



# California Department of Fish and Wildlife: Quagga/Zebra Mussel Prevention Planning Resources

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CALIFORNIA DEPARTMENT OF  
**Fish and Wildlife**



1. Investing in Prevention
2. Code and Regulations
3. How to Prepare a Prevention Plan
  - Guidance for Developing a Dreissenid Mussel Prevention Program
  - Assessment of Vulnerability
  - Monitoring Program
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  - Documenting the Prevention Program
4. CA State Parks Division of Boating and Waterways  
Requirements for QZ Grant Program Applications
5. How CDFW Regional Staff Can Help You
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# Invasive Species Management Approach



- Prevent further introductions into and within the State
- Contain invasive species within currently infested waters
- Eradicate invasive species from infested areas, when feasible

# Quagga and Zebra Mussel Sightings Distribution in California, 2007 - 2017

## LOCATIONS

- 1: Lake Havasu - San Bernardino Co. - January 2007
- 2: Copper Basin Reservoir - San Bernardino Co. - March 2007
- 3: Colorado River Aqueduct - Riverside Co. - July 2007
- 4: Lower Otay Lake - San Diego Co. - August 2007
- 5: Skinner Reservoir - Riverside Co. - August 2007
- 6: Dixon Reservoir - San Diego Co. - August 2007
- 7: Lake Mathews - Riverside Co. - August 2007
- 8: San Vicente Reservoir - San Diego Co. - August 2007
- 9: Murray Reservoir - San Diego Co. - September 2007
- 10: Colorado River at Parker Dam - San Bernardino Co. - November 2007
- 11: Lake Miramar - San Diego Co. - December 2007
- 12: Sweetwater Reservoir - San Diego Co. - December 2007
- 13: San Justo Reservoir - San Benito Co. - January 2008
- 14: El Capitan Reservoir - San Diego Co. - January 2008
- 15: Colorado River at Imperial Dam - Imperial Co. - February 2008
- 16: Olivenhain Reservoir - San Diego Co. - March 2008
- 17: Pipeline in Lakeside - San Diego Co. - March 2008
- 18: Irvine Lake - Orange Co. - April 2008
- 19: Lake Jennings - San Diego Co. - April 2008
- 20: Rattlesnake Reservoir - Orange Co. - May 2008
- 21: Lake Ramona - San Diego Co. - March 2009
- 22: Walnut Canyon Reservoir - Orange Co. - July 2009
- 23: Anaheim Lake - Orange Co. - September 2009
- 24: Kraemer Basin - Orange Co. - September 2009
- 25: Black and Gold Golf Course Pond - Orange Co. - January 2010
- 26: Lake Poway - San Diego Co. - May 2010
- 27: Shadow Lake - Riverside Co. - April 2012
- 28: Coachella Canal Irrigation Lateral - Riverside Co. - July 2012
- 29: Coachella Canal at Avenue 56 - Riverside Co. - July 2012
- 30: Lake Cathulla - Riverside Co. - August 2012
- 31: Ridgemark Golf Course Pump - San Benito Co. - October 2012
- 32: Lake Piru - Ventura Co. - December 2013
- 33: Lower Piru Creek - Ventura Co. - January 2014
- 34: Lake Forest - Orange Co. - February 2014
- 35: Lake Forest Keys - Orange Co. - March 2014
- 36: Coachella Canal at Bridge - Riverside Co. - May 2014
- 37: Angeles Tunnel - Los Angeles Co. - December 2016
- 38: Elderberry Forebay - Los Angeles Co. - December 2016
- 39: Pyramid Lake - Los Angeles Co. - December 2016
- 40: Santa Clara River - Ventura Co. - August 2017
- 41: Santa Clara River - Ventura Co. - August 2017
- 42: Lower Piru Creek - Ventura Co. - October 2017
- 43: Upper San Gabriel R. below Morris Dam. - October 2017



Data Sources: CA Department of Fish and Wildlife, City of San Diego Water Authority, Imperial Irrigation District, Helix Water District, Irvine Ranch Water District, Coachella Valley Water District, National Park Service, CA Department of Water Resources, Los Angeles Department of Water and Power, United Water Conservation District. Map produced by the California Department of Fish and Wildlife, December 15, 2017.



