to understand the efficacy of curlyleaf pondweed removal, a better understanding is needed of both the temporal pattern in rhizome growth in Lake Tahoe, and the efficacy of integrative treatments for reducing rhizome and turion spread.

### Invertebrates

The first extensive collection of benthic invertebrates from Lake Tahoe occurred in 1962–1963 and revealed the existence of 10 endemic benthic invertebrate species, including 2 species of blind amphipod (*Stygobromus tahoensis* and *Stygobromus lacicolus*), a deepwater stonefly (*Capnia lacustra*), 2 turbellarians (*Phagocata tahoena* and *Dendrocoelopsis hymanae*), and an ostracod (*Candona tahoensis*) (Frantz & Cordone 1967, 1996; Caires et al. 2013). Other common benthic invertebrate species observed at Tahoe include Amphipoda (introduced *Hyaella* sp.), Chironomidae, Oligochaeta, Gastropoda (Planorbidae and Physidae), and the native bivalves, Sphaeriidae (*Pisidium casertanum* and *P. compressum*). Since the 1960's, Tahoe native benthic invertebrates have significantly declined, potentially due to the effects of invasive species, climate change or declines in water transparency (Caires et al. 2013).

Here we consider three established non-native invertebrate species: one unintentionally introduced bivalve, the Asian clam (*Corbicula fluminea*), and two species intentionally introduced to Lake Tahoe to support game fish, signal crayfish (*Pacifastacus leniusculus*) and mysid shrimp (*Mysis diluviana*).

### Asian clam

The invasive, Asian clam is established and spreading in Lake Tahoe (Figure 4). In 2002, low density populations (2-20 individuals m<sup>-2</sup>) were first observed in the south eastern portion of the lake, and by 2009 densities up to 5000 individuals/m<sup>-2</sup> had been measured (Wittmann et al. 2012a). Its distribution was regionally confined to the southeastern quadrant of the lake, until 2011 when a population was discovered in Emerald Bay. The Asian clam was generally found in the nearshore zone at depths of 2 - 10 m, but low density populations were also located at depths between 10 and 50 m. One individual was recovered from 70 meters; deeper than the scientific literature has previously described or studied. Where it is established, the Asian clam comprises the majority of the benthic community biomass, and has been associated with, (but not necessarily the cause of) filamentous algal blooms (Forrest et al. 2012). Through shell deposition, the Asian clam has had a negative impact on the aesthetic qualities of the nearshore environment in the Lake (TRPA 2014).

A recent experiment indicated that passive transport of adult Asian clams is a potential dispersal mechanism in Tahoe, particularly in the movement of adults and juveniles from shallow depths to deeper zones (Wittmann et al. 2013, Forrest et al., *in preparation*). A simulation model indicates that water currents in Lake Tahoe have a 7% probability of transporting juvenile Asian clams multiple kilometers from an origination point (Hoyer et al. 2014). However, the likelihood of establishment is dependent on the characteristics of the receiving habitat (Hoyer et al. 2014).

### 2014 Observations of Asian clam at Sand Harbor

In August 2014 at Sand Harbor, one half of an Asian clam shell was found on the beach about 50m south of the boat ramp. Scuba surveillance crews returned in September 2014 to do an exploratory survey off of the boat ramp and found one small live Asian clam. During Spring 2015 all suitable habitat within Sand Harbor State Park was surveyed for Asian clam and the

shell from one recently deceased Asian clam was recovered at approximate 5 m water depth off the boat ramp. There was no evidence of Asian clams in Divers Cove or along the main swim beach (K. Webb, Pers Comm 2015). Sand Harbor is over 20 kilometers away from the nearest established Asian clam population.

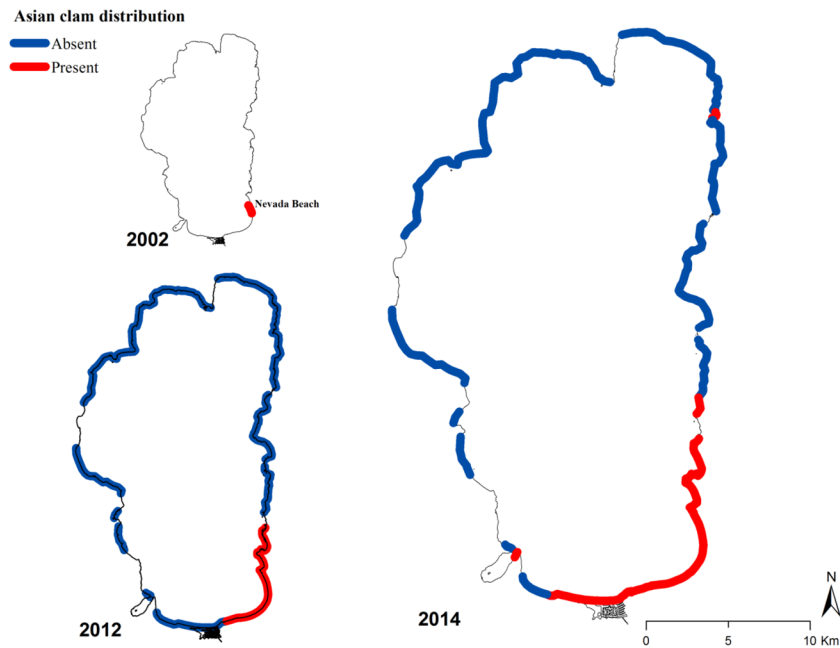


Figure 4. Asian clam (*Corbicula fluminea*) distribution in Lake Tahoe, 2002–2014. Asian clam were discovered in 2002 at Nevada Beach, the rest of the Tahoe nearshore zone was not surveyed. Information in the 2010 panel is after Forrest et al. (2012) and other observations (Wittmann, Unpublished Data). The 2014 panel includes current observations such as the Emerald Bay population (discovered 2011) and the recently observed (2014) Sand Harbor individuals.

#### Control of Asian clam

Most treatments for the control of the Asian clam were developed specifically to reduce biofouling at electric or nuclear power plants. These methods incorporate both mechanical and chemical options and include the use of screens, strainers, filters, physical removal (vacuuming clams from floors or horizontal surfaces of intake bays), thermal control, paints and coating, metals (copper and zinc), oxidizing compounds such as chlorine, bromine, ozone, and halogenation (Isom et al. 1986). Chlorination is the most widespread chemical treatment used for Asian clam, but is often ineffective due to regulatory limitations in application

concentrations (Mattice et al. 1982). Other physical control methods include emersion induced mortality through manual water draw-down (White & White 1977) or unintended die-offs as a result of natural water level fluctuations (Baumgärtner et al. 2008). In general, most treatments are targeting the removal of biofouling clams (i.e., those accumulated on commercial structures, intakes, etc.) and are not appropriate for use in open waters, particularly in locations where state or federal policies limit the use of pesticides. In 2014, the US Geological Survey indicated that the eradication of Asian clams from infested open waters is unlikely and placed management emphasis on preventing further spread (Foster et al. 2015).

#### Experimental control of Asian clam in Lake Tahoe

Two non-chemical management strategies (i.e., physical harvest through diver assisted suction removal and application of gas impermeable bottom barriers) had been tested in both small ( $\sim 8 \text{ m}^2$ )- and large ( $\sim 2000 \text{ m}^2$  and  $\sim 20,000 \text{ m}^2$ ) scale pilot projects in Lake Tahoe (Wittmann et al. 2012a, 2012b, UNR 2015).

#### *Suction Removal*

In 2009, physical harvest of Asian clams using a suction dredge in small experimental plots ( $\sim 8 \text{ m}^2$ ) in Marla Bay, in the southeastern region of Lake Tahoe. This treatment resulted in short-term reductions ( $1500 \text{ individuals m}^{-2}$  before treatment to  $60 \text{ individuals m}^{-2}$  14 days after treatment) but caused significant disruption to the benthic macroinvertebrate (BMI) community (Wittmann et al. 2012a). The impact to the Asian clam population was present up to 450 days after treatment and the BMI community diversity was not recovered after 365 days. Certain non-target macroinvertebrate taxa (Chironomidae and native clam (*Pisidium spp.*)) increased in the dredged plots to levels higher than before treatment. Sites were only monitored for 450 days after dredging and Asian clams fully recolonized the areas after 2 years. The cost of suction removal was significant: labor and materials associated with the implementation of diver-assisted suction removal were  $\$265/\text{m}^2$  and included the purchase of dredge equipment, high altitude commercial diver labor, sediment disposal, and permitting fees. A major logistical difficulty associated with suction removal included the inability to separate juvenile clams from similarly sized sediments. This potentially increased overall population growth rates of Asian clam populations within treatment plots relative to control plots due to the reduction of intra-specific density dependence.

#### *Bottom barrier treatments*

An experimental, large scale treatment (two half-acre plots) of gas impermeable (EPDM) bottom barriers was implemented between 2009 and 2010 in Marla Bay and near Lakeside Marina in southeastern Lake Tahoe (Figure 4) (Wittmann et al. 2012b). It was found that Asian clam populations were significantly reduced during these applications, with up to 95 - 99% mortality observed. The combination of anoxic conditions and increased toxicity of water due to elevated ammonia conditions under the barriers may have been a key mechanism in the mortality of Asian clams (Wittmann et al. 2012b). Unfortunately native BMI communities were also significantly reduced, but after a one year period, both Asian clams and BMI communities demonstrated rapid recolonization in the treatment plots (Wittmann et al. 2012b). Asian clam abundances in the treatment plots were not different than those observed in control plots 22

months after bottom barrier removal (Wittmann et al. 2013). In an attempt to scale up this treatment, a hypothetical analysis was done by Wittmann et al. (2013) with a 100 acre area. This analysis indicated that the total cost of treatment would range between \$2 and \$26 million. Unfortunately due to the observed recolonization rates for the bivalve in Lake Tahoe, eradication or even significant reduction to low density with this treatment option was not likely (Wittmann et al. 2013). This outcome agrees with some work from similar benthic barrier treatments in Lake George, NY. In 2013, 7 acres of barriers were used to successfully kill populations of Asian clams in Lake George, however, a recent lake wide survey revealed that the invasive clams continue to appear in new locations as well as spreading beyond the treated areas. Managers at Lake George indicated that bottom barriers can cause Asian clam mortality, but are "generally not sufficient to contain them" ([www.stoptheasianclam.info](http://www.stoptheasianclam.info)).

A second Tahoe application of gas impermeable barriers was deployed across a 5 acre region near the mouth of Emerald Bay in 2012. In October of that year, prior to barrier application 485 petite-Ponar grab samples were collected to characterize the population and live Asian clams were identified in 63% of the samples. The average density in Emerald Bay was approximately  $60 \pm 3$  individuals/m<sup>2</sup>. Relative to the Marla Bay and Lakeside populations, this was a relatively low density population.

After the barriers were installed in Emerald Bay (this application included a layer of "curlex" a biodegradable fiber intended to increase biochemical oxygen demand (BOD) under the barriers), Asian clam populations both under the barriers and outside of the barriers were examined to determine the effectiveness of the barriers. Asian clam mortality increased underneath the barriers over time while the small populations outside the mats appeared to be unaffected; mortality rates for these clams remained at approximately 10-15%, representing the natural mortality rates. The barriers increased mortality most during the summer months (Jul, Aug, Sept) achieving 100% mortality in several, but not all, locations. This mortality is thought to be related to warm water temperatures and less frequent storm events which can potentially cause water to flow underneath the mats and impair barrier integrity (Chandra unpublished data, 2015).

Asian clam population densities after the barrier removal in Emerald Bay decreased by an average of 88% (average Asian clam density:  $7 \pm 1$  individuals m<sup>-2</sup>). In addition, the density of native clams (*Pisidium sp.*) decreased significantly from  $8 \pm 1$  to  $1 \pm <1$  individuals/m<sup>-2</sup>. Upwelling and high wind/wave activity was observed during the Emerald Bay treatment. These variables together with increased porosity of the sediment due to composition of the substrate may have caused water to flow underneath the barriers causing dissolved oxygen levels to increase (as opposed to remaining at 0 mg/L as was observed in the Marla Bay and Lakeside treatments). In general, the treatment significantly reduced the Asian clam population in Emerald Bay. Unfortunately the treatment was less effective than the Marla Bay and Lakeside treatments and took considerably longer (2 years compared to 3 months). Planning for post-treatment monitoring to quantify Asian clam recolonization rates in Emerald Bay is currently underway.

#### Conclusions based on Asian clam control research

While both bottom barriers and suction dredging may be useful to reduce Asian clam populations in the short term, the species' observed rapid recolonization rates likely pre-empts any potential for effective widespread removal and control of Asian clam in Lake Tahoe with these methodologies. This is supported by evidence from technical reports and peer-reviewed studies of Asian clam control experiments in both Lake Tahoe and Lake George and from suggestions put forth in the USGS Non-indigenous Aquatic Species database (e.g., Foster et al. 2015). Further, treatment of Asian clams with pesticides is likely not feasible in Lake Tahoe due to difficulties associated with exposure time in open water conditions. However, the potential for pesticide treatment applied in combination with bottom barriers may provide a means for effective pesticide contact times and containment.

In scenarios where there may be an exceptional need to manage clams, such as where infestations may negatively affect water clarity, recreation, survival of native taxa or other important attributes of the lake, further investigation into various removal strategies over small scales to mitigate some of the potential damages that Asian clam may cause is recommended.

#### Signal crayfish

Signal crayfish (*Pacifastacus leniusculus*) have been introduced to Lake Tahoe four times between the late 1880's - 1930's. This species is widely distributed in Tahoe with highest densities observed in Northern and Western regions of the lake (Figure 5). Crayfish comprise the bulk of the benthic biomass in the littoral zone and show seasonal movement and migration across depths. Long term monitoring in Lake Tahoe have indicated that at one transect location (i.e. Sunnyside – on the west shore), crayfish population densities have steadily increased between 1991 - 2010 (Figure 6). In 2011 crayfish populations decreased around the lake due to unknown causes, but in the years since, their numbers have steadily increased.

Signal crayfish are well known for their aggressive behavior and ability to significantly impact all levels of aquatic food webs. Crayfish are “poly-trophic” feeders, meaning they will eat everything and can dominate the benthic community. These characteristics suggest that their role in lake food webs may be significant (Light 2003). In Lake Tahoe, Flint (1975) showed that at low densities, crayfish can stimulate periphyton production by feeding upon old senescent periphyton biomass. In turn, at higher densities (1.05 individuals m<sup>-2</sup>) crayfish can reduce periphyton, thereby potentially reducing food for the benthic macroinvertebrate community. Crayfish excretion experiments by Flint (1975) indicated that crayfish are a source of nitrogen and can increase periphyton production. Recent studies suggest there have been drastic declines in all invertebrates (besides crayfish) in Tahoe (Caires et al. 2013). A number of endemic aquatic invertebrates have been particularly impacted by crayfish presence including, the Tahoe stonefly (*Capnia lacustra*), the Tahoe blind amphipod (*Stygobromus spp.*), and the Tahoe flatworm (*Phagocata tahoena*), among others (Caires et al. 2013). The interaction between crayfish abundance and the decline of these sensitive endemic species is unknown. Further, Kamerath et al (2008) suggest that crayfish have subsidized the populations of predatory invasive warm water fishes in Lake Tahoe.



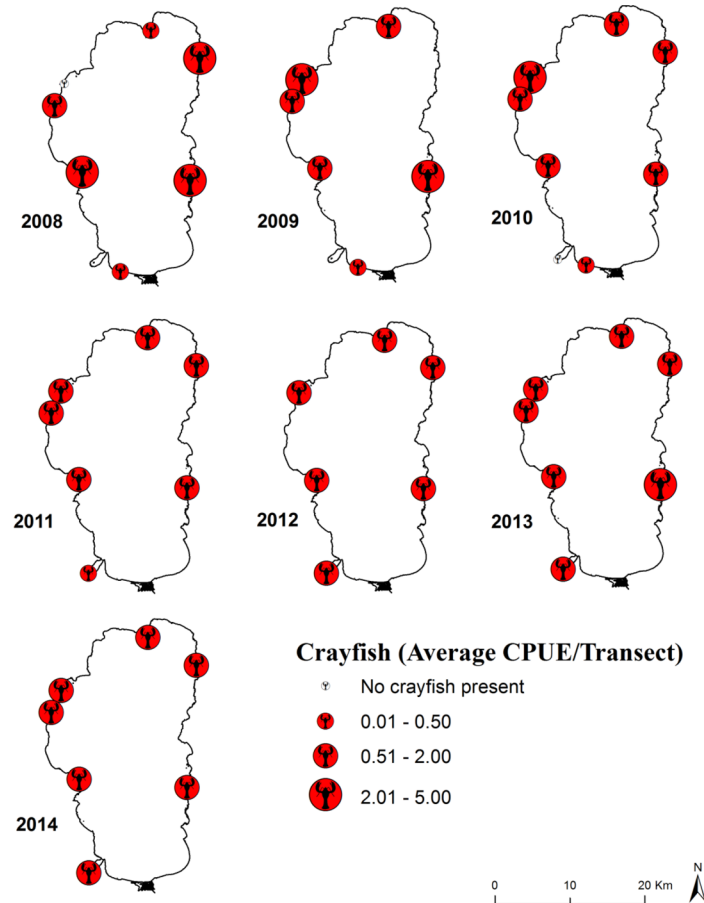


Figure 5. Signal crayfish (*Pacifastacus leniusculus*) distribution in Lake Tahoe 2008 – 2014. Each symbol represents the average catch per unit effort (CPUE) over a regional transect.

#### Control of Signal Crayfish

Crayfish are harvested globally as a food resource; however whether crayfish populations can be significantly reduced or eradicated is unknown. Manual removal of signal crayfish using traps and pond experiments with biocides have met with only moderate success in the UK (Freeman et al. 2010). Research in the Midwestern US suggests that crayfish invaders in lakes and streams

can be significantly reduced in the short term by harvesting individuals through trapping. Qualitative information suggests that crayfish abundance in these situations remained low following removals (Vander Zanden pers comm, 2015). The success of a trapping program will depend on growth rates and reproductive life histories of the crayfish (Hein et al. 2006, 2007).

In the last 3 years, the states of NV and CA have passed legislation or amended regulations that allow for the commercial harvest of crayfish in Lake Tahoe. In 2014, licensed operators finished their third season of harvesting crayfish from Lake Tahoe, a program which began in 2011. It is not clear if commercial harvest can successfully reduce crayfish populations in Lake Tahoe; however, it is recommended that harvester activity should be coordinated and/or centralized in order to more efficiently reduce populations across different regions of the lake.

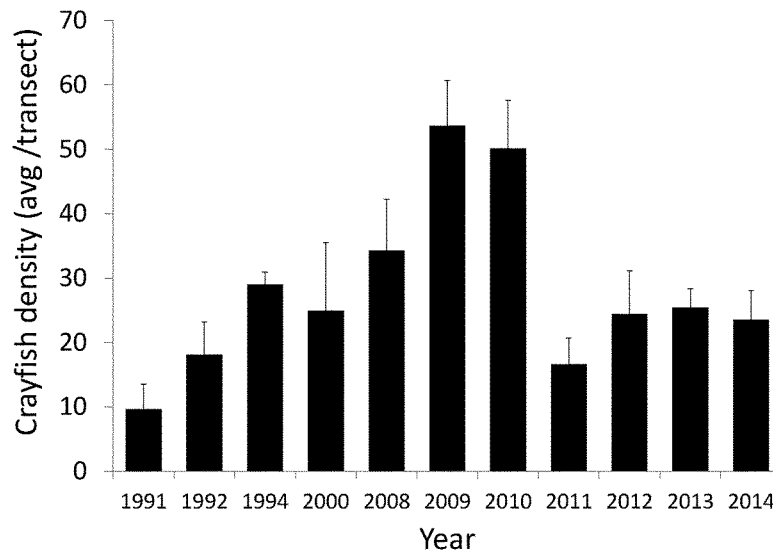


Figure 6. Average summer/fall signal crayfish density, 1991 – 2014. Data were collected at the “Sunnyside” transect, located on the west shore of Lake Tahoe. Data presented from Chandra et al., 1991, 1992, and 1994 and 2008 - 2010 from Umek et al. unpublished.

#### Conclusions based on Signal Crayfish control research

The unwanted effects of signal crayfish are significant, in Lake Tahoe and elsewhere. Continued monitoring of crayfish populations is important for understanding the long-term dynamics of the nearshore communities and the potential impacts they may have to native species in Lake Tahoe, as well as other synergistic effects they may be having on other non-native species. In addition, monitoring can inform managers of crayfish population changes across the current

harvest areas. Harvesting of crayfish has significantly reduced populations in other systems over short time periods (1-3 years), and potentially over longer time intervals (e.g., 10 years) (Vander Zanden pers com, 2015). Continued exploration into the use of commercial or non-commercial harvest as a means to reduce both the population density and the associated impacts of crayfish on native taxa, water clarity or other aspects of the Lake's ecosystem is recommended. Further, investigations evaluating the amount of effort and harvest needed to control this relatively long-lived species of crayfish which can live up to 9 years is warranted.

#### *Mysid shrimp*

*Mysis diluviana* (previously *Mysis relicta*), is an important invertebrate omnivore in many aquatic ecosystems. In the past, fisheries managers have introduced Mysid shrimp to lakes across the North American Pacific Northwest and Scandinavia with the intent to increase fish production (Lasenby et al. 1986; Northcote 1991). Although some introductions to support fisheries were successful (e.g., Sparrow et al. 1964), a great number resulted in the collapse of fisheries and significant changes to food webs (Rieman and Falter 1981; Beattie and Clancey 1991; Bowles et al. 1991; Richards et al. 1991; Ellis et al. 2011). Perhaps one of the most well-known failures of mysid shrimp introduction occurred in the Flathead River-Lake ecosystem. Owing to predation by the shrimp, cladoceran zooplankton declined dramatically, contributing to the collapse of kokanee salmon, an important planktivorous fish in that system. Loss of this formerly abundant forage fish caused displacement of mammals and birds (eagles) that had fed on them in an upstream tributary within Glacier National Park (Spencer et al. 1991).

Mysid shrimp were introduced into Lake Tahoe in the mid 1960's as forage for introduced gamefish, kokanee salmon and lake trout. Mysids were not recorded in the lake until 1968, when they were found only in lake trout stomachs (Morgan et al. 1978). Prior to *Mysis* invasion, Lake Tahoe's zooplankton community was comprised of two copepod (*Epishura nevadensis*, *Diaptomus tyrelli*) and three cladoceran (*Daphnia rosea*, *D. pulicaria*, *Bosmina longirostris*) species. Following the establishment of *Mysis*, cladocerans (both *Bosmina* and *Daphnia*) were virtually eliminated from the lake. As a result of competition for cladoceran food sources, kokanee salmon population and body size decreased (Morgan et al. 1978). From 1971-1975, mysids established high densities in the lake ( $>300 \text{ m}^{-2}$ ) and continue today to be one of the dominant zooplankton taxa. Similar to the situation in the Flathead Lake system, mysids in Lake Tahoe have the potential to seriously impact the food web of the greater Tahoe ecosystem and potentially hamper future efforts with native cutthroat trout reintroduction.

#### Control of Mysid Shrimp

Management options are extremely limited for mysid shrimp. Some research has indicated that biological controls such as large-scale introductions of amphipods or fish (deepwater sculpin, Arctic Char) appear feasible, however no research successfully demonstrated this (Martinez & Bergersen 1989; Olsen 2014).

#### Conclusions based on Mysid shrimp control research

In Lake Tahoe, it appears that management option for *Mysis* are also extremely limited. The harvest of mysid shrimp in the lake does not appear feasible, based on general life history

characteristics, their high population growth rate, and the widespread distribution of the taxon throughout the lake. Further monitoring of mysid densities to understand their role in controlling phytoplankton, sediment particle delivery from the lake bottom to open water, and impacts on organisms such as endemic invertebrates which have declined is recommended to understand whether restoration actions or the promotion of other species reintroductions in Lake Tahoe is feasible.

#### Warm water fish

Beginning in the mid-late 1970s through the late 1980s, a variety of warm water fish species were found in the nearshore zone of Lake Tahoe (Reuter & Miller 2000). These illegal introductions are thought to be the result of either angler introduction (e.g., largemouth bass, (*Micropterus salmoides*)), aquarium releases (e.g., goldfish, (*Carassius auratus auratus*)) or other unintentional introduction activities. Prior to the 1970s, native minnows were abundant in the lake; however, by the late 1980s largemouth bass and bluegill (*Lepomis macrochirus*) were common in the Tahoe Keys region of the lake. By the 1990s, recreational fishing guides were unable to collect native bait minnows at certain marinas. This rapid reduction in native fish abundance raised concerns, while at the same time nearshore habitat for non-native fishes increased with the expansion of aquatic weed beds (Kamerath et al. 2008). Until 2006, the distribution of warm water fishes beyond the Tahoe Keys was largely unknown. 2006 surveys by Kamerath et al. (2008) found non-native fishes, including bluegill, largemouth bass, goldfish, brown bullhead (*Ameiurus nebulosus*), and black crappie (*Pomoxis nigromaculatus*), at 12 of 19 sites (not including the Tahoe Keys) around Lake Tahoe (Figure 7). Most sites outside of the Tahoe Keys were characterized by very low abundances (observations of 1-10 individuals per snorkel survey), and the highest densities have always been observed in the Tahoe Keys. Since 2011, a number of non-native warm water fish discoveries (e.g., first sightings) occurred. The first voucher specimen of a small mouth bass (*Micropterus dolomieu*, a 15.5 inch, 2.3lb, gravid female) was collected from the Tahoe Keys in June of 2011. The first voucher specimen of common carp (*Cyprinus carpio*) (Total length 28.5 inches, 10.6 lbs, gravid female) was collected in the Tahoe Keys in September 2012.

At this time, the extent to which warm water fishes have established in areas outside of the Tahoe Keys is unclear. Nearshore temperature data suggest that all of the monitored sites are thermally suitable for spawning by largemouth bass, bluegill, and other warm water fishes (Kamerath et al. 2008). However, not all monitored sites are currently thermally suitable for the over-winter survival of warm water fishes. A study by Chandra et al. (2009) suggests that bass migrate out of the Tahoe Keys in early to mid-summer. This and other research also suggests that suitable habitat for nonnative warm water fishes in the nearshore has increased with the expansion of aquatic weed beds and increased nearshore water temperatures (Kamerath et al. 2008; Chandra et al. 2009; Ngai et al. 2013).

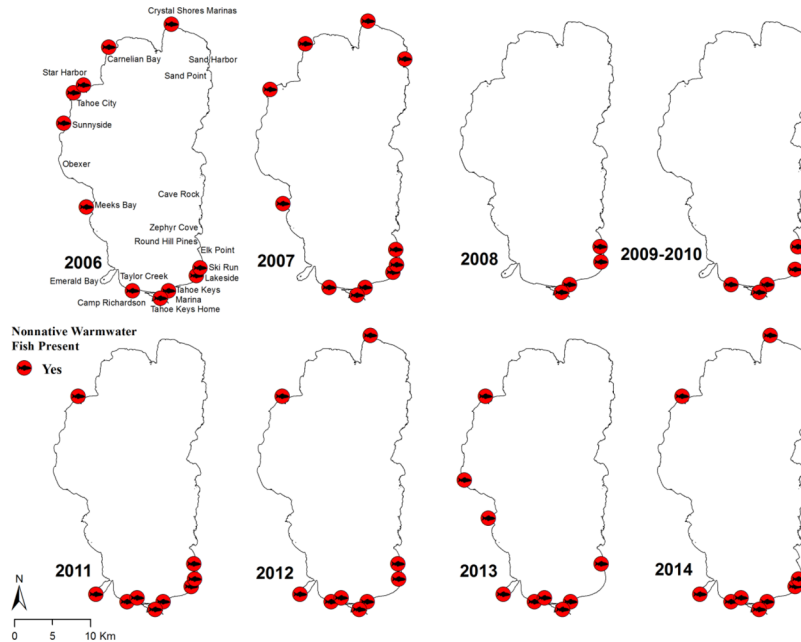


Figure 7. Warm water fish distribution (presences) in Lake Tahoe, 2006–2014. Surveys were conducted by snorkel or electroshocking. See Table 2 for list of warm water fish found in Lake Tahoe.

Warm water fish establishment has altered food web function and decreased the biodiversity of the native fish assemblages in other ecosystems (MacRae & Jackson 2001). Comparing historical and contemporary diet data for native and nonnative warm water fish in Lake Tahoe, Kamerath et al (2008) found both direct and indirect impacts of nonnative warm water fishes on the native fishes through predation and competition, when their habitats overlap. Chandra et al. (2009) recommended control and removal of largemouth bass and other nonnative warm water fish to minimize predation pressure on and competition with native fishes. In addition, based on the shift in largemouth diet to piscivory at two to four years (8.0 to 12.0 cm), Chandra et al. (2009) also recommended largemouth bass and other warm water fish removal, optimally every two years, to minimize predation pressure and competition with native fishes.

#### Control of warm water fish

There are a number of chemical and non-chemical methods available to control warm water fish species, and their efficacies are highly species and system dependent. Here, we provide a

cursory background to some of these methods and report in detail on the findings from a Lake Tahoe specific non-chemical warm water fish pilot removal program that took place from 2011-2014.

**Table 2.** Native and nonnative fishes found in the nearshore of Lake Tahoe.

| <b>Species (Common Name)</b>                       | <b>Latin Name</b>                          |
|----------------------------------------------------|--------------------------------------------|
| <b>Native fishes</b>                               |                                            |
| Tahoe sucker                                       | <i>Catostomus tahoensis</i>                |
| Lahontan redbreasted shiner                        | <i>Rhyssodonta egregius</i>                |
| Lahontan speckled dace                             | <i>Rhinichthys cataractae</i>              |
| Tui chub                                           | <i>Gila bicolor (obesus or pectinifer)</i> |
| Paiute sculpin                                     | <i>Cottus beldingii</i>                    |
| Mountain whitefish                                 | <i>Prosopium williamsoni</i>               |
| <b>Established non-native salmonids</b>            |                                            |
| Rainbow trout                                      | <i>Oncorhynchus mykiss</i>                 |
| Brown trout                                        | <i>Salmo trutta</i>                        |
| Kokanee salmon                                     | <i>Oncorhynchus nerka</i>                  |
| <b>Non-native fishes with limited distribution</b> |                                            |
| Goldfish                                           | <i>Carassius auratus</i>                   |
| Bluegill                                           | <i>Lepomis macrochirus</i>                 |
| Black crappie                                      | <i>Pomoxis nigromaculatus</i>              |
| Brown bullhead                                     | <i>Ictalurus nebulosus</i>                 |
| Carp                                               | <i>Cyprinus carpio</i>                     |
| Largemouth bass                                    | <i>Micropterus salmoides</i>               |
| Smallmouth bass                                    | <i>Micropterus dolomieu</i>                |
| Golden Shiners                                     | <i>Notemigonus crysoleucas</i>             |

Examples of non-chemical, mechanical methods to control unwanted warm water fishes include angling, water level manipulation or dewatering, fyke nets, gill nets, minnow traps, seines, electro-fishing, and electric fields (Loppnow et al. 2013). Mechanical removal of non-native fishes in other lake systems has shown promising results by reducing reproductive success, thereby limiting recruitment, and helping restore native fish communities (Weidel et al. 2007). Unlike chemical methods, most mechanical methods are selective and can be used to target only nonnative species.

Chemical methods to control warm water fish include sodium cyanide, cresol, copper sulphate, toxaphene, Antimycin A, and the most commonly used fish toxicant, rotenone. Sodium cyanide is unacceptable in water supply reservoirs due to its toxicity to mammals, cresol is likely to cause tainting and toxaphene is undesirably persistent. Copper sulphate, at concentrations likely to kill fish, is very toxic to vegetation. Rotenone and Antimycin A were approved for use as piscicides in fisheries management, but fish contaminated by them are not acceptable for human consumption, primarily because no suitable methods are available for residue analysis. Rotenone acts by inhibiting oxygen uptake through the gills, resulting in suffocation. Antimycin

A has the advantage over rotenone in that fish do not avoid it. Rotenone and Antimycin A are non-selective, meaning it will kill all fish within the target tolerance level as well as other aquatic organisms. No piscicide is limited in its effects to those on fish, and many chemicals are lethal, at concentrations used on fish, to planktonic and benthic invertebrates, reptiles and amphibians, and occasionally toxic (but not necessarily lethal) to birds or mammals.

*Tahoe Warm Water Fish Removal Pilot Project, 2011-2013*

Starting in the spring of 2011, a three-year pilot control project for warm water fish was implemented in Lake Tahoe, with most effort focused on the Tahoe Keys. The main objective of this project was to determine the feasibility and effectiveness of using mechanical removal methods (mainly electro-fishing) for the management of warm water fishes. By reducing the reproductive populations of warm water fishes the research could examine how this removal might facilitate native fish restoration in Lake Tahoe.

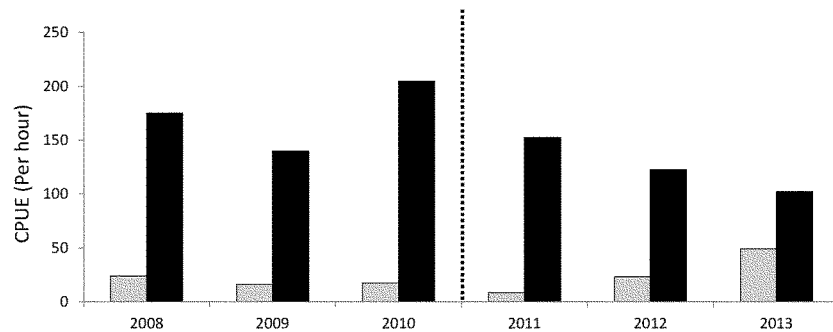


Figure 8. Catch per unit effort (CPUE) of native (solid bars) and non-native (line bars) fish in the Tahoe Keys, Lake Tahoe, 2008 – 2013. The warm water fish removal effort commenced in 2011 (represented by dashed line) and continued through 2013.

During this project, the overall abundance of warm water fish decreased and native fish increased (Figure 8). Despite this general trend, there were various outcomes for the different warm water fish taxa. A total of 51,142 nonnative warm water fish were removed by electrofishing between spring 2011 and fall 2013, with 99% of these fish collected in the Tahoe Keys. The distribution of nonnative warm water fish was uniform across all portions of the Tahoe Keys indicating no “hotspots” of warm water fish aggregation and therefore removal effort should be targeted uniformly across the region. Largemouth bass and bluegill made up the majority of the nonnative catch. In particular, large spawning largemouth bass adults ( $\geq 400\text{mm}$ ) showed significant and consistent reduction in numbers over the project period, with no collections in 2013. This suggests that mechanical removal may be effective at reducing the reproductive population of spawning adult largemouth bass. For bluegill, demographic comparisons between pre and post removal years suggests that the removal effort shifted the size structure toward larger individuals and may have increased recruitment, particularly for

individuals between 145 and 185mm. This is likely the result of a low bluegill catch rate, which allowed individuals to grow throughout the season.

Due to a lack of funding, control efforts ceased during the 2014 spring/summer period. A 2014 fall survey of the Tahoe Keys showed that after one year without any control effort, the relative abundance of largemouth bass may have recovered. This suggests that ongoing removal efforts may be necessary maintain low numbers of largemouth bass. Results from the 2014 fall survey also showed significant increases in catch of age-0 bluegill (<55mm) after one season of no control effort. This implies that mechanical removal may not be effective at reducing bluegill numbers in the Tahoe Keys.

#### Conclusions based on warm water fish control research

Based on the results of the electroshocking removal experiment (i.e. short term decreases in largemouth bass in the Tahoe Keys and potential impacts to bluegill sunfish population structure), we recommend continued mechanical removal for this species until alternate approaches (e.g. pesticides) can be utilized in the basin. Mechanical removal should be coupled with the development of a population harvest model to determine the effectiveness of removal for each taxa. In addition, it is important to establish a monitoring program for invasive fishes including coldwater taxa such as small mouth bass recently discovered in the lake; these may live outside of marina in rocky habitats.

#### Amphibians

##### American Bullfrog

The American bullfrog (*Rana catesbeiana*) is native to eastern North America but has become widespread across the U.S. It is the largest true frog in North America, reaching sexual maturity between three to five years following metamorphosis and living for upwards of 13 years. Like other bullfrogs, *R. catesbeiana* is cannibalistic, frequently consuming newly metamorphosed bullfrogs and larval tadpoles (Stuart 1993). Bullfrogs prefer wet vegetated areas to lay eggs, hide from predators and wait for prey. In the Tahoe Basin, American bullfrog has been observed since 2004 in the south shore region, with breeding populations occurring in Sawmill Pond, Seneca Pond, Taylor Creek, and Lake Baron (Figure 9). Information related to population growth, spread or breeding rates is currently unknown.

