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Managing Water in the West

Facility Impacts, Water Testing, & Mussel Control Research

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U.S. Department of the Interior
Bureau of Reclamation

Reclamation's Mission

The core mission of the Bureau of Reclamation is to operate and maintain projects to ensure continued delivery of water and power benefits to the Western States

- Reclamation delivers 10 trillion gallons of water to more than 31 million people each year
- Reclamation is the second largest producer of hydro-electric power in the Western U.S.

Reclamation Assets

- 348 storage reservoirs
- 254 diversion dams
- 16,075 miles of canals
- 1,460 miles of pipelines
- 280 miles of tunnels
- 37,495 miles of laterals
- 17,040 miles of project drains
- 268 pumping plants over 1,000 horsepower
- 58 hydroelectric powerplants

Vulnerable Systems & Equipment

Invasives can potentially impact systems, equipment, and instrumentation in contact with raw water:

Piping	Cooling Water Systems	Pumps & seals
Trashracks	Strainers	HVAC
Grates	Supply piping & tubing	Fire suppression systems
Screens	Packing & stuffing boxes	Nozzles
Stoplogs & bulkheads	Generator air coolers	Bubblers
Gates & valves	Bearing oil coolers	Storage tanks
Penstocks	Compressor coolers	Hose taps
Water level sensors	Transformer coolers	Fish ladders
Stilling wells	Turbine pit drains	Diffusers
Float controllers	Unwatering Drains	Separators
Air vents	Drainage systems & sumps	Fish screens
Flowmeters	Float switch arrangements	Fish bypasses
Press & temp gauges/sensors	Eductors	

Invasive Species

$120 Billion spent annually on invasive species in the United States.

David Lodge, Notre Dame 2014

Invasive species have been identified as a priority at the highest levels of the Department in the Invasive Species Action Plan. The technologies that you work on have been acknowledged as critically important by our advisory committee that provides advice to the NISC members including the Sec. of the Interior.

Chris Dionigi, Assistant Director National Policy and Programs, National Invasive Species Council June 2014

The Invasive Species Program

Fred Nibling & Julie Nachtrieb
Water Primrose Biocontrol Project

IPM:

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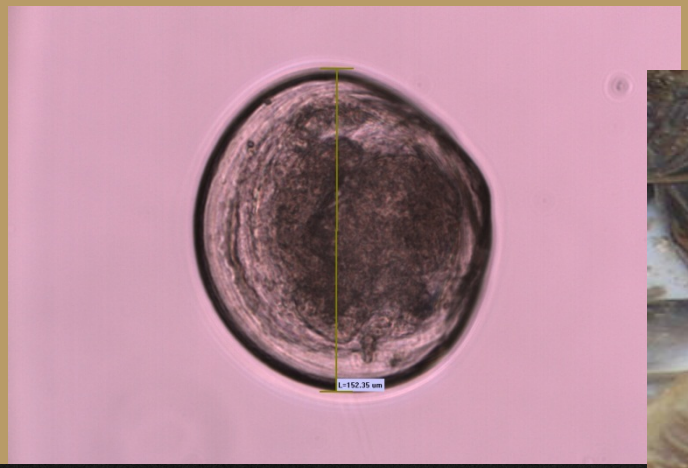
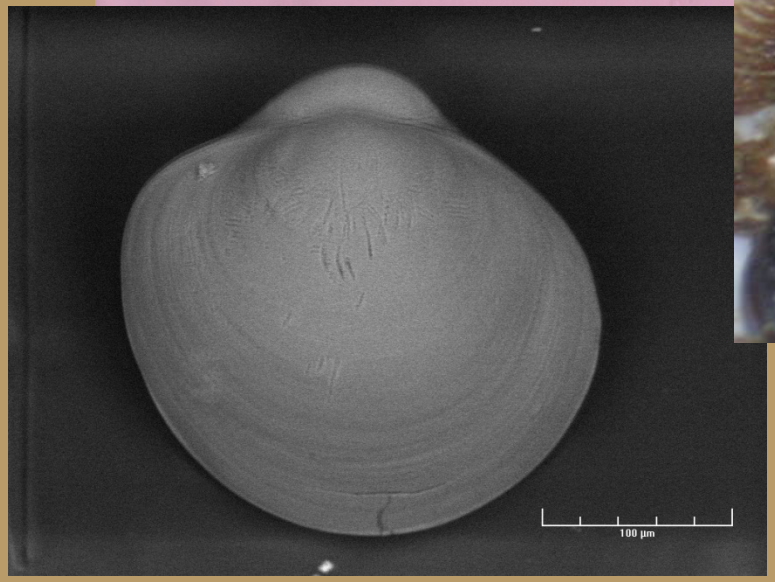
Western State AIS of Concern