# Mussel Biology



- Freshwater bivalve
- Broadcast spawner
  - 1 million eggs/year
  - Year-round spawning in warmer waters
- Two life stages
  - Adult: Benthic (bottom)
  - Veliger: Planktonic (free floating in water column)



# Investing in Prevention: Impacts to the Environment



- Disrupt the food chain
- Out-compete other species
- Change water quality



# Impacts to Recreation



- Ruin boats
- Require expensive decontamination
- Some lakes have restricted access
- Mandatory inspection programs



K. Aubushon Lake Mead 5/2011



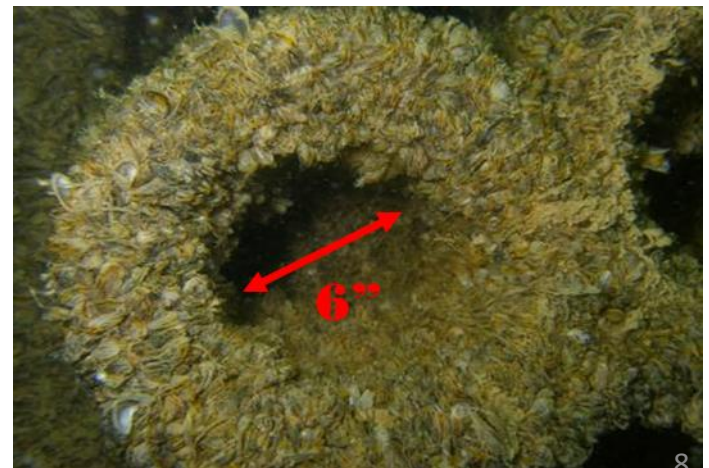
# Impacts to Infrastructure



- Dense populations clog pipes, pumps, fire suppression and components of water supply system
  - Removal = on going cost
- Metropolitan Water District spent \$30 million in 5 years on control



Davis Dam, Lake Mohave





# Questions and Discussion



# California Department of Fish and Wildlife Mussel Laws



## **Fish and Game Code §2301**

- Restricts importation, possession and transport of dreissenid mussels
- Authorizes inspection of conveyances
  - Enforcement authority to CDFA and State Parks
- Authorizes inspection of waters of the state
- Requires reporting of mussel detections
- Requires Control Plans

## **Fish and Game Code §2302**

- Applies to reservoirs open to the public
- Requires assessment of the vulnerability of introduction
- Requires Prevention Programs

# Mussel Regulations

(Effective on April 1, 2016)



## Title 14 §672

- Definitions
  - (a)(6) “Introduction” means the intentional or unintentional placement of adult or veliger dreissenid mussels into a reservoir.
  - (a)(7) “Prevention Program” is a written document that describes the actions to be implemented at a reservoir to keep dreissenid mussels from being introduced and keep them from being moved from the reservoir should they be present.
- Dead Mussel Permits

# Mussel Regulations

(Effective on April 1, 2016)



## **Title 14 §672.1(a) and (b)**

- Control Plan
- Prevention Program
- Annual reports
- Inspection of conveyances

## **Title 14 §672.2**

- Penalty and appeal procedures



# CCR Title 14, Section 672.1(b)



- Requires reservoir owners/managers to summarize their Prevention Program in a written “Plan”
- Plan must include:
  - Vulnerability assessment for the introduction of mussels
  - Monitoring for mussels
  - Management of recreational activities, and education and outreach
- Submit annual reports by March 31 covering the prior January 1 – December 31
  - Summarize any changes in reservoir’s vulnerability, monitoring results, and management activities