The American bullfrog is considered invasive largely due to its rapid population growth and voracious and unspecialized feeding habits (Lowe et al. 2000; Kraus 2009; CABI 2011; Jancowski and Orchard 2013). Bullfrogs develop nonlethal infections from chytridiomycosis, caused by the chytrid fungus (*Batrachochytrium dendrobatidis*) (Daszak et al. 2004). Chytrid fungus appears capable of infecting most amphibian species and has been linked to significant population declines (Fisher et al. 2009). Recent research suggests bullfrogs are also known to transmit the disease to other anuran species (Greenspan et al. 2012).

##### Control of American bullfrog

To control adult bullfrogs, a variety of methods may be employed, including shooting, spears/gigs, bow and arrow, clubs, nets, traps, angling, and by hand (Global Invasive Species



Database 2008). Recently, methods have been developed to collect and control frogs using a modified electro-fishing shocker. Collecting egg masses using a bilge pump can be an effective adjunct control (Govindarajulu 2004). Targeting egg searches to areas where male bullfrogs are heard calling during the night may improve the probability of detecting egg masses (Govindarajulu 2004). Incomplete removal of eggs or larvae, however, can inadvertently increase the growth and survival of the remaining individuals and cause an increase in the population (Govindarajulu 2004). Direct removal of bullfrog is often very difficult and typically unsuccessful due to their high fecundity rate, high dispersal capability, opportunistic diet, and the complex habitats in which they are often associated. Habitat manipulation, in association with direct removal efforts, could prove more successful. Maret et al. (2006) used a method of draining and drying ponds to eliminate bullfrogs. Because bullfrogs overwinter as larvae and are dependent on permanent water for growth, this method has shown success. Direct removal of adults in combination with periodic drying (approximately every two years) could allow native amphibians the opportunity to reestablish (Doubletree et al. 2003). Although this dual pronged approach may be successful, it is unclear how periodic draining would impact native species that also rely on a permanent water source.

#### Conclusions based on American bullfrog control research

At this time, it is not clear whether American bullfrogs are expanding their populations within the Tahoe Basin or what unwanted effects this species may be having on native species, recreational use or ongoing restoration efforts in the basin. In addition, it is not known which mechanical or chemical methods may be the most suitable for effective control, particularly at sites that are undergoing restoration, such as Taylor Creek. As both mechanical and chemical control options have yielded some success in other systems, we recommend continued assessment of the population dynamics, life histories and impacts to other species, in order to better characterize the magnitude of the threat and to understand when control activities would best be applied. Further, experimentation of *in situ* control actions would significantly inform decision-making for this species moving forward.

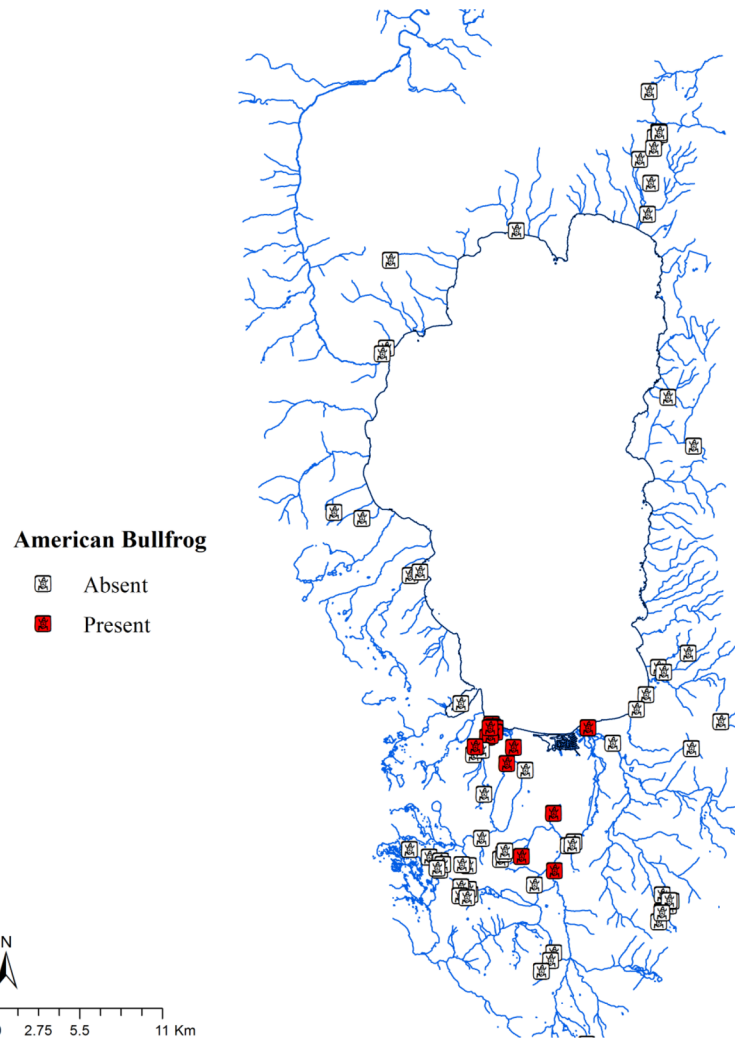


Figure 9. American bullfrog (*Rana catesbeiana*) distribution in the Tahoe Basin, 2004 – 2008, 2011 – 2014. Data from Taylor-Tallac Ecosystem Restoration Plan, S. Muskopf, USFS LTBMU, Sept 30, 2009 and American Bullfrog 2013 Summary, 13-CO-11051900-039 TRPA AIS. Presence indicates when at least one life stage of Bullfrog found.

## Prioritization of species, locations for control and recommended actions

### Introduction

A strategic approach to management of an invasive species can be defined as a spatial and temporal distribution of effort that yields the greatest benefit from the available resources (Grice 2010). Four strategic goals for countering biological invasions can be identified: prevention, eradication, containment and control. Prevention is only applicable prior to the transport and introduction stages (Lockwood et al. 2013). Generally, eradication is possible either during the establishment stage, or during the earliest part of the spread stage, (Lockwood et al. 2013). When eradication of an invasive species becomes impractical, containment or adaptation may be the most appropriate strategy. Containment and control strategies seldom have an end point, and often the size of the infestation is positively correlated with the time required to control the infestation (Rejmánek & Pitcairn 2002).

The current AIS implementation plan for Lake Tahoe focuses on the selection of AIS taxa for management targets, specific site selection for management actions, and recommendations for control strategies. These recommendations contribute to the four strategic goals presented above, which also directly overlap with the three goals of the Tahoe AIS Management Plan. The prioritization of this implementation plan is based on several well-established principles in invasion ecology and management and is motivated by the following concept:

***The reduction of AIS from the highest ranked sites will reduce overall expansion in the lake.***

Thus, at this time, containment and control are the objectives for selected AIS in Lake Tahoe. While instances of localized eradication for aquatic invasive plants may be possible, the goal of the implementation is for reduction of biomass of AIS at existing locations and the suppression of spread of AIS to new locations. Further, this implementation plan is intended to guide management actions over a 3-5 year period. Whether species eradication is possible over the longer term can potentially be better informed after a systematic management and control program is implemented in Lake Tahoe.

To prioritize and recommend site- and species- specific AIS control actions, this section includes five components: (1) Categorization of AIS into management groupings, (2) An ecologically-based prioritization of site selection the top management grouping (which includes invasive aquatic plants and warm water fish, (3) Recommended management actions for all species of concern, (4) Recommendations for monitoring, and (5) Identification of knowledge gaps.

### Aquatic invasive species management groupings

Based upon the information provided in the preceding section which describes control actions taken either in Lake Tahoe or in other systems, three management groupings have been determined for the AIS considered for control actions in Lake Tahoe. The three management groupings have been determined based on the feasibility of control actions as determined in previous sections, relative to the biology of the AIS under consideration, and subject to the regulations currently in place in Lake Tahoe. These management groupings are based on the

best available knowledge and management options for all of the considered species may change depending on changes to regulations in the Tahoe region, the development of novel technologies or other means by which to control AIS in Lake Tahoe, or new knowledge or information gained through research, monitoring or other AIS management actions at Tahoe or elsewhere.

The management groupings are as follows: (A) Species which have feasible control options available at this time. Potential control actions are for species or species groups for which information exists from studies at Tahoe or the scientific literature, and where removal of one species may lead to the reduction of additional AIS (e.g., fish-plant interaction). (B) Species for which potential actions exist, but there is ample uncertainty at the current time to implement right away. This includes species groups for which there may be some evidence of potential control or biomass reduction strategies, but whether these strategies have long-term feasibility, or ability to be successfully applied in the Tahoe environment is unknown. (C) No feasible control options are available at this time. This designation is based upon experimentation or practice observed either in Lake Tahoe or outside of Lake Tahoe. In the cases considered here, reasons for the infeasibility of potential control options can be attributed to biological or ecological characteristics of species which may prohibit effective control, a lack of technologies or tools, or cost prohibitiveness of available or existing control options. As more information becomes available, or the development of novel control strategies or technologies arise, designations of species may likely change. The species groupings are as follows:

**A) Feasible control actions:**

- Eurasian watermilfoil
- Curlyleaf pondweed
- Warm water fish

**B) Potential control actions:**

- Signal crayfish
- American bullfrog

**C) No feasible control options at this time:**

- Mysid shrimp
- Asian clam

**Site prioritization for invasive aquatic plants and warm water fish removal**

Here, we employ a prioritization scheme for the invasive aquatic plants and warm water fish in Lake Tahoe. This prioritization is based on several well-established principles in invasion ecology and management and is motivated by the following concept:

*The reduction of AIS from the highest ranked sites will reduce overall expansion in the lake.*

*Methods of the ecologically based site prioritization model*

The metrics used in the prioritization model described below concern the following: (1) fish-plant interactions, (2) size of infestation, (3) human interaction with infestations, and (4) location of infestation. Other factors of major significance concerning the control of AIS such as suitability of the receiving habitat, proximity to sensitive native species, or potential impact of control actions on the surrounding environment are vital components of site selection, but are not included in this model due to lack of available data.

This prioritization is built upon these four concepts, in part, because they are well supported in the empirical and theoretical literature and also through experimentation and data collection carried out in Lake Tahoe. Vital knowledge gaps related to aquatic invasive species and their harmful effects will be identified in the following section, and should be integrated into this prioritization scheme as they are addressed through future research and management efforts. As such, the current prioritization scheme is quantified based on the following:

**(1) Locales with fish-plant interactions:** The presence of aquatic macrophytes enhances the ability for warm water fish to establish and to increase in population size (Dibble et al. 1996; Hoyer & Canfield 1996). In Lake Tahoe, aquatic plants provide important habitat for warm water fish reproduction and survival (Kamerath et al. 2008; Tucker et al. 2010). We assume that the removal of invasive aquatic plants in Lake Tahoe will not only decrease the unwanted effects from these species, but will also remove habitat for warm water fish.

We have identified 28 sites in Lake Tahoe that have had either current or historically established populations of Eurasian watermilfoil, curlyleaf pondweed, warm water fish or some combination of the three. Each site that is known to have established populations of these species as of 2012 (aquatic plants) - 2014 (warm water fish) is given a score of "1" for each of these three taxonomic categories. The scoring of these sites are based upon results from the warm water fish removal and surveillance efforts carried out by University of Nevada Reno (UNR) or other aquatic plant surveys conducted by various surveillance teams as coordinated by the Tahoe Resource Conservation District. These categories are additive; a score of "3" indicates that Eurasian milfoil, curlyleaf pondweed and warm water fish are all present. A score of "2" indicates that only two of these species groups are present.

**(2) Plant infestation size:** There is a demonstrated positive relationship between the size of the population and the number of viable offspring or propagules it creates (Lockwood et al. 2013). The more offspring or viable propagules, the greater the likelihood of establishment, spread and range expansion for a species within a particular ecosystem (Lockwood et al. 2005). Therefore, we assume that targeting large populations may reduce the overall abundance of the species within a system. In 2012-14, field surveys were conducted to estimate the areal invasive plant coverage in the nearshore of Lake Tahoe. We converted estimated areal coverages into site-specific proportions relative to the overall coverage in Lake Tahoe. Thus, each site that is positive for invasive plant presence, will receive a score between 0 - 1. This value is intended to represent a location's potential relative contribution of propagules (aka

propagule pressure) for the rest of the lake. A high score indicates that a site contributes more to the likelihood of spread within the lake.

**(3) Human use and visitation:** Species invasions are associated with human disturbance. Aquatic ecologists have often modeled human movement patterns as a means to capture the frequency, type and transport mechanism of non-native species introduction events (Carlton 1993; Leung et al. 2006; Herborg et al. 2007). As an example, established populations as well as viable plant fragments of AIS are found in greater abundance in estuaries with high rates of recreational boating compared to areas with less recreational boating (Mosisch & Arthington 1998; West et al. 2009; Clarke Murray et al. 2011). Here, recreational boater visitation is used to quantify the amount of site-specific use intensity, in relative terms. We assume that areas with more recreational boat pressure represent areas of invasive species propagation.

Through an interview based survey of approximately 800 Lake Tahoe recreational boaters, the number of in-lake recreational boat trips to nearshore sites in Lake Tahoe has been quantified (Wittmann et al. 2015). Using this metric of recreational boater visitation as an indication of human pressure, each site is given a score between 0-1, representing the number of boater visits to that site, relative to the overall in-lake recreational boat visits to all sites in Lake Tahoe. A score closer of one indicates that a site is visited by all boaters in the lake. A score of zero indicates no visitation by recreational boaters.

**(4) Isolated, or satellite populations:** Remotely located populations (e.g., satellite populations) of invasive species may increase the range expansion of that species within a system (Shigesada & Kawasaki 1997; Tobin & Blackburn 2008). It has been demonstrated that satellite populations increase the rate of expansion of an invasion (Lockwood et al. 2013) and targeting such populations for reduction or removal can act to reduce spread rates.

Each nearshore site that contains AIS is scored by determining the straight line distance between the set of all nearshore sites that presently or historically contain invasive aquatic plants or warm water fish, and standardized these distances over the whole set of distances. Thus, a site with a higher score relative to other sites indicates that its nearest neighbor is relatively farther away compared to other sites.

#### Site Prioritization Model

Overall site prioritization was then determined through a combination of the categorical (species presence/absence) and continuous (e.g., size of infestation, human pressure, satellite populations) variables described above. The sites were then ranked according to the overall score received through the aggregation of these variables. The following describes the model.

For each site,  $i$ :

$$\text{rank}(S_i) = (CL_i + MF_i + WF_i) * PP_i * BV_i * ED_i$$

Where,

$S_i$  = Site specific prioritization score  
 $CL_i$  = Curlyleaf pondweed presence (0,1)  
 $MF_i$  = Eurasian watermilfoil presence (0,1)  
 $WF_i$  = Warm water fish presence (0,1)  
 $PP_i$  = Proportion of plant areal coverage in the lake (0-1)  
 $BV_i$  = Proportion of boater visitation (0-1)  
 $ED_i$  = Shortest distance from nearest AIS establishment site (0-1)

It is important to note that all components of the continuous elements of the model are scale invariant (meaning there are no units associated with them) and that they are equally weighted. Thus, we assume that each of the three variables, PP, BV, and ED are equally as important as each other. In addition, each of the categorical variables (e.g., MF, CL, WF) also receive equal score assignments, which indicates that the presence of all three species receives the highest priority. Further, due to the seasonal variability in AIS biomass, survey techniques and detection capabilities, there are some uncertainties associated with the presence and size of several infestations around the lake.

#### ***Results of the site prioritization and species- and site-specific recommendations***

See Table 3 and Figure 10 for results of the site prioritization. Site rankings are based on the site specific prioritization score ( $S_i$ ) that each site received. Note the large difference (sometimes order of magnitude in size) between site specific prioritization score (Figure 10). Please see below for a discussion of these differences.

Relative to other nearshore locations in Lake Tahoe, the **Tahoe Keys** locations scored very high and ranked #1 and #2. This priority ranking was largely due to the magnitude of the plant and fish infestations as well as the high recreational use of these areas by Tahoe boaters. These sites also had very little sensitivity to changes in estimates of plant coverage or other model variables, and thus always remain in the top priority spots. We defer to the Tahoe Keys Integrated Weed Management Plan for microsite-specific recommendations for the treatment of aquatic plants. However, due to the notable abundance of invasive and nuisance native aquatic plants in this system, an integrated program for removal which not only includes the use of non-chemical removal efforts such as bottom barriers and diver assisted suction removal, but other actions such as the reduction of nutrient loads, plant fragment collection, and herbicide application is recommended to reduce unwanted plant biomass.

Based on preliminary results from the experimental mechanical fish removal project at this location, continued electroshocking for the removal of largemouth bass and other warm water fishes is recommended. However, further research to determine the effects of this removal on various age classes of warm water fish, and the effort required to successfully reduce warm water fish populations at this and other Tahoe sites is needed. Based on feedback from the external expert review panel, a suggested 90% reduction of warm water fish biomass in the Tahoe Keys may be feasible and the amount of effort currently being allocated is not adequate (Hoff, pers. comm 2015). Also recommended is the development of a targeted warm water fish nest control program.

| Site Name                           | EWM | CLP | WWF | Plant | BV    | ED    | S <sub>i</sub> | Rank |
|-------------------------------------|-----|-----|-----|-------|-------|-------|----------------|------|
| TK Main Lagoon and Channel (West)   | x   | x   | x   | 0.791 | 0.122 | 0.041 | 1.2E-02        | 1    |
| TK Marina Lagoon and Channel (East) | x   | x   | x   | 0.151 | 0.122 | 0.025 | 1.4E-03        | 2    |
| Meeks Bay                           | x   |     | x   | 0.007 | 0.052 | 0.197 | 1.5E-04        | 3    |
| Ski Run Marina/Channel              | x   | x   | x   | 0.022 | 0.006 | 0.039 | 1.4E-05        | 4    |
| Tahoe City Dam                      | x   |     | x   | 0.008 | 0.017 | 0.021 | 5.6E-06        | 5    |
| Lakeside Marina                     | x   | x   | x   | 0.006 | 0.043 | 0.004 | 3.0E-06        | 6    |
| Regan Beach                         | x   | x   |     | 0.001 | 0.009 | 0.065 | 1.7E-06        | 7    |
| Taylor Creek                        | x   | x   | x   | 0.000 | 0.046 | 0.046 | 1.4E-06        | 8    |
| Crystal Bay 2                       | x   |     | x   | 0.000 | 0.008 | 0.441 | 6.4E-07        | 9    |
| Crystal Bay 1                       | x   |     | x   | 0.000 | 0.008 | 0.441 | 6.4E-07        | 9    |
| Crystal Bay 3                       | x   |     | x   | 0.000 | 0.008 | 0.441 | 6.4E-07        | 9    |
| Lakeside Swim Area                  | x   | x   |     | 0.002 | 0.043 | 0.004 | 5.8E-07        | 12   |
| Tahoe Tavern                        | x   |     |     | 0.004 | 0.005 | 0.021 | 3.5E-07        | 13   |
| Timber Cove Pier                    | x   | x   | x   | 0.000 | 0.001 | 0.039 | 1.3E-08        | 14   |
| Elk Point Marina                    | x   |     | x   | 0.003 | 0.001 | 0.003 | 1.2E-08        | 15   |
| Nevada Beach                        | x   |     |     | 0.000 | 0.001 | 0.003 | 3.4E-11        | 16   |
| Logan Shoals Marina                 | x   |     |     | 0.005 | 0.000 | 0.172 | 8.9E-16        | 17   |
| Baldwin Beach                       | x   |     | x   | 0.000 | 0.009 | 0.046 | 0.0E+00        | 18   |
| Emerald Bay, Avalanche Beach        |     |     | x   | 0.000 | 0.155 | 0.171 | 0.0E+00        | 18   |
| Emerald Bay, Vikingsholm            |     |     | x   | 0.000 | 0.155 | 0.171 | 0.0E+00        | 18   |
| Emerald Bay, Parson's Rock          |     |     | x   | 0.000 | 0.155 | 0.171 | 0.0E+00        | 18   |
| Upper Truckee River                 | x   | x   | x   | 0.000 | 0.003 | 0.025 | 0.0E+00        | 18   |
| Camp Richardson                     |     |     | x   | 0.000 | 0.046 | 0.083 | 0.0E+00        | 18   |
| Homewood (Obexer's)                 |     |     |     | 0.000 | 0.040 | 0.042 | 0.0E+00        | 18   |
| Boatworks Marina                    |     |     | x   | 0.000 | 0.024 | 0.025 | 0.0E+00        | 18   |
| Sunnyside Marina                    |     |     | x   | 0.000 | 0.036 | 0.074 | 0.0E+00        | 18   |
| Zephyr Cove                         |     |     |     | 0.000 | 0.041 | 0.046 | 0.0E+00        | 18   |
| Fleur du Lac Marina                 |     |     |     | 0.000 | 0.000 | 0.042 | 0.0E+00        | 18   |

Table 3. Lake Tahoe Site Prioritization Table. EWM = Eurasian watermilfoil presence (x = present, blank = absent), CLP = curlyleaf pondweed presence (x = present, blank = absent), WWF = warm water fish presence, (x = present, blank = absent), PP = proportion of areal plant coverage relative to lake wide value (0-1), Prop Low = lower estimate of areal plant coverage relative to lake wide value, Prop High = higher estimate of areal plant coverage relative to lake wide value, BV = proportion of recreational boater visitation, ED = Euclidean distance of site, relative to nearest infested site, S<sub>i</sub> = Site specific prioritization score, Rank = Ranking based on best estimate of plant areal coverage.

**Meeks Bay**, the highest ranked location after the Keys, was scored high and prioritized largely due to its "remote" location and presence of all three species of concern, but also because of the large size of its estimated areal plant coverage. Due to the uncertainties associated with the invasive aquatic plant survey information, an updated but detailed site survey at this location is recommended. Without a better understanding of the extent of the Meeks Bay infestations, at this time, targeted removal efforts at this location will make planning difficult. Warm water fish removal utilizing electroshocking is also recommended within the marina in 2015.



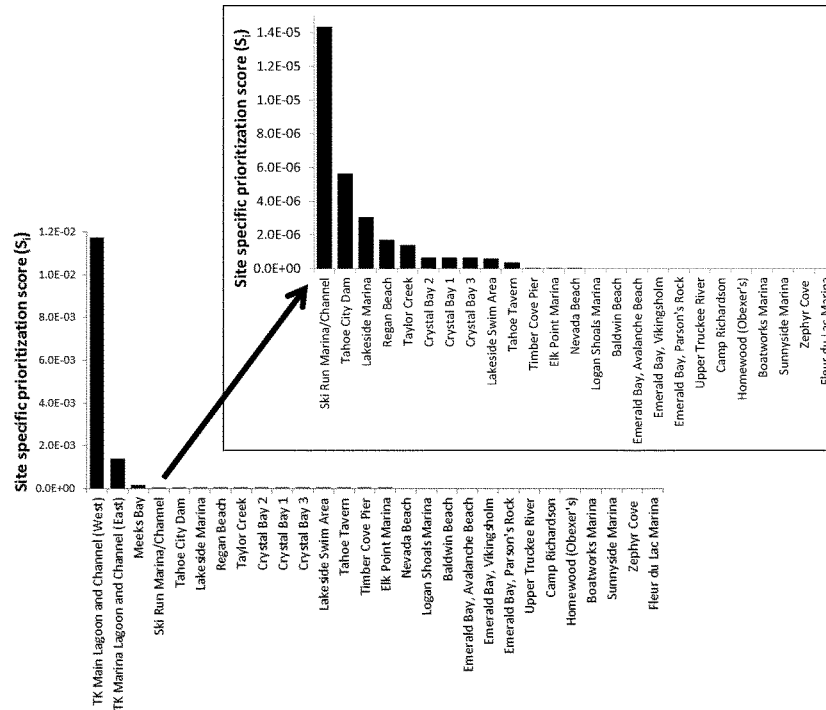


Figure 10. Site prioritization based on site specific prioritization score,  $S_i$ . The prioritization score incorporates invasive aquatic plant and warm water fish presence/absence, areal coverage of aquatic plant infestation, recreational boater use and location of infestation. The Tahoe Keys (TK) Lagoons and Channels (West and East) score extremely high relative to other sites in Lake Tahoe.

The **Ski Run Marina and Channel** was the highest ranked location after the Tahoe Keys with reliable plant areal coverage and warm water fish information, thus making it suitable for immediate control action. Control activities as early as 2015 are recommended at this location based on the established and existing partnership between the Marina managers and the Tahoe Resource Conservation District, the high abundance of invasive aquatic plants both within and outside of the marina, and the high intensity recreational boater use. Because of the presence of both Eurasian watermilfoil and curlyleaf pondweed, an integrated program utilizing hand pulling, suction removal, and bottom barriers will certainly be necessary here. Due to the high density of curlyleaf pondweed at this location, control actions or experimentation targeted at turion inhibition (e.g., integrated bottom barrier and acetic acid application) as well as

rhizome reduction is recommended. Warm water fish removal utilizing electroshocking is also recommended within the marina in 2015.

The **Tahoe City Dam** location scored as the fifth highest priority in this assessment. Due to this location's importance as a source of viable plant fragments for AIS establishment in the lower Truckee River below the dam, immediate action is recommended; particularly with respect to ongoing mechanical removal efforts led by the Tahoe Resource Conservation District (TRCD). The integrated use of hand-pulling and bottom barriers may be especially effective in 2015 due to low water conditions. Similar to these non-chemical methods, the use of herbicides at this time may be effective due to increased application efficacy attributable to the low water condition. However, at present herbicide usage is not permitted; therefore alternative methods will need to be used to control aquatic plants and warm water fish at these locations.

The following sites were ranked from 6 - 12: **Lakeside Marina (and swim area), Regan Beach, Taylor Creek and the Crystal Bay Marinas/Rock Cribs**. Characteristics of these locations indicate their importance for targeted invasive plant and also warm water fish removal; however uncertainties which pose management obstacles occur at each location. For example, the **Lakeside Beach and Marina locations** as well as the **Crystal Bay Marinas** have been part of invasive plant control efforts over the past few years (2011-2013). However, post treatment monitoring and plans for continued removal efforts are currently unknown. We recommend integrated removal programs using bottom barriers (gas impermeable at Lakeside (due to presence of Eurasian watermilfoil and curlyleaf pondweed) and gas permeable at Crystal Bay (due to presence of Eurasian watermilfoil)) and suction removal, coupled with multi-year efficacy monitoring and surveillance. There is conflicting information concerning the size and location of aquatic plant infestations at both **Regan Beach** and **Taylor Creek**. Updated and detailed site surveys in both locations is warranted. In particular, Taylor Creek is currently undergoing a large scale restoration project and is home not only to invasive aquatic plants, warm water fish, but also bullfrogs which may be using Eurasian watermilfoil beds as habitat along this creek system (S. Muskopf pers comm, 2015). More information is needed regarding the density and distribution of aquatic plants in this system.

Of the 28 sites considered, 11 sites did not have any aquatic invasive plant coverage in 2012-2014. However, of these 11, 6 had warm water fish, although in low abundance. Sites without aquatic invasive plant presence were ranked lowest as a result, and we recommendation continued monitoring. It is important to note that all three locations in Emerald Bay (e.g., Parson's Rock, Avalanche Beach and Vikingsholm) have been scored zero for curlyleaf pondweed and Eurasian watermilfoil. Despite the historical abundance Eurasian watermilfoil and a one-time observation of curlyleaf pondweed at this location, we assume for the sake of this prioritization exercise that both of these species are currently absent in Emerald Bay. This assumption is based on reports of the multi-year Emerald Bay aquatic plant removal program headed by the California State Lands Commission and the most recent (2014) survey results. Continued monitoring (and associated rapid response actions) is encouraged at Emerald Bay.

### Recommendations for species in other management groups

**American bullfrog:** At this time, it is not clear whether American bullfrogs are expanding their populations in the Tahoe Basin. Further which mechanical or chemical methods may be most suitable for effective control of American bullfrog in the Tahoe Basin is unknown, particularly in sites that are undergoing restoration work (i.e. Taylor Creek). Continued assessment of the population dynamics, life histories and impacts to other species, (including humans), in the Tahoe Basin are recommended. These assessments will allow for the characterization of the biological properties of these populations, magnitude of the invasion, and the feasibility of mechanical or chemical control options given these properties. Understanding where and when breeding populations may occur in the Tahoe Basin can help develop specifics of mechanical removal efforts for this species. Further, experimentation of *in situ* control actions or the initiation of a pilot control project will significantly inform decision-making concerning targeted control efforts for this species moving forward.

**Signal crayfish:** The negative effects of signal crayfish are significant, both in Lake Tahoe and elsewhere. Continued monitoring of crayfish populations is important for understanding long term dynamics of the near shore systems, and particularly to understand potential population changes from harvest areas in the lake. The harvest of crayfish has significantly reduced population numbers in other systems over short time periods (1-3 years), and potentially over longer intervals (e.g., 10 years) (Vander Zanden pers com, 2015). Continued exploration of the use of commercial or non-commercial harvest as a means to reduce population densities and associated impacts of crayfish where they may be impacting native species, water clarity or other aspects of the Lake's functioning is recommended.

**Asian clam:** While both bottom barriers and suction dredging may be useful to reduce Asian clam populations in the short term, the species' observed rapid recolonization rates likely pre-empts any potential for effective widespread removal and control of Asian clam in Lake Tahoe with these methodologies. This is supported by evidence from technical reports and peer-reviewed studies of Asian clam control experiments in both Lake Tahoe and Lake George and from suggestions put forth in the USGS Non-indigenous Aquatic Species database (e.g., Foster et al. 2015). Further, treatment of Asian clams with molluscicides is likely not feasible in Lake Tahoe due to difficulties associated with exposure time in open water conditions. However, the potential for molluscicide treatment applied in combination with bottom barriers may provide a means to improve effectiveness of application and contact time as well as containment of molluscicide.

In scenarios where there may be an exceptional need to manage clams, such as where infestations may negatively affect water clarity, recreation, the survival of native taxa or other important attributes of the lake, further investigation into various removal strategies over small scales to mitigate some of the potential damages that Asian clam may cause is recommended.

**Mysid shrimp:** Based on life history characteristics, high population growth rates, and distribution throughout the lake, harvest of mysid shrimp in Lake Tahoe does not appear

feasible at this time. Further monitoring of impacts to native or sport fish species relative to mysid population densities is recommended to better understand how actions related to the restoration or promotion of other species in Lake Tahoe may be negatively impacted by *Mysis* shrimp.

#### Recommended efficacy monitoring

The progress and consequences of containment and control programs must be effectively monitored in order to provide both information and feedback to managers. Monitoring data is necessary to the process so that management actions can be modified, adjusted or concluded, if/when new information arises. Monitoring should document changes in the distribution or abundance of an invasive species, or changes in components of the system, such as variables like water clarity, productivity, or native species abundance (Grice 2010). Well-designed monitoring programs should not only contribute to the knowledge of the impacts of particular invasive species, but also to the value of the containment and control actions used to help manage them. Further, efficacy monitoring can serve to significantly reduce control costs as it improves the ability to rapidly respond to small, incipient populations that may arise after treatment. This is in contrast to observing a recolonization after it has achieved significant areal coverage or biomass.

Efficacy monitoring for aquatic plant, warm water fish, and all AIS control activities should be conducted on a project-specific basis. Any site-specific targeted removal action (either mechanical removal or chemical treatment) should have an accompanying efficacy monitoring plan that is based on both the timing of the control action and phenology of the AIS. Specific efficacy monitoring actions for invasive aquatic plants and warm water fish include:

- Quantification of areal coverage, and when possible, density of Eurasian watermilfoil, curlyleaf pondweed and/or warm water fish in treatment area and in adjacent non-treatment area prior to treatment action.
- Quantification of areal coverage, and when possible, density of native aquatic plants and native fish in the treatment area, and in adjacent non-treatment area prior to treatment action.
- Repeated quantification of the two items listed above ***immediately after treatment action, 6 months after treatment, and 1 year after treatment (or some other determined time intervals)***. The surveillance carried out one year after treatment (or some other determined time interval) can inform the level of effort and materials needed for upcoming treatments.
- Quantification of the ***effort*** per spatial unit spent to implement site specific removal. For example, the number of hours spent by divers, boat operators, data enterers, data assessors to implement and evaluate the information associated with a removal activity.
- Localized populations should not be considered eradicated unless a five year period has passed without an observation of an incipient population (e.g., see Anderson 2005). Continued surveillance is recommended at all locations due to potential reintroductions from outside of Lake Tahoe (e.g., recreational boater or waterfowl dispersal) and within Lake Tahoe (e.g., other established populations).

### Knowledge Gaps

Through the development of this AIS Control Implementation Plan, a number of important informational needs required in order to improve planning and implementation for any AIS control actions to be carried out in Lake Tahoe have been identified by the authors, the AISCC and the external expert review panel. Addressing these items can facilitate AIS control implementation in Tahoe, as well as a strategic AIS management plan moving forward. Not listed in any order of priority, these gaps include:

**1. Need for established metrics or goals to evaluate success of AIS management:** The ability to set eradication versus control objectives will improve implementation of AIS management at Tahoe. At this time, there is no defined, desired outcome for control in the Basin. The ability to determine whether eradication or containment is a site or species specific objective is a key step to setting goals for any AIS management plan. Further, as potential control options or technologies are introduced, it will be helpful to know which could be used for eradication or which could be used for control. Over the next 3-5 years, evaluating the success of invasive aquatic plant removal by determining the change in areal coverage (e.g., plants) or fish density at each site location and effort expended can inform future control efforts.

**2. Aquatic plant distribution:** Estimates of areal coverage of aquatic invasive plants in Lake Tahoe range widely; our highest-confidence estimate for whole-lake coverage was 125 acres, with a minimum range of 25 and a maximum of 146 acres. The Tahoe Keys alone has been estimated to be about 130 acres of aquatic plants: mainly *M. spicatum*, *C. demersum* and to a lesser extent, *P. crispus*, with some seasonal nuisance filamentous algae as well. Planning, resource acquisition and implementation for site-specific control actions depends heavily on the accurate measurement of species infestations. Site specific inconsistencies in the aquatic plant survey information could potentially be resolved with a standardized surveillance program with consistent methodologies and surveillance parameters. Namely:

- **Taylor Creek and the Upper Truckee River:** The identification and distribution of aquatic invasive plants Taylor Creek is highly uncertain. A detailed survey of the creek between Fallenleaf Lake and Lake Tahoe is warranted to understand the magnitude of the infestation. Particularly because this region is an upstream source for AIS for Lake Tahoe. The same is true for populations in the Upper Truckee River.
- **Baldwin Beach, Tahoe Tavern and Sunnyside Marina** all have conflicting reports of aquatic plant presence.
- **Meeks Bay** has not been surveyed for aquatic plant coverage since 2009. A high priority site; a detailed species specific survey is warranted at Meeks Bay.
- **Fleur du Lac and Logan Shoals Marinas:** These marina locations have historical establishments of Eurasian milfoil and have either been resurveyed as part of individual efforts (e.g., Logan Shoals surveyed by L. Anderson in 2010), have not been recently resurveyed (Fleur du Lac) or have conflicting reports.

**3. Curlyleaf pondweed control actions.** Citing examples from both the published literature and Tahoe specific research actions, the non-chemical removal of Eurasian watermilfoil in moderate abundances may be feasible in certain locations. However, the feasibility of non-chemical mechanical treatments for curlyleaf pond weed are uncertain at this time due to uncertainties related to the timing of its growth and reproduction, longevity of turion survival, propagation via rhizomes relative to turions, and other Tahoe specific dynamics. How mechanical or chemical treatments relate to the phenology and recolonization of curlyleaf pondweed in Lake Tahoe at this time is currently not well understood. Recent publications indicate that combined treatment using acetic acid (e.g., vinegar) or hot water and EPDM bottom barriers inhibit turion growth (Barr & Ditomaso 2014, Barr & Ditomaso In Press). Integrating these potential turion inhibition treatments with other pilot removal products may provide important information for long-term implementation planning in Tahoe.

**4. Warm water fishes harvest and removal:** Ongoing efforts to remove warm water fishes are largely based on mechanical removal. Based on recommendations from the external expert review panel, increases in electroshocking effort in the Tahoe Keys are highly recommended. Further, establishing stock-recruitment models based on the harvest of warm water fish from the Tahoe Keys or at other locations in Lake Tahoe should be developed to guide future mechanical removal methods with a focus on developing alternative, efficient methods for removing these taxa.

**5. Consistent surveillance for aquatic plant and warm water fish populations:** The evaluation of AIS expansion in Lake Tahoe, as well as the efficacy of control actions carried out in Lake Tahoe is dependent on information that consistently describes the size and location of AIS populations, as well as the discovery of new species occurrences (e.g., the first observation of smallmouth bass in Tahoe in 2011). Inconsistencies in timing, strategy and methodology of aquatic plant surveillance has led to uncertainties concerning aquatic plant distribution in the Lake (see knowledge gap #1 above), which effects the ability to accurately identify the resources required for site specific management actions. Consistency in terms of surveillance efforts and collection protocols will tend toward more effective program evaluation and success. We recommend the development of:

- Species-specific data collection protocols that enable future users of the information to utilize spatial visualization tools (e.g., GIS) or employ other types of analyses that contribute to ecosystem functioning and systematic program evaluation.
- Consistent timing of surveillance efforts. Seasonal differences in when surveys are conducted may account for some of the variability in field observations.
- Use of hydroacoustic/GPS/mapping systems will help provide baseline and post-control conditions while generating quantitative metrics that can be compared across all infested areas, including the Tahoe Keys sites.
- Whole-lake surveillance rather than selectively returning to sites with known infestations.