- Eurasian watermilfoil
- Hydrilla
- Giant salvinia
- Water hyacinth
- Phragmites
- Purple Loosetrife
- Tamarisk
- Russian Olive
- Asian carp
- Golden Mussels
- New Zealand Mudsnail
- Rusty Crayfish
- White Perch
- Zebra & Quagga Mussel

Dreissenids – Quagga and Zebras





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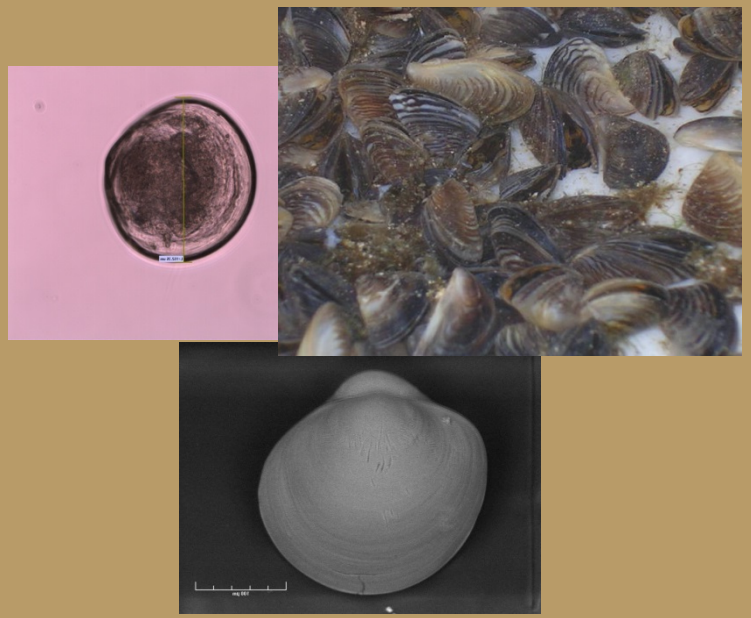
Initial Reclamation findings in the Colorado River



Map by Chris Holdren

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Davis Dam Bulkhead Gate – Oct 2007

2007 Immediate Concerns

- Potential shutdown water delivery and hydropower generation functions
- Facility structures and/or components in direct contact with raw water are susceptible to mussel-related impacts
- Larval mussels disperse and are transported via currents. With high fecundity settlement densities can reach tens of thousands per m^2
- Protection strategies
  - Proactive – Prevents settlement in critical systems/structures
  - Reactive – Periodic manual removal after settlement
  - Retrofit – redundant systems

Reclamation Actions Taken

- **Facility Vulnerability Assessments**

Joe Kubitschek, Fred Nibling, Leonard Willett, Dave Tordonato, and Scott O'Meara under the guidance of Renata Claudi (RNT Consulting Inc.)

- **Control Research**

Joe Kubitschek, Leonard Willett, and Sherri Pucherelli in cooperation with Renata Claudi (RNT Consulting Inc.)

- **Dreissenid Detection & Monitoring**

Denise Hosler & RDLES Staff
Kevin Bloom, Suzanne Brenimer, Jamie Carmon, Tanna George, Andrew Humes, Jacque Keele, Kevin Kelly, Susan McGrath, Rachael Lieberman, Sherri Pucherelli, Jeremiah Root, Ben Roske, Kyle Rulli, Kevin Scofield, Francesca Tordonato, Scott Thullen, Anne Williamson, Dan S. Williamson, and numerous interns. Additional Reclamation staff: Curtis Brown, Chris Holdren, Michael J Horn, Davine Lieberman, and S. Mark Nelson, Michael Simonavice, and Richard Wydowski.

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Facility Vulnerability Assessments

- Provides information on vulnerability of facility features to invasive mussel impacts

- Assists in anticipating potential impacts and planning responses and budgeting.