# Questions and Discussion



# How to Prepare a Prevention Plan



## Plan Elements

- Description of regulatory and environmental settings
- Vulnerability Assessment – risk of introduction
- Mussel monitoring
- Management of recreation
- Public education

# Prevention Plan Introduction



Provide an introduction to the managing authority and each waterbody

- Regulatory setting
- Environmental setting
  - County, acre/feet, source water, access, # of launch ramps, fish stocking, etc.
  - Recreation that takes place: fishing, boating, hiking, camping, hunting, fishing tournaments, use of live bait
  - Could be displayed in a table



# Types of Risk



## Introduction

The potential mussels will be brought into a waterbody

## Establishment

The potential mussels, if introduced into a waterbody, will survive and reproduce in that waterbody

## Pathways

Mussel biology and water chemistry

## Vulnerability Assessment

Monitoring and management actions

# Vulnerability Assessment



Identify pathways: natural  
& human-mediated

Describe the pathways:  
who, what, where, & when

Identify potential  
management actions

# Vulnerability Assessment



## Assesses the Potential Introduction of Mussels

- Examining Pathways
  - Source of water
  - Recreational activities
    - Boating
    - Fishing
    - Fishing tournaments
    - Sea/float planes
  - Maintenance equipment
  - In-water equipment
  - Firefighting equipment
  - Research



# Common Pathways of Introduction



Natural Pathways	Potential management actions to prevent mussel introduction via this pathway (including education and outreach)
Open water flowing from upstream sources	Chlorination, filtration
Flooding	
Human-mediated Pathways	Potential management actions to prevent mussel introduction via this pathway (including education and outreach)
<b>Watercraft</b> Motorized Ballast ski boats Non-motorized Law enforcement Natural resource agencies Rental	Self-inspections, inspections by trained staff at the waterbody, mandatory dry periods, decontamination, etc.
<b>Fishing</b> Anglers / Angling equipment Fishing tournaments Live bait Fish planting	Inspect fishing gear, provide gear cleaning stations, conditions on fishing tournaments, inspect live bait (check origin of live bait), restrict live bait, etc.



# Common Pathways of Mussel Introduction



Human-mediated Pathways	Potential management actions to prevent mussel introduction via this pathway (including education and outreach)
<b>In-water equipment</b> Construction equipment Docks Buoys Floating restrooms Firefighting tanker trucks or equipment	Inspect all incoming equipment, allow sufficient dry time if equipment cannot be drained, coordinate with firefighting agencies for inspections of equipment, decontaminate equipment used previously, etc.
<b>Facility maintenance</b> Large equipment Field gear and equipment	Inspect maintenance gear and equipment, if managing multiple waterbodies have dedicated equipment, etc.
<b>Aerial contact</b> Sea planes Float planes Firefighting aircraft	Prohibit planes coming from infested waters, etc.
<b>Research</b>	Inspect gear, require mandatory decontamination of equipment prior to use at waterbody, etc.

# Example Pathway Assessment



**Pathway: Pleasure boating (no fishing from watercraft); includes motorized and non-motorized**

<b>Who:</b>	The public
<b>What:</b>	Boaters come from throughout the state for day-use boating; many visitors are local residents
<b>Where:</b>	Happy Valley Lake; north and south boat ramps with self-service pay kiosks
<b>When:</b>	Open for boating year-round; visitation highest May-October from sunrise – dusk

**Current efforts to prevent or mitigate an introduction:**

None

**Potential management options to prevent or mitigate an introduction:**

- Watercraft inspection program for all watercraft (install gates, limit access hours)
- Offer banding for returning boats to expedite launching
- Self-serve decontamination unit on-site
- Limit boating season to highest use times

**Education and outreach opportunities:**

- Conversation preceding and during inspection will convey information
- Post informational poster and handouts on kiosks
- Post permanent metal signs at each boat ramp