- Centralization of a data or information database; designate an entity to keep information so that it can be quality assured and easily accessible to Tahoe Basin managers and researchers.

**5. Control methodologies for Asian clam, Signal crayfish, American bullfrog:** Further exploration into novel technologies or integrated methods for the control of Asian clam is warranted. While the use of bottom barriers and suction dredging can reduce the abundance of Asian clam in the short term, this species reproductive capabilities limits the use of these methods over large scales. However, in smaller scale settings where Asian clam may be having an unwanted impact, these or other methodologies may be effective at reducing these impacts. Similar to Asian clam, there may be promise in the continued or focused use of harvest to reduce the abundance of this species and impacts to other native taxa in the Lake. For Asian clam, Signal crayfish and American bullfrog, there remains much uncertainty concerning the magnitude and dynamics of the unwanted impacts they may be having on Tahoe's ecosystem. For all species, action is recommended to quantify the unwanted impacts that each may have, as well as to identify potential novel control techniques for each.

**6. Comprehensive surveillance program for species not yet established in the Tahoe Basin:** At present, there is no comprehensive surveillance program to monitor or detect novel species introductions or establishments within the Lake Tahoe Basin. The ability to carry out a rapid response, and thus minimize damages caused by AIS, for an incipient population of a nonindigenous species is highly dependent on early detection. The utilization of regularly scheduled field surveillance efforts, coupled with new technologies such as environmental DNA (eDNA) tools, stakeholder involvement such as citizen science efforts, or rapid data collection through the development of smartphone apps, may increase the efficiency and coverage of a consistent surveillance program.

**6. Use of Aquatic Pesticides:** The use of aquatic pesticides for Eurasian milfoil, curlyleaf pondweed, warm water fish species, particularly egg and juvenile stages, and other AIS of concern in the Lake Tahoe Basin have shown to be effective in laboratory and field settings elsewhere. At this time, the discharge of pesticides into Lake Tahoe is prohibited. However, further exploration of the safe and effective use of pesticide as an integrated AIS management tool in Lake Tahoe is recommended.

**7. Need to improve site specific prioritization model:** At present, each of the scoring categories is equally weighted. This suggests that each of the elements which determine the ranking of specific sites, such as site size, location or recreational boater visitation is equally important. It is highly likely that these elements do not necessarily each play an equal role in the determination of invasion patterns or dynamics in Lake Tahoe, however it is unknown what the relative contribution of these and other elements may be to the rate of range expansion of AIS. The ranking of locations provided here is sensitive to this aspect of the model. In addition, other factors that determine the establishment of a species, such as the abiotic as well as biotic characteristics of the nearshore habitats in Lake Tahoe, are not currently included because of a lack of information. Further, the sensitivity of the site specific model to the explanatory

variables or potential weights assigned to each explanatory variable has not been quantified. Understanding the relative important of each variable through model validation may provide a more effective implementation plan.

**8. Understanding of how Tahoe AIS are impacting nearshore indicators or other components related to management or regulatory thresholds:** As the decision to invest in the prevention or control of an invasive species is determined by how much damage it may cause, the understanding of how a species may impact an ecological system is key a component of informed decision making. Information that adequately quantifies the impacts of AIS in the nearshore region of Lake Tahoe is unknown. Better understanding of the impacts caused by these species can aid in decision-making for available management options and pursuits.

**9. The role of nearshore algal growth and AIS establishment:** Recent observations of increased or altered algal growth in the nearshore zone which may influence not only water clarity but also the establishment of AIS. Further, feedbacks between AIS and algal communities may be creating synergistic effects that promote the establishment and growth of both AIS and algal communities. Experimental evidence or data that may be able to inform scientists and managers about these relationships is unknown.

#### Next steps

The following are recommended next steps to implement the site and species specific recommendations provided in this implementation plan over the next 3-5 year period:

**1. Act now:** Use species and site specific recommendations provided herein as a guide to prioritize non-chemical treatments of aquatic plants in the highly prioritized sites. As the ability to treat the largest infestations of nuisance aquatic plants in the Tahoe Keys will be highly resource intensive, we recommend prioritizing specific sites as resources allow.

**2. Determine metrics for successful outcomes:** We recommend the use of the following metrics: plant areal coverage, fish density (specific to size class) and effort allocated to evaluate the outcomes of each implementation and control actions.

**3. Develop a lakewide monitoring and surveillance plan:** We recommend regular surveillance for invasive aquatic plants and warm water fish every year, for invasive invertebrates every other year and the integration of the use of novel technologies such as eDNA for species that are not yet present in the Basin.

**4. Integration of AIS control with the nearshore plan:** The control of AIS in Lake Tahoe should be in accordance with the recommendations put forward in the 2013 Lake Tahoe Nearshore Evaluation and Monitoring Framework (Heyvaert et al. 2013).

**5. Development of a research plan** for addressing data gaps as identified in this implementation plan and elsewhere. Identified knowledge or data gaps can negatively impact the successful implementation of the control or removal of biological species within an aquatic



system. Targeted experimentation or assessment to address these management oriented research questions can reduce overall costs and increase efficacy for an AIS control program.

**6. Aligning available funding sources** with the priority locations and species proposed in this implementation plan. Determining optimal allocation of resources, as they become available, will improve budgetary and activity planning for implementation of AIS control actions in Lake Tahoe.

**7. Support the exploration or development of new strategies or technologies for the control of AIS in Lake Tahoe.** This includes investigation of the safe use of chemical or other non-traditional methods for control or efficacy monitoring of AIS in Lake Tahoe.

### Acknowledgements

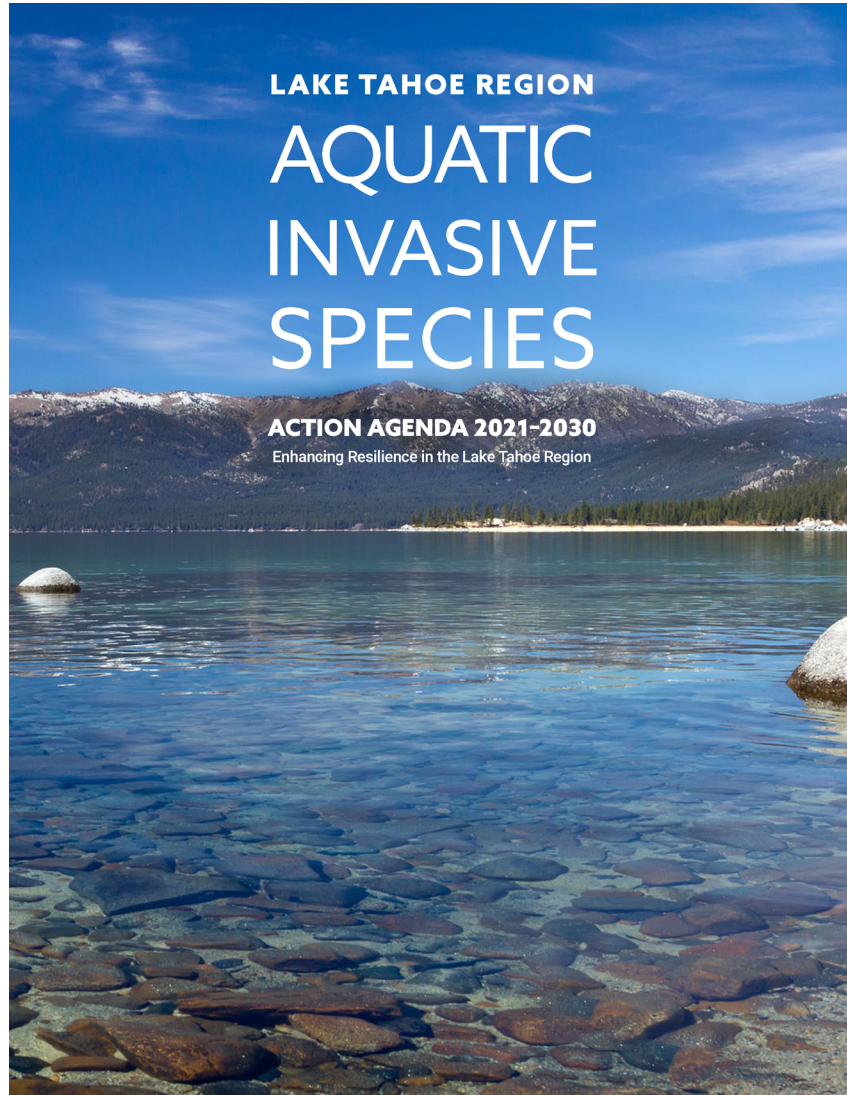
Funding for this report was provided by the State of California SB 630 funds through the Lake Tahoe Science and Lake Improvement Account to S. Chandra and M. Wittmann at the University of Nevada via the Tahoe Resource Conservation District (TRCD) from the California Tahoe Conservancy. We thank members of the Lake Tahoe AIS Coordination Committee who provided feedback on the draft version of this report: D. Shaw (CA State Parks), D. Zabaglo (Tahoe Regional Planning Agency), J. Thompson (CA State Lands Commission), E. Kingsland (Nevada Tahoe Resource Team), J. Patterson (League to Save Lake Tahoe), K. Boyd, M. Hurt (Tahoe Resource Conservation District), P. Stewart, P. Wright (CA Tahoe Conservancy), Z. Hymanson (UC Davis TERC). We thank the expert panel (M. Marchetti, S. Nierzwicki-Bauer, L. Anderson, M. Hoff, J. Rothlisberger, M. Brown, N. Mandrak) for their careful review and input; K. Ngai, T. Caldwell, J. Umek, A. Caires (University of Nevada), N. Cartwright, (TRCD), S. Muskopf (US Forest Service) contributed to the development of this report.

## References

- Anderson, L., and D. F. Spencer. 1996. Survey of Lake Tahoe for presence of Eurasian watermilfoil: USDA Agricultural Research Service Aquatic Weed Control Investigations, Annual Report. Davis, CA.
- Anderson, L. W. J. 2003. A review of aquatic weed biology and management research conducted by the United States Department of Agriculture - Agricultural Research Service. *Pest Management Science* 59:801–813.
- Anderson, L. W. J. 2005. California's reaction to *Caulerpa taxifolia*: A model for invasive species rapid response. *Biological Invasions* 7:1003–1016.
- Anderson, W., W. Tan, and C. Mallek. 2005. Preliminary evaluation of SolarBee effects on water quality at Lake Tahoe. Western Aquatic Plant Management Society. 24th Annual Western Aquatic Plant Management Society Meeting, Denver, CO.
- ANSTF. 2012. Aquatic Nuisance Species Task Force Strategic Plan 2013 - 2017. Arlington, VA.
- Barr, T. C., and J. M. Ditomaso. 2014. Curlyleaf pondweed (*Potamogeton crispus*) turion control with acetic acid and benthic barriers. *Journal of Aquatic Plant Management* 52:31–38.
- Baumgärtner, D., M. Mörtl, and K. O. Rothhaupt. 2008. Effects of water-depth and water-level fluctuations on the macroinvertebrate community structure in the littoral zone of Lake Constance. Pages 97–107 *Hydrobiologia*.
- Berent, L., C. C. Jacono, and M. M. Richerson. 2015. *Myriophyllum spicatum*. Retrieved March 20, 2015, from <http://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=237>.
- Boylan, C. W., L. W. Eichler, and J. D. Madsen. 1999. Loss of native aquatic plant species in a community dominated by Eurasian watermilfoil. *Hydrobiologia* 415:207–211.
- Brockett, J., K. Boyd, D. Shaw, and P. Stone. 2013. Invasive Aquatic Weed Control Program Lake Tahoe, CA: Bureau of Reclamation Final Report No. R10AP20613.
- Caires, A. M., S. Chandra, B. L. Hayford, and M. E. Wittmann. 2013. Four decades of change: dramatic loss of zoobenthos in an oligotrophic lake exhibiting gradual eutrophication. *Freshwater Science* 32:692–705.
- CAST. 2014. Benefits of Controlling Nuisance Aquatic Plants and Algae in the United States: Commentary QTA2014-1. Ames, IA.
- Chandra, S., K. Ngai, M. Kamerath, and B. Allen. 2009. Warmwater Nonnative Fishes in Lake Tahoe. Carson City, NV.
- Clarke Murray, C., E. A. Pakhomov, and T. W. Theriault. 2011. Recreational boating: A large unregulated vector transporting marine invasive species. *Diversity and Distributions* 17:1161–1172.
- Crowell, W., N. Troelstrup, L. Queen, and J. Perry. 1994. Effect of harvesting on plant communities dominated by Eurasian watermilfoil in Lake Minnetonka, MN. *Journal of Aquatic Plant Management* 32:56–60.
- Dibble, E. D., K. J. Killgore, and S. L. Harrel. 1996. Assessment of fish-plant interactions. American Fisheries Society Symposium 16:357–372.
- DNR, W. 2012. Eurasian water-milfoil (*Myriophyllum spicatum*). Retrieved April 1, 2013, from <http://dnr.wi.gov/topic/invasives/fact/eurasianwatermilfoil.html>.
- Eiswerth, M. E., S. G. Donaldson, and W. S. Johnson. 2000. Potential Environmental Impacts and Economic Damages of Eurasian Watermilfoil (*Myriophyllum spicatum*) in Western Nevada and Northeastern California. *Weed Science Society of America* 14:511–518.
- Forrest, a. L., M. E. Wittmann, V. Schmidt, N. a. Raineault, a. Hamilton, W. Pike, S. G. Schladow, J. E. Reuter, B. E. Laval, and a. C. Trembanis. 2012. Quantitative assessment of invasive species in lacustrine environments through benthic imagery analysis. *Limnology and Oceanography: Methods* 10:65–74.
- Foster, A. M., P. Fuller, A. Benson, S. Constant, D. Raikow, J. Larson, and A. Fusaro. 2015. *Corbicula fluminea*.
- Frantz, T. C., and A. J. Cordone. 1967. Observations on deepwater plants in Lake Tahoe, California and Nevada. *Ecology* 48:709–714.
- Frantz, T., and A. Cordone. 1996. Observations on the macrobenthos of Lake Tahoe, California-Nevada. California Fish and Game.
- Freeman, M. A., J. F. Turnbull, W. E. Yeomans, and C. W. Bean. 2010. Prospects for management strategies of invasive crayfish populations with an emphasis on biological control. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20:211–223.
- Gamble, A., T. Barr, B. Allen, K. Webb, J. E. Reuter, M. E. Wittmann, S. Chandra, and S. G. Schladow. 2013. Potential for pondweed control in Lake Tahoe using bottom barriers. Incline Village, NV.

- Gillies, E., and V. Van Way. 2006. Minute Item C50: Completion of a previously approved demonstration project for hand removal of a non-native invasive aquatic plant, Eurasian watermilfoil, from Emerald Bay, Lake Tahoe and Initiate another small pilot study using a barrier control technique. California State Lands Commission, Sacramento, CA.
- Govindarajulu, P. 2004. Introduced bullfrogs (*Rana catesbeiana*) in British Columbia: impacts on native Pacific treefrogs (*Hyla regilla*) and red-legged frogs (*Rana aurora*). University of Victoria, Canada.
- Greenfield, B. K., N. David, J. Hunt, M. E. Wittmann, and G. Siermering. 2004. Aquatic Pesticide Monitoring Program: Review of Alternative Aquatic Pest Control Methods For California Waters. Oakland, CA.
- Grice, T. 2010. Principles of containment and control of invasive species. Pages 61–76 in M. Clout and P. Williams, editors. *Invasive Species Management: A Handbook of Principles and Techniques*. Oxford University Press, New York, NY.
- Halstead, J. M., J. Michaud, S. Hallas-Burt, and J. P. Gibbs. 2003. Hedonic Analysis of Effects of a Nonnative Invader (*Myriophyllum heterophyllum*) on New Hampshire (USA) Lakefront Properties. *Environmental Management* 32:391–398.
- Hein, C. L., B. M. Roth, A. R. Ives, and M. J. Vander Zanden. 2006. Fish predation and trapping for rusty crayfish (*Orconectes rusticus*) control: a whole-lake experiment. *Canadian Journal of Fisheries and Aquatic Sciences* 63:383–393.
- Hein, C. L., M. J. Vander Zanden, and J. J. Magnuson. 2007. Intensive trapping and increased fish predation cause massive population decline of an invasive crayfish. *Freshwater Biology* 52:1134–1146.
- Heyvaert, A. C., J. E. Reuter, S. Chandra, R. Susfalk, S. G. Schladow, and S. Hackley. 2013. Lake Tahoe Nearshore Evaluation and Monitoring Framework. Final Report.
- Hoyer, A. B., M. E. Wittmann, S. Chandra, S. G. Schladow, and F. J. Rueda. 2014. A 3D individual-based aquatic transport model for the assessment of the potential dispersal of planktonic larvae of an invasive bivalve. *Journal of Environmental Management* 145:330–340. Academic Press.
- Hoyer, M. V., and D. E. Canfield. 1996. Largemouth bass abundance and aquatic vegetation in Florida lakes: an empirical analysis. *Journal of Aquatic Plant Management* 34:23–32.
- Isom, B. G., C. F. Bowman, J. T. Johnson, and E. B. Rodgers. 1986. Controlling *Corbicula* (Asiatic clams) in complex power plant and industrial water systems. *American Malacological Bulletin: Special Edition* 2:95–98.
- Johnson, J. A., A. R. Jones, and R. M. Newman. 2012. Evaluation of lakewide, early season herbicide treatments for controlling invasive curlyleaf pondweed (*Potamogeton crispus*) in Minnesota lakes. *Lake and Reservoir Management* 28:346–363.
- Kamerath, M., S. Chandra, and B. Allen. 2008. Distribution and impacts of warm water invasive fish in Lake Tahoe, USA. *Aquatic Invasions* 3(1):35–41. *Aquatic Invasions* 3:35–41.
- Lockwood, J. L., P. Cassey, and T. Blackburn. 2005. The role of propagule pressure in explaining species invasions. *Trends in ecology evolution* 20:223–8. Elsevier.
- Lockwood, J. L., M. F. Hoopes, and M. P. Marchetti. 2013. *Invasion Ecology*. John Wiley & Sons, West Sussex.
- Loeb, S. L., and S. H. Hackley. 1988. The distribution of submerged macrophytes in Lake Tahoe, California and Nevada, and the possible influence of groundwater seepage. *Verhandlungen des Internationalen Verein Limnologie* 23:1927–1933.
- Loppnow, G. L., K. Vascotto, and P. A. Venturelli. 2013. Invasive smallmouth bass (*Micropterus dolomieu*): history, impacts, and control. *Management of Biological Invasions* 4:191–206.
- MacRae, P. S. D., and D. A. Jackson. 2001. The influence of smallmouth bass (*Micropterus dolomieu*) predation and habitat complexity on the structure of littoral zone fish assemblages. *Canadian Journal of Fisheries and Aquatic Sciences* 58:342–351.
- Madsen, J. D., K. D. Getsinger, R. M. Stewart, and C. S. Owens. 2002. Whole Lake Fluridone Treatments For Selective Control of Eurasian Watermilfoil: II. Impacts on Submersed Plant Communities.
- Martinez, P. J., and E. Bergersen. 1989. Proposed biological management of *Mysis relicta* in Colorado lakes and reservoirs. *North American Journal of Fisheries Management* 9:1–11.
- Mattice, J., R. McLean, and M. Burch. 1982. Evaluation of short-term exposure to heated water and chlorine for control of the Asiatic clam (*Corbicula fluminea*) Publication No. 1748. Springfield, VA.
- Mosisch, T. D., and A. H. Arthington. 1998. The impacts of power boating and water skiing on lakes and reservoirs. *Lakes & Reservoirs: Research and Management* 3:1–17.

- Ngai, K. L. C., B. J. Shuter, D. A. Jackson, and S. Chandra. 2013. Projecting impacts of climate change on surface water temperatures of a large subalpine lake: Lake Tahoe, USA. *Climatic Change* **118**:841–855.
- Olsen, D. M. 2014. Arctic Char *Salvelinus alpinus* can enhance fisheries in reservoirs with trophic constraints. Colorado State University.
- Petty, D. G., J. G. Skogerboe, K. D. Getsinger, D. R. Foster, B. A. Houtman, J. F. Fairchild, and L. W. Anderson. 2001. The aquatic fate of triclopyr in whole-pond treatments. *Pest Management Science* **57**:764–775.
- Poovey, A., J. G. Skogerboe, and C. S. Owens. 2002. Spring treatments of diquat and endothal for curlyleaf pondweed control. *Journal of Aquatic Plant Management* **40**:63–67.
- Rejmánek, M., and M. J. Pitcairn. 2002. When is eradication of exotic pest plants a realistic goal. Pages 249–253 *Turning the tide: the eradication of invasive species*.
- Reuter, J. E., and W. W. Miller. 2000. Lake Tahoe Watershed Assessment: Aquatic resources, water quality and limnology of Lake Tahoe and its upland watershed.
- Shigesada, N., and K. Kawasaki. 1997. Biological invasions: theory and practice. Oxford series in Ecology and Evolution.
- Siemering, G. S., J. D. Hayworth, and B. K. Greenfield. 2008. Assessment of potential aquatic herbicide impacts to California aquatic ecosystems. *Archives of Environmental Contamination and Toxicology* **55**:415–431.
- Spencer, C. N., B. R. McClelland, S. Uri, J. A. Stanford, B. Sciences, T. J. Archive, and T. Archive. 1991. Shrimp stocking, salmon collapse, and eagle displacement. *BioScience* **41**:14–21.
- TKPOA. 2015. AIS Public Forum: Aquatic Weed Management in the Tahoe Keys. South Lake Tahoe, CA.
- Tobin, P. C., and L. M. Blackburn. 2008. Long-distance dispersal of the gypsy moth (Lepidoptera: Lymantriidae) facilitated its initial invasion of Wisconsin. *Environmental entomology* **37**:87–93.
- TRPA. 2014. Lake Tahoe Region Aquatic Invasive Species Management Plan, California - Nevada.
- Tucker, A. J., C. E. Williamson, K. C. Rose, J. T. Oris, S. J. Connelly, M. H. Olson, and D. L. Mitchell. 2010. Ultraviolet radiation affects invasibility of lake ecosystems by warm-water fish. *Ecology* **91**:882–890.
- USACE. 2011. Aquatic Herbicides. Vicksburg, Mississippi.
- Van Way, V. 2005. Minute Item Number 66: A Demonstration project to remove an area of a non-native invasive aquatic species, Eurasian watermilfoil from sovereign lands in Emerald Bay, Lake Tahoe, El Dorado County. California State Lands Commission, Sacramento, CA.
- Walter, K. M. 2000. Ecosystem effects of the invasion of Eurasian watermilfoil (*Myriophyllum spicatum*) at Lake Tahoe, CA-NV. University of California Davis.
- Weidel, B. C., D. C. Josephson, and C. E. Kraft. 2007. Littoral Fish Community Response to Smallmouth Bass Removal from an Adirondack Lake.
- West, E. J., A. R. Davis, P. B. Barnes, and J. T. Wright. 2009. The role of recreational activities in creating fragments of invasive *Caulerpa taxifolia*. *Journal of Experimental Marine Biology and Ecology* **376**:17–25.
- White, D. S., and S. J. White. 1977. The Effect of Reservoir Fluctuations on Populations of *Corbicula-Manilensis* *Pelecypoda Corbiculidae*. *Proceedings of the Oklahoma Academy of Science* **57**:106–109.
- Wittmann, M. E. et al. 2014. Grass carp in the Great Lakes region: Establishment potential, expert perceptions, and re-evaluation of experimental evidence of ecological impact. *Canadian Journal of Fisheries and Aquatic Sciences* **71**:992–999.
- Wittmann, M. E., S. Chandra, J. E. Reuter, A. M. Caires, S. G. Schladow, and M. E. Denton. 2012a. Harvesting an invasive bivalve in a large natural lake : species recovery and impacts on native benthic macroinvertebrate community structure in Lake Tahoe , USA. *Aquatic Conservation: Marine and Freshwater Ecosystems* **597**:588–597.
- Wittmann, M. E., S. Chandra, J. E. Reuter, S. G. Schladow, B. C. Allen, and K. J. Webb. 2012b. The control of an invasive bivalve, *Corbicula fluminea*, using gas impermeable benthic barriers in a large natural lake. *Environmental Management* **49**:1163–73.
- Wittmann, M. E., S. Chandra, S. G. Schladow, and J. E. Reuter. 2013. Natural and Human Limitations to Asian clam distribution and recolonization--Factors that Impact the Management and Control in Lake Tahoe (P057): A report submitted to the Pacific Southwest Research Station, US Forest Service.
- Wittmann, M. E., B. E. Kendall, C. L. Jerde, and L. W. J. Anderson. 2015. Estimating relative risk of within-lake aquatic plant invasion using combined measures of recreational boater movement and habitat suitability. *PeerJ* **3**:e845. Retrieved from <https://peerj.com/articles/845>.



## The Lake Tahoe Region Aquatic Invasive Species (AIS) Action Agenda 2021-2030:

- Increases the pace and scale of aquatic invasive species control work
- Identifies priorities for AIS investments
- Maximizes return on investment
- Incorporates new performance metrics
- Supports adequate levels of monitoring
- Adds capacity to achieve goals
- Defines a complete approach to addressing aquatic invasive species in the Region

### Regional AIS Goals:

- Prevent new introductions of AIS to the Region.
- Limit the spread of existing AIS populations by employing strategies that minimize threats to native species, and extirpate existing AIS populations when possible.
- Abate harmful ecological, economic, recreational, and public health impacts resulting from AIS

### The Action Agenda is a 10-year plan with two five-year implementation phases:

**Phase I (2021-2025)** aggressively treats and controls AIS throughout the Region while completing environmental documents and AIS control testing for the Tahoe Keys. The Phase I goal is to reduce aquatic invasive plants to maintenance levels (or complete eradication) in areas outside of the Tahoe Keys.

**Phase II (2026-2030)** focuses on reducing aquatic invasive plants and invasive fish in the Tahoe Keys while continuing to maintain, reduce, or eradicate AIS in other parts of the Lake Tahoe Region.



This document was prepared by  
Creative Resource Strategies, LLC

## The Time to Act is Now

Aquatic invasive species pose one of the greatest threats to Lake Tahoe's ecology, and to the \$5 billion recreation-based economy of the Lake Tahoe Region. Now is the time to increase the pace and scale to reduce the distribution and abundance of aquatic invasive species in the Lake Tahoe Region.

Failure to implement comprehensive control actions on all aquatic invasive species through 2030 will:

- Lessen chances of eradicating and controlling AIS populations;
- Harm the ecological function of Lake Tahoe;

- Inject uncertainty into the regional economy;
- Make it more difficult to recover populations of the federally-listed Lahontan cutthroat trout;
- Degrade the quality of experiences of residents and visitors; and
- Significantly increase long-term costs to address AIS in the Region.

Enhancing the resilience of Lake Tahoe by addressing AIS threats will achieve the most strategic return on investment and ensure the Region continues to thrive.

## Aquatic Invasive Species Performance Metrics

New performance metrics assess both effort and outcomes associated with AIS control projects in the Region.

| Programmatic Metrics                                                                                                           | Outcome-based Metrics                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  Acres treated for invasive species         |  <b>PLANTS</b> <ul style="list-style-type: none"> <li>• Percentage increase or decrease in infested area (acres) per species</li> <li>• Number of AIS-infested acres</li> <li>• New aquatic invasive plant populations that have become established</li> </ul> |
|  Number of projects completed               |  <b>INVASIVE FISH</b> <ul style="list-style-type: none"> <li>• Reduction of invasive fish in regions of Lake Tahoe</li> </ul>                                                                                                                                  |
|  Invasive species risk assessment completed |  <b>AQUATIC INVASIVE INVERTEBRATES</b> <ul style="list-style-type: none"> <li>• Reductions of signal crayfish and mysid shrimp in designated regions of Lake Tahoe</li> </ul>                                                                                  |
|  Funds expended per unit                    |  <b>INVASIVE AMPHIBIANS</b> <ul style="list-style-type: none"> <li>• Reductions of bullfrogs in designated regions of Lake Tahoe</li> </ul>                                                                                                                    |

### Achieving an Optimal Return on Investment, 2021-2030

The Action Agenda proposes a three-fold increase in pace and scale relative to current actions. Complete Action Agenda implementation will cost an estimated \$74 million through 10 years (\$7.4 million annually) and will achieve the greatest return on investment, maximize benefits to ecosystem services, minimize risk, and reduce degradation to fish and wildlife habitats in the Region. Implementing this recommendation will achieve:

- 90 percent reduction to eradication of aquatic invasive plants in nearshore and upstream areas and the Tahoe Keys;
- 90 percent reduction in invasive fish biomass in priority areas;
- Reductions of aquatic invasive invertebrates and amphibians in regions of the lake and upstream areas;
- Support for effective Early Detection Rapid Response actions through the creation of an emergency invasive species fund;
- Newly developed detection and monitoring tools;
- Comprehensive nearshore-wide and in-situ diver survey and drone transects;
- Strategic investment in new technologies and methodologies to control aquatic invasive species;
- An assessment of high-risk invasive species every two years; and
- Investment in a marina engagement strategy.





The plan outlines four funding levels to achieve Region AIS goals:

**Level A:** Complete AIS control throughout the Region, including Tahoe Keys

**Level B:** AIS plant-only control throughout Region, including Tahoe Keys

**Level C:** AIS plant-only control throughout the Region, excluding Tahoe Keys

**Level D:** AIS plant-only control in nearshore, excluding Tahoe Keys

Implementing Action Agenda Level A achieves the greatest biological integrity in the Lake Tahoe Region while minimizing risk to the economic, environment, and societal values.

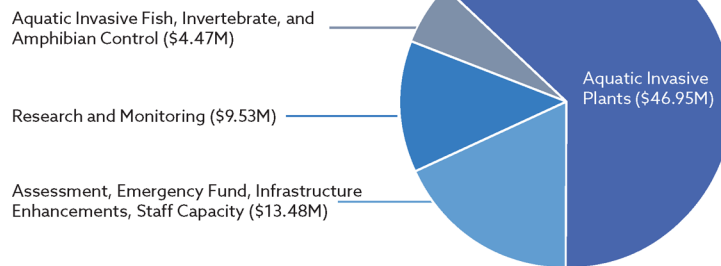
Implementing Level D funding achieves the least biological integrity and involves the greatest risk.



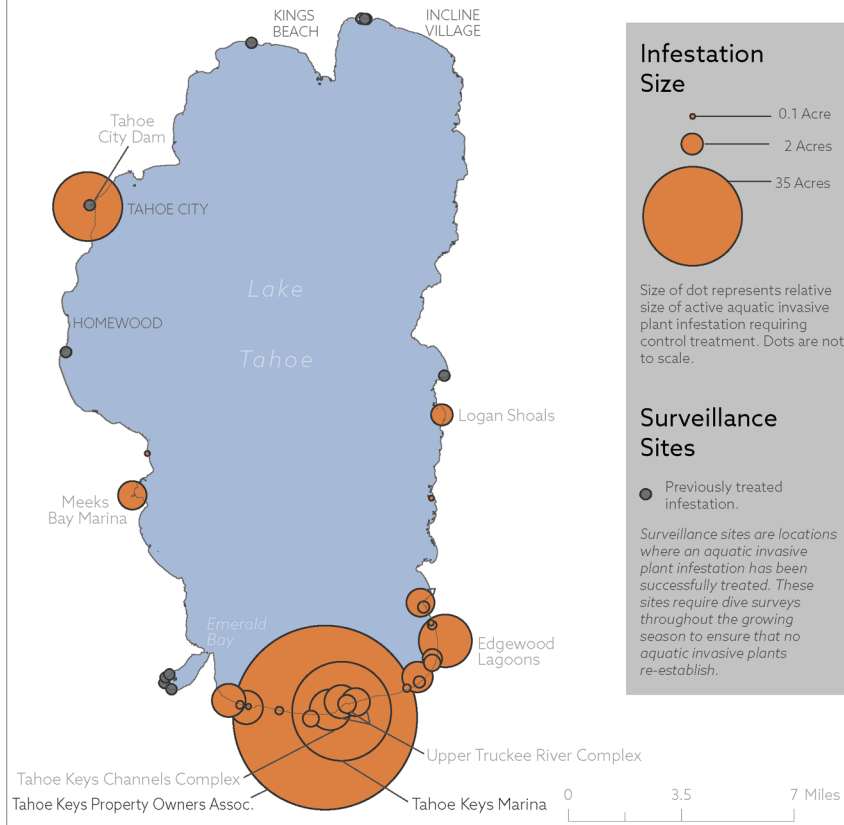
## Strategic Investments Needed to Implement the Action Agenda, 2021–2030

| Strategic Outcomes                                                                                                                                                                                                                                                                                                                                                                     | Phase I<br>(2021–2025) | Phase II<br>(2026–2030) |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------|
| <b>Aquatic Invasive Plant Control Outside Tahoe Keys</b><br>90% reduction in acreage of aquatic invasive plant populations outside the Tahoe Keys                                                                                                                                                                                                                                      | \$12.5 M               | \$6.25 M                |
| <b>Aquatic Invasive Plant Control Outside Tahoe Keys</b><br>Early Detection and Rapid Response - no new aquatic invasive plant populations become established outside the Tahoe Keys                                                                                                                                                                                                   | \$1.25 M               | \$1.25 M                |
| <b>Aquatic Invasive Plant Control in Tahoe Keys</b><br>90% reduction, or eradication, of aquatic invasive plant populations in the Tahoe Keys                                                                                                                                                                                                                                          | \$7.0 M                | \$17.2 M                |
| <b>Aquatic Invasive Plant Control in Tahoe Keys</b><br>Environmental documentation that informs control work in the Tahoe Keys                                                                                                                                                                                                                                                         | \$1.5 M                | \$0                     |
| <b>Aquatic Invasive Plant Control Totals</b>                                                                                                                                                                                                                                                                                                                                           | <b>\$22.25 M</b>       | <b>\$24.70 M</b>        |
| <b>Aquatic Invasive Fish, Invertebrate, and Amphibian Control</b><br>90% reduction of invasive fish biomass, and invasive aquatic invertebrates and American bullfrogs in regions of the lake                                                                                                                                                                                          | \$2.63 M               | \$1.85 M                |
| <b>Aquatic Invasive Fish, Invertebrate and Amphibian Control Totals</b>                                                                                                                                                                                                                                                                                                                | <b>\$2.63 M</b>        | <b>\$1.85 M</b>         |
| <b>Research and Monitoring</b><br>Enhanced detection of aquatic invasive species, surveys conducted (nearshore, in-situ diver, drone), assessments of AIS population abundance and distribution, investments in new technologies                                                                                                                                                       | \$4.29 M               | \$5.235 M               |
| <b>Research and Monitoring Totals</b>                                                                                                                                                                                                                                                                                                                                                  | <b>\$4.29 M</b>        | <b>\$5.24 M</b>         |
| <b>Assessment, Emergency Fund, Infrastructure Enhancements to Prevent Spread of AIS, and Added Staff Capacity</b><br>High-risk assessment of AIS every two years, established partnership program to advance infrastructure at marinas and other lake locations, establish an Early Detection and Rapid Response emergency fund, and hire sufficient staffing to implement the Agenda. | \$7.2 M                | \$6.28 M                |
| <b>Administrative Totals</b>                                                                                                                                                                                                                                                                                                                                                           | <b>\$7.20 M</b>        | <b>\$6.28 M</b>         |
| <b>TOTALS</b>                                                                                                                                                                                                                                                                                                                                                                          | <b>\$36.39M</b>        | <b>\$38.06 M</b>        |
| <b>GRAND TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                     |                        | <b>\$74.45 M</b>        |

### AIS Budget, 2021–2030



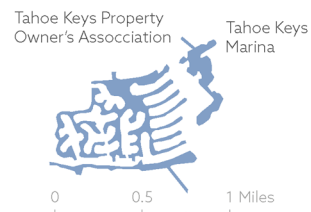
## Aquatic Invasive Plant Infestations 2019



## The Tahoe Keys Challenge

Based on acreage, the Tahoe Keys comprise 70 percent of all aquatic plant infestations in Lake Tahoe. The size of these infestations and the complexity associated with the geography of the Tahoe Keys make identifying and implementing control treatments a challenge. Although most marinas contain one or two embayments, the Tahoe Keys complex contains a myriad of connected waterways equalling approximately 170 acres.

Map produced by S. Matthews, Tahoe RCD 2019.



## MOST UNWANTED LAKE TAHOE AQUATIC INVASIVE SPECIES

Aquatic invasive plants, fish, invertebrates, and amphibians are degrading Lake Tahoe Region ecosystems.

### Plants

#### Eurasian Watermilfoil and Curlyleaf Pondweed

- Reduce native species
- Degrade water quality by
  - Contributing to nutrient loading
  - Impairing boating navigation
- Reducing clarity
- Reduce scenic quality
- Create habitat for other invasives



*Eurasian Watermilfoil*



*Curlyleaf Pondweed*

### Invasive Fish

- Alter food web function
- Decrease the biodiversity of native fish
- Compete with native fish
- Inhibit Lahontan cutthroat trout recovery



*Goldfish*

## Aquatic Invertebrates

### Asian Clams

- Where present, Asian clams comprise the majority of benthic community biomass
- Contribute to algal blooms
- Shell deposits affect nearshore aesthetics



### Mysid Shrimp

- Reduce or eliminate native phytoplankton
- Alter food web dynamics
- Inhibit Lahontan cutthroat trout recovery
- Reduce clarity



### Signal Crayfish

- Comprise the bulk of littoral-zone benthic biomass
- Reduce food for native benthic macroinvertebrates
- Degrade water quality
- Reduce native aquatic invertebrates



## Invasive Amphibians

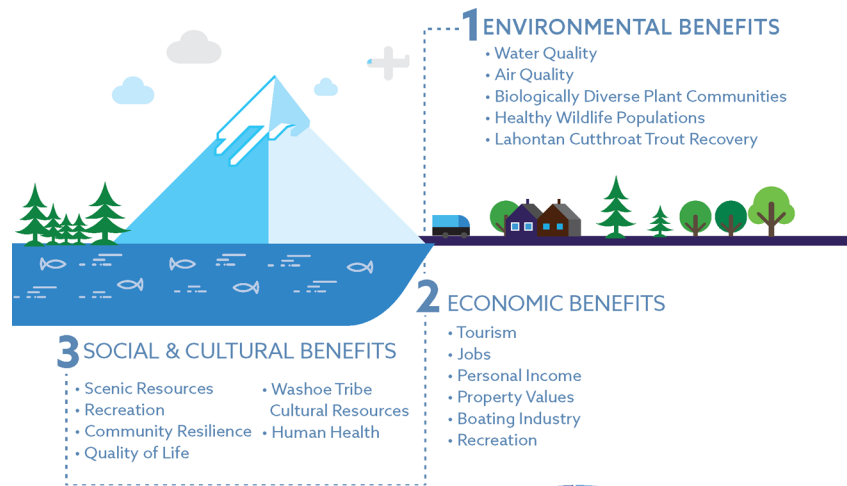
### American Bullfrogs

- Transmit fungus to other amphibians
- Outcompete native species
- Consume native fish, birds, and amphibians



## The Regional Economy Depends on a Healthy Lake Tahoe

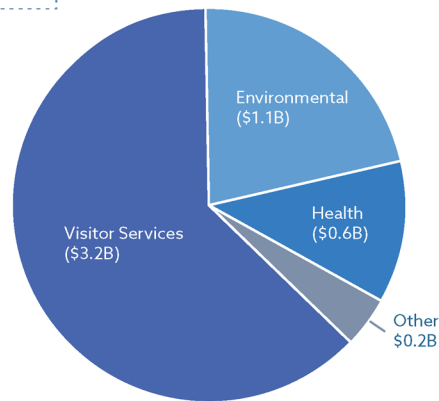
Lake Tahoe is one of the largest subalpine lakes in the world and is recognized nationally and globally as a natural resource of special significance. Lake Tahoe is also an Outstanding National Resource Water known for its extraordinary clarity and blue color. Maintaining and sustaining a healthy Lake Tahoe protects valuable economic, environmental, and social/cultural resources in the Region.



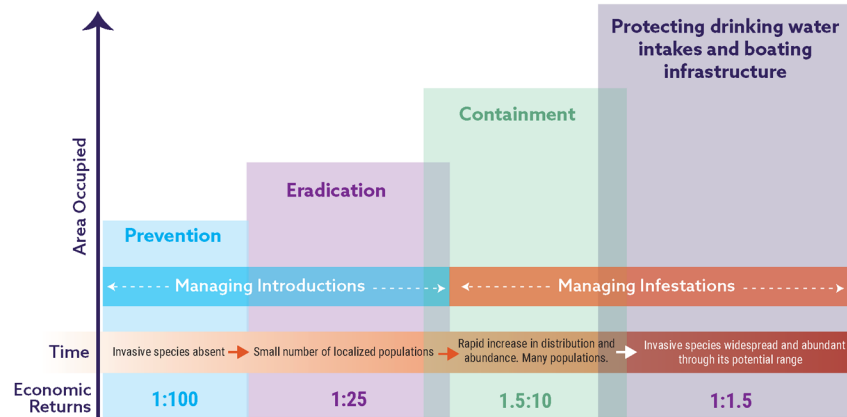
### \$5 Billion Regional Economy

Visitor services, Environmental, Health, and Other clusters drive 95 percent of the regional economy (Applied Development Economics 2015). Recreation is the second most important component of the Visitor Services cluster. The top three clusters depend on the continued outstanding quality of the natural environment.

Total Tahoe Economy = \$5.1 billion



## Cost-Effectiveness of AIS Management Approaches



### Prevention

The most cost-effective approach to managing invasive species is to **prevent** their introduction. As populations become established, containment and management result in the greatest long-term economic, environmental, and social damages.

The watercraft inspection program shields the Tahoe Basin from an invasive mussel infestation by focusing on the *Clean, Drain and Dry* strategy. This includes watercraft inspection and decontamination stations, and outreach and education. During the past 11 years, these strategic investments have prevented the introduction of quagga or zebra mussels to the Region, at a fraction of the cost of containment and eradication. An infestation of these invasive mussels would cost the Region millions of dollars annually and in perpetuity.

### Eradication

The next most cost-effective invasive species management method is to eradicate infestations when their populations are small and localized. Eurasian watermilfoil is an aquatic invasive

plant found both inside the Tahoe Keys and along Lake Tahoe's shoreline. Managers have effectively **eradicated** newly detected populations of Eurasian watermilfoil along the shoreline while populations are small.

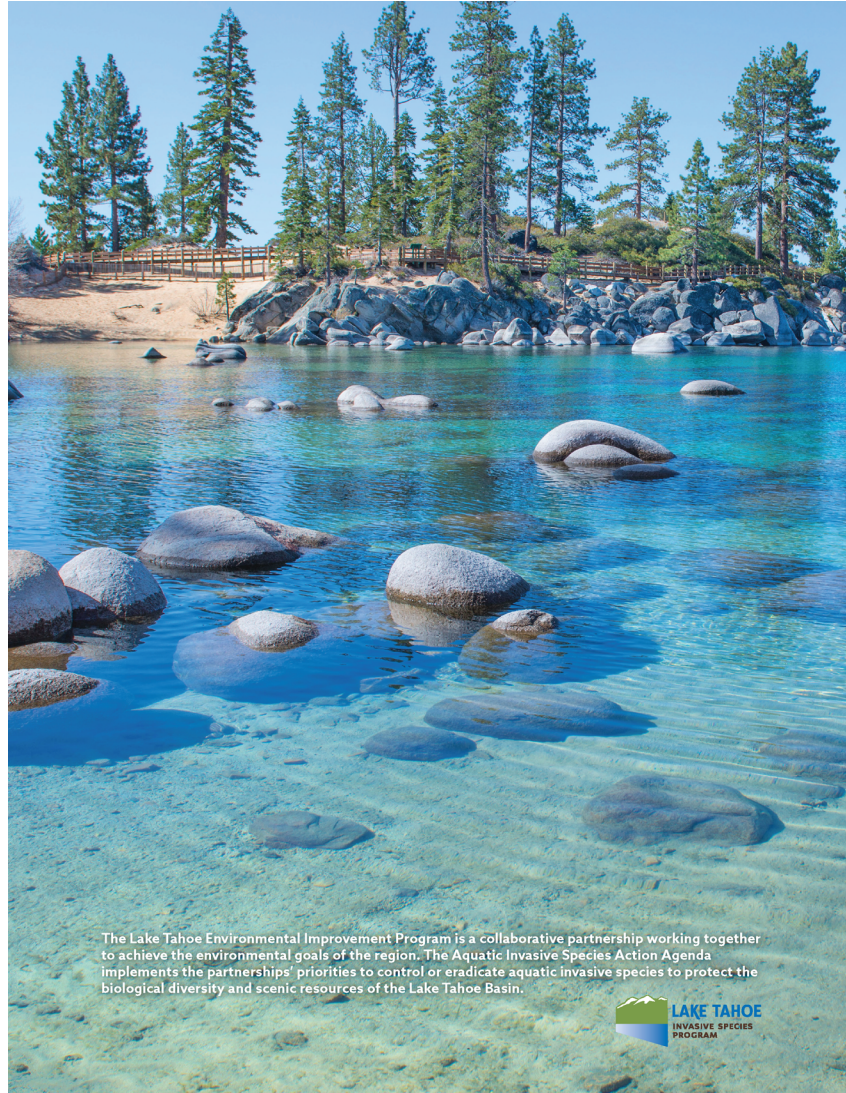
### Containment

The Tahoe Keys, which are infested with aquatic invasive plants and invasive fish, serve as invasive species source populations for the Region. Managers work to **contain** AIS in the Tahoe Keys while pilot projects are completed to test the efficacy of eradication methods. Containment is costlier than eradication, or prevention.

### Asset Protection

When invasive species cannot be prevented, eradicated, or contained, actions to **protect assets, such as drinking water intakes and boating infrastructure**, have the greatest cost and fewest returns on investment.





The Lake Tahoe Environmental Improvement Program is a collaborative partnership working together to achieve the environmental goals of the region. The Aquatic Invasive Species Action Agenda implements the partnerships' priorities to control or eradicate aquatic invasive species to protect the biological diversity and scenic resources of the Lake Tahoe Basin.





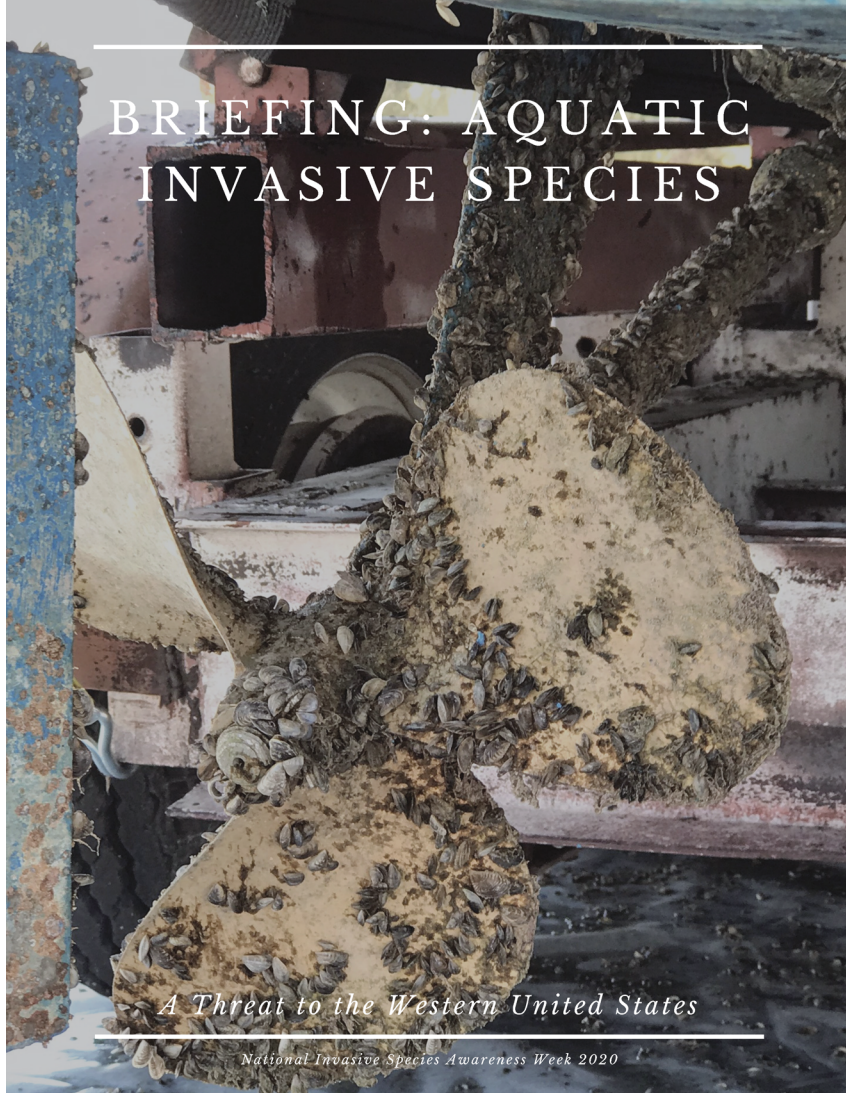
---

# BRIEFING: AQUATIC INVASIVE SPECIES

*A Threat to the Western United States*

---

*National Invasive Species Awareness Week 2020*



## ZEBRA AND QUAGGA MUSSELS

*The greatest threat to western water supply systems, aquatic resources, and public access.*

Zebra and quagga mussels have cost more than other invasive species, costing an estimated \$6 billion in prevention and control efforts since their arrival in 1988.

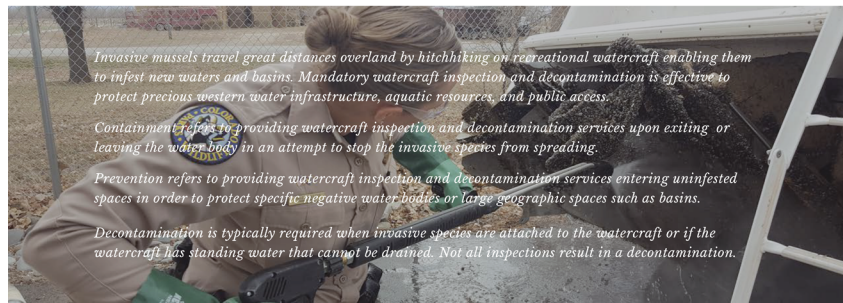
The potential estimated costs of a quagga mussel introduction into the Pacific Northwest is more than \$500 million annually, including costs to control mussels at irrigation, hydropower, and municipal drinking water facilities.

Lake Tahoe, the second deepest lake in the U.S., has estimated an impact of more than \$20 million annually if zebra or quagga mussels invade.

The optimal place to stop rapid spread is to contain mussels at the source by preventing the overland movement of mussels on watercraft exiting through mandatory inspection, decontamination, and enforcement.

It is widely accepted that prevention at negative waters is necessary to protect high priority infrastructure, natural resources, and to maintain public access.

Current and past funding levels have been insufficient to contain mussels at federal and inter-jurisdictional waters and stop new infestations.



*Invasive mussels travel great distances overland by hitchhiking on recreational watercraft enabling them to infest new waters and basins. Mandatory watercraft inspection and decontamination is effective to protect precious western water infrastructure, aquatic resources, and public access.*

*Containment refers to providing watercraft inspection and decontamination services upon exiting or leaving the water body in an attempt to stop the invasive species from spreading.*

*Prevention refers to providing watercraft inspection and decontamination services entering uninfested spaces in order to protect specific negative water bodies or large geographic spaces such as basins.*

*Decontamination is typically required when invasive species are attached to the watercraft or if the watercraft has standing water that cannot be drained. Not all inspections result in a decontamination.*

## POLICY PRIORITIES

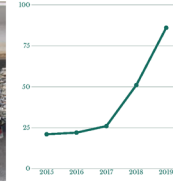
*Improve federal and state capacity for prevention, containment, and rapid response.*

**Implement Mandatory Watercraft Inspection and Decontamination at Infested Waters** - The Departments of the Interior and Agriculture should implement mandatory inspection and decontamination (per regional standards) of watercraft leaving federal waters in the southwest US.

**Provide Dedicated Funding for Watercraft Inspection and Decontamination** - The responsibility of preventing the movement of invasive mussels on watercraft must be shared by both state and federal agencies.

**Enable Rapid Response** - The Secretaries of the Interior, Agriculture, and Commerce in consultation with the Army Corps of Engineers and the Aquatic Nuisance Species Task Force, should develop a funding process to direct resources to entities responsible for prevention, containment, control, and rapid response efforts.

**Reduce Mussel Impacted Watercraft Leaving Glen Canyon National Recreation Area** - From 2008-2014, the average number of mussel boats intercepted per year in Colorado was 13. The graph below shows a large increase due to the quagga mussel infestation at Lake Powell. In fact, 80% of the watercraft intercepted by Colorado in 2019 were from Lake Powell. Alternate management strategies must be explored to reduce the number of mussel impacted waterfowl leaving Glenn Canyon National Recreation Area.



### *A Public-Private Partnership To Stop the Spread of Invasive Species on Watercraft*

*The National Marine Manufacturers Association, the American Boating and Yachting Council, and now the Watersports Industry Association are engaged with the states and federal agencies in an effort to find innovative solutions to stop the movement of invasive species on recreational watercraft and to improve decontamination efficacy and safety. Beginning with a co-learning workshop in 2013, funded by U.S. Fish and Wildlife Service, the private-public partnership group completed a Technical Information Report on Aquatic Invasive Species for Manufacturers in 2018. A priority for western watercraft inspection and decontamination programs is to engineer solutions to prevent the movement of invasive species in spaces that can't be drained, such as ballast tanks and engines. Encourage and provide incentives for manufacturers to develop and implement these solutions.*

## LEGISLATIVE PRIORITIES

*Working together to protect western waters.*

### Water Resources Development Act Section 1170 of S. 3021

- Provide appropriations of \$15M in FY21 and beyond to meet the expanded geographic scope for watercraft inspection, decontamination and rapid response; and \$3M for monitoring.
- Secure a solution in the House to correct the typo and change the Arizona River Basin to Arkansas River Basin, as was the original intent.

### Preventing the Spread of Invasive Mussels Act of 2019 (S.2975)

Support the passage of this legislation and corresponding appropriations to resolve legislative barriers to implementing mandatory watercraft inspection and decontamination on federally owned or managed properties.

### The Quagga Zebra Action Plan for Western Waters (QZAP)

was requested by Senator Feinstein and published by the WRP in 2010. The WRP's *Building Consensus in the West Workgroup* and the DOI's *Safeguarding the West Initiative* have furthered prevention and containment activities. Congress authorized the U.S. Fish and Wildlife Service to administer a QZAP grant and it is recommended that be continued at \$2M per year focused on providing resources to states for inspection and decontamination.

**Increase appropriations for State/Interstate ANS Management Plans** per section 1204 of the National Invasive Species Act (1996) in the amount of \$4M annually, but do not compromise funding for the complementary Regional Panels (e.g. WRP) and the ANS Task Force.

Congress authorized the *Western Regional Panel (WRP)* in the *National Invasive Species Act* as a subcommittee of the *Aquatic Nuisance Species Task Force*. Funding of \$100,000 per year is needed to sustain the continued work of the WRP, which includes coordinating marine and freshwater activities in the nineteen states west of the Mississippi, including Alaska and Hawaii. The WRP authored the Quagga Zebra Action Plan for Western Waters (QZAP) in 2010 and in the last year published a QZAP Status Update Report, in addition to the Building Consensus in the West Final Summary Report (2011-2019). The WRP is currently drafting the Updated Recommendations for the QZAP and seeks to increase capacity to provide regional and basin-level coordination for implementation.

Senator MCSALLY. Thank you, Ms. Regan. We will now go to questions, and I will kick it off.

Mayor Meck, thanks again for being here and for your leadership and your testimony on this important salt cedar issue. Can you get into more details about restoration efforts along the Gila River, who is involved, how much time it takes, what the cost is, and anything else related to obstacles and barriers for that effort?

Mr. MECK. I think the biggest thing, Senator—thank you for having me, of course. The biggest thing that we ran into is nobody knows how to control them, and we basically started from scratch. We've been to Colorado. We've been to Southern Arizona. We've attended several seminars. We, ourselves, have gone in with a trackhoe and took the salt cedars out, piled them and then we placed an incinerator, started using that which didn't require any smoke. They need to be burnt during the winter, obviously, because the summer rules and such with smoke and inhalation from the Maricopa County, EPA, et cetera.

So we took it out of the ground, piled 'em up and came back with an incinerator that cost around \$200,000 on 40 acres—very, very, very expensive. So then what we did is when the county came in with a masculator and that just ground it up and blew it back behind on the ground, much cheaper, much faster, much easier.

In both cases, we have to go in after the first, second and third year, obviously, either pull it out again and/or with herbicide, but we have to maintain. So we've done everything that we know what to do. If we were allowed to get in and do some things, as opposed to being restricted without permitting processes, that's what hurts is the permitting process is so long and so complicated and intensive, and when people say we'd like to do this, we cannot do that. This is seven years and running to date that we're trying to get this, get something done with the trees themselves.

Senator MCSALLY. So in seven years, how large an area have you been able to eradicate?

Mr. MECK. We—the City has done right at 60 acres and the other piece of that is the county has done 40 acres and replanted some trees. So in our case, the City, the City itself, we have over 200—\$2 million in labor as well as manpower from the City and cash, along with Cities of Avondale and Goodyear. So it's been just us and we've had the county or, excuse me, the Corps of Engineers. We've been working with them for seven years and we just keep getting, kind of, put off, if you will.

Senator MCSALLY. Thanks, Mayor Meck.

You talked about the challenges of permitting. Mr. Cameron, you mentioned this in your testimony as well, but it was related to the mussels. Is there anything else? What else can federal partners do besides direct federal funding? Anything related to the permitting? I mean, 40 and 60 acres is miniscule compared to the magnitude of the problem and what needs to be eradicated. Are there any other thoughts on federal partnerships on this?

Mr. CAMERON. Yeah, thank you, Chairwoman McSally, for the question.

There are a number of things that we can do, and we're moving on a number of fronts. I think, first of all, the Mayor was really right. Sometimes our paperwork and our bureaucracy and our red



tape prevent us from doing obviously intelligent things on a timely basis. So that's an issue.

But another—some of the things we're doing are information sharing. So as, again, as the Mayor pointed out, the Federal Government has got a pretty big research establishment. We could be more aggressive in sharing research information, potentially, with our state and local partners. Or monitoring, as I mentioned in terms of invasive mussels, we are now beginning to participate in the State of Colorado's led Westwide system for reporting on movement of watercraft that may be infested with invasive mussels. That's really important to the states because they can't enforce unless they've got information. We are also looking to see how we could more effectively work with state governments to enforce state invasive species law on federal lands. The Park Service has been doing that in the Lower Colorado, Lake Mead, as an example.

We've got—I can't resist the opportunity to point out—for the second year in a row the President's budget requests \$1 million specifically for Lake Havasu for dealing with invasive mussels in that area working with state and local government partners in that part of Arizona.

So there are a number of things we can do, and we're especially interested in looking for ways as a Federal Government to get our own act together more effectively so we can speak with one voice. For instance, in the Lower Colorado, the Field Special Assistant, the DOI employees are responsible for coordinating all our bureaus there. A fellow named Ray Suazo, his day job is the BLM State Director but he's working with Clark County, Nevada. He's working with the Fish and Wildlife Service, with the U.S. Geological Survey, with the Bureau of Reclamation and the state governments of Arizona, Nevada and California to try to collectively pull folks together and see how we can leverage these other resources.

Senator MCSALLY. Okay, great.

Can I get your commitment for a follow-up coordination, even with Buckeye and the local communities there, to see what else we might be able to do specifically targeted in that area for increasing collaboration research and other things you mentioned?

Mr. CAMERON. Yeah, absolutely, Senator.

Senator MCSALLY. Okay, awesome, thank you and I know I am over time.

Senator Cortez Masto.

Senator CORTEZ MASTO. Thank you.

Let me talk to Ms. Regan because I think there is a lesson to be learned from collaboration. Can you talk a little bit about how the Tahoe Regional Planning Agency collaborates and coordinates with stakeholders to address invasive species, not just at the federal level, but also with the private sector and how you have all come together and maybe some of the challenges that you faced and have overcome? That would be helpful.

Ms. REGAN. Thank you. Thank you, Senator Cortez Masto, for the opportunity to be here. And yes, you referred to what we call in Lake Tahoe, "epic collaboration." There's collaboration and then there's "epic collaboration," and we really go the extra mile. As a regional convener, our agency has an opportunity to bring this very wide partnership together. There are about ten federal agencies

that operate in Lake Tahoe, two states, multiple local jurisdictions, the private sector and on and on.

So we have this framework called the Environmental Improvement Program where we have regular meetings. We have the heads of all the agencies and executives together very frequently and then from there we form working groups. One is called the Invasive Species Collaborating Committee, and so we bring the science community, local implementors on-the-ground, marinas, private sector concessionaires and we meet regularly to talk about this threat. We've actually relied on science in this collaborative effort. We have the University of Nevada at Reno who's published a report on how we can best attack the problem of existing invasive species while prevention, of course, is our number one priority. An ounce of prevention is worth a pound of cure. We also have to tackle what's already in the lake, the milfoil, the pondweed, the Asian clams.

So we rely on these collaborative working groups to work at home, but not just at home at Lake Tahoe is enough. We work with our Western states partners through the Western Regional Panel and all the other working groups that you've heard in testimony today. Our agency has an ex officio seat on the Aquatic Nuisance Species Task Force at the federal level, and we've hosted multiple workshops in Lake Tahoe to learn from each other and to inspire new action on the ground. One of the challenges to that is certainly communication. We try to follow what in the literature is referred to as that collective impact model where having a shared agenda and constant communication are critical to preventing new attacks of invasive species in this case.

So it's through all of those working frameworks that we find the collaboration to be successful, but inertia is very difficult to overcome so we constantly have to nurture those relationships and make it a priority that it's not just a "nice to do," it's a "must do" in terms of fighting this fight for invasive species.

Senator CORTEZ MASTO. Thank you.

And then, let me ask you, what do you think are the biggest challenges and solutions to address climate change in the work that the TRPA is doing around Lake Tahoe?

Ms. REGAN. Thank you, Senator, for the question. Again, Julie Regan with the Tahoe Regional Planning Agency.

Climate change is happening. We know our lake is warming, statistically from 1968 we have continuous records that show we have this trend. Lake Tahoe is a high alpine lake. Generally about 50 degrees is the normal temperature, but just last year we clocked records of 77 degrees in the shoreline just in the shallow areas. So this is happening and that, of course, poses a new threat to host new invasives that perhaps wouldn't grow in those cold waters.

If we, again, go back to the solution of prevention and having mandatory boat inspections in place, we feel, is ground zero. Folks are not allowed to launch their boats on Lake Tahoe unless they go through an inspection. They have a sticker. Some folks leave their boats in Tahoe year-round. It says, "Tahoe Only." If they come from another water body, it's called the "Tahoe In-Out" sticker and we know there's an extra level of scrutiny. And we actually decontaminate about half of the boats that enter the lake from

other areas with hot water flushing to make sure that they are not bringing in any invasives.

So those solutions are critical but we also have to rely on data and technology. We've been able to coordinate with our western partners that now, through an app, there is an automatic email sent. Let's say a boat leaves Lake Mead, Nevada, that had mussels. It was decontaminated. We get an alert instantly that that boat could be headed to Lake Tahoe. And so our inspectors actually have extra eyes on those boats with the registration information. So a solution there is important for the future for technology.

And then also, collaboration and continuing to partner with the science community to make sure that we're aware of potentially new threats and new species that could be making their way, species that we might not even have on the radar. So using that relationship with the science community to guide our policies is another potential solution.

Senator CORTEZ MASTO. You talked a little bit about the regional data sharing. It is my understanding the Quagga-Zebra Mussel Action Plan prepared by the Western Regional Panel for the Aquatic Nuisance Species Task Force launched this regional data sharing system to enable this rapid sharing of information that you talked about. Is that what you are accessing? And I am curious—for the rest of the panelists—that type of data sharing, has that enabled you as well to have this quick, rapid response to these invasive species?

Ms. REGAN. Yes, Senator. Again, Julie Regan, for the record, Tahoe Regional Planning Agency.

Thank you, yes, I am referring to the data sharing through the application. I believe there are 11 different entities across the West that are participating in that and we have found that to be most effective and actually have intercepted mussel-laden boats. So it has been effective to our knowledge.

Senator CORTEZ MASTO. That is impressive. For the other panelists, is that something you are utilizing as well or aware of or do we need more education?

Mr. CAMERON. Yes, Senator, that's the information sharing program I referred to in my testimony. Notably it took us about six months to comply with the Paperwork Reduction Act so the Park Service could actually start participating in that program, and we're thinking maybe it'll take another six months to get BLM and the Fish and Wildlife Service to participate in the program. We're glad we did it. It's really important, but that's, you know, just one example of well-intentioned laws can sometimes get in the way of good cooperation with the states.

Senator CORTEZ MASTO. Well, and I think that is important for us to know because I think it is a great program and a platform that all of our federal agencies should be coordinating with both our municipalities, our states and private sector as well.

Mr. Preston, did you have a comment?

Mr. PRESTON. Yes, I do have something to add, I mean, I think these are all good additions to, you know, the early warning and, kind of, knowing what's coming our way. But I want to emphasize that the key to this exercise is not letting trailered boats on the reservoirs. And so, that's kind of our, that's what our inspection



programs are set up to do. Nobody gets on the reservoir without an inspection, decontamination as necessary so that—and then we've also tried, I mean, one of our challenges, we've got a lot of small reservoirs in Southwest Colorado so we've tried to work with other reservoir operators that have smaller levels of risk in terms of ways that they can manage, but it's really, really the key is not to let infected boats on the, on our lakes.

Senator CORTEZ MASTO. Thank you. I know my time is up. Thank you, Madam Chair, for your indulgence.

Senator MCSALLY. Yes, thanks. Round two.

So the information sharing platform, that is specifically for mussels, right? Is that something that could be adapted for other invasive species like salt cedar? I mean, it is a different challenge, obviously, but the same kind of information sharing need.

Mr. CAMERON. Senator, I think you've got a really good idea there. In fact, back in the early 2000s there was a West-wide conference that was convened in Albuquerque called Team Tamarisk and one of the things we did was to use the U.S. Geological Survey to partner with states and try to collect information on the geographic distribution of salt cedar across the West—literally create a map, an online map, that anyone who, you know, had some scientific background could add data to and that was a tool for figuring out how high up in the watershed are they, might they be coming downstream in my direction. So we can use technology. We can use spatial technology to help us deal with a wide variety of invasive species challenges.

Senator MCSALLY. Great, let's maybe explore that more.

Speaking of the beetle, it seemed like another example of well-intended but not thinking through second order consequences. I think back to even when salt cedar was originally put in to control erosion and now here we are. Then somebody had an idea to introduce the beetle, but that is now impacting endangered species. Sounds like we should maybe not, you know—Mother Nature is a little smarter than we are on some of these ideas. Can you talk about, Mayor Meck, what is going on with this beetle and what the concerns are and, Mr. Cameron, what is being done related to it and the impact?

Mr. MECK. We attended, we meaning the City, myself and a couple of others, Colorado, and they discussed the beetle there thinking it was going to stay in that area and obviously it moved into Texas and it's also in Wickenburg which is northwest of Buckeye. They thought we would have it in two years. The problem is it will be, come in and defoliate the plant—

Senator MCSALLY. Right.

Mr. MECK. —the tree, in the summer. That's when your southwest flycatcher has the hatchlings in the nests and such. So those birds will die once that is—the problem, in our area, where the river used to be a quarter mile wide because of the salt cedars acting like a dam and growing so well, if the beetle comes in and defoliates what we call the leaves or the fuzz and drops that on the ground, that's additional barrier to water. The water will move to the north, meaning on the farmland and through the City of Buckeye, the southside. The southside of Buckeye is the bulk of it,

where I was physically born and that's over 75, actually 79 years ago.

And those houses, very old, and the fires, when we have a fire because of this thickness of the salt cedars and such, that fire will burn and it's about a quarter of a million dollars just to start to try to get the fire out. When the beetles come in and they defoliate it, and all that defoliation gets on the ground and builds up, additional fuel for fire.

Senator MCSALLY. Tinder, yes.

Mr. MECK. Bad, it's really bad. It's going to be a problem if we get the beetle which they're projecting within two more years.

Senator MCSALLY. Mr. Cameron, do you have anything to share about what is going on with the beetle and also, anything else technology wise or anything else that could be shared about the salt cedar and now the beetle issue on top of it?

Mr. CAMERON. So, Chairwoman, I think that the Mayor got it exactly right when he said earlier that it's not enough to kill the salt cedar trees, you actually need to plant willows or cottonwoods. I mean, the southwest willow flycatcher, willow is in its name. It belongs in willow trees. So if you can plant willows so that you've got good nesting habitat for the willow flycatcher, instead of a poor-quality nesting habitat like the salt cedar trees, then over time you'll be able to take care of the bird and get rid of the salt cedar. But it's not just killing the salt cedar, you've got to get it out of there and then you've got to plant a good habitat, willows and cottonwoods, so the birds will have a good place to nest.

Senator MCSALLY. Do you have any sense of the cost of doing that per acre?

Mr. CAMERON. I do not, but I'm happy to go back and try to get some information for the record. I imagine it varies a lot from one piece of geography to another, but we'll see what we can come up with.

Senator MCSALLY. Okay, great.

I want to do a final question. So I want to go down the line here, speaking of cost. If each of you can share what you may know about direct costs, indirect costs, but then also the cost of doing nothing, like if we don't address these invasive species in a collaborative and aggressive way, what ends up being the cost to the economy, cost to the environment, cost to water—you have to do that cost-benefit analysis—so direct costs, indirect costs, and costs of doing nothing. I will start with you, Mr. Cameron.

Mr. CAMERON. Okay, so that's a big question, Chairwoman. Let me try to make it a little bit narrower, if you will.

So in the Great Lakes, invasive mussels are about a \$500 million annual drag on the Great Lakes economy. As was mentioned earlier, I think by Stephanie Criswell, if these things got into the Pacific Northwest at Columbia River Basin, the regional estimate by a non-profit is it would be a similar hit on the Northwestern economy. There are other ways to think about it.

So this is a quagga mussel infested pipe [holds up pipe]. I spoke to an Idaho State Legislator who was an irrigator in the Snake River Basin. He pumps water and that has a pivot irrigation system. If these things got into his pumps or got into his pivot irriga-

tion system, it would put him out of business. He can't afford to replace those systems every two or three years.

There's a photograph—I think the Committee has—of a beach in the Great Lakes with quagga mussel shells.

[The photograph of quagga mussel shells referred to follows:]



Mr. CAMERON. So imagine if this was on a Lake Tahoe beach, Senator Cortez Masto. What would that do to families who want to have their five-year-old kids playing on the beach? It would not be very good for the Lake Tahoe tourist economy.

The Bureau of Reclamation estimated that for every hydroelectric facility that's totally infested with zebra or quagga mussels, it raises the O&M cost for that dam by about half a million dollars a year. That means higher electric rates in Las Vegas, higher electric rates in Reno, in Phoenix, in Tucson, and so on and so forth, all around the West.

These things in the Great Lakes, they have added to the problems of around 20 endangered species in the Great Lakes. I think the last thing Nevada or Arizona needs are more endangered species because these things are smothering them, or sucking up their food, or otherwise occupying their habitat, and I think we all know the implications of more Endangered Species Act listings. So, unfortunately, we could go on and on, you know, sector by sector. Water supply for Las Vegas, water supply for Tucson, if these things are clogging up the pipes. So—

Senator MCSALLY. Great, thank you.

Mr. CAMERON. —there's a lot to be said, unfortunately.

Senator MCSALLY. Thanks.

Now I will go to Senator Cortez Masto. When I come back, I will get everybody else's answers.

Senator CORTEZ MASTO. Let me follow up on that. What is the solution? Is there a solution? How do we combat—particularly when we are talking about these invasive species—the quagga mussels and the zebra mussels? Is there a way to address this or we are, just, now going to have to manage and mitigate it and hope it doesn't expand?

Mr. CAMERON. Well, one thing we can do, Senator, as other panelists have suggested, is keep them out of places where they aren't already through aggressive boat inspection and decontamination programs that everyone is doing. Another thing we can do is to do research on technologies that make it relatively cheaper to deal with them when they are in an infested area, or materials that we can use so it—that we can put on pipes—so it's tougher for them to attach themselves, for instance.

And there's always the potential for a research breakthrough. For instance, in the 1950s and 1960s, sea lamprey pretty much devastated the fisheries in the Great Lakes. Then the Fish and Wildlife Service came up with a selective toxicant that only kills sea lampreys and nothing else. And now the sea lamprey population is down by 90+ percent in the Great Lakes and you've got a \$7 billion fishery. So I wouldn't discount the possibility of research, you know, providing some silver bullet solutions, but in the meantime, we need to rely on things like boat inspection and decontamination to manage the problem where it isn't quite and to keep it from spreading.