# Incorporating Risk of Establishment



Based on mussel biology, and physical and chemical properties of the waterbody

- Calcium
- Salinity
- Temperature (minimum and maximum)
- pH

Considered for selecting appropriate

- Mussel monitoring
- Management actions

# Why Monitor?



- Required by law
- Required by DBW of grant applicants
- Provides a measure of prevention program effectiveness
- Early detection is key
- Stop the spread to other waters



# Monitoring Methods



- Surface survey
- Artificial substrate
- Plankton tow

# Monitoring – Surface Surveys



Life Cycle Stage	Optimal Sampling Frequency	Optimal Sampling Period	Equipment Cost	Relative Cost
Juveniles & Adults	Twice Monthly	Year round	Minimal	\$



# Monitoring – Artificial Substrates



Life Cycle Stage	Optimal Sampling Frequency	Optimal Sampling Period	Equipment Cost	Relative Cost
Juveniles & Adults	Monthly	Year round	\$50 Substrates, lines	\$\$





# Monitoring – Plankton Tows



Life Cycle Stage	Optimal Sampling Frequency	Optimal Sampling Period	Equipment Cost	Relative Cost
Veliger (larvae)	Monthly based on water temperature and risk	<u>Warm Climates:</u> Year Round <u>Seasonal Climates:</u> May - Oct.	\$200 Net, line	\$\$\$\$



# Calcium concentration > 24 mg/L



## Dreissenid Mussel Biology

- Adult mussels survive long-term
- Reproduction and full life-cycle completion occurs
- Introduced veligers (any developmental stage) can survive
- Calcium is not a limiting factor
- Dense infestations highly likely, if introduced

## **Monitoring Regime**

- Plankton tows (frequency based on settlement as a function of water temperature)
  - CDFW- 1/month 12-28 °C
  - Water agency- 1/month, 12-28 °C
  - Water agency- 1/2 weeks, 16-24 °C
- Artificial substrate surveys, at each plankton tow visit
- Surface surveys, monthly

# Calcium concentration 15 - 24 mg/L



## Dreissenid Mussel Biology

- Adult mussels survive long-term
- Reproduction can occur, but survivorship is reduced due to inadequate calcium for veliger development
- Survivorship increases as calcium increases up to 24 mg/L
- Minimum calcium required for (> 0%) veliger survival:
  - 15 mg/L for zebra mussels
  - 18 mg/L for quagga mussels
- Introduced, later-stage veligers likely to survive

## **Monitoring Regime**

- Plankton tows
  - Water agency- 1/month, while water temps are between 12-28 °C
- Artificial substrate surveys, monthly (CDFW or water agency)
- Surface surveys, monthly (CDFW or water agency)

# Calcium concentration 12 - 15 mg/L



## Dreissenid Mussel Biology

- Adults mussels can survive long-term
- Reproduction may occur, but veligers cannot survive
- Introduced, late-stage veligers may survive and settle out of the water column

## **Monitoring Regime**

- No CDFW plankton tows
- Artificial substrate surveys (where Ca >13 mg/L)
- Water agency surface surveys
- If agencies choose to conduct plankton monitoring, samples must be sent to an external lab. Bodega Marine Lab will engage for any suspect veligers.

**Waterbody: Happy Valley Lake (Calcium concentration 28 mg/L)**

Monitoring Method	Location(s)	Dates	Frequency	Agency
<b>Plankton sampling</b>	<ol style="list-style-type: none"> <li>1. North boat ramp</li> <li>2. South boat ramp</li> <li>3. Dam</li> <li>4. Outlet</li> <li>5. Happy Valley Marina</li> <li>6. Floatable Port-a-potties</li> <li>7. Rush Creek inlet</li> </ol>	May – October	Twice per month	Plankton sampling: Happy Valley Water District Sample analysis: CDFW- Bodega Shellfish Health Lab
<b>Surface surveys</b>	<ol style="list-style-type: none"> <li>1. North boat ramp and dock</li> <li>2. South boat ramp and dock</li> <li>3. Full length of dam from surface to 3' below surface</li> </ol>	May – October May – October Year-round	Once per month	Happy Valley Water District
<b>Artificial substrates</b>	<ol style="list-style-type: none"> <li>1. Sheriff boat dock</li> </ol>	Year-round	Once per month	Happy Valley Water District