Senator CORTEZ MASTO. Let's go back to this idea of research then. Is the Department of the Interior engaging in some of that research or funding it or do we need to be aware of more funding that is necessary at the federal level to support that type of research you have just talked about?

Mr. CAMERON. So the Bureau of Reclamation actually does, is spending some money on research on invasive mussels. The U.S. Geological Survey may, although I'm not absolutely certain of that. We could get more detailed information for you for the record. I know the Army Corps of Engineers is spending money on research on invasive mussels as well.

Senator CORTEZ MASTO. Yes, but I think our concern is this has been since 2007 and it hasn't gotten any better. I think we need to really make it a priority in trying to address and fund the research that is necessary.

But let me talk about another issue and, Mr. Cameron, I am going to ask you to talk about this, although it is not an aquatic invasive species, it is cheatgrass and it is all over our rangelands in the West. I was literally just talking with some of our local communities and ranchers. It is a concern. And my biggest challenge is getting Department of the Interior—because in Nevada most of our public land is BLM land—getting them to the table to work with our local ranchers and our private sector to address cheatgrass which is, my understanding, not a native grass in Nevada, and start looking at how we remediate our lands with native seed. I am curious, do you have any information on how we mitigate the cheatgrass and what Department of the Interior is doing in that space?

Mr. CAMERON. That's a great question, Senator. So as you're obviously aware from your question, there's a real connection between wildland fire risk and the prevalence of cheatgrass because the stuff dies early in the growing season. It grows in dense mats and the next thing you know you're setting the stage for significant rangeland fires.

So in the President's FY21 budget request for the Department of the Interior, there's a \$50 million increase that would enable us to hire more employees to do fuels reduction to get rid of cheatgrass, just as one example, and to allow us to have employees work, not just for six months, on a temporary basis during the season, but potentially for nine months or ten months. We just got OPM approval for that, so we can do more fuels reduction on the two shoulders of the peak fire season, if you will.

So fuels reduction, whether it's in a forest ecosystem or a rangeland ecosystem, is absolutely critical. Burning up sage grouse habitat through wildland fire is not a good thing. Burning up houses or ranches because of the spread of wildland fire because of cheatgrass prevalence is not a good thing. So we need to focus on fuels reduction. It would help solve both the environmental and the public health and safety risk posed by cheatgrass.

Senator CORTEZ MASTO. Thank you and for that reason can I get your commitment that you would be willing to work with me and the State of Nevada in how we address this issue with respect to cheatgrass and move forward in a mitigation plan?

Mr. CAMERON. Yeah, absolutely, Senator, I would be delighted to work with you to see what additionally could be done. I might also mention there's a fellow named Stan Austin who's a Field Special Assistant for the California-Great Basin, Interior Region, his day job is to be the Park Service Regional Director. He's based in San Francisco. So in the same way that Ray Suazo was trying to coordi-

nate Interior Bureaus in the Lower Colorado, one of Stan's roles is to see how BLM, Fish and Wildlife, Reclamation, and so on in Nevada and California, might work more effectively together.

Senator CORTEZ MASTO. Thank you.

Senator MCSALLY. Okay, just as a wrap-up, if we could continue down the line on the direct costs, indirect costs, and costs of doing nothing, and then what else can we be doing here and what can the Federal Government be doing better to address this issue?

Mayor Meck.

Mr. MECK. Thank you. If I may, I would like just to make sure that you understand there's other people that are involved with us, other entities. Arizona State Forestry, Corps of Engineers Flood Control, U.S. Fish and Wildlife, Arizona Game and Fish, RiversEdge West out of Colorado, 200 homeowners, over 103 individual people that are on our website, Arizona Department of Transportation, Bureau of Land Management and, certainly, I'm not here to throw anybody under the bus, but the costs that we're talking about, and I mentioned earlier, if we have a fire in the river, which we've had several over the years, that fire, the cost of it to begin with is \$250,000. We've had several of those. To go in and channel the river and do everything perfect, that would be \$80-\$100 million in an 18- or 20-mile stretch.

The problem with that is, that does not allow private landowners which are willing to bring dozers to get in there which would do it, gladly, because several farmers, one farmer lost 160 acres with a feed lot that it's in the river bottom. We had three dairies that were lost because of the river bottom. All of those two, both properties, are currently under the guise of the salt cedars and the river bottom.

As I mentioned earlier, a quarter mile wide is what the river was when I was growing up. All floods stayed in the river. Now, because the river is flat due to the sediment transfer of sands and gravels coming downstream, those trees have held the water back and all of that flood in the future is going to go across farmland and we view it as similar to the Midwest with the Mississippi where you could see piles of sand on fields themselves. And those are things we'd like to stop.

The big part of what we want to do is to put trails along the river, if we can get that. We currently have a Skyline Park in the White Tank Mountains that's three years old. The first year we had over 200,000 visitors, hikers and such. The second year was 280,000. Last year we had 320,000 people come 30 miles west of Phoenix to go on the trail. There's 18 miles of trail. If we can take and clean the river and make it where people can utilize that, we will join Maricopa County Parks' trails which will be a total of over 100 miles of trails.

So we know the fact as far as what the benefits are. The cost is hard. If we could get the permit to get in the river and take these trees out, we can have private landowners. We have Arizona Sand and Rock, they're willing to get in. We have a lot of things we can do. We just can't move to get something done.

I'd just like to make a statement. We're always told what we cannot do. We're not told what we can do. And that's our problem.

Thank you.

Senator MCSALLY. Great. Thank you, Mayor Meck, I appreciate it.

Ms. Criswell.

Ms. CRISWELL. Chair McSally, I think Mr. Cameron did a good job of covering a lot of the information related to direct and indirect costs. As I mentioned, Montana commissioned a study. The reason we did not do a full cost accounting is because, I think, indirect costs are not totally identified, one, and then secondly, it was too expensive, it was out of our budget. So I think widely, those are the reason these economic impact studies are done, you know, here and there and there's not one full accounting.

But I wonder, you know, if it matters too. Five hundred million just to the hydroelectric, hydropower in the Columbia River Basin is a pretty staggering number. There was another number that I had, and it was \$1 billion for mitigation and these are actually real costs.

And I know a lot of the federal reservoirs have done impact statements, so collectively I don't know if there's a way to just throw one big number out there, but those staggering numbers really do make a difference.

The other thing that I wanted to address—and this is what Mr. Cameron was talking about—about technology, and I completely agree with that. That is the answer when people say we have mussels, you know, I'm throwing my hands up. It's no, there is a chance. We can prevent these water bodies that are not impacted so far and maybe there will be the technology to control them. So we need to hold on to that and protect these places.

So those two things, and then the third thing I would say is that the biggest thing is prevention and it all goes to behavior change. It's every citizen's obligation to "Clean. Drain. Dry" and practice these. We're the ones moving this stuff. It's not the boats. We're moving the boats. And that applies to quagga-zebra mussels as well as all invasive species.

So how do we get to the American public to change behavior? And I know there's a lot of social marketing going on with different invasive species, people in the invasive species field and we're getting, you know, we're getting better at figuring out how to change behavior, but I think that would be an area that we should really focus on and put resources toward is how do we convince the American public this is all our responsibility?

Senator MCSALLY. Thank you.

Mr. Preston.

Mr. PRESTON. I guess I would agree that Mr. Cameron covered, kind of, the broad, kind of, direct costs and we don't know what they would be in our area and we hope we never find out. But again, the stakes, as I mentioned earlier, these rural areas where tourism and recreation economy, we can't destroy one of our major recreation assets. Where there's 17 states downstream from us, we can't afford to spread these mussels downstream. The struggle to keep irrigation delivery systems intact and still be able to have your farmers viable because they're paying the cost at the end of the day. We're operating on margins that would be impossible to absorb if we have to up these maintenance costs. The same goes for water treatment plants.



So to the question of what the Federal Government can do, a lot of good discussion this morning. I've been really informed, and I'm glad I showed up at this hearing. One is exit inspections out of Lake Powell. We are getting 80, 90 hot boats a year coming out of Lake Powell. McPhee Reservoir is about three hours and that is, I think, probably the biggest threat risk in the Interior West and if we don't get a handle on it, we're letting infested boats come out of Powell, everybody is at risk.

The other thing, I think that is really promising, are these collaborative partnerships at all levels. For one thing, you build social awareness, you have the benefit of everybody's resources and everybody's knowledge that comes into the collaborative process. And at the end of the day, we're going to have to form, I mean, we're forming, kind of, formal partnerships. We're going to have to take actions. We may have to invest. But we need to be together, you know, through these collaborative relationships from here forward and really adapting. And again, I emphasize that there are no mussels above our reservoirs in Colorado. Any risk is coming from out of state and so the rigorous inspection of all trailered boats is still the linchpin of keeping these mussels out of the Interior West or at least trying to arrest their spread.

Senator MCSALLY. Right, thank you.

Ms. Regan.

Ms. REGAN. Thank you, Chairwoman.

A couple of things. The direct cost we've anticipated, as Senator Cortez Masto mentioned, at \$22 million potentially a year should quagga mussels enter Lake Tahoe. We believe that is a very low estimate. That does include direct and indirect, some water infrastructure costs. Just thinking of things like our wedding industry. We have a very big destination wedding market. If quagga mussels were to get established on our beaches, that would be a huge hit to our tourism-based economy.

And so, therefore leading down the path of what is the cost of doing nothing? It puts our whole \$5 billion annual economy at risk should quagga mussels become introduced. And I must emphasize also what Ms. Criswell said about human behavior. We've had good results with our public education, but it's a constant challenge and we have to continue to invest in those programs because behavior change is difficult and getting the word out in a very crowded marketplace of ideas is difficult.

So we appreciate all the support that we've had from the Congress and from the Administration, and we would ask to keep that drumbeat alive. Your leadership is much appreciated in terms of what the Federal Government can do maintaining that leadership, that this is a very urgent matter, right up there with issues like wildfire in the West. These issues really need the attention of the Federal Government. And then, support for funding, continually, because all of our boaters are going everywhere. We've had, actually, account and evidence of every state in the country of a boat coming into Lake Tahoe. So that prevention is critical. Any boat that we have leaving the lake clean is a boat that's not going to infect another water body. So it's all interconnected.

And then I would say the third thing for the Federal Government to support is that coordination and collaboration. And then to un-

underscore that collaboration is more than coordination. It's not just a check box that I made a phone call but it's actually rolling up your sleeves and working with the partners. We've mentioned Lake Powell but also at Lake Mead and just continuing that communication between the boats that are leaving there and making sure that they are leaving clean and at least notification to other water bodies that they are. So thank you very much.

Senator MCSALLY. Great, thank you.

Well, thank you to all our panel members. Thanks for sharing your expertise and your testimonies. There is still a lot of work to be done but this helps to focus our efforts as well.

Before we adjourn, I want to ask that a statement from the Western Governors' Association be included in the hearing record, without objection.

[Statement from the Western Governors' Association follows:]

**Written Testimony of James D. Ogsbury, Executive Director  
Western Governors' Association**

**Submitted to the United States Senate  
Committee on Energy and Natural Resources  
Subcommittee on Water and Power**

**Hearing to Examine the Impact of Invasive Species on Bureau of Reclamation Facilities  
and Management of Water Resources in the West**

**March 4, 2020**

The Western Governors' Association (WGA) appreciates the opportunity to provide written testimony for the record on the important issue of invasive species in the West. WGA is an independent organization representing the Governors of the 22 westernmost states and territories. The Association is an instrument of the Governors for bipartisan policy development, information-sharing and collective action on issues of critical importance to the western United States.

Western Governors have long been concerned about the threat invasive species pose to western waters, ecosystems and economies. Studies have found that invasive species cost the U.S. more than \$120 billion every year, and the National Wildlife Federation estimates that 42 percent of threatened or endangered species are at risk due to invasive species. Invasive species harm a wide variety of economic sectors dependent on natural resources, including agriculture, ranching, tourism, energy production and transmission, and forest products. Aquatic nuisance species, including invasive quagga and zebra mussels decrease water quantity and quality, impair native wildlife, damage hydroelectric and irrigation systems, and impede maritime transport by fouling vessel hulls.

The spread of invasive and non-native species affects nearly every aspect of life in the West. As invading species replace native plants and wildlife, the ecosystems, economies and communities that depend on the West's natural resources are damaged and diminished, sometimes permanently. Improving biosecurity and invasive species management practices is essential to protecting the West from new invading species, reducing the effects of established species, and restoring the region's working lands and native ecosystems.

In July 2018, Hawai'i Governor David Ige, as Chair of WGA, launched the *Western Governors' Biosecurity and Invasive Species Initiative*. The Initiative focused on the effects that nuisance species, pests and pathogens have on ecosystems, forests, rangelands, watersheds and infrastructure in the West, and examined the role biosecurity plays in addressing these risks. The Initiative explored these issues through workshops hosted by Governors throughout the West, followed by webinars focusing on discrete topics in invasive species management.

The *Biosecurity and Invasive Species Initiative's Special Report* contains more than 35 recommendations to achieve the following goals:

- Protect the West from the introduction of new invasive species through enhanced biosecurity practices, preparedness, and planning;
- Improve cross-boundary collaboration and coordination for the management of established and emerging invasive species;
- Empower state and federal agencies to manage invasive species by aligning federal laws, regulations, and funding mechanisms with states' needs;
- Support and utilize biosecurity research, technology and planning tools, and;
- Standardize and mobilize invasive species data.

In June 2019, Western Governors adopted WGA Policy Resolution 2019-06, *Biosecurity and Invasive Species Management*. In the resolution, Western Governors articulate detailed policies and outline concrete action items to improve biosecurity and combat invasive species.

One of those items was to call for the creation of a Western Invasive Species Council (WISC) to: enhance coordination between existing state invasive species councils; improve communication and collaboration on regional biosecurity and invasive species control efforts; and advocate for regional needs at the federal level. I am pleased to report that WGA announced the formation of WISC in October 2019. To date, 17 Western Governors have appointed members to the Council, and it is already working to improve coordination of invasive species management in western states.

The resolution also emphasizes that accurate, standardized and accessible geospatial data is essential to biosecurity and invasive species management in the West. Governors support efforts to: standardize and centralize invasive species occurrence data; streamline the exchange of data between the nation's major invasive species data aggregators; and increase the accessibility of data to federal, state, and local land and resource managers. To address these needs, WGA is launching an Invasive Species Data Mobilization Campaign to encourage invasive species managers in the West to standardize and share their invasive species occurrence data. The campaign is largely being informed by the findings and recommendations of the WGA Invasive Species Data Management Workshop, hosted by WGA in Denver, Colorado, in March 2019.

In December 2018, WGA and the U.S. Department of Agriculture (USDA) signed a Memorandum of Understanding (MOU) to establish a framework for the U.S. Forest Service and WGA to work collaboratively to accomplish mutual goals, advance common interests, and effectively respond to the increasing suite of challenges facing western landscapes. The MOU, an outgrowth of the USDA Shared Stewardship strategy and the WGA National Forest and Rangeland Management Initiative, has helped Western Governors and USDA identify shared priorities and collaborative projects to increase active management on western forests and rangelands.

One such effort, announced by WGA and USDA in June 2019, is a campaign to meaningfully address the large-scale infestation of cheatgrass and other invasive annual grasses

on forests and rangelands in the West. Non-native grasses and trees have seriously deleterious effects on water quantity in western states. Invasive species also affect wildfire potential, impair post-fire restoration efforts, and diminish water quality in wildfire-affected landscapes.

WGA and USDA are developing a common spatial strategy to address cheatgrass and invasive annual grass management at a regional scale. This strategy will employ new analytical tools and use proven management practices, such as integrated pest management and targeted grazing. The strategy will use early detection and rapid response principles to protect pristine and biologically intact “core” areas and will include an examination of the operation of cooperative weed management areas or similar locally based invasive annual grass cooperatives.

Because these terrestrial invasives can have such significant effects on both the quality and quantity of water resources, Western Governors appreciate the Committee’s consideration of species such as salt cedar (tamarisk). In 2018, WGA surveyed invasive species coordinators in western states and territories to develop a list of the Top 50 Invasive Species in the West, and salt cedar was identified as the number one terrestrial threat. Also near the top of the list of terrestrial threats were Eurasian watermilfoil and curly leaf pondweed.

The Subcommittee’s focus on the effect of aquatic invasive species on western water resources is also encouraging. Invasive quagga and zebra mussels are of particular concern, as these invaders annually result in millions of dollars in lost economic activity and cause significant environmental damage to waterbodies in the West. It is of paramount importance to prevent the spread of these species into waterways that are not yet infested, including the Columbia River basin – the last major non-infested water system in the continental U.S. and the headwaters of other major rivers.

Cross-boundary cooperation across all levels of government and between federal agencies is critical to adequately addressing these invasive threats. The primary means by which these aquatic mussels spread is by traveling on the hulls and in the ballast tanks of boats leaving infested waterbodies. The coordinated application of effective inspection and decontamination practices as watercraft leave infested waters is the first line of defense against their proliferation.

Federal agencies have jurisdiction over several major infested waterbodies in the West, including Lake Mead, Lake Powell and Lake Havasu. The boat inspection and decontamination policies of the agencies managing infested waterbodies – the Bureau of Land Management (BLM), the Bureau of Reclamation (BOR), and the National Park Service (NPS) – are key to regional efforts to contain these species. These agencies operate several voluntary inspection and decontamination programs at these infested waterbodies, mostly at the request of, and in collaboration with, states. These programs are hampered, however, by a lack of clear statutory authority for federal agencies to manage all high-risk vessels (long-term slipped and moored watercraft) upon their departure from infested waterbodies under federal jurisdiction.

The containment of invasive quagga and zebra mussels at infested waters in the West depends upon the collaboration of federal, state and local agencies. Many state-led containment programs benefit from federal cooperation and funding, and state and federal agencies should be encouraged to sustain and expand these effective partnerships.

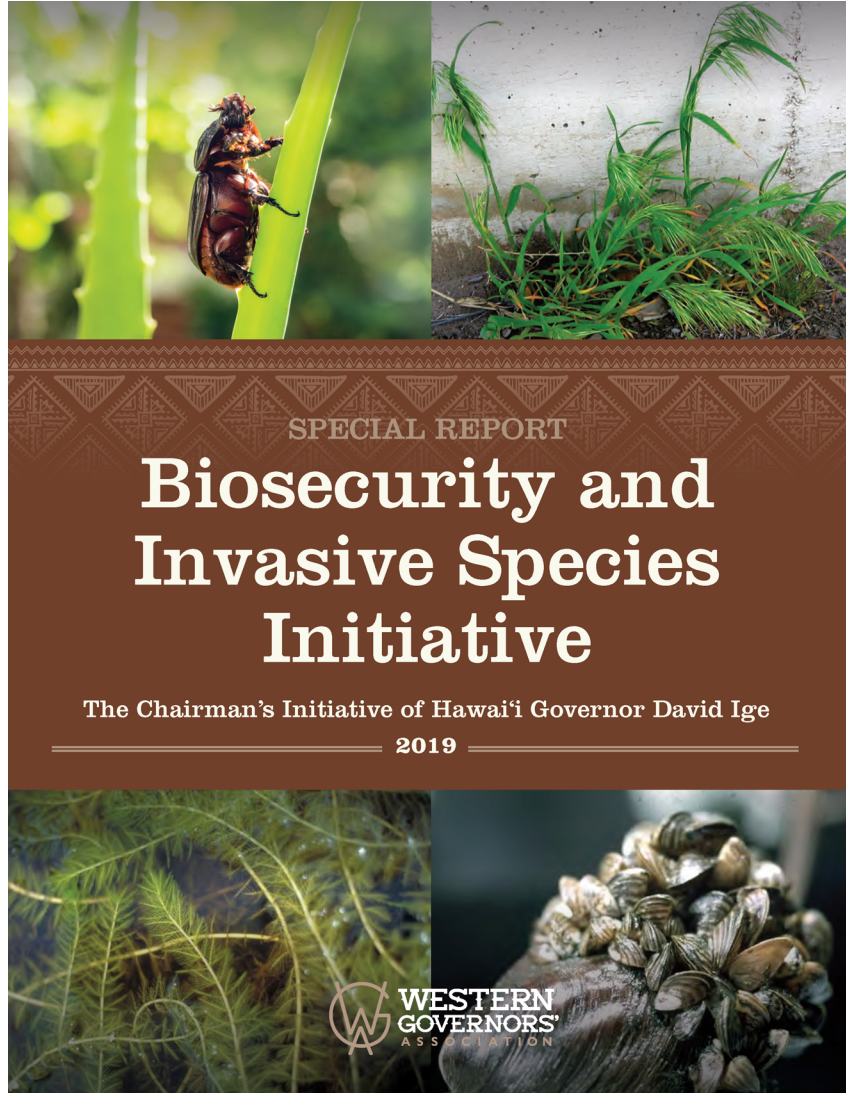
To adequately protect the West from the movement of aquatic invasive species, federal agencies must be able to act as full partners in invasive species containment efforts and have the funding and authorities necessary to contain invasive species within lands and waters under their jurisdiction. To this end, federal agencies, including BLM, BOR, and NPS, should be vested with clear authority to manage watercraft upon their departure from infested waterbodies under federal jurisdiction.

Federal agencies also have jurisdiction over the management of vessels in the marine environment, particularly following the passage of the Vessel Incidental Discharge Act of 2018. Under this policy, management of discharges from vessels, including ballast water and hull fouling organisms, is consolidated under the Environmental Protection Agency and the U.S. Coast Guard. It is critical that these agencies engage in more substantial consultation with states in order to adequately address the risk of invasive species being transported by maritime vessels.

Western Governors support the Early Detection and Rapid Response (EDRR) framework as a method to limit or eliminate new introductions and existing species expansion. Programs for the control and/or eradication of invasive species must result in more on-the-ground prevention, management and eradication. The Incident Command System (ICS) should be evaluated for use in instances of fast-spreading invasives and used as part of EDRR; state, federal, and local agencies can opt to practice and implement the ICS as part of rapid response. The Federal Emergency Management Agency can support these efforts by working with western states to create an ICS training module for invasive species rapid response.

The federal government can support state-led rapid response programs by: 1) increasing federal funding for state-led aquatic invasive species rapid response programs, including those that provide mechanisms for flexible, long-term support of state early detection rapid response efforts; 2) streamlining federal permitting and approval processes for treatment and management actions for new mussel detections; 3) creating a single federal authority for aquatic invasive species treatment permitting and approval in freshwater systems; and 4) simplifying reporting on new invasive mussel infestations by creating a single federal point of contact for new mussel detections.

Thank you for providing the opportunity to submit testimony on behalf of WGA. Western Governors appreciate your examination of the serious and pervasive threat invasive species pose to western water resources and stand ready to assist as you consider steps to improve our nation's biosecurity and invasive species management practices.



## Dear Friends and Colleagues,

Life in the West is built on our unique landscapes: our natural resources, our agricultural production, and our communities. The West is a region of great diversity, from the dense rainforests of the Pacific Islands to the sprawling sagebrush sea of the Great Basin and beyond. A respect for, and reliance on, our natural environment gives meaning to western life and shape to the western character. The diversity of these resources forms the breadth of western culture and fuels some of our most important economic sectors, such as agriculture, ranching, recreation, and tourism.

But the natural resources that define life in the West are under attack: Invasive species, including plants, animals, and pathogens, pose a significant threat to the western experience. Every day, populations of invasive species such as fire ants, fire-prone grasses, saltcedar, and tree-boring beetles expand into new territory, damaging and degrading native ecosystems. New invasive species are transported across borders daily, with each invader bringing the potential for permanent harm to the region.

The damage done by invasive species is real, and their impacts on western ecosystems, economies and communities can be staggering. According to the National Wildlife Federation, approximately 42 percent of threatened or endangered species are at risk due to invasive species. The West has more federally-listed threatened and endangered species than any other region of the U.S. One study estimates that invasive species costs the U.S. more than \$120 billion every year. A single species, the red imported fire ant (*Solenopsis invicta*), costs the mainland U.S. billions of dollars in economic damage each year and would cost Hawai'i hundreds of millions of dollars annually if it were to be introduced into the state.

These invaders also threaten our culture. Here in Hawai'i, Rapid 'Ōhi'a Death, an invasive forest pathogen, continues to diminish populations of the native 'Ōhi'a, a tree at the heart of Hawai'i's culture and a foundational species of our native forests. This is a story familiar throughout the West, as multi-generational ranching communities face pressure from non-native annual grasses and Native American communities reliant on native salmon are negatively affected by aquatic nuisance species.

We are not helpless in the face of these invasions. Biosecurity – measures taken to manage the risk from invasive species to economies, environments, health and lifestyles – is an essential element in the fight against invasive species. Throughout the West, a network of state, federal, tribal and local biosecurity agencies strive to protect resources from new invading species. Simultaneously, a broad coalition of stakeholders work to monitor, control and eradicate invasive species once they have been established.

My goal in launching the *Western Governors' Biosecurity and Invasive Species Initiative* was to examine the efforts of the West's dedicated biosecurity and invasive species professionals and to identify areas where Western Governors could support and enhance their work. To accomplish this goal, the Western Governors' Association hosted a series of workshops throughout the West, which brought regional leaders together to discuss how invasive species affect life in the region, how established species can be better managed, and how biosecurity practices can be improved to limit new introductions. These workshops were followed by webinars focusing on discrete issues arising from the workshops.

This report's findings, recommendations, best practices and case studies are the culmination of that process. I encourage you to use this document as a bipartisan policy roadmap on the issue and to work with Western Governors as they implement the recommendations through the WGA Working Lands Roundtable and the Western Invasive Species Council.

Thank you for joining me on this journey over the last year. I am grateful for all the hard work and investments made by our state and federal partners, industry, private landowners and non-governmental organizations. I look forward to collaborating on the solutions to one of the most pressing environmental issues of our time.

Sincerely,



*David Y. Ige*

David Y. Ige  
Governor, State of Hawai'i





## Dear Friend of the West,

As national politics have become more polarized – as our federal government has become more dysfunctional – people throughout the country (and of all political stripes) have increasingly looked to states and their governors for bipartisan leadership and solutions to problems facing our nation and region.

Western Governors have risen to that challenge in a big way.

Through the Western Governors' Association, the Governors have developed deliberative policy and generated creative ideas to sustain and develop the economies and environments of the great American West. I commend your attention to their detailed, substantive and policy-rich resolutions on energy, water, forest fires, species conservation, public lands management and a host of other critical resource issues.

Though these detailed resolutions articulate measured and thoughtful principles, Western Governors are men and women of action. As valuable as their policy pronouncements are, the Governors prefer to get things done.

It was with this mentality that WGA Chair and Hawai'i Governor **David Ige** launched the *Western Governors' Biosecurity and Invasive Species Initiative*. The Initiative has mobilized Western Governors to leverage their influence and resources to more aggressively confront the scourge of invasive species. The impacts of invasive species in the West are as pervasive as they are underreported. The spread of noxious weeds threatens ranching communities and fuels wildfires. Invasive species can radically alter habitat, compounding threats to wildlife and endangering species. The competition that non-native species pose to native game impacts hunting and fishing. Industries across the West – including agriculture, forestry and tourism

– are struggling to eradicate, contain and mitigate the insidious impacts of these invaders.

Governor Ige's Initiative builds on a significant body of work executed by the Association in recent years. In 2016, for example, Western Governors formed the WGA Invasive Species Advisory Group, which provides technical assistance to inform our work on this critical issue. In the last year, the Association conducted the WGA Invasive Species Data Management Workshop, which produced new regional guidance for the interagency exchange of invasive species occurrence data. In 2018, WGA published a compendium of the *Top 50 Invasive Species in the West*, a first-of-its-kind regional invasive species prioritization tool. And we continue to work collaboratively with the Department of the Interior to combat the spread of invasive quagga and zebra mussels in the West.

The *Western Governors' Biosecurity and Invasive Species Initiative* represents an even greater commitment of resources and attention to this issue and these ongoing efforts. This report – which communicates specific recommendations and distills information generated by Initiative workshops, webinars and other channels – will help guide WGA's work on invasive species for years to come.

Thank you for your consideration of the report's findings and for your interest in the work of Western Governors.

Appreciatively,



*Jim Ogsbury*

Jim Ogsbury  
WGA Executive Director



## EXECUTIVE SUMMARY

The spread of invasive and non-native species affects nearly every aspect of life in the West. As invading species replace native plants and wildlife, the ecosystems, economies and communities that depend on the West's natural resources are damaged and diminished, sometimes permanently. Improving biosecurity and invasive species management practices is essential to protecting the West from new invading species, reducing the effects of established species, and restoring the region's working lands and native ecosystems.

Hawai'i Governor David Ige, Chair of the Western Governors' Association, launched the *Biosecurity and Invasive Species Initiative* in July 2018 in response to this challenge. The Initiative focuses on the impacts that nuisance species, pests and pathogens have on ecosystems, forests, rangelands, watersheds and infrastructure in the West, and examines the role that biosecurity plays in addressing these risks.

The *Biosecurity and Invasive Species Initiative* commenced with an exploration of these issues through workshops hosted by Western Governors **Brian Sandoval** in Nevada, **Matt Mead** in Wyoming, **Steve Bullock** in Montana, and **David Ige** in Hawai'i. The workshops, which were livestreamed to reach the widest possible audience, assembled leaders in biosecurity and invasive species management to discuss the challenges that invasive species pose to the West and identify opportunities for Western Governors to address those challenges.

The workshops were followed by webinars that examined discrete issues surrounding invasive species management and control. Webinars examined several topics, including the effects of invasive species on fisheries, the role of conservation districts in invasive species management, and impacts of invasive species on Pacific Islands forests and ecosystems.

This report presents the findings of the Initiative and recommends actions Governors can take to achieve the following goals:



Hawai'i Governor David Ige launched the *Biosecurity and Invasive Species Initiative* as his central policy effort as WGA Chair.

**Protect the West from the introduction of new invasive species through enhanced biosecurity practices, preparedness, and planning.** State and federal agencies should develop state and regional level biosecurity plans and utilize new and emerging biosecurity technologies. A regional biocontrol research center should be established, and interagency collaboration on biocontrol research, permitting, and utilization should be improved and streamlined.

**Improve cross-boundary collaboration and coordination for the management of established and emerging invasive species.** State, federal and local agencies should strengthen existing invasive species coordination mechanisms and build new collaborative structures to

improve invasive species management at a regional scale, including a new Western Invasive Species Council. Rapid response practices can be enhanced by expanding the use of the Incident Command System, conducting regular practice exercises, and establishing a federal center dedicated to biosecurity and invasive species management.

**Empower state and federal agencies to manage invasive species by aligning federal laws, regulations, and funding mechanisms with states' needs.** State and federal agencies should have the funding and authorities necessary to effectively manage established and emerging species. Federal statutes and regulations should be structured to provide states greater flexibility with



respect to invasive species funding, permitting, and rapid response. Federal regulations should reflect the broad diversity of habitat types and uses in the West. Where necessary, federal law should make provisions to effectively protect all states, whether their habitats include arctic tundra, rangeland, or tropical forests.

**Support and utilize biosecurity research, technology and planning tools.** Research and innovation are essential components of invasive species management in the West. State and federal agencies should identify and seize opportunities to pool research funds, coordinate the employment of new technology, and develop new monitoring, analytical, and decision-making tools. Enhanced use of electronic manifesting for commodity shipments, detector dogs, in-water vessel cleaning, and other tools can increase our effectiveness in mitigating invasive species impacts.

**Standardize and mobilize invasive species data.** Invasive species managers need access to accurate regional invasive species occurrence data to address invasive species at a landscape scale. However, technological barriers often prevent large amounts of useful invasive species occurrence data from being shared. As part of the Initiative, Western Governors will lead an effort to improve the mechanisms by which interagency invasive species data are standardized, stored and exchanged in the West.

The *Western Governors' Biosecurity and Invasive Species Initiative* has provided a valuable regional forum to examine one of the most pressing natural resource issues in the West. The following report describes WGA's invasive species work in greater detail and will guide the Association's ongoing efforts.

Initiative workshops were hosted by, from top, Western Governors Brian Sandoval of Nevada, Matt Mead of Wyoming and Steve Bullock of Montana.





## BACKGROUND

The effects of invasive species on life in the West are as broad and diverse as the region itself. Nearly every acre of land and body of water is either host to an invading pest or pathogen or at risk of being invaded. The impacts of these invaders are sometimes easily overlooked; at other times they are clear, inescapable and devastating. Invasive species cause substantial cumulative harm to the West's natural and built environments, as well as to the communities and economies that depend upon those environments.

Global economic losses caused by biological invaders were estimated at more than \$1.4 trillion as far back as 2002.<sup>1</sup> Another study highlighted that, in the U.S., nearly 50,000 foreign species were responsible for \$120 billion in major environmental damages and losses annually.<sup>2</sup> This estimate represents economic losses from environmental damages only; it does not capture substantial control costs or public health impacts. As much as one-fourth of the U.S. agricultural gross national product is lost due to foreign pests<sup>3</sup> and as much as 42 percent of the species on threatened or endangered species lists are at risk primarily because of alien invasive species.<sup>4</sup>

These estimates, however, may not fully reflect the toll of invasive species. Quantifying the effects of invasive species can be challenging because of the complexities of modern economies and the difficulty of monetizing biodiversity and ecosystem service benefits. Not only do invasive species impact local resources, they can combine with other environmental stressors, such as drought or climate change, to further

diminish native ecosystems. These factors contribute to a lack of up-to-date regional-level economic impact studies and risk assessments, an information gap that can hamper land managers' ability to incorporate invasive species impacts into management decisions.

Some invasive species infestations have grown to such an extent that they fundamentally change the landscape. For more than a century, for example, invasive cheatgrass has spread throughout the West. It is now present in every western state and, in some places, has permanently altered ecosystems. As little as one percent of cheatgrass groundcover can double the wildfire risk in an area; by some estimates cheatgrass covers more than 15 percent of the ground in 31 percent of the Great Basin.<sup>5</sup> These conditions contributed to the 2018 Martin Fire, which, at more than 435,000 acres, was the largest wildfire in Nevada's history. In addition to increasing wildfire risk, cheatgrass reduces forage, outcompetes native vegetation, and diminishes habitat for native wildlife, including the greater sage-grouse. In Hawai'i, watershed forests are threatened

by plants including Himalayan ginger, strawberry guava, and miconia. Miconia alone is estimated to cause roughly \$700M in damage annually to Hawai'i's forests.<sup>6</sup>

Aquatic invasive species, such as quagga and zebra mussels, can pose similar landscape-level threats. These invasive mussels arrived in North America in the 1980s, and have since spread to nearly every major waterway in the U.S. They have caused substantial damage to water delivery systems, hydroelectric facilities, agriculture, recreational boating and fishing, and native wildlife. Once established in a waterbody the mussels are expensive to control and virtually impossible to eradicate. The damage to North American power plants and municipal drinking water systems can reach as high as \$1 billion per year.<sup>7</sup> If the mussels spread to the Columbia River Basin — the last major uninfested water system in the continental U.S. — the control costs in the Basin alone could reach \$500 million annually.<sup>8</sup>

Many other pests and pathogens continue to harm western communities.





A shoe encrusted with invasive mussels vividly illustrates the impact of the rapidly spreading invasive species.

Since it first emerged in the U.S. in 1999, West Nile virus has infected at least 17,737 people and caused 1,654 deaths.<sup>7</sup> Chronic wasting disease, an emerging infectious disease that is fatal to free-ranging and captive deer and elk, has been discovered in 24 states and continues to spread.<sup>10</sup> In Hawai'i, invasive fungal pathogens are resulting in Rapid 'Ōhi'a Death, a vast die-off of endemic 'Ōhi'a trees that are crucial to Hawai'i's ecosystems and culture. The emerald ash borer has killed hundreds of millions of ash trees in North America and has caused lasting damage to native and urban forests since 2002.<sup>11</sup> In Guam, the coconut rhinoceros beetle caused the native fadang tree, once the most abundant tree in Guam's forest, to be placed on the endangered species list in 2015.<sup>12</sup> The beetle was detected in Hawai'i in 2013 in the area around Pearl Harbor and has been contained to that area thus far. The beetle is now threatening the native coconut palm, a tree central to the environment, economy, and culture of Guam, Hawai'i and other Pacific Islands.

This short list is merely illustrative of the harm that invasive species are causing in the region.

In the West, biosecurity and invasive species management are the responsibility of a large network of state and federal agencies, as well as stakeholders that include industry, non-profit organizations and conservation groups, private landowners and private citizens. Each of these entities operates under a different set of laws, regulations, and authorities. Their capacities vary, as do their incentives, interests and objectives. Such a diverse network offers opportunities to implement creative and flexible biosecurity and invasive species management practices, but its decentralized nature creates challenges in developing and implementing sophisticated regional management strategies.

It is with these challenges in mind that WGA Chairman Hawai'i Governor **David Ige** launched the *Biosecurity and Invasive Species Initiative*. Hawai'i

is often called "the invasive species capital of the world," not only because of the threats that invasive species pose to its native ecosystems, but also due to the groundbreaking and innovative work the state is undertaking to confront these threats. With the Initiative, WGA has drawn on Hawai'i's experience and harnessed Western Governors' unique ability to assemble state and federal experts and a broad group of stakeholders to foster a bipartisan dialogue to improve regional coordination and collaboration to protect the West from invasive species.

Through workshops, webinars, surveys and ongoing dialogue with stakeholders, Western Governors have made genuine progress on this formidable challenge. The Initiative has produced a new set of recommendations, best practices, technical tools, and collaborative frameworks to confront this pressing environmental issue and help preserve the West's natural heritage and resource economies for generations to come.



## FINDINGS AND RECOMMENDATIONS

The *Western Governors' Biosecurity and Invasive Species Initiative* assembled a wide variety of stakeholders over the past year to find new solutions to one of the oldest and most challenging environmental issues in the West. Surveys, workshops and a webinar series elicited a diverse set of perspectives from federal, state, local and tribal governments, researchers, higher education, industry, non-governmental organizations (NGOs) and conservation groups, private landowners and citizens.

The comments, perspectives and opinions expressed by these stakeholders have been synthesized into these findings and recommendations, which are organized into key recommendations. Each recommendation includes steps that Governors, Congress, federal agencies, and regional coordinating groups might take to improve biosecurity and invasive species management practices in the West. Also included are case studies highlighting specific invasive species and their associated management challenges and opportunities.

### RECOMMENDATION:

#### Protect the West from the introduction of new invasive species through enhanced biosecurity practices, preparedness and planning.

Biosecurity is the most cost-effective method of invasive species control. Stopping new invading species before they are introduced not only prevents any impacts on economic activities, it also protects natural resources and human health. Federal, state, tribal and local agencies, as well as industry and private landowners, work diligently throughout the West to prevent the introduction of new invasive species. While many of these biosecurity programs work effectively, there is often a lack of communication between state, federal, and local program managers, as well as a lack of regional interagency coordination. Biosecurity managers in the West should develop state and regional biosecurity plans, improve coordination and increase collaborative funding on biosecurity and biocontrol research projects, and increase the development and implementation of new biosecurity technologies.

#### Biosecurity

The set of measures taken to manage the risk from invasive species to economies, environments, and health and quality of life for citizens.

**Improve regional biosecurity planning.** In January 2017, the Hawai'i Invasive Species Council adopted the Hawai'i Interagency Biosecurity Plan: 2017-2027. This plan provides state agencies in Hawai'i with a coordinated path forward to increase support for local agriculture, protect the state's environment, and provide safeguards for the health and lifestyle of Hawai'i's people.

Other western states should consider following the Hawai'i model by developing state-level biosecurity plans. These plans could be used as the foundation to develop a first-of-its-kind biosecurity plan for the western region. Such a plan could help further prevent movement of invasive species by standardizing and regularizing biosecurity practices between state, federal and local governments in the West.

**Increase international collaboration.** The Initiative demonstrated that effective communication and collaboration of biosecurity and invasive species

management across administrative boundaries is an evolving process. Cross-boundary communication presents a challenge to federal, state and local agencies, but the challenge is even greater for international collaboration to address invasive species.

State and federal agencies should examine how they collaborate internationally on biosecurity and invasive species management issues and, when possible, consider developing formal and enduring agreements and communication structures with other countries. Improved international coordination on biosecurity and invasive species management has the potential to increase the effectiveness of monitoring, early detection and rapid response, and control and eradication programs.

**Create regional reciprocity between states for U.S. Department of Agriculture (USDA) baggage inspections.** USDA regulation of interstate movement of airline baggage is focused on the protection of agricultural industries in the contiguous United States. This is particularly evident in Hawai'i, where baggage destined for the U.S. mainland is subject to federal inspection, while baggage moving from the mainland to Hawai'i is not. Agricultural industries in the Pacific Islands need to be similarly



## WORKSHOP

### The Prevention, Control, and Management of Established Species

Lake Tahoe, Nevada (Sept. 17-18, 2018)

The *Biosecurity and Invasive Species Initiative* workshop series kicked off on the shores of Lake Tahoe in Stateline, Nevada. The workshop focused on cross-boundary collaboration and efforts to control, manage, and eradicate established invasive species in Lake Tahoe and throughout the region.

Nevada Governor Brian Sandoval delivered a keynote in which he reminded the audience of what is at stake in the fight against invasive species, asserting that "invasive species impact nearly every economic sector that depends upon western working lands, and by doing so they can interrupt the very social fabric of the West." The Governor added that "invasive species are an underlying cause of many challenges in the West, including the record 2018 wildfire in Nevada that swept across 439,000 acres, in many cases fueled by invasive cheatgrass. That area will now be an area where invasive species will flourish again."

WGA Executive Director Jim Ogsbury also



Nevada Gov. Brian Sandoval noted in his keynote that invasive species "can interrupt the very social fabric of the West."

spoke and highlighted how "Western Governors are using their convening power and energy to confront the scourge of invasive species. The impacts of invasive species in the West are as pervasive as they are underreported."

The keynotes were augmented by a series of roundtables over two days moderated by California Secretary for Natural

Resources John Laird. Panelists from state and federal agencies, nonprofits, industry, and academia discussed issues such as: the relationship between invasive species, wildfire, and vegetation management; the economic impacts of invasive species and tourism; and the implementation of new research and technology in invasive species management.

protected from the risk of interstate movement of invasive species. USDA quarantines and airline baggage inspections should incorporate the priorities of non-contiguous states and territorial islands in the western region. This includes maintaining federal quarantines on pests (such as the emerald ash borer) that have not yet reached the West, and adopting policies that adequately protect Pacific states and territories, such as inspection of baggage moving from the contiguous U.S. to non-contiguous areas.

#### **Increase use of innovative biosecurity prevention and detection programs.**

Western states should invest in tools and technology that increase the likelihood

of interception and bolster the efforts of limited personnel. The use of electronic manifesting for imported goods allows agricultural inspectors to focus on those commodities designated as high-risk for carrying invasive species. Similarly, the use of detection dogs can greatly enhance interdiction efforts. A pre-departure detection dog program for brown tree snakes on Guam, managed by USDA Wildlife Services, has saved Hawai'i and the mainland U.S. billions of dollars in damages and can serve as a model for the interdiction of other invasive species.

#### **Enhance regional biocontrol coordination.**

Biological control (biocontrol) can be an important component of invasive species control

**Biological Control** (biocontrol) is the reduction of pest populations by natural enemies (predators, parasites or diseases).

and integrated pest management strategies. Effective biological control is only possible through thorough and deliberate research, as well as effective interstate and federal-state communication and collaboration. Federal decisions related to the use of biocontrol should only be made after federal agencies engage in substantive consultation with implementing state agencies. The effectiveness and utilization of this important management tool could be improved by:



▪ **Creating a regional biocontrol research center:** For invasive species that have established beyond land managers' ability to conduct manual removal, biological control represents the most cost-effective, and often only, option for large-scale mitigation of invasive species. Invasive species do not recognize state boundaries, and neither should research and control efforts. Invasive species managers in the West would benefit from the creation of a new, state-of-the-art biological control facility, as well as a collaborative, multi-agency plan for maintaining and staffing new biocontrol facilities at a level that more adequately meets the expanding needs of the region.

▪ **Establishing an interagency working group to improve coordination and increase information exchange for biocontrol research, permitting and utilization.** As part of the Western Invasive Species Council (see below), Western Governors will convene a working group to explore the status of biological control research, permitting and utilization in the West. This working group comprised of representatives from state and federal agencies, academia, and private industry will examine how stakeholders can better work together to promote the development and utilization of safe and effective biocontrol methods. The working group will also examine how biological control actions are permitted by federal agencies and how states can exercise a more active role in permitting decisions.

**RECOMMENDATION:**

**Improve cross-boundary collaboration and coordination for the management of established and emerging invasive species in the West.**

The management of emerging and established invasive species is conducted

**Executive Order 13112** invasive species" means "with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health. States may have different definitions, as well as regulatory and nonregulatory terms that are related to but not synonymous with the term, including pests, noxious weeds and injurious wildlife.

by a large network of public agencies, industry, private entities and NGOs. These entities often work to manage, control or eradicate invasive species for the benefit of specific resources such as wildlife, grazing, water, or hazardous fuel reduction. Many invasive species managers are also restricted, either by statute or by habit, to only implementing invasive species management at the level of their districts, management units, or specific area of geographic responsibility.

Invasive species are often not viewed as the cross-cutting, interdisciplinary resource threat that they truly are. States, federal agencies, regional coordinating groups, and local invasive species managers should manage invasive species at a regional level by improving formal invasive species management coordination mechanisms and developing new and innovative ways to address key aquatic and terrestrial species. They also should utilize existing innovative tools for cross boundary management, such as Good Neighbor Authority and the Incident Command System.

State and federal invasive species managers would benefit from the creation of new coordination mechanisms for invasive species policy development, as well as the planning, implementation, and monitoring of regional management actions. To this end, the following coordination instruments should be created:

**Western Invasive Species Council: State**

Invasive species councils and invasive plant councils provide policy level direction, planning and coordination for state-level biosecurity and invasive species prevention and management actions in the West. Councils are led by state agencies, non-profit organizations, industry, private landowners, and public-private partnerships. These groups empower those engaged in the prevention, detection, and eradication of invasive species, and serve as forums for invasive species education, communication, and strategic planning. Invasive species councils collaborate on regional-level issues and benefit from mechanisms that help coordinate and solve cross-boundary, cross-jurisdictional challenges.

Western Governors support the creation of a **Western Invasive Species Council (WISC)** to enhance coordination among existing state invasive species councils, improve communication and collaboration on regional biosecurity and invasive species control efforts, and to advocate for regional needs at the federal level. The Council should initially be coordinated through the WGA and work to address cross-boundary and cross-jurisdictional challenges identified through the Initiative.

**A National Biosecurity and Invasive Species Management Center to streamline and centralize federal invasive species management:**

Throughout the Initiative, stakeholders often compared the threats posed by invasive species to the threats posed by wildfire. Like wildfire, invasive species move rapidly once established, can have devastating effects on landscapes and communities, negatively affect public health, and require a sophisticated response from a wide variety of federal, state and local agencies. Although invasive species present a landscape-level threat comparable to wildfire in terms of scope, scale and economic impact, federal coordination mechanisms for biosecurity and invasive species management receive only a fraction





## WORKSHOP

### WGA Working Lands Roundtable: Invasive Species and Restoration

Cheyenne, Wyoming (Oct. 11-12, 2018)

The Initiative's second workshop was conducted as part of WGA's Working Lands Roundtable, an effort to examine crosscutting policy issues and engage a broad coalition of stakeholders to advance WGA Chair Initiatives and other policy priorities. The focus of the event in Cheyenne, Wyoming was on efforts to restore western lands after invasive species infestations have been controlled and eradicated.

In his opening remarks, Wyoming Governor Matt Mead encouraged participants to work within the WGA framework, which "is sincere about finding solutions and doing it in a bipartisan way." He reminded attendees "you are sitting here today involved in a process that will work through the Western Governors and have potential for change in Congress. Time here is well spent because it can make a difference. This is a place where answers can be found. This is not a place where bipartisanship is just a talking point."

USDA Under Secretary for Natural Resources and Environment Jim Hubbard participated in a panel on Restoration Challenges in Fire-affected Landscapes.



The Working Lands Roundtable attracted regional experts such as Bob Budd of the Wyoming Wildlife and Natural Resource Trust.

Hubbard observed how collaboration with states is a central component of the new USDA Shared Stewardship Initiative. "The Shared Stewardship notion is that the Forest Service is going to sit down with states through Governors' offices and see what our shared priorities are." The goal "is to have a discussion about where to make investments and, as much as possible, have mutual priorities" for active

management of western forests and rangelands.

The event also included a discussion on best practices and policy tools to help restore native western ecosystems and working lands after invasive species infestations. Additional panels examined rangeland restoration, post-fire restoration, and livestock and wildlife disease management.

of the federal funding of wildfire coordination.

The National Interagency Fire Center (NIFC) in Boise, Idaho, coordinates wildfire response throughout the U.S. Through NIFC, federal, state and local agencies develop regional wildfire preparedness strategies, coordinate wildfire response actions, and pool intelligence gathering and predictive services.

To improve national interagency communication and collaboration on biosecurity and invasive species

management, a National Interagency Biosecurity and Invasive Species Management Center should be created on the model of NIFC. Such a center should act as a nerve center for coordinating invasive species prevention, early detection and rapid response, and eradication efforts. The center should house representatives from all relevant federal land management agencies, as well as interested states, local, and tribal agency representatives.

**Develop new approaches to regional species.** The spread of cheatgrass

and other invasive annual grasses has become a critical threat to healthy western rangelands. These invaders fuel uncharacteristic wildfire, harm watersheds, outcompete native vegetation, and diminish wildlife habitat on a large scale. Similarly, invasive quagga and zebra mussels fundamentally alter infested waterbodies, diminishing water quality and quantity, imperiling native species, and driving up the cost of boating, irrigation and hydroelectric power generation. As an outcome of this initiative, WGA will work with the Western Invasive Species Council to:



• **Work with state, federal and private entities to identify and implement cross-boundary projects to control invasive annual grasses at a regional level.** Such projects should include those using alternative management techniques such as outcome-based grazing.

• **Continue efforts to improve the interagency management of invasive quagga and zebra mussels in the West by hosting a WGA Invasive Mussels Leadership Forum.** The goal of the forum will be to collectively determine common interagency priorities for the prevention and containment of invasive mussels in the West and identify a shared interagency strategy to address these priorities.

#### **Utilize and expand the Incident Command System.**

The Incident Command System (ICS) can be a powerful tool for rapid response to new invasive species introductions. Federal, state and local agencies have increasingly been using ICS for rapid response efforts. Utilization of the system could be improved by the following practices:

• **Increasing state, federal and local interagency preparedness training exercises.** The effective use of ICS depends upon practice and preparedness training by emergency responders in advance of incidents. State, federal, local and tribal agencies can opt to practice and implement the ICS as part of rapid response and strive to prepare for these responses through increased interagency training and preparedness exercises.

• **Creating an aquatic invasive species (AIS) ICS module.** To improve and standardize interagency response to new invasive species introductions, the Federal Emergency Management Agency (FEMA) should work with states to develop a new ICS training module for AIS rapid response.

**Identify and expand use of Good Neighbor Authority.** Good Neighbor Authority (GNA) allows states to enter into cooperative agreements with certain



Hawai'i Gov. David Ige described his state's battle against invasive species as not only the "right thing" to do but work that makes "economic sense."

federal agencies permitting them to perform various land management activities on federal lands. These tools have been successfully used by forest and rangeland managers to achieve various management objectives across federal, state and local government, and privately-owned lands. State and federal invasive species managers should learn from these successes and consider using GNA for cross-boundary collaborative invasive species control, management and eradication programs.

**Utilize effective partnerships.** Regional interagency stakeholder groups are key to the success of biosecurity and invasive species management in the West. When possible, policy-makers and invasive species managers should rely on these groups' expertise and collaborative frameworks.

#### **RECOMMENDATION:**

**Empower state and federal agencies to manage invasive species.**

State and local agencies – including conservation districts, collaborative weed

management areas, and collaborative invasive species management areas – are key players in the fight against invasive species. These institutions are the tip of the invasive species response spear, providing the resources, local expertise, and on-the-ground results necessary to control the spread of invasive species in the West. These agencies not only manage invasive species on lands and waters under their own jurisdiction, but also often provide direct and indirect support to federal invasive species management programs.

Whenever possible, Congress and the Executive Branch should support the efforts of state and local groups. Federal agencies should recognize the role these groups play in protecting federal resources, and federal funding mechanisms should be structured so that these groups have sustainable, predictable and flexible long-term funding for invasive species management actions. Congress and the Executive Branch should engage in early and substantive consultation on biosecurity and invasive species management decisions that affect state resources.



## WORKSHOP

### Early Detection and Rapid Response

Helena, Montana (Nov. 14, 2018)

The third Initiative workshop focused on efforts to monitor for the introduction of new invasive species and rapidly respond once new infestations are detected. Panels at the event in Helena, Montana, moderated by Invasive Species Action Network Executive Director Leah Elwell, also examined topics like regional collaborative groups for invasive mussel containment, international coordination on feral swine management, and the use of emerging environmental DNA technologies.

In his keynote, Montana Governor Steve Bullock identified invasive species and their associated impacts as one of the “great environmental and economic threats to western landscapes.”

“This is not a local problem, but a global problem, one that can impact virtually every facet of natural resource management,” said Gov. Bullock. “Fortunately, I think that view is starting to change and it’s one that we can continue to broaden through WGA. Land managers, policy makers, and the general public are really working to discuss the broad implications of invasive species on the western landscape.”



Rayola Jacobsen took part in the Montana workshop, which included a focus on rapid respond to new infestations.

WGA Executive Director Jim Ogsbury opened the workshop by saying “we are here to drive towards affirmative, positive action. We are here to devise and lay the groundwork for implementation of on-the-ground solutions to the scourge of

invasive species in the West. Because, as we have seen time and again, no one is more capable than Western Governors to approach land management challenges in a methodical, practical, effective and bipartisan way.”

**Examples of effective collaborative and cooperative invasive species management programs include:** the National Fish and Wildlife Foundation's Pulling Together Initiative; the Natural Resources Conservation Service's Working Lands for Wildlife Program; the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program; and interagency collaborative programs under the U.S. Forest Service (USFS) State and Private Forestry Program.

Federal agencies should also be provided with the full suite of authorities necessary to control and contain the movement of invasive species in lands and waters under their jurisdiction.

**Provide necessary federal authorities.** The containment of invasive quagga and zebra mussels at infested waters in the West depends on the mutual effort of federal, state and local agencies. Many state-led containment programs benefit from federal cooperation and funding; state and federal agencies should be encouraged to sustain and expand these effective partnerships. However, to adequately protect the West from the

movement of aquatic invasive species, federal agencies must act as full partners in invasive species containment efforts and have the funding and authorities necessary to contain invasive species within lands and waters under their jurisdiction. To this end, federal agencies, including the National Park Service and the Bureau of Land Management, should be vested with clear authority to manage watercraft upon their departure from infested waterbodies under federal jurisdiction.

**Consult with states on biosecurity decisions.** Congress and federal agencies must ensure early and substantive



consultation with states regarding biosecurity and invasive species management decisions that affect state resources, including:

- Federal pest quarantine decisions can affect state ecosystems, economies and public health. USDA's Animal and Plant Health Inspection Service should consider effects on state resources and strive to engage with states in early and substantive consultation when making pest quarantine decisions.
- State and local agencies are leaders in on-the-ground biosecurity and invasive species management. Federal funding, cooperative agreements, grants, and procurement contracts for state and local biosecurity and invasive species management should be structured in a deliberate and transparent way that provides for the greatest amount of flexibility and long-term planning.

**Review federal biosecurity and invasive species statutes.** Federal, state and local invasive species managers need federal laws that support on-the-ground action to prevent, contain and control invasive species. Western Governors encourage the Western Invasive Species Council to lead a state review of federal biosecurity and invasive species statutes — including the Lacey Act, the National Invasive Species Act, and the Nonindigenous Aquatic Nuisance Prevention and Control Act — to evaluate how they support on-the-ground management, identify gaps in their application, and ensure their structure and implementation addresses 21st century biosecurity and invasive species challenges. Of particular interest: opportunities to expand the taxonomic scope of the Lacey Act to benefit U.S. biosecurity.

**Utilize cooperative agreements.**

Cooperative agreements, grants and procurement contracts between federal agencies and state and local invasive species management authorities establish structured partnerships for collaborative invasive species management. Cooperative agreements lessen the burden on local federal land managers, while increasing the efficiency of invasive species



Springer Kaye of the Big Island Invasive Species Committee makes a point during a panel on Integrated Pest Management.

management programs and enabling local collaborative goal setting. Additionally, these agreements simplify project-based contracting by using the authorities of state and local government agencies. This can be extremely useful where infestations extend across multiple landownerships or the management objective is early detection and rapid response.

Federal agencies should be encouraged to expand the use of cooperative agreements with state and local governments and ensure that they are approved in a timely manner and in collaboration with implementing agencies. Federal agencies can also support invasive species management efforts by encouraging contract recipients to coordinate with state and local invasive species management agencies, regulatory programs, and cooperative weed and invasive species management areas.

**Provide collaborative and flexible**

**funding.** Formal and informal collaborative efforts involving federal, state, local and tribal governments, researchers, higher education, industry, NGOs, conservation groups, and private landowners are a source of place-based expertise and responsive invasive species management actions. Invasive species managers should participate in

The Bureau of Reclamation defines **environmental DNA (eDNA)** as "DNA present in an environmental sample, as differentiated from traditional sampling of DNA directly from an intact organism. eDNA frequently is thought of as DNA in tissue and cells that have been shed by an organism but can also refer to DNA within an intact organism (usually microscopic), if that organism is collected in the environmental sample. For eDNA analysis, samples are collected from the environment and DNA is then extracted from the full sample or some fraction of it.

eDNA assays allow surveillance for the presence of an organism in an environment without having to collect the whole organism itself... Because the purified eDNA is a mixture representing multiple species and individuals present in the environment, this technique can be used to detect a wide range of organisms, including those that are endangered or invasive, and be used for both research and monitoring purposes." (source: <https://www.usbr.gov/mussels/docs/eDNA.pdf>)



## WORKSHOP

### Biosecurity and Agriculture

Kohala Coast, Hawai'i (Dec. 9-10, 2018)

The Initiative's final workshop was held on the Kohala Coast of Hawai'i. The event began with a field trip to the Pu'u Wa'awa'a Forest Reserve, where participants learned about the detrimental impacts that invasive species have on watersheds as well as some of the ways that the Hawai'i Department of Lands and Natural Resource is reducing those impacts through invasive species removal, hazard fuel control, and native tree planting.

Hawai'i Gov. David Ige opened the workshop the next day by highlighting his state's significant work to battle invasive species as not only the "right thing," but work that makes "economic sense."

The Governor observed that "too often, we focus on managing and eradicating invasive species once they are established. However, it is more effective and cost-efficient to prevent these harmful invaders from entering our lands in the first place. That is why enhancing border biosecurity is a key component to invasive species management."

Panelists then participated in a discussion of pressing issues related to biosecurity and invasive species



Jules Kuo of the Hawai'i Department of Natural Resources took part in the panel "Pre-Border Detection and Prevention Strategies."

management in agriculture, with panels on pre-border prevention and detection strategies, the economic impacts of invasive species on agriculture, and the use of biocontrols.

Moderator John Laird, California Secretary for Natural Resources, offered closing remarks reflecting on the Initiative workshop series. "One goal of the workshops has been to broaden the

conversation about invasive species, their impacts, and the work being done to prevent their movement. By that measure, I feel that these workshops have been an outstanding success. Laird added:

"The work of preventing, controlling, and eradicating invasive species will never end, and neither will the work of improving the way that agencies collaborate to address these risks."

inter-agency programs and collaborations that include private landowners and implement cross-boundary biosecurity invasive species management actions. Congress and the Executive Branch should support these programs and ensure that they benefit from long-term, stable and flexible funding that bolsters state, local and private invasive species management efforts.

**Coordinate state and federal aquatic invasive species inspection, decontamination and quarantine programs.** Aquatic invasive species

coordination groups have worked with the National Sea Grant Law Center (See Page 16) to develop a set of best practices for aquatic invasive species containment. These efforts have improved interagency communication and coordination on such containment in the West. Federal agencies should work to promote and implement these best practices in invasive species response efforts.

**Support state-led rapid response programs.** Prevention and containment are the most effective methods to

control the spread of invasive species, particularly invasive quagga and zebra mussels. Once a species is no longer contained, however, state-led rapid response programs represent key efforts to control their spread. Congress and the Executive Branch can support state-led rapid response programs by taking the following steps:

- Increasing federal funding for state-led aquatic invasive species rapid response programs, including those that provide for flexible, long-term support of state early detection rapid response efforts;





## CASE STUDY

## National Sea Grant Law Center

The National Sea Grant Law Center at the University of Mississippi School of Law is a nationally-recognized resource for information on aquatic invasive species (AIS) laws and policies. The Law Center has undertaken extensive research on ballast water management in the Great Lakes and published articles related to genetic biocontrol of invasive species and the impact of climate change on marine invasions.

The Law Center began conducting dreissenid mussel law and policy work in 2012. That year, Oregon Sea Grant, in partnership with the Law Center, U.S. Fish and Wildlife Service, and the Western Regional Panel on Aquatic Nuisance Species, secured funding from the National Sea Grant College Program to support a "Collaborative Learning Workshop for Assistant Attorneys General, Aquatic Invasive Species Coordinators, and Law Enforcement Officials" in Phoenix, Arizona.

To enhance collaborative learning during the Phoenix workshop, and to answer questions state agencies and AIS Coordinators had about authorities for watercraft inspections, decontaminations and quarantine, a team of Law Center staff and law students identified key legal issues that needed to be addressed in the region. Background papers were drafted for workshop attendees, which were further developed into five articles published in the *Arizona Journal of Environmental Law and Policy*. The law review articles covered a range of topics including the Lacey Act, 4th Amendment search and seizure issues, and state privacy laws.

Following the Phoenix workshop, the Law Center, in collaboration with the Association of Fish and Wildlife Agencies

(AFWA), led efforts to develop a model legal framework for watercraft inspection and decontamination (WID) programs. In April 2014, the Law Center and the AFWA released "Preventing the Spread of Aquatic Invasive Species by Recreational Boats: Model Legislative Provisions & Guidance to Promote Reciprocity among State Watercraft Inspection and Decontamination Programs." The "Model Regulation for State Watercraft and Inspection Programs" was released in December 2016 and the "Model Memorandum of Understanding [MOU] for Watercraft Inspection and Decontamination Programs" in December 2018. With the publication of the Model MOU, policymakers and regulators now have access to a model legal framework identifying model WID provisions from legislation through implementation.

To assist state natural resource managers and policy-makers in identifying commonalities, differences, and gaps among states, the Law Center undertook a review of each state's WID laws and regulations to see how each state's program compared to the authorities set forth in the Model State Legislative Provisions and Model Regulation. This companion report, updated in December 2018, contains a summary of the Law Center findings for all 50 states and detailed state-by-state comparisons

for the 19 states with WID programs. This analysis has provided crucial information in support of state legal reform efforts to address identified gaps. In 2017, for example, 12 states and the Tahoe Regional Planning Commission engaged in legal reform efforts related to their WID programs.

To support this policy work, the Law Center conducts extensive legal research and provides technical assistance to western state partners. The Law Center maintains a compilation of AIS laws and regulations relevant to WID programs in the western United States. The Law Center prepares summary documents to inform legal reform efforts upon request. For example, in July 2016, the Law Center prepared a memo on state "Clean, Drain, and Dry" provisions and related requirements to inform discussions of the Western Association of Fish and Wildlife Agencies (WAFWA), which subsequently led to WAFWA adopting a resolution on drain plugs and vegetation removal.

The Law Center also conducts and publishes scholarly research related to invasive species. In addition to the law review articles mentioned above, in 2016, Law Center attorneys authored a law review article entitled "Working Together to Combat Invasive Species Threats: Strategies for Facilitating Cooperation between the National Park Service and the States." This article was included in a special issue of the *Natural Resources Journal* commemorating the 50th Anniversary of the National Park Service. In 2014, the Law Center director contributed a chapter in *Climate Change Impacts on Ocean and Coastal Law: U.S. and International Perspectives* entitled "Confronting the Marine Invasive Species Threat: Practical and Legal Challenges."



- Streamlining federal permitting and approval processes for treatment and management actions for new mussel detections;
- Creating a single federal authority for aquatic invasive species treatment permitting and approval in freshwater systems;
- Simplifying reporting on new invasive mussel infestations in states by creating a single federal point of contact for new mussel detections.

**Work collaboratively with states to implement the Vessel Incidental Discharge Act.** The U.S. Coast Guard and the Environmental Protection Agency should consult with Western Governors and states on implementation of the Vessel Incidental Discharge Act to ensure aquatic resource protection needs are met across the West and the Pacific. Federal and state partners should collaborate on the development of evidence-based risk assessments and assess the efficacy of policies and tools to mitigate the impact of various discharges, including hull biofouling. Protecting marine habitats in western states and Pacific territories is best accomplished by working with states that have the greatest knowledge of their ecosystems and invasive risks.

**RECOMMENDATION:**  
**Support and utilize new biosecurity research, technology and planning tools.**

Research and technology development are essential components of biosecurity and invasive species management. Emerging technologies may lead to solutions for some of the West's most intractable challenges. By utilizing new research, technology and planning tools, invasive species managers can dramatically increase the effectiveness and cost-efficiency of invasive species management actions.

State and federal agencies can support



**WGA Executive Director Jim Ogsbury highlighted the Western Governors' collaboration to "confront the scourge of invasive species."**

biosecurity and invasive species research by encouraging invasive species workforce development, pooling research funding, and improving biocontrol information exchange. Invasive species managers can implement new research and technology by encouraging the development of modeling, risk-assessment and decision-making tools, as well as improved regional invasive species economic impact analyses.

**Improve and utilize environmental DNA monitoring.** Monitoring environmental DNA (eDNA) can be an effective tool to assess new aquatic invasive species introductions. State, federal and local agencies and regional coordinating groups should develop and implement a set of best practices for conducting eDNA monitoring and incorporating positive detection results into rapid response strategies.

**Encourage biosecurity and invasive species education and workforce development.** Effective biosecurity and invasive species management depends

on a dedicated and highly-skilled workforce. State and federal agencies should collaborate with universities to support programs essential to biosecurity and invasive species management, such as botany, zoology, plant pathology, taxonomy, and systematics.

**Take advantage of new research and technology.** Emerging research and technology can dramatically increase the efficiency and effectiveness of biosecurity and invasive species management actions. When possible, state and federal agencies should evaluate and utilize emerging technologies in areas such as remote sensing and monitoring, unmanned aircraft, use of artificial intelligence for species identification, and the use of innovative targeted grazing practices. Congress should continue to support research as a fundamental component of effective invasive species management.

**Pool research funding.** Institutions conducting research on biosecurity, biocontrol and invasive species control



methods should look for opportunities to pool funding resources and exchange information across administrative lines. By pooling resources, state, federal and private researchers can decrease redundancy and increase the efficiency of research funding. Pests and pathogens that affect wildlife at a regional scale, such as chronic wasting disease and elk hoof disease, present unique threats to western resources that would benefit from pooled resources and collaborative research efforts.

**Encourage the development and use of decision-making tools.** Biosecurity and invasive species decision-making tools help land managers examine invasive species management issues at a regional level and make sound, science-based decisions. Examples of these tools include risk-assessments, modeling programs, and prioritization tools such as the WGA Top 50 Invasive Species in the West.

Invasive species managers and policymakers should be encouraged to develop new decision-making tools, as well as build and improve upon the decision-making tools now in use. Invasive species managers should strive to incorporate regional-level, science-based decision-making tools into management decisions.

**Develop and utilize economic assessments.** The costs associated with invasive species management, both in terms of lost economic activity and control costs, are substantial but often poorly understood. Biosecurity and invasive species managers need to understand these costs in order to develop effective prevention and control strategies. Too few regional-level biosecurity and invasive species economic impact studies exist, however, and existing analyses are often too infrequently updated to reflect changing conditions.

State and federal land managers should be encouraged to develop new biosecurity and invasive species economic analysis tools and implement these tools into management decisions. When possible, state and federal

**WGA Top 50 Invasive Species in the West.** Individual states have developed invasive species risk assessments within their boundaries, but previously no such list existed for the entire western region. WGA surveyed invasive species coordinators in its member states and territories to develop the "Top 50 Invasive Species in the West, a first-ever regional prioritization tool.

agencies should pool resources to develop regional-level invasive species economic impact assessments.

**Support National Institute of Food and Agriculture programs.** The USDA National Institute of Food and Agriculture (NIFA) operates several agricultural, biosecurity and biocontrol research programs that facilitate state efforts to prevent the introduction of new invasive species. The programs are focused on detection and diagnostics, regulatory systems support, and development and deployment of new pest management systems and protection technologies.

Among these programs are the Tactical Sciences Initiative, which develops and deploys tools to protect food and agriculture production systems against threats from pests, diseases, contaminants and disasters. Congress and the Executive Branch should continue to support and expand needed research on biosecurity and invasive species, including work accomplished under NIFA such as the Tactical Sciences Initiative.

#### **RECOMMENDATION:**

##### **Standardize and mobilize invasive species data**

High-quality information is essential in the fight against invasive species in the West. Land managers, conservation groups, industry and private landowners need access to accurate, up-to-date regional invasive species occurrence data. Technological barriers often

prevent large amounts of useful invasive species occurrence data from being shared. Western Governors are leading an effort to improve how interagency invasive species data is standardized, stored and exchanged in the West.

**Standardize Invasive Species Data.** On March 14-15, 2018, WGA held a workshop that focused on the interagency management and exchange of invasive species occurrence data in the West. The WGA Invasive Species Data Management Workshop in Denver, Colorado, convened 27 representatives from state and federal agencies, NGOs, industry, and other groups. The goal of the workshop was to develop a set of agreements to improve the reporting, exchange and utilization of invasive species occurrence data by state and federal agencies, invasive species data aggregators, private landowners, industry, and other stakeholders. The workshop outcomes were memorialized in the workshop's Findings and Recommendations document.

Western Governors encourage all public and private invasive species data managers to consider the findings and recommendations developed at the WGA Invasive Species Data Management Workshop, and to record, store, and exchange invasive species occurrence data using common regional standards and formats whenever possible.

**Mobilize Invasive Species Data.** As an outcome of the Initiative, Western Governors will lead a new "Invasive Species Data Mobilization Campaign" to increase the availability of invasive species occurrence data to all land managers in the West. Through the campaign, WGA will work with federal, state, local and tribal governments, researchers, higher education, industry, NGOs and conservation groups, private landowners and citizens. The goal will be to encourage stakeholders to enter data that is not recorded using a common standard or is not shared or recorded using a common data aggregating platform into existing invasive species data management platforms as described in the Findings and Recommendations document.







### WEBINAR: Biosecurity and Invasive Species Initiative Launch

WGA Chair and Hawai'i Governor David Ige highlighted the importance of invasive species management in the West and the Initiative's goals and deliverables. WGA Policy Advisor Bill Whitacre then moderated a discussion with leaders in invasive species data management that showcased the outcomes of the WGA Invasive Species Data Management Workshop, an effort to improve the interagency exchange of invasive species occurrence data in the West.

**Moderator:** Bill Whitacre, WGA Policy Advisor. **Panelists:** Chuck Barger, Associate Director for Invasive Species and Information Technology, University of Georgia; Pam Fuller, Program Leader, Nonindigenous Aquatic Species Database, USGS; Stinger Guala, Director of Biodiversity Information Serving Our Nation, USGS; Jamie Reaser, Executive Director, National Invasive Species Council; Lori Scott, Interim President & CEO, NatureServe.

#### Comments included:

"We've developed the Hawai'i Interagency Biosecurity Plan to establish a path forward to a more secure future where Hawai'i is better protected from new invasive species threats, and to better mitigate our current threats."  
Governor David Ige

"All invasive species management is local. When you start telling the story about these problems, you need to make sure that the data is available at a larger level in order to paint an accurate picture of what the problem is and what the next one might be." **Chuck Barger**

"We try to provide the national view of aquatic species: where they are, where they have been, and where they're moving. We also keep track of pathway information. We are trying to serve land managers with this information." **Pam Fuller**

"BISON (Biodiversity Information Serving Our Nation) is the place to go for a geographically and taxonomically comprehensive overview. That's why the data management piece is important to us; we're trying to do national-scale views of where the deepest problems are in invasive species." **Stinger Guala**

"There's a step beyond just sharing the data. There's a necessary collaboration around the development and open access to the decision support tools that move the data in a direction needed by decision-makers, whether in policy or land management." **Jamie Reaser**

"In building this integrated system, we're thinking about data standards not only for moving data back and forth, but moving data in a way that doesn't end up ballooning on itself."  
**Lori Scott**





### WEBINAR: Invasive Species Impacts on Fisheries

Land managers and invasive species experts discussed the impacts of invasive species on fisheries in the Pacific Northwest. Speakers from Washington highlighted the management challenges related to northern pike in the Columbia River Basin. Panelists also discussed the effects of non-native predation of salmon in Alaska.

**Moderator:** Justin Bush, Executive Coordinator with the Washington Invasive Species Council. **Panelists:** Joe Maroney, Director of Fishery and Water Resources, Kalispel Tribe of Indians; Parker Bradley, Invasive Species Research Biologist, Alaska Department of Fish & Game; Laura Robinson, Program Liaison Coordinator, Northwest Power & Conservation Council.