# Management of Recreational Activities



- Inspections
  - Self, screening, trained staff
- Decontamination, dry time, exclusion, banding
- Gear cleaning stations
- Live bait restrictions or inspections
- Restrict access (locking gates)



# Public Education



- Signs and rack cards
- Interpretive programs at waterbody
- Train and educate staff so they can educate the public
- Information on your agency's website, informing public of your Prevention Program
- Presentations to surrounding communities

\*CDFW can provide posters and rack cards



## HELP PREVENT THE SPREAD OF QUAGGA AND ZEBRA MUSSELS

**REMOVE** plants, animals & mud from gear, boat, trailer & vehicle before you leave the area.

**CLEAN** your gear before entering & leaving the recreation area.

**DRAIN** bilge, ballast, wells & buckets before you leave the area.

**DRY** equipment before launching into another body of water.

**DISPOSE** of unwanted bait in the trash.

**WAIT** before launching into different fresh waters. Waiting periods can vary – check with your local water body.



[www.wildlife.ca.gov/mussels](http://www.wildlife.ca.gov/mussels) | 866-440-9530





# Annual Report



- Summarize any changes in vulnerability
- Monitoring Results
  - Mussel monitoring
  - Water quality
  - Visitor use information
- Implemented Management Activities
  - Description of action, pathway(s) addressed and relevant details

# Mussel Prevention Plan Review



- Submit or resubmit Plan to CDFW
- Comments returned
- Resubmit plan
- CDFW acceptance letter
- Revision of Plan

# Questions and Discussion



# CA State Parks Division of Boating and Waterways Quagga and Zebra Mussel Infestation Prevention Program Grant Applications

## Planning and Assessment Grants

- Data collected since March 2018 indicating waterbody is uninfested

## Implementation Grants

- Letter from CDFW stating that their Prevention Plan has been accepted
- Data collected since March 2018 indicating waterbody is uninfested

# Questions and Discussion



# How CDFW Regional Staff Can Help You Prepare a Prevention Plan



- Plan preparation
  - Identify potential vectors for mussel introduction
  - Suggestions for prevention measures
- Training
  - Monitoring methods
  - Watercraft inspections
  - Inspection tracking
- Water quality sampling
- Mussel monitoring
- Plankton sample analysis
- Provide educational materials such as signage and handouts

# CDFW Contact Information



## Region 1 - Northern Region

Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity

L. Breck McAlexander

[Louis.McAlexander@wildlife.ca.gov](mailto:Louis.McAlexander@wildlife.ca.gov)

Office: (530) 225-2317

## Region 2 - North Central Region

Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba

Angie Montalvo

[Angie.Montalvo@wildlife.ca.gov](mailto:Angie.Montalvo@wildlife.ca.gov)

Cell: (530) 333-7749

## Region 3 - Bay Delta Region

Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo

Catherine Mandella

[Catherine.Mandella@wildlife.ca.gov](mailto:Catherine.Mandella@wildlife.ca.gov)

Cell: (831) 588-1463

## Region 4 - Central Region

Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne

Robert Delmanowski

[Robert.Delmanowski@wildlife.ca.gov](mailto:Robert.Delmanowski@wildlife.ca.gov)

Office: (559) 243-4017 X-285

## Region 5 - South Coast Region

Counties: Los Angeles, Orange, San Diego, Santa Barbara and Ventura

Eloise Tavares

[Eloise.Tavares@wildlife.ca.gov](mailto:Eloise.Tavares@wildlife.ca.gov)

Office: (562) 342-7155

## Region 6 - Inland Deserts Region

Counties: Imperial, Inyo, Mono, Riverside and San Bernardino

Ian Ralston

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# Questions and Discussion



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