#### Comments included:

*"Predation of northern pike has really wide-reaching impacts. In the Columbia River Basin, over \$1 billion has been invested in salmon recovery over the last two decades. This investment and the progress made towards recovery of those species are directly threatened if northern pike continue to spread downstream of the Columbia River and they begin to prey on salmon and steelhead."* **Justin Bush**

*"Managers local to the Columbia River Basin need to be concerned about what they're going to do (about northern pike). It's better to do something now than to do something later because the costs associated will be significantly less."* **Joe Maroney**

*"We have evidence that pike specifically target salmon. When pike are introduced to a new area that also have salmon, often they will target salmonids, and when those populations become depleted or extirpated then they'll shift their diet over to other species of fish... finally they'll move on to invertebrates because that is all that is left."*

**Parker Bradley**

*"Working across jurisdictions allows for really wonderful things like coordination and collaboration, but it can also make reaching an agreement difficult. An invasive species in one state could be a game fish in another."* **Laura Robinson**

### WEBINAR: Conservation Districts and Invasive Species Management

Representatives from conservation districts in Hawai'i, Oregon and New Mexico discussed innovative, cross-boundary efforts to manage invasive species. Panelists also highlighted how Natural Resources Conservation Service (NRCS) programs and funding can facilitate invasive species management on private land.

**Moderator:** Travis Thomason, Director Pacific Islands Area, NRCS. **Panelists:** Mae Nakahata, Director, Maui County Soil and Water Conservation District; Michelle Delepine, Invasive Species Program Manager, West Multnomah Soil and Water Conservation District; Lindsey Karr, WeedWise Specialist, Clackamas Soil and Water Conservation District; Debbie Hughes, Executive Director, New Mexico Association of Conservation Districts

#### Comments included:

*"I learned from experience that if I wanted to be successful with any conservation program, whether it be federal, state, or local, it needed to be done hand-in-hand with conservation districts."*

**Travis Thomason**

*"Conservation districts help provide immediate boots on the ground who are aware of local risks. It is important to be able to take immediate action when circumstances change."*

**Mae Nakahata**

*"Garlic mustard is considered an ecosystem modifier. It has been documented to cause ecosystem imbalance where it becomes established. It is a highly elastic plant that adapts easily to different growing conditions and climate."* **Michelle Delepine**

*"Conservation district partnerships can help address gaps in management. Invasive weeds don't pay attention to property lines. Public land managers will often treat a weed only for it to be re-infested by a neighboring property on private land. Conservation districts can step in and work with private landowners to address this challenge."* **Lindsey Karr**

*"Many of the ranches we work on are checkerboard ranches of private, state and federal land. Being able to use Farm Bill funding on BLM and USFS land has made a huge difference in being able to leverage resources and form partnerships."*

**Debbie Hughes**





Coconut Rhinoceros Beetle.

#### **WEBINAR: Innovative Approaches to Addressing Forest Health & Invasive Species in the Pacific Islands**

Invasive species can have particularly devastating effects on specialized island ecosystems and economies. Panelists discussed the unique challenges related to invasive species prevention and control in the U.S. Pacific Islands.

**Moderator:** Bill Whitacre, WGA Policy Advisor. **Panelists:** Susan Cordell, Director, Institute of Pacific Islands Forestry, U.S. Forest Service; Pua Michael, Head Forester, Division of Forestry, Palau Bureau of Agriculture; DJ Sene, American Samoa Community College, Agriculture, Community and Natural Resources Division; Chelsa Muna-Brecht, Director, Guam Department of Agriculture

#### **Comments included:**

*"Many island species are highly endemic and have lost their ability to compete with invasive species. These systems are more vulnerable to invasion from the get-go. Once an invasive*

*species becomes established, it can create cascading effects system-wide."* **Susan Cordell**

*"Our congress passed a 'Green Fee,' which is a tax built into the ticket price to come to Palau. The fund helps support marine and terrestrial environments. The funds are working really well, and we are now looking at ways to expand outside of protected areas to prevent invasive species from entering sensitive areas."* **Pua Michael**

*"Increased funding would be a great help not just for more personnel, but for additional training and workshops with our sister islands and the U.S. mainland. Having other managers or researchers visit American Samoa or other islands to share knowledge and resources would help us to better tackle issues together."* **DJ Sene**

*"Our top three forest species from 2002 are now facing annihilation from the Coconut Rhinoceros Beetle and Asian Cycad Scale, two invasive species. You need to think about what losing your top three species will do to your landscape, let alone your ecosystem."* **Chelsa Muna-Brecht**



### WEBINAR: Exploring the State-APHIS Relationship

Panelists focused on how the Animal and Plant Health Inspection Service (APHIS) collaborates with western states to prevent the spread of invasive species. Participants from Hawai'i highlighted the role of state authority in regulating the movement of pests and plants and explored strategies to improve coordination between federal and state regulations. The discussion also included regulations affecting the movement of forest pests in the West.

**Moderator:** Bill Whitacre, WGA Policy Advisor. **Panelists:** Andrea Huberty, Director, Plant Health Programs, Plant Protection and Quarantine, APHIS; Rob Hauff, State Protection Forester, Hawaii Dept. of Land & Natural Resources; Jonathan Ho, Acting Manager, Plant Quarantine Branch, Hawaii Dept. of Agriculture; Bob Simpson, President, Greenwood Global Consulting.



Emerald Ash Borer.

#### Comments included:

*"Through increased conversations between states and APHIS, agencies have the opportunity to share what their capacities and challenges are in managing biosecurity and pests, and model an example for future efforts."* **Bill Whitacre**

*"Our actions need to be based on risk, and we can only implement the least drastic action that is feasible and adequate to address that risk. We want to make sure we are only stepping into states' issues when there is an extraordinary emergency in front of us."* **Andrea Huberty**

*"The preemption issue we have with the Plant Protection Act is that it requires us to act at both the state and federal level if we are going to protect Hawaii from additional invasions of this pest. Both require information to demonstrate the potential damage caused by additional introductions. This is an especially difficult issue when you're trying to protect an endemic species that only exists on a remote archipelago."*

**Rob Hauff**

*"We are preempted from inspecting foreign commerce. Hawaii has gotten a few pests that were not invasive in their native range, but upon entering Hawai'i they became a pest. The state has the ability to regulate things that aren't necessarily a pest yet, but not necessarily through the Plant Protection Act."* **Jonathan Ho**

*"From European colonization to 1930, over 300 years, America lost only two tree species to invasive species: the American Chestnut and the American Elm. Loss of the Chestnut almost decimated eastern forests. This led to near extinction of the eastern black bear, turkey, and white-tailed deer. Today, 25% of all trees greater than 1-inch in diameter have a great chance of expiring by 2027 due to invasive species. This means that over the next 50 years we are expected to lose over 20 tree species."* **Bob Simpson**

### WEBINAR: Species Distribution Modeling and Scenario Planning

Decision support tools and scenario planning strategies can help land managers plan for and react to uncertain future conditions. Panelists discussed a collaborative effort between the U.S. Geological Survey and National Park Service to develop species distribution models for high-priority invasive plants. Panelists also reported on a research project that pairs scenario planning with quantitative modeling to explore potential effects of climate scenarios and management alternatives on rangelands in South Dakota.

**Moderator:** Jeff Morissette, Science Coordinator with the National Invasive Species Council Secretariat.

**Panelists:** Terri Hogan, Invasive Plant Program Manager, National Park Service; Catherine Jarnevich, Ecologist, U.S. Geological Survey; Greg Haubrich, Noxious Weed Coordinator, Washington Department of Agriculture; and Brian Miller, Research Ecologist, U.S. Geological Survey.

#### Comments included:

*"I want to look at the issue of private, state, and federal collaboration. People focus on where their mandate mission takes them, which makes a lot of sense, but one of the opportunities that WGA brings through these webinars and future work is to leverage the work that is being done across those various jurisdictions."* **Jeff Morissette**

*"Land managers need tools to help make strategic decisions about where to focus their limited resources to best address invasive plant control."* **Terri Hogan**

*"We used modeling to create maps where cheatgrass may actually be on the landscape. The Forest Service was then able to use the maps to first get funding, and then to guide aerial herbicide application to try to control cheatgrass in the post-burn landscape."*

**Catherine Jarnevich**

*"With the 23 major invasive species in Washington, if we had let them expand to their potential, we would be looking at \$1.3 billion in losses per year and loss of up to 8,000 jobs."* **Greg Haubrich**

*"Something we're able to find with quantitative ecological modeling is being able to identify some tradeoffs. For example, having a lower density of livestock on a landscape may provide a buffer in forage for dry years, but allows for increased growth of cool-season exotic grasses."* **Brian Miller**





## STATE PROGRAMS

### Colorado

Colorado has the largest mandatory watercraft inspection and decontamination station network in the nation. The network prevents the introduction of zebra and quagga mussels, as well as other aquatic invasive species, into the nation's headwaters to protect natural resources and the critical water storage and supply infrastructure necessary for municipal, agricultural and industrial uses.

Following the detection of quagga mussels in Lake Mead more than a decade ago, Colorado quickly implemented a multi-jurisdictional network focused on halting the single largest pathway of invasive mussel spread – recreational watercraft. Education is a cornerstone of the invasive species program, but the state also requires professional inspection and decontamination of all motorized or trailered watercraft entering the state, and those that launch on high-risk waters.

Colorado's robust lake and reservoir sampling and monitoring program exceeds regional standards for early detection monitoring. While states without these kinds of networks continue to detect new invasions of zebra or quagga mussels, Colorado has remained negative for invasive mussel infestations.

The state also developed the Regional WID Data Sharing System, now the main method of communication among inspection stations and managers. The system is now performing watercraft inspection and decontamination in 10 western states, as well as for numerous local governments, national parks, and private industry. It consists of a mobile application for field personnel, a website for managers and a shared database. The system, which sends out real time alerts when infested watercraft are moving into uninfested waters, has directly resulted in more interceptions preventing new invasions.



**Zebra Mussels.** USFWS photo

Colorado has additionally provided leadership by chairing the Western Regional Panel on Aquatic Nuisance Species, the main coordinating body for western aquatic invasive species programs and is focused on the multi-state implementation of the Quagga Zebra Action Plan for Western Waters.

### Hawai'i

The State of Hawai'i adopted its first interagency biosecurity plan in 2017, presenting a comprehensive gap analysis of biosecurity policies, personnel, and infrastructure alongside a 10-year implementation plan of 147 action items to address gaps identified. The Hawai'i model takes a broad view of biosecurity, examining needs in pre-border risk mitigation, border interception, and post-border detection and response.

**Interagency Scope:** The Hawai'i Interagency Biosecurity Plan (HIBP) recognizes that dealing with invasive species is a team effort. Plan development was led by the Hawai'i Department of Agriculture (HDOA) and the Hawai'i Invasive Species

Council (HISC), with input from the Department of Land and Natural Resources (DLNR), Department of Health (DOH), University of Hawai'i (UH), Department of Transportation (DOT) and Department of Business, Economic Development, and Tourism (DBEDT). Critically, plan development included several workshops for industry representatives and members of the public, including farmers, nurseries, air and sea transportation companies, and commodity consolidators.

**Gap Analysis:** The HIBP identified a number of critical policy, infrastructure, and capacity gaps in Hawai'i, including:

- A need for new biocontrol research facilities for both pathogens and insects;
- A need for modern databases for import manifests, ballast water inspections, and data collection to inform risk assessments;
- Policy gaps regarding the regulation of biofouling on vessel hulls;
- Adequate funds and standardized policies for emergency response;



## The 2027 Hawaii Interagency Biosecurity Plan

A shared path forward



- The need for increased operating funds and staffing. While Hawai'i's economy and visitor industry rebounded from the 2008 economic downturn, staff numbers at HDOA, DOH, and other important agencies had not similarly rebounded from a reduction in force.

**Long-term Goals:** The 2027 biosecurity vision described in the HIBP would effectively protect Hawai'i's agriculture, natural resources, economy, and way of life from the risks associated with invasive species. Key components of biosecurity in 2027 include:

- New state and federal biocontrol laboratories, capable of serving regional biocontrol needs;
- Fully implemented electronic manifesting for incoming cargo, allowing for commodity and pathway risk analyses built on interception databases;
- Transitional inspection facilities to allow biosecure agricultural inspections away from busy port areas;
- State policies on ballast water and biofouling allowing for in-water cleaning and standardized reporting;
- Emergency response plans and training based on Incident Command Systems;
- Fully restored DOH Vector Control Branch, doubled capacity for agricultural inspection and pest response.



**Paper manifests for incoming cargo will soon be replaced with electronic manifesting that speeds up import while more effectively directing limited inspection resources.** (photo: HDOA)

**Progress to Date:** Agency staff provide status updates every six months on each of the 147 action items in the HIBP. By January of 2019 half of the action items in the plan had been initiated, primarily those actions that could be completed with existing staff and funding. Remaining years in the implementation window will focus on increasing staff and enhancing facilities. To date:

- DOH Vector Control Branch has been restored;
- Additional positions provided to HDOA for import risk assessments;
- Electronic manifest and import database development in final stages at HDOA;

- UH has added a number of extension agents focusing on the nursery industry;
- Funds provided for biocontrol facility planning, detector dog program restoration, and construction of ungulate exclusion fences;
- Increased funding provided to HISC for interagency project support.

The HIBP and biannual progress reports are available online at <http://dlnr.hawaii.gov/hisc/plans/hibp/>.

## Montana

The Montana Invasive Species Council (MISC) identifies and coordinates independent science advisory panels to inform state efforts based on the current status, trends, and emerging technology related to invasive species management.

Environmental DNA (eDNA) was identified as the first area for further exploration, specific to invasive dreissenid mussels. The use of eDNA to detect the presence of invasive mussel DNA in the environment holds both promise and uncertainty. eDNA technology is evolving rapidly and may in the future surpass traditional methods for efficiency and confidence. However, natural resource managers across the West have struggled with how best to utilize information provided from eDNA results in real-time management applications as well as having confidence in the method and results.

An international panel of six technical experts was assembled to evaluate the value of eDNA for dreissenid mussel early detection and provide guidance to managers regarding its use. The panel also responded to questions related to the state of the science, sampling in the field, lab analysis, interpreting results, and management implications. A workshop attended by MISC members, stakeholders, and partners provided an opportunity for discussion of those questions and answers and for panelists to identify the challenges and formulate recommendations for the use of eDNA.



Panelists agreed on a set of nine recommendations spanning areas such as communications planning, confirmation of results, and appropriate applications of eDNA. WRP has since formed a subcommittee to address the panel recommendations.

## Utah

The Utah Division of Wildlife Resources (UDWR) has worked cooperatively with Arizona Game and Fish Department and the National Park Service since 2013 to conduct watercraft inspection and decontamination activities as part of a containment program for invasive quagga mussels at Lake Powell.

The agencies reported in 2018 that they had inspected nearly 70,000 watercraft destined for other waterbodies, decontaminating nearly 4,500 boats. Lower lake levels and an expanding mussel population resulted in floating adult mussels in the water column -- something not observed previously.

Upon inspection, adult mussels were frequently found in sea strainer devices aboard watercraft, necessitating the quarantine of dozens of boats in Utah and surrounding states. Through collective knowledge and creativity, UDWR was able to rapidly modify and adapt standard inspection and decontamination protocols used throughout the West to combat these new developments.

The changes quickly resulted in improved inspections and decontaminations, a significant decrease in the number of boats found with mussels aboard upon subsequent inspections, and spawned a partnership between UDWR, the Bureau of Reclamation, and the National Park Service to conduct research studies examining the viability of both larval and adult mussels passing through different types of ballast pumps. Study results indicated that adult mussels can easily survive passage through ballast pumps, spurring further research studies and critical analysis of current decontamination protocols.



The Utah Division of Wildlife Resources is working with the Arizona Game and Fish Department and the National Park Service at Lake Powell.

## Washington

Washington's approach to invasive species has five key aspects. The state focuses on collaboration and works with many groups, including tribes, agencies, industry and academia.

**Education:** The state created Washington Pest Watch — a citizen science initiative led by agencies and universities that enables citizens to report sightings, which are delivered immediately to responders.

**Prevention:** There are state boat inspection stations at two Ports of Entry. Increased funding enables the state to keep stations open longer and add a mussel-sniffing dog. To further increase protection, the state created agreements with the National Park Service and a county sheriff's office to give officers the state's authority to inspect boats; arrest drivers for not stopping at the inspection stations; enforce clean, drain, dry requirements; and issue decontamination orders.

### Early Detection and Rapid Response:

The state has created a collaborative to improve readiness for urban forest pests. This collaborative is developing a plan that will clarify response roles between cities and state and federal agencies in protecting Washington's more than 200 cities from invasive insects and infectious diseases that could decimate forests.

**Containment:** To prepare for invasive mussels, Washington is holding a first-in-the-West field exercise with on-the-ground response, containment, watercraft inspection & decontamination, rapid monitoring and assessment, and mock treatment.

**Long-Term Management:** Washington State and Canada created an action plan for European green crab that delivers a coordinated response in the Salish Sea and guides research and management in both jurisdictions. In addition, Washington created a collaborative to address flowering rush by sharing best practices and developing an action plan for basin-wide management.



## ON THE WEB:

Find Initiative resources and join the conversation at [westgov.org](http://westgov.org)

The work of the Western Governors' Biosecurity and Invasive Species Initiative focused on the impacts that nuisance species, pests and pathogens have on ecosystems, forests, rangelands, watersheds and infrastructure in the West. The Initiative examined the role that biosecurity plays in addressing these risks and identified emerging issues to develop policy recommendations, best practices and technical tools to address those challenges. To ensure the conversation reached the widest possible audience, WGA launched an online resource that includes videos of all workshops and webinars. We've also created the Initiative Appendix, a document that delivers expanded detail on the conversations at each workshop and webinar.



## WORKSHOPS

WGA hosted four regional Initiative workshops that attracted nearly 300 attendees combined. The workshops were livestreamed via YouTube and Facebook, amassing more than 7,300 views during the Initiative's first year. Workshops were hosted by Western Governors **Brian Sandoval** in Nevada, **Matt Mead** in Wyoming, **Steve Bullock** in Montana and **David Ige** in Hawai'i.

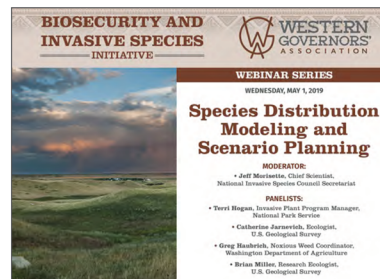
All workshops may be viewed on WGA's website or YouTube Channel.



## WEBINARS

The Initiative was launched with a webinar, hosted by WGA Chair and Hawai'i Gov. David Ige, that featured a discussion on how to improve the interagency exchange of invasive species occurrence data. Additional webinars included topics such as "Invasive Species Impacts on Fisheries," "Conservation Districts and Invasive Species Management," "Exploring the State-AHPIS Relationship," "Species Distribution Modeling and Scenario Planning," and "Innovative Approaches to Addressing Forest Health and Invasive Species in the Pacific Islands."

All webinars may be viewed on WGA's website or YouTube Channel.





The Western Governors' Association would like to thank the following for their support of the Biosecurity and Invasive Species Initiative

INITIATIVE SPONSOR



WORKSHOP SIGNATURE SPONSOR



FEDERAL PARTNERS



## PARTICIPANTS

WGA appreciates the time and effort that workshop panelists provided to the Initiative.

### Panelists and Speakers

#### Lake Tahoe, Nevada Workshop, September 17-18, 2018

The Honorable Brian Sandoval, Governor,  
State of Nevada

John Laird, California Secretary for Natural  
Resources, California

Amy Berry, Chief Executive Officer, Tahoe Fund

Meghan Brown, Deputy Administrator-Plant  
Industry, Nevada Department of Agriculture

Nicole Cartwright, Executive Director,  
Tahoe Resource Conservation District

Sudeep Chandra, Associate Professor,  
University of Nevada Reno

Cindy Gustafson, Chief Executive Officer,  
North Lake Tahoe Resort Association

Lisa Heki, Project Leader, Lahontan National  
Fish Hatchery Complex, U.S. Fish and Wildlife  
Service

Karen Jetter, Research Economist, University  
of California Davis, Agricultural Issues Center

Doug Johnson, Executive Director,  
California Invasive Plant Council

John Kabashima, University of California  
Cooperative Extension, Emeritus

Kacey KC, State Forester, State of Nevada

Elizabeth Leger, Associate Professor,  
University of Nevada Reno

Jeff Marsolais, Forest Supervisor, Lake Tahoe  
Basin Management Unit, U.S. Forest Service

Ken Mayer, Fire and Invasive Initiative  
Coordinator, Western Association of Fish  
and Wildlife Agencies

Laura Megill, Aquatic Invasive Species  
Coordinator, Nevada Department of Wildlife

Don Neal, Director of Environmental Services,  
Southern California Edison

Heath Packard, Director of Government &  
Public Relations, Island Conservation

Jesse Patterson, Chief Strategy Officer,  
League to Save Lake Tahoe

Paul Petersen, Fire Management Officer,  
Nevada Bureau of Land Management Office

Roland Quitugua, Extension Biosecurity  
Associate, University of Guam Extension  
and Outreach

Julie Regan, External Affairs Chief,  
Tahoe Regional Planning Agency

Jon C. Sjöberg, Chief of Fisheries,  
Nevada Department of Wildlife

Sheri Smith, Regional Entomologist,  
Pacific Southwest Region, U.S. Forest Service

Katie Steiger-Meister, Public Affairs Specialist,  
U.S. Fish and Wildlife Service

Martha Volkoff, Environmental Program  
Manager, California Department of Fish  
and Wildlife

Dennis Zabaglo, Aquatic Resources Program  
Manager, Tahoe Regional Planning Agency

#### Cheyenne, Wyoming, WGA Working Lands Roundtable, October 11-12, 2018

The Honorable Matt Mead, Governor of  
Wyoming

Jim Hubbard, Under Secretary for Natural  
Resources and Environment, U.S. Department  
of Agriculture

Doug Miyamoto, Director, Wyoming  
Department of Agriculture

Willow Bish, Wildlife Biologist,  
Wyoming Game and Fish Department

Bob Budd, Executive Director, Wyoming  
Wildlife and Natural Resource Trust

Bill Crapser, State Forester, State of Wyoming

Jessica Crowder, Policy Director, Western  
Landowners Alliance

Randy Crowl, Manager, Colorado Seed Lab,  
Colorado State University

Daniel Denipah, Forest Development  
Restoration Manager, Santa Clara Pueblo

Curtis Elke, Idaho State Conservationist,  
Natural Resources Conservation Service

Colleen Faber, Environmental Health & Safety  
Supervisor, Anadarko

Mary Farnsworth, Deputy Regional Forester,  
Intermountain Region, U.S. Forest Service

Bobbie Frank, Executive Director, Wyoming  
Association of Conservation Districts

Garth Fuller, Eastern Oregon Manager,  
The Nature Conservancy

Don Hajar, Owner, Pawnee Buttes Seed Inc.

Matt Holloran, Principal, Operational  
Conservation LLC

Camille Hopkins, Wildlife Disease Coordinator,  
Ecosystems Mission Area, U.S. Geological  
Survey

Shara Howie, Program Manager, NatureServe

Gwyn McKee, President, Great Plains Wildlife  
Consulting

Peggy Olwell, Plant Conservation Program  
Lead, Bureau of Land Management

Dave Pellatz, Executive Director, Thunder  
Basin Grassland Prairie Ecosystem Association

Barry Perryman, Professor, University of  
Nevada-Reno

Jolie Pollet, Division Chief, Fire Planning  
and Fuels Management, Bureau of Land  
Management

Lisa Reynolds, Assistant Attorney General,  
State of Colorado

Brenda Richards, Coordinator, Idaho  
Rangeland Conservation Partnership

John Ruhs, Assistant Director, Fire and  
Aviation, Bureau of Land Management

Derek Sebastian, Western Area Sales Manager-  
Vegetation Management, Bayer U.S.

Scott Smith, Deputy Director of External  
Operations, Wyoming Game and Fish  
Department

Tom Spezze, Senior Director of Conservation-  
Western US, National Wild Turkey Federation

Peter Stahl, Professor of Soil Ecology,  
University of Wyoming

Scott Talbott, Director, Wyoming Game  
and Fish Department

Jeremy Maestas, Sagebrush Ecosystem  
Specialist, Natural Resources Conservation  
Service

Michael Miller, Senior Wildlife Veterinarian,  
Colorado Department of Wildlife

Kurt VerCauteren, Feral Swine and Ungulate  
Project Leader, National Wildlife Research  
Center

Noreen Walsh, Director, Mountain-Prairie  
Region, U.S. Fish and Wildlife Service

Jeff Whitney, State Forester, State of Arizona

#### Helena, Montana Workshop, November 14, 2018

The Honorable Steve Bullock, Governor,  
State of Montana

Leah Elwell, Executive Director, Invasive  
Species Action Network

Gary Adams, Montana State Plant Health  
Director, U.S. Department of Agriculture-  
Animal and Plant Health Inspection Service

Jon Amberg, Fish Biologist Researcher,  
U.S. Geological Survey

Josh Atwood, Invasive Species Coordinator,  
Hawai'i Invasive Species Council

Hans Bodenhamer, Northern Rocky Mountain  
Grotto

Ryan Brook, Associate Professor, University  
of Saskatchewan



Elizabeth Brown, Invasive Species Coordinator,  
Colorado Parks & Wildlife

Dave Burch, State Weed Coordinator,  
Montana Department of Agriculture

Justin Bush, Executive Coordinator,  
Washington Invasive Species Council

Leigh Greenwood, Forest Health Program  
Director, The Nature Conservancy

Justin Hossfeld, President, Sunlight Ranches

Mike Ielmini, National Invasive Species  
Program Leader, U.S. Forest Service

Rayola Jacobsen, Invasive Species  
Coordinator, Bruneau River & Soil  
Conservation District

Chuck Laudner, Senior Advisor for  
Congressional and Legislative Affairs,  
National Park Service

Jane Mangold, Associate Professor and  
Extension Invasive Plant Specialist,  
Montana State University

Christy Martin, Program Manager & Public  
Information Officer, University of Hawaii-  
Pacific Cooperative Studies Unit,  
Coordinating Group on Alien Pest Species

Brian Meador, Director and Associate Professor,  
Sheridan Research and Extension Center

Dale Nolte, National Feral Swine Program  
Manager, U.S. Department of Agriculture-  
Animal and Plant Health Inspection Service,  
Wildlife Services

John Steuber, Montana State Director, U.S.  
Department of Agriculture-Animal and Plant  
Health Inspection Service, Wildlife Services

Tahnee Szymanski, Assistant State  
Veterinarian, Montana Department of  
Livestock

Erin Raney, Aquatic Invasive Species  
Coordinator, Arizona Game and Fish  
Department

Helmuth Rogg, Director of Plant Program Area,  
Oregon Department of Agriculture

Steve Tyrrel, Central & Eastern Montana  
Invasive Species Team

John Vore, Game Management Bureau Chief,  
Montana Fish, Wildlife & Parks

Germaine White, Information and Education  
Program Manager, Confederated Salish &  
Kootenai Tribes

Tom Woolf, Aquatic Invasive Species Bureau  
Chief, Montana Fish, Wildlife & Parks

#### **Kohala Coast, Hawai'i, December 9-10, 2018**

The Honorable David Ige, Governor of Hawai'i

John Laird, Secretary for Natural Resources,  
State of California

Josh Atwood, Program Supervisor,  
Hawai'i Invasive Species Council

Patty Baiao, U.S. Program Manager,  
Island Conservation

Matt Baur, Associate Director, Western  
Integrated Pest Management Center

Kimberly Burnett, Associate Specialist,  
University of Hawai'i Economic Research  
Organization

Suzanne Case, Chair, Hawai'i Department  
of Land and Natural Resources

Scott Enright, Chair, Hawai'i Department  
of Agriculture

Josh Fisher, Invasive Species Biologist,  
U.S. Fish & Wildlife Service

Mark Fox, Director of External Affairs,  
The Nature Conservancy, Hawai'i Program

Vernon Harrington, State Plant Health  
Director, U.S. Department of Agriculture-  
Animal and Plant Health Inspection Service

Robert Hauff, State Protection Forester,  
Hawai'i Department of Land & Natural  
Resources

Jonathan Ho, Plant Quarantine Branch  
Manager, Hawai'i Department of Agriculture

Flint Hughes, Ecologist, Institute of Pacific  
Island Forestry, U.S. Forest Service

Tracy Johnson, Research Entomologist,  
Pacific Southwest Research Station,  
U.S. Forest Service

Springer Kaye, Program Manager,  
Big Island Invasive Species Committee

Jules Kuo, Ballast Water and Biofouling  
Coordinator, Division of Aquatic Resources,  
Hawai'i Department of Land & Natural  
Resources

Chris Manfredi, President, Hawai'i Coffee  
Association

Christy Martin, Program Manager & Public  
Information Officer, University of Hawai'i-  
Pacific Cooperative Studies Unit, Coordinating  
Group on Alien Pest Species

Michelle Montgomery, Program Specialist,  
Hawai'i Ant Lab

Darcy Oishi, Biocontrol Section Chief,  
Hawai'i Department of Agriculture

Roland Quitagua, Extension Biosecurity  
Associate, University of Guam Extension  
and Outreach

Joel Price, Biological Control Entomologist,  
Oregon Department of Agriculture

David Smith, Administrator, Division of  
Forestry and Wildlife, Hawai'i Department  
of Land & Natural Resources

Cas Vanderwoude, Research Manager,  
Hawai'i Ant Lab

Warren Watanabe, Executive Director,  
Maui County Farm Bureau

#### **We would also like to thank the groups and organizations who participated in workshops, webinars, and initiative surveys over the past year:**

3 Quarter Circle Land & Water Co. Inc.

A&B Diversified

Ag Association Management Services, Inc.

Alaska Department of Fish and Game

Altar Valley Conservation Alliance

American Samoa Community College

American Samoa Department of Agriculture

Anadarko Petroleum Corporation

Ann Walker Consulting

Aquatic Nuisance Species Task Force

Arizona Department of Forestry and Fire  
Management

Arizona Game and Fish Department

Bayer U.S.

Bear Lake Watch

Big Island Invasive Species Committee

Bonneville Power Administration

Boone and Crockett Club

California Department of Fish and Wildlife

California Invasive Plant Council

California Natural Resources Agency

California State Lands Commission

California State Parks

Cardno

Clackamas Soil and Water Conservation  
District

Colorado Attorney General's Office

Colorado Department of Agriculture

Colorado Department of Wildlife

Colorado Parks and Wildlife

Colorado State University

Confederated Salish & Kootenai Tribes

Council of Western State Foresters/  
Western Forestry Leadership Coalition

Eastern Nevada Landscape Coalition

East-West Center

Ecosystem Research Group, LLC

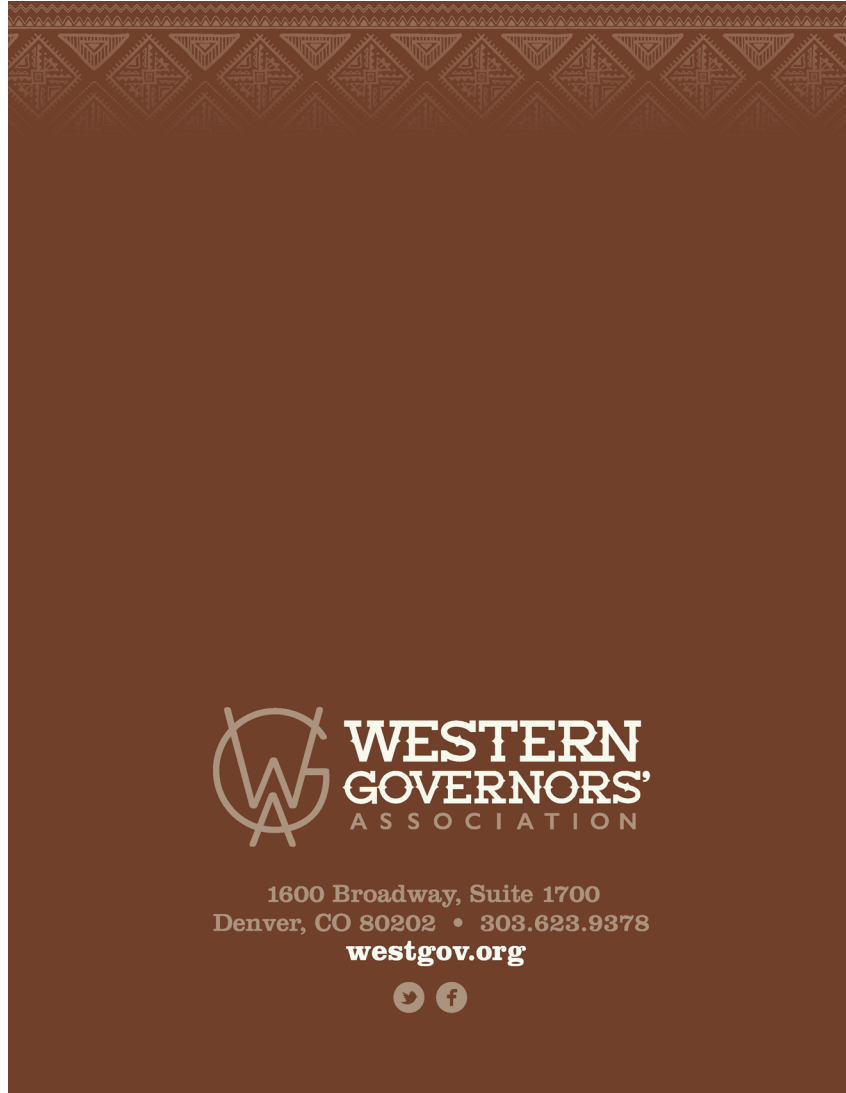


|                                                          |                                                                                                   |                                                                                                    |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Edison International                                     | Nevada Department of Conservation and Natural Resources                                           | • Natural Resources Conservation Service                                                           |
| ESRI                                                     | Nevada Department of Wildlife                                                                     | • U.S. Forest Service                                                                              |
| Fort Belknap Indian Community                            | Nevada Division of Forestry                                                                       | U.S. Department of the Interior                                                                    |
| Great Plains Wildlife Consulting                         | Nevada Division of State Lands                                                                    | • Bureau of Land Management                                                                        |
| Greenwood Global Consulting                              | Nevada Tahoe Conservation District                                                                | • Bureau of Reclamation                                                                            |
| Guam Department of Agriculture                           | New Mexico Association of Conservation Districts                                                  | • Fish and Wildlife Service                                                                        |
| Hawai'i Ant Lab                                          | New Mexico State University                                                                       | • National Park Service                                                                            |
| Hawai'i Coffee Association                               | NIC Inc.                                                                                          | • U.S. Geological Survey                                                                           |
| Hawai'i Department of Agriculture                        | North Dakota Game and Fish Department                                                             | University of California Agricultural Issues Center                                                |
| Hawai'i Department of Land and Natural Resources         | North Lake Tahoe Resort Association                                                               | University of California Cooperative Extension                                                     |
| Hawai'i Invasive Species Council                         | Northern Rocky Mountain Grotto / Bigfork High School Cave Club                                    | University of Georgia Center for Invasive Species and Ecosystem Health                             |
| Idaho Office of Species Conservation                     | Northwest Power & Conservation Council                                                            | University of Guam                                                                                 |
| Idaho Rangeland Conservation Partnership                 | Oahu Invasive Species Committee                                                                   | University of Guam Cooperative Extension and Outreach                                              |
| Idaho State Department of Agriculture                    | Off-Road Business Association                                                                     | University of Hawai'i                                                                              |
| Integrated Ag Services                                   | Operational Conservation LLC                                                                      | University of Hawai'i at Manoa                                                                     |
| Intermountain West Joint Venture                         | Oregon Department of Agriculture                                                                  | University of Hawai'i Economic Research Organization                                               |
| Invasive Species Action Network                          | Oregon Department of Fish and Wildlife                                                            | University of Hawai'i - Pacific Cooperative Studies Unit, Coordinating Group on Alien Pest Species |
| Island Conservation                                      | Oregon Invasive Species Council                                                                   | University of Nevada - Reno                                                                        |
| Kauai Invasive Species Committee                         | Palau Bureau of Agriculture                                                                       | University of Saskatchewan                                                                         |
| Laramie County Conservation District                     | Partners for Conservation                                                                         | University of Wyoming                                                                              |
| League to Save Lake Tahoe                                | Pawnee Buttes Seed                                                                                | Utah State University Extension                                                                    |
| Lonesome Pines Land & Cattle Co.                         | Placer County                                                                                     | Washington Invasive Species Council                                                                |
| Maui County Farm Bureau                                  | Research Corporation of the University of Hawai'i                                                 | Washington Recreation and Conservation Office                                                      |
| Maui County Soil and Water Conservation District         | RiversEdge West                                                                                   | Waterweed Solutions                                                                                |
| Maui Invasive Species Committee                          | Rosebud County Weed District                                                                      | West Multnomah Soil and Water Conservation District                                                |
| Montana Department of Agriculture                        | Ruckelshaus Institute, University of Wyoming                                                      | Western Integrated Pest Management Center                                                          |
| Montana Department of Livestock                          | Santa Clara Pueblo Forestry                                                                       | Western Association of Agriculture Experiment Station Directors                                    |
| Montana Department of Natural Resources and Conservation | Sonoma Water                                                                                      | Western Association of Fish and Wildlife Agencies                                                  |
| Montana Department of Transportation                     | Southern California Edison                                                                        | Western Landowners Alliance                                                                        |
| Montana Fish Wildlife and Parks                          | Sunlight Ranch                                                                                    | Working Dogs for Conservation                                                                      |
| Montana Invasive Species Council                         | Sustainable Rangelands Roundtable                                                                 | Wyoming Association of Conservation Districts                                                      |
| Montana State University                                 | Tahoe Chamber of Commerce                                                                         | Wyoming Department of Agriculture                                                                  |
| Montana Trout Unlimited                                  | Tahoe Fund                                                                                        | Wyoming Game and Fish Department                                                                   |
| National Association of Conservation Districts           | Tahoe Regional Planning Agency                                                                    | Wyoming Reclamation and Restoration Center                                                         |
| National Interagency Fire Center                         | Tahoe Resource Conservation District                                                              | Wyoming State Forestry Division                                                                    |
| National Invasive Species Council Secretariat            | The National Audubon Society                                                                      | Wyoming Stock Growers Association                                                                  |
| National Oceanic and Atmospheric Administration          | The Nature Conservancy                                                                            | Wyoming Wildlife and Natural Resource Trust                                                        |
| National States Geographic Information Council           | Thunder Basin Grasslands Prairie Ecosystem Association                                            | Wyoming Wildlife Federation                                                                        |
| National Wild Turkey Federation                          | U.S. Air Force, Colorado State University - Center for Environmental Management of Military Lands |                                                                                                    |
| National Wildlife Research Center                        | U.S. Department of Agriculture                                                                    |                                                                                                    |
| NatureServe                                              | • Agricultural Research Service                                                                   |                                                                                                    |
| Nevada Department of Agriculture                         | • Animal and Plant Health Inspection Service                                                      |                                                                                                    |



## ENDNOTES

- <sup>1</sup> Pimentel, D., McNair, S., Janecka, J., Wightman, J., Simmonds, C., O'Connell, C., ... & Tsomondo, T. (2001). Economic and environmental threats of alien plant, animal, and microbe invasions. *Agriculture, Ecosystems & Environment*, 84(1), 1-20.
- <sup>2</sup> Pimentel, D., Zuniga, R., & Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological economics*, 52(3), 273-288.
- <sup>3</sup> Simberloff, D. (1996). Impacts of introduced species in the United States. *Consequences*, 2(2), 13-22.
- <sup>4</sup> Wilcove, D. S., Rothstein, D., Dubow, J., Phillips, A., & Losos, E. (1998). Quantifying threats to imperiled species in the United States. *BioScience*, 48(8), 607-615.
- <sup>5</sup> Bradley, B. A., Curtis, C. A., Fusco, E. J., Abatzoglou, J. T., Balch, J. K., Dadashi, S., & Tuanmu, M. N. (2018). Cheatgrass (*Bromus tectorum*) distribution in the intermountain Western United States and its relationship to fire frequency, seasonality, and ignitions. *Biological Invasions*, 20(6), 1493-1506.
- <sup>6</sup> Burnett, K., Kaiser, B., & Roumasset, J. (2007). Economic lessons from control efforts for an invasive species: *Miconia calvescens* in Hawaii. *Journal of Forest Economics*, 13(2-3), 151-167.
- <sup>7</sup> Connelly, N. A., O'Neill, C. R., Knuth, B. A., & Brown, T. L. (2007). Economic impacts of zebra mussels on drinking water treatment and electric power generation facilities. *Environmental management*, 40(1), 105-112; Pimentel, D. (2005). Aquatic nuisance species in the New York State Canal and Hudson River systems and the Great Lakes Basin: an economic and environmental assessment. *Environmental Management*, 35(5), 692-702.
- <sup>8</sup> <https://www.nwcouncil.org/fish-and-wildlife/fw-independent-advisory-committees/independent-economic-advisory-board/economic-risk-associated-with-the-potential-establishment-of-zebra-and-quagga-mussels-in-the-columbia-river-basin>
- <sup>9</sup> Barrett, A. D. (2014). Economic burden of West Nile virus in the United States. *The American journal of tropical medicine and hygiene*, 90(3), 389.
- <sup>10</sup> Carlson, C. M., Hopkins, M. C., Nguyen, N. T., Richards, B. J., Walsh, D. P., & Walter, W. D. (2018). Chronic Wasting Disease: Status, Science, and Management Support by the US Geological Survey. US Department of the Interior, US Geological Survey.
- <sup>11</sup> <http://www.emeraldashborer.info/>
- <sup>12</sup> <https://cnas-re.uog.edu/crb/>





## Policy Resolution 2019-06

### Biosecurity and Invasive Species Management

#### A. BACKGROUND

1. Per Executive Order 13751, “invasive species” means “with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health.” This definition can include aquatic and terrestrial plants and animals, forest and agricultural pests, and pathogens.
2. The 2017-2027 Hawai’i Interagency Biosecurity Plan defines biosecurity as “the set of measures taken to manage the risk from invasive species to the economy, environment, and health and lifestyle of the people.” This includes pre-border measures, border measures, post-border measures, and measures that increase public awareness about invasive species.
3. The Plant Protection Act of 2000 (Pub. L. 106–224) defines “biological control” (biocontrol) as the use of biological control organisms as an “enemy, antagonist, or competitor used to control a plant pest or noxious weed.” When used properly, biocontrol can be an effective tool in efforts to manage and eradicate invasive species.
4. States have different definitions of biosecurity, biological control and invasive species. They also may use regulatory and nonregulatory terms that are related to, but not synonymous with, the term invasive species, including pest, nuisance species, noxious weed, and injurious wildlife.
5. Invasive species have substantial negative effects on ecosystems, economies, and communities in the West. Studies have found that invasive species cost the U.S. more than \$120 billion every year, and the National Wildlife Federation estimates that 42 percent of threatened or endangered species are at risk due to invasive species. Invasive annual grasses such as cheatgrass, medusahead, fountain grass, and ventenata pose a major threat to western rangelands by increasing the risk of wildfire, outcompeting native grasses, and diminishing soil and water quality. Aquatic nuisance species, including invasive quagga and zebra mussels, decrease water quantity and quality, impair native wildlife, harm hydroelectric and irrigation systems, and can impede maritime transport by fouling vessel hulls. Invasive pathogens affect human health and welfare, and invasive species, such as mosquitoes, can vector human diseases. Invasive species damage multiple types of environments, from virgin forests to urban tree canopies. Invasive species harm a wide variety of economies dependent on natural resources, including agriculture, ranching, tourism, energy production and transmission, and forest products. Invasive species threaten many native plants central to western life and the cultures of Native Americans, Native Hawai’ians, Alaska Natives, and other indigenous peoples.



6. The spread of invasive species results from a combination of human activities, susceptibility of invaded environments, climate change, biology of the invading species, and dispersal. These characteristics are not dictated by geopolitical boundaries, but rather by ecosystem-level factors, which cross state and national borders. Scientists, private landowners, and state and federal land managers across the West have expressed the need to develop a more aggressive and cohesive strategy for invasive species management that includes prevention, monitoring, control, and eradication.
7. The impacts of invasive species on natural resources and human health and welfare are similar in scope and intensity to the threats posed by wildfire. Wildfire management on federal, state, tribal, and local land is coordinated through a sophisticated planning and response network, which includes the National Interagency Fire Center (NIFC).
8. Many invasive species were introduced, or their distribution was expanded, due to inadequate federal and state regulations dealing with interstate transport, international trade and interstate commerce, and a lack of communication and coordination between land management agencies.
9. Early Detection and Rapid Response (EDRR) is a coordinated set of actions to find and eradicate potential invasive species in a specific location before they spread and cause harm. The Incident Command System (ICS) is a management system designed to enable effective and efficient incident management, including invasive species rapid response, by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure.
10. In the West, biosecurity and invasive species management is the responsibility of a wide network of state, federal, and local agencies. Federal agencies manage invasive species on federal lands and waters under a complex system of mandates and authorities.
11. Cooperative agreements, grants, and procurement contracts between federal agencies and state and local invasive species management authorities are effective in establishing structured partnerships for collaborative invasive species management. The use of cooperative agreements lessens the burden on local federal land managers, while increasing the efficiency of invasive species management programs utilizing local collaborative goal setting. Additionally, cooperative agreements simplify project-based contracting utilizing the authorities of state and local government agencies. This can be extremely useful, especially where infestations extend across multiple landownerships or EDRR is the management objective.
12. Good Neighbor Authority (GNA) allows states to enter into agreements with the U.S. Forest Service (USFS) or Bureau of Land Management (BLM) permitting them to perform various land management activities on federal lands. These tools have been successfully used by forest and rangeland managers to achieve various land management objectives across federal, state and local government, and privately-owned lands
13. U.S. Department of Agriculture (USDA) regulation of interstate movement of commodities via airlines is focused on the protection of agricultural industries in the contiguous United States. This is particularly evident in Hawai'i, where baggage destined for the U.S. mainland is subject to federal inspection, while baggage moving from the mainland to Hawai'i is not.

14. Environmental DNA (eDNA) is DNA present in an environmental sample, as differentiated from traditional sampling of DNA directly from an intact organism. eDNA frequently is thought of as DNA in tissue and cells that have been shed by an organism but can also refer to DNA within an intact organism, if that organism is collected in the environmental sample. eDNA can be used to detect a wide range of organisms, including those that are endangered or invasive, and be used for both research and monitoring purposes.
15. The West includes a number of highly important seaports on the U.S. mainland and across the Pacific region. Maritime vessels represent a primary pathway for the movement of aquatic invasive species. With the passage of the Vessel Incidental Discharge Act in 2018, regulations regarding ballast water and other discharges are centralized under Section 312 of the Clean Water Act with the Environmental Protection Agency setting environmental standards, the U.S. Coast Guard (USCG) setting vessel requirements to meet those standards, and the USCG and interested states enforcing those requirements.
16. State invasive species councils and invasive plant councils provide policy level direction, planning, and coordination for state-level biosecurity and invasive species prevention and management actions in the West. Councils are led by state agencies, non-profit organizations, industry, private landowners, and public-private partnerships. These groups empower those engaged in the prevention, detection, and eradication of invasive species, and serve as forums for invasive species education, communication, and strategic planning. Invasive species councils can collaborate on regional-level issues and benefit from mechanisms that help them to coordinate and solve cross-boundary, cross-jurisdictional challenges.

**B. GOVERNORS' POLICY STATEMENT**

1. Western Governors support the creation of a Western Invasive Species Council (WISC) to help enhance coordination between existing state invasive species councils, improve communication and collaboration on regional biosecurity and invasive species control efforts, and to advocate for regional needs at the federal level. The WISC should be initially coordinated through the Western Governors' Association and should work to address cross-boundary and cross-jurisdictional challenges identified in this resolution.
2. Western Governors urge Congress and the Administration to support state, territorial, and tribal invasive species prevention, control and management programs and redouble efforts on federal lands. This should be accomplished through accountability and oversight of programs administered by the USDA, the U.S. Department of the Interior, the U.S. Department of Defense, the USCG, and the National Oceanic and Atmospheric Administration. These programs provide valuable services in the detection and elimination of invasive species, as well as coordination, public outreach, and communication.
3. Western Governors support research as needed to provide understanding of invasive species life potential range distribution, and to develop geographically-appropriate control measures. Western Governors urge Congress and the Administration to support much-needed research on biosecurity and invasive species, including programs under the National Institute of Food and Agriculture and to facilitate funding mechanisms that enable land grant universities to conduct research and development of new pesticides. Institutions conducting research on biosecurity, biocontrol and invasive species control methods should look for opportunities to pool funding resources and exchange information across

administrative lines. Invasive species managers and policymakers should be encouraged to develop new decision-making tools and economic analyses, as well as build and improve upon the decision-making tools and analyses currently in use. Invasive species managers should strive to incorporate economic analyses and regional-level, science-based decision-making tools into management decisions.

4. Western Governors strongly encourage expansion and creation of partnerships – such as invasive species councils with representation from local weed and pest districts, conservation districts, county governments, non-profit and industry organizations, local stakeholders, state, island, tribal, federal, regional and international agencies – committed to preventing the spread of invasive species, averting new unauthorized introductions, responding rapidly to new introductions, and working together to find creative regional approaches for protecting and restoring natural, agriculture, power and water conveyance infrastructure, and recreational resources. Federal agencies should build a more sophisticated and centralized biosecurity and invasive species management network, including a National Biosecurity and Invasive Species Management Center based on the model of the NIFC.
5. Congress and the federal government should ensure that invasive species funding, including support for emergency response, is sustainable, flexible and able to be maximized by federal, state and local agencies with pooled resources and collaborative funding mechanisms. Federal funding, cooperative agreements grants, and procurement contracts for state and local biosecurity and invasive species management should be structured in a deliberate and transparent way that allows for the greatest amount of flexibility and long-term planning. When possible, federal agencies should look for collaborative projects and funding opportunities that multiply state resources and support state-led biosecurity and invasive species management projects.
6. Western Governors call upon Congress to promote state-directed programs to combat invasive species. Regional leadership and state-directed programs provide place-based solutions tailored to unique regional or local conditions in land and aquatic ecosystems. The federal role should be one of partnership and policy-making that strengthen states' on-the-ground efforts and mitigates risks associated with the movement of invasive species between states.
7. Federal agencies are encouraged to expand the use of cooperative agreements with state and local governments and should ensure that they are approved in a timely manner and in collaboration with implementing state agencies. Federal agencies can also support invasive species management efforts by encouraging contract recipients to coordinate with state and local invasive species management agencies, regulatory programs, and cooperative weed and invasive species management areas. State invasive species managers should consider using Good Neighbor Authority on USFS and BLM lands for cross-boundary collaborative invasive species control, management and eradication programs.
8. Federal actions should support state biosecurity and invasive species management efforts by ensuring the timely approval of state permits for biosecurity, quarantine, biocontrol, and rapid response actions. Federal agencies should consult with Governors early and substantively regarding biosecurity or invasive species management decisions that affect state resources and state actions.

9. Federal agencies should identify individuals within district and region offices that can be contacted and assist in the planning and implementation of local cross-boundary invasive species management programs.
10. The threats that invasive species pose to western landscapes and communities are serious and should be met with a sophisticated and coordinated response commensurate with the level of their impacts.
11. Prevention is the most efficient and cost-effective method of invasive species management. Effective biosecurity, prevention, and containment methods can mitigate the need for more expensive and burdensome control and eradication programs. Prevention strategies should be coordinated across state, national, and international lines. Federal and state agencies should increase the use of innovative biosecurity prevention and detection programs, including increased use of electronic manifesting in interstate shipments for the purposes of inspection, and the use of canine detection resources.
12. Western Governors support the EDRR framework as a method to limit or eliminate new introductions and existing species expansion. Programs for the control and/or eradication of invasive species must result in more on-the-ground prevention, management and eradication. The ICS should be evaluated for use in instances of fast-spreading invasives and used as part of EDRR; state, federal, and local agencies can opt to practice and implement the ICS as part of rapid response. The Federal Emergency Management Agency can support these efforts by working with western states to create an ICS training module for invasive species rapid response. The Executive Branch can support state-led rapid response programs by: 1) increasing federal funding for state-led aquatic invasive species rapid response programs, including those that provide mechanisms for flexible, long-term support of state early detection rapid response efforts; 2) streamlining federal permitting and approval processes for treatment and management actions for new mussel detections; 3) creating a single federal authority for aquatic invasive species treatment permitting and approval in freshwater systems; and 4) simplifying reporting on new invasive mussel infestations by creating a single federal point of contact for new mussel detections.
13. Federal agencies should support states' effort to identify, study and approve the use of biological control organisms. Federal permitting models should be structured to ensure biocontrol can be utilized by states in a safe and timely manner. Biocontrol research is encouraged at a regional level, with biocontrol research information being encouraged to move freely between institutions and across state lines. Invasive species managers in the West would benefit from the creation of a new, state-of-the-art biological control facility, as well as a collaborative, multi-agency plan for maintaining and staffing new biocontrol facilities at a level that more adequately meets the expanding needs of the region. Furthermore, effective biocontrol, biosecurity, and invasive species research depends upon a highly-skilled workforce. State and federal agencies should collaborate with universities to support programs essential to biosecurity and invasive species management, such as botany, zoology, plant pathology, taxonomy, systematics, and related fields.
14. The containment of invasive quagga and zebra mussels at infested waters in the West depends upon the collaboration and mutual effort of federal, state and local agencies. Many state-led containment programs benefit from federal cooperation and funding, and state and federal agencies should be encouraged to sustain and expand these effective partnerships as necessary. However, to adequately protect the West from the movement of

aquatic invasive species, federal agencies must be able to act as full partners in invasive species containment efforts and must have the funding and authorities necessary to contain invasive species within lands and waters under their jurisdiction. To this end, federal agencies, including the National Park Service and BLM, should be vested with clear authority to manage watercraft upon their departure from infested waterbodies under federal jurisdiction.

15. Integrated pest management, biocontrol, outcome-based grazing, and targeted grazing can be effective tools to control the spread of invasive annual grasses. Federal, state, and local agencies should view invasive annual grasses as a regional threat and strive to identify and implement cross-boundary projects to control invasive annual grasses at a regional level. Such projects should include those utilizing alternative management techniques such as outcome-based grazing.
16. Agricultural industries in the Pacific Islands need to be similarly protected from the risk of interstate movement of invasive species as the contiguous U.S. mainland. USDA quarantines and commodity inspections should incorporate the priorities of the West, including non-contiguous states and territorial islands in the western region. This includes maintaining federal quarantines on pests that have not yet reached the West, like the emerald ash borer, and adopting policies that adequately protect Pacific states and territories, such as inspection of baggage moving from the contiguous U.S. to non-contiguous areas.
17. State, federal and local agencies and regional coordinating groups should develop and implement a set of best practices for conducting eDNA monitoring and incorporating positive detection results into rapid response strategies.
18. To effectively prevent, contain, and control invasive species, federal, state and local invasive species managers need federal laws that support on-the-ground action. Western Governors support a states-led review of federal biosecurity and invasive species statutes, including the Lacey Act and the National Invasive Species Act, to evaluate how they support on-the-ground management, identify any gaps in their application, and ensure that their structure and implementation are able to address 21<sup>st</sup> century biosecurity and invasive species challenges. Of particular interest are opportunities to expand the taxonomic scope of the Lacey Act to benefit U.S. biosecurity.
19. As directed by the Vessel Incidental Discharge Act, the U.S. Coast Guard and the Environmental Protection Agency should consult with Western Governors and work closely and collaboratively with states on the implementation of that act to ensure that state and regional aquatic resource protection needs are met across the West and the Pacific. Federal and state partners should collaborate on the development of evidence-based risk assessments and should work together to assess the efficacy of policies and tools that may be used in mitigating the impact of various types of discharges, including hull biofouling. Western Governors believe that protecting the diversity of marine habitats in western states and Pacific territories is best accomplished by working with states that have the greatest knowledge of their ecosystems and invasive risks.
20. Accurate, standardized, and accessible geospatial data is essential to biosecurity and invasive species management in the West. Western Governors support efforts to standardize and centralize invasive species occurrence data, streamline the exchange of

data between the nation's major invasive species data aggregators, and increase the accessibility of data to federal, state, and local land and resource managers.

**C. GOVERNORS' MANAGEMENT DIRECTIVE**

1. The Governors direct WGA staff to work with Congressional committees of jurisdiction, the Executive Branch, and other entities, where appropriate, to achieve the objectives of this resolution.
2. Furthermore, the Governors direct WGA staff to consult with the Staff Advisory Council regarding its efforts to realize the objectives of this resolution and to keep the Governors apprised of its progress in this regard.

*Western Governors enact new policy resolutions and amend existing resolutions on a bi-annual basis. Please consult [westgov.org/resolutions](http://westgov.org/resolutions) for the most current copy of a resolution and a list of all current WGA policy resolutions.*



## Top 50 Invasive Species in the West

Invasive species pose an enormous environmental challenge to western states and territories. Western Governors have experienced first-hand how these invaders affect the region's forests and rangelands, water, and agriculture. Left unchecked, invasive species permanently alter ecosystems and negatively impact the native species and local economies that depend upon them.

The Nature Conservancy has estimated that invasive species management costs over \$120 billion a year and affects more than 100 million acres – an area the size of California. Additionally, invasive species are estimated to have contributed to the decline of 42 percent of threatened and endangered species.

Land managers must combat a nearly limitless number of invading species with a limited amount of resources. In this environment, it is critical to have up-to-date information to plan and prioritize management decisions.

Individual states have developed invasive species risk assessments within their boundaries. Until now, however, no such list has existed for the western region.

The Western Governors' Association (WGA) has addressed this need by surveying invasive species coordinators in WGA member states and territories



No. 1 Terrestrial Invasive Species:  
Salt cedar (tamarisk) (*Tamarix* spp.)



No. 5 Terrestrial Invasive Species:  
Emerald Ash Borer  
(*Agrius planipennis*)



No. 19 Aquatic Invasive Species:  
Nutria (*Myocastor coypu*)



No. 2 Aquatic Invasive Species:  
Quagga and Zebra Mussel  
(*Dreissena polymorpha*)

to develop the "Top 50 Invasive Species in the West." The compilation of terrestrial and aquatic invasive species includes highly-publicized examples such as cheatgrass, Quagga Mussels, tamarisk and the Emerald Ash Borer. The list also encompasses less well known, but still impactful, examples such as leafy spurge, Red shiner, Russian knapweed, and Golden algae.

This first-of-its-kind risk assessment by WGA will enable state managers to better understand

the regional-level risks posed by terrestrial and aquatic invasive species and improve cross-boundary management actions. Additionally, this effort of WGA's Invasive Species Data Management Project will be used to populate the association's West-wide Invasive Species Risk Assessment, created to help guide future work to battle invasive species.





Terrestrial Invasive Species, from left: **No. 9 Johnsongrass** (*Sorghum halepense*); **No. 3 Canada thistle** (*Cirsium arvense* (L.) Scop.); **No. 8 Leafy spurge** (*Euphorbia esula*); **No. 2 Cheatgrass** (*Bromus tectorum*)

## Top 25 Terrestrial Invasive Species in the West

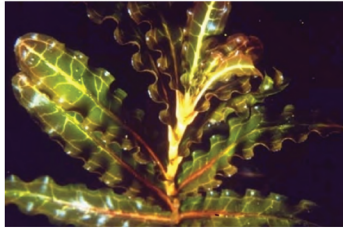
1. Salt cedar (tamarisk) (*Tamarix* spp.)
2. Cheatgrass (*Bromus tectorum*)
3. Canada thistle (*Cirsium arvense* (L.) Scop.)
4. Hoary cress (*Cardaria draba*)
5. Emerald Ash Borer (*Agrilus planipennis*)
6. Feral Hog (*Sus scrofa*)
7. Russian olive (*Elaeagnus angustifolia* L.)
8. Leafy spurge (*Euphorbia esula*)
9. Johnsongrass (*Sorghum halepense*)
10. European starling (*Sturnus vulgaris*)
11. Giant Reed (*Arundo donax*)
12. Russian knapweed (*Acroptilon repens*)
13. Feral (or spay-neuter-release) Cat (*Felis domesticus*)
14. Perennial Pepperweed (*Lepidium latifolium*)
15. White nose syndrome
16. Yellow starthistle (*Centaurea solstitialis*)
17. Knotweeds (*Polygonum* sp.)
18. Sericea lespedeza (*Lespedeza cuneata*)



19. Coqui frog (*Eleutherodactylus coqui*)
20. Purple loosestrife (*Lythrum salicaria* and *L. virgatum*)
21. Scotch thistle (*Onopordum acanthium*)
22. Dyer's woad (*Isatis tinctorial* L.)
23. Flowering rush (*Botomus umbellatus*)
24. Reed canary-grass (*Phalaris arundinacea*, the introduced genotype)
25. Little fire ant (*Wasmannia auropunctata*)



## Top 25 Aquatic Invasive Species in the West



1. Eurasian Watermilfoil (*Myriophyllum spicatum*)

2. Quagga and Zebra Mussel (*Dreissena polymorpha*)

3. New Zealand mudsnail (*Potamopyrgus antipodarum*)

4. Asian Clam (*Corbicula fluminea*)

5. Curly-leaved pondweed (*Potamogeton crispus*)

6. Silver carp (*Hypophthalmichthys molitrix*)

7. Northern pike (*Esox lucius*)

8. Purple loosestrife; *Lythrum salicaria*

9. Hydrilla (*Hydrilla verticillata*)

10. Whirling disease (*Myxobolus cerebralis*)

11. Common carp (*Cyprinus carpio*)

12. American bullfrog (*Lithobates catesbeianus*)

13. Bighead Carp, *Hypophthalmichthys nobilis*

14. Rusty crayfish (*Orconectes rusticus*)

15. Brazilian elodea (*Egeria densa*)

16. Nonnative crayfish (*Orconectes* spp., *Procambarus clarkii*)

17. Golden algae (*Prymnesium parrum*)

18. Didymo (*Didymosphenia geminata*)

19. Nutria (*Myocastor coypu*)



Aquatic Invasive Species, clockwise from left: No. 5 Curly-leaved pondweed (*Potamogeton crispus*); No. 8 Purple loosestrife; *Lythrum salicaria*; No. 1 Eurasian Watermilfoil (*Myriophyllum spicatum*); No. 14 Rusty crayfish (*Orconectes rusticus*)



20. White Perch (*Morone americana*)

21. Grass Carp (*Ctenopharyngodon idella*)

22. Water Hyacinth (*Eichornia crassipes*)

23. Red shiner (*Cyprinella lutrensis*)

24. Phragmites Common Reed (*Phragmites australis*)

25. Western Mosquitofish (*Gambusia affinis*)



No. 6 12 Aquatic Invasive Species: American bullfrog (*Lithobates catesbeianus*).

## Western Governors' Association Invasive Species Data Management Project

Western Governors' Association staff surveyed invasive species coordinators in member states and territories in 2017 to rank the top-priority invasive species as part of WGA's Invasive Species Data Management Project. Participants were asked to rank their states' top-15 most impactful and potentially impactful terrestrial and aquatic invasive species.

The responses were then compiled into a top-25 list for each category for the western region. Responses are weighted by their relative rank, with the most impactful species in a state or island being given 15-points, the second most impactful being given 14 points, etc.

As of December 12, 2017, WGA had received 30 responses. State participation is as follows:

### Terrestrial survey participants:

Alaska, California, Colorado, Hawaii, Montana, North Dakota, Nebraska, New Mexico, Nevada, Oklahoma, South Dakota, Texas, Washington, Wyoming.

### Aquatic survey participants:

Alaska, Arizona, California, Colorado, Montana, North Dakota, Nebraska, New Mexico, Nevada, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, Wyoming.



**WESTERN  
GOVERNORS'**  
ASSOCIATION

1600 Broadway, Suite 1700  
Denver, CO 80202 • 303.623.9378  
**westgov.org**



Senator MCSALLY. For information of members, questions may be submitted for the record before the close of business on Thursday. The record will remain open for two weeks. We ask that you all respond as promptly as possible, and your responses will be made a part of the record.

With that, thanks so much for coming today. This hearing is now adjourned.

[Whereupon, at 12:03 p.m. the hearing was adjourned.]

## **APPENDIX MATERIAL SUBMITTED**

---

U.S. Senate Committee on Energy and Natural Resources  
 Subcommittee on Water and Power  
 March 4, 2020 Hearing: *The Impact of Invasive Species in  
 Bureau of Reclamation Facilities and Management of Water Resources in the West*  
 Questions for the Record Submitted to Mr. Scott Cameron

Questions from Senator Catherine Cortez Masto

**Question 1:** The National Invasive Species Council provides high-level interagency coordination of Federal invasive species actions and works with many partners to address invasive species issues at the national level. I understand that the National Invasive Species Council Management Plan was updated in 2016. It is my understanding that the Council evaluates and updates the plan every 3 years.

- What is the current status of the management plan?

**Response:** Implementation of the 2016-2018 National Invasive Species Council (NISC) Management Plan concluded last year with the completion of the majority of action items. As an alternative to publishing a three-year Management Plan with limited interagency engagement, in 2019 NISC developed its first Terms of Reference document, which establishes the relationship among NISC, its staff, and member agencies. NISC also adopted an annual work plan process to be more responsive to immediate interagency priorities and more effectively tap into available interagency energy and capacity. The NISC FY 2020 Work Plan includes six thematic priority activities and a series of general coordination responsibilities. These documents are available [www.invasivespecies.gov](http://www.invasivespecies.gov). NISC staff are coordinating interagency teams to advance these priorities.

- Do you have the funds and resources to actively implement the management plan?

**Response:** NISC's role is to promote interdepartmental coordination. Most federal invasive species funding, approximating \$2 billion annually, is administered through individual agency programs, predominantly in the Departments of Homeland Security and Agriculture. The shift to an annual planning cycle and streamlining of NISC operations under the new Terms of Reference, discussed in the response to the previous question, was partially due to the need to be more effective and efficient in view of the fact that the Department of the Interior has sought statutory authorization, as part of the President's Budget, to receive financial contributions from other agencies to support its work. In anticipation of receiving that authority, the Department reduced its FY 2020 budget request for NISC to \$600,000, but Congress has yet to provide the requested authority. The NISC FY 2020 Work Plan was developed to be in line with available resources with a focus on areas where coordination can be improved by working across NISC member agencies. The efforts of NISC staff therefore help leverage and are in turn dependent on the engagement of NISC member agencies.

**Question 2:** Research and development plays a crucial role in providing insight, options and solutions to protect our economy and ecosystems from the threat of invasive species.

- How can Congress work with you (DOI) and other federal agencies to prioritize research and development efforts related to invasive species?

U.S. Senate Committee on Energy and Natural Resources  
 Subcommittee on Water and Power  
 March 4, 2020 Hearing: *The Impact of Invasive Species in  
 Bureau of Reclamation Facilities and Management of Water Resources in the West*  
 Questions for the Record Submitted to Mr. Scott Cameron

**Response:** Congress should support the President's FY 2021 budget request for Interior's research programs on invasive species in both the U.S. Geological Survey and the Bureau of Reclamation. More broadly, the Department plays a leadership role in using science and innovation to improve invasive species management activities. This includes understanding current and emerging invasive species, their biology and impacts; developing and applying new tools, technologies, and methods to prevent, detect, and control invasive species as cost-effectively as possible; and developing decision-support tools to inform planning and management actions. Importantly, the Department emphasizes making these and other products available to managers across our programs and partners. Examples of specific research efforts include:

**Reclamation:** Reclamation's Research and Development Office, Science and Technology Program has funded \$1.85M annually for mussel research since 2018. Since the development of Reclamation's invasive mussel early detection and monitoring program in 2008, Reclamation's Ecological Research Laboratory has processed 21,754 samples from 670 water bodies across 17 states. Research has focused on development of methods for control of invasive mussel settlement and shell debris at Reclamation hydropower facilities, control of populations in open water, development of effective monitoring methods, and predictive modeling. Research into control methods to prevent significant increases in operation and maintenance costs and potential failure or outages of critical hydropower generation systems has led to the installation of ultraviolet light treatment for generator cooling systems at three large Reclamation hydropower facilities.

Other agencies managing hydropower facilities also rely on Reclamation's research when considering mussel mitigation methods. Research is ongoing using novel methods to support the development of open water control and eradication of invasive mussels. Reclamation researchers are currently working to sequence the quagga mussel genome and have partnered with the winning solver of a prize challenge that was funded and administered by Reclamation's Prize Competition Program.

**US Geological Survey:** USGS scientists partner with state and federal agencies, tribes, agriculture, natural resource managers, and the private sector to help solve problems posed by invasive species. The USGS provides information on early detection and assessment of newly established invaders; monitoring invading populations; improving understanding of the ecology of invaders and factors in resistance of habitats to invasion; developing and testing prevention and management and control alternatives, stressing integrated control management approaches where appropriate; and assessing approaches for restoring disturbed habitats after control. USGS's Invasive Species Program, funded at \$23M in 2020 and at \$16.7 in the President's FY 2021 budget, researches high impact invasive species.

Tools and technologies developed by USGS and its partners - such as acoustic deterrent systems, carbon dioxide as a deterrent for movement, and the modified unified method to improve commercial harvest - are being deployed to help contain and control Asian carp in the Mississippi River basin. Innovative approaches of USGS scientists continue to provide new tools crucial to



U.S. Senate Committee on Energy and Natural Resources  
 Subcommittee on Water and Power  
 March 4, 2020 Hearing: *The Impact of Invasive Species in  
 Bureau of Reclamation Facilities and Management of Water Resources in the West*  
 Questions for the Record Submitted to Mr. Scott Cameron

maintain control of sea lamprey in the Great Lakes; adaptively manage Phragmites (common reed) in the Great Lakes region; reduce the spread and impact of zebra and quagga mussels in the Midwest and the West; and to help managers in Hawaii deal with new, high impact species such as Rapid Ohi'a Death that threaten important native species. USGS decision science tools, online databases and alert systems help managers to more optimally allocate resources to address invasive species issues.

Congress typically provides funding for specific invasive species, those both long-established and high impact, rapidly spreading invasive species. This approach focuses on controlling invasive species that are causing problems now. Expanding the focus to also support the President's budget request in USGS for \$4.5M and the U.S. Fish and Wildlife Service for \$15.3M specifically for prevention and early detection/rapid response activities to limit introductions and spread in the United States would be beneficial. Taking action before invasive species become established and widespread is the most cost-effective approach. These proactive, cost-effective approaches include efforts such as horizon scanning - looking for potentially high impact invasive species across the globe not yet in the country; biosurveillance - monitoring, early detection, and sharing information about relative risk to stakeholders across the country; and rapid response, such as deployment of interjurisdictional teams to eradicate new incursions, before invasive species have had the opportunity to spread.

In addition, in 2019, Congress passed the John D. Dingell Jr. Conservation, Management, and Recreation Act (Act). One of the Act's provisions established the Theodore Roosevelt Genius Prize for Management of Invasive Species. The purpose is to encourage technological innovation with the potential to advance the mission of the FWS with respect to the management of invasive species. The Act authorized funding for this and other prize competitions. This type of Congressional direction will help leverage advancements to pilot and implement winning technologies, in partnership with conservation organizations, federal or state agencies, federally recognized Indian tribes, private entities, and research institutions.

**Question 3:** Cheatgrass, an invasive species, is highly flammable and acts as a fuel that increases fire intensity. In Nevada, the 2018 Martin's Fire sped through cheatgrass to consume over 435,000 acres. Coordination between different agencies and levels of government and sustained commitment and funding are necessary to address this invasive grass. The Bureau of Land Management is working to treat vegetation and fuels as part of wildfire mitigation in the West.

- Will you commit to working with stakeholders in Nevada to mitigate cheatgrass?

**Response:** Yes. The Bureau of Land Management is committed to working with stakeholders in Nevada to mitigate cheatgrass. BLM uses a variety of approaches, including proactive inventorying and monitoring, robust weed treatments using multiple tools, and active restoration of lands impacted by cheatgrass. Partnerships with an array of federal, state, tribal and local partners are key to the BLM's success in addressing weed infestations. BLM continues to support a comprehensive approach to weed treatments that cross ownership and administrative boundaries through our partnership with the

**U.S. Senate Committee on Energy and Natural Resources**  
**Subcommittee on Water and Power**  
**March 4, 2020 Hearing: *The Impact of Invasive Species in***  
***Bureau of Reclamation Facilities and Management of Water Resources in the West***  
**Questions for the Record Submitted to Mr. Scott Cameron**

Cooperative Weed Management Areas. We also partnered with the Nevada Department of Wildlife to complete aerial herbicide treatments on the Martin Fire, totaling approximately 15,000 acres in the Fall of 2018. BLM is also working on establishing a working partnership with the Natural Resources Conservation Service, Nevada Department of Agriculture, and U.S. Forest Service to proactively address nonnative annual grasses in Paradise Valley, NV (near the Martin Fire). Further, the BLM works in collaboration with the State of Nevada, FWS, and the Forest Service under a Shared Stewardship Agreement to prioritize landscapes in Nevada for fuels treatments. The BLM is committed to continued collaboration with agency partners and stakeholders to identify and implement necessary treatments to address invasive grasses and hazardous fuels.

- **How will the National Invasive Species Council support efforts to control cheatgrass in Nevada?**

**Response:** Wildland fire and invasive species is one of NISC's thematic priority activities for FY 2020 with the aim of advancing landscape scale approaches to the management of this problem area. NISC has formed a federal interagency task team to address the topic and is coordinating with intergovernmental groups like the Wildland Fire Leadership Council to identify joint activities to reduce risks associated with wildland fire and invasive species. Additionally, NISC staff actively participate in discussions with resource managers in the west, including through the Western Weed Coordinating Committee, the North American Invasive Species Management Association, and the Western Governors' Association to support inter-jurisdictional efforts to address invasive grasses.