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Flow restriction

- Live mussel attachment & shell debris accumulation
- Potential for complete blockage
- Roughening (Friction loss)
- ↑ Head loss = ↓ Discharge & Power generation capacities
- Settlement can occur at velocities < 6 ft/s
- Can remain attached at higher velocities

Ecological/Environmental

- Food chain & habitat
- Water quality

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…And then Enhanced Aquatic Weed Growth

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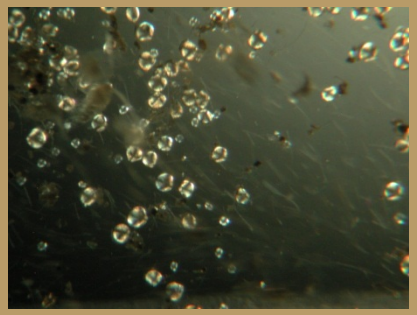
Reclamation Detection Laboratory for Exotic Species (RDLES)



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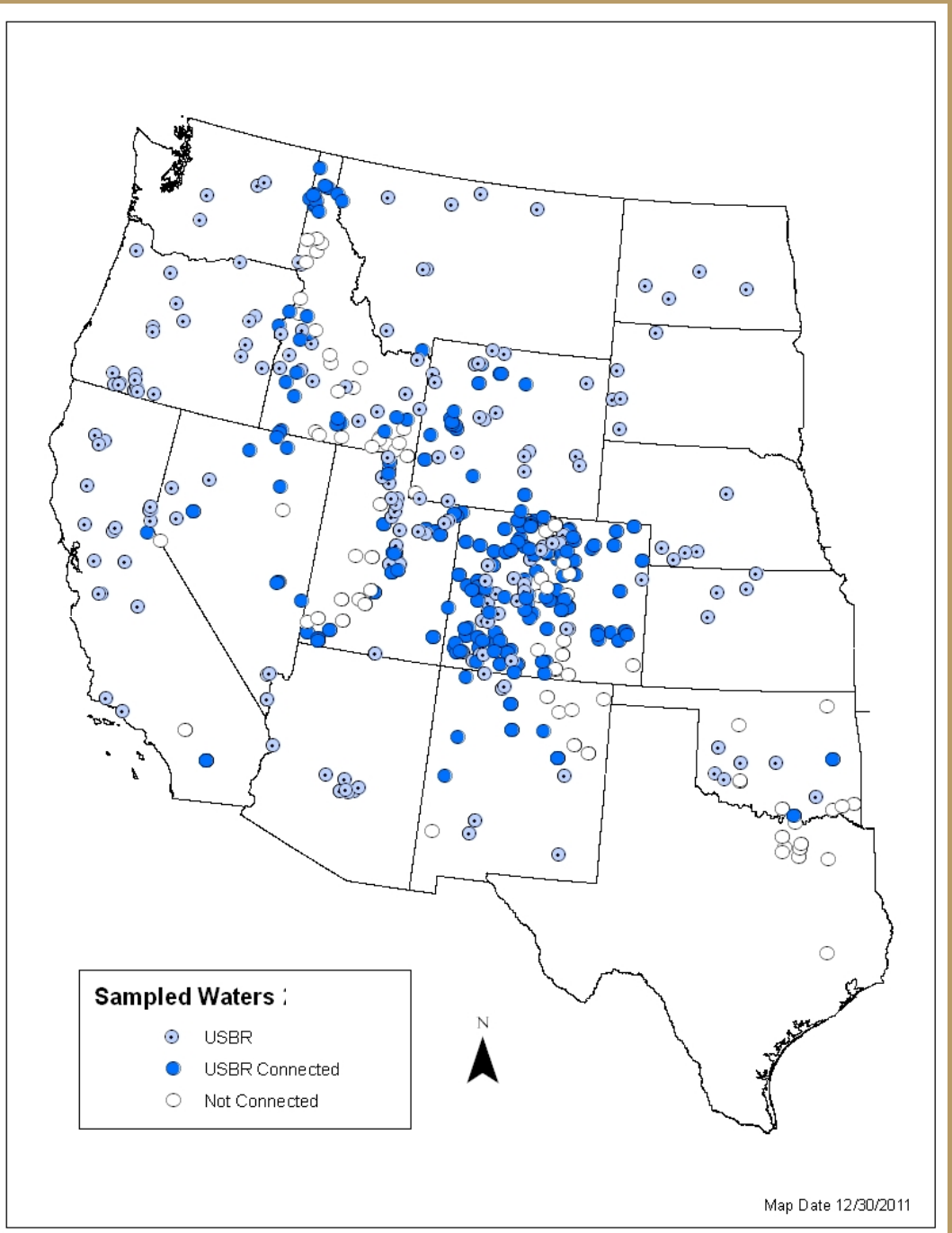
2007-2015



425 water bodies sampled by USBR, State and local partners

15,915 samples collected and tested

15 States collaborated in this program in 2011

2011 Began performing all tests on any sample where a “body” had been found

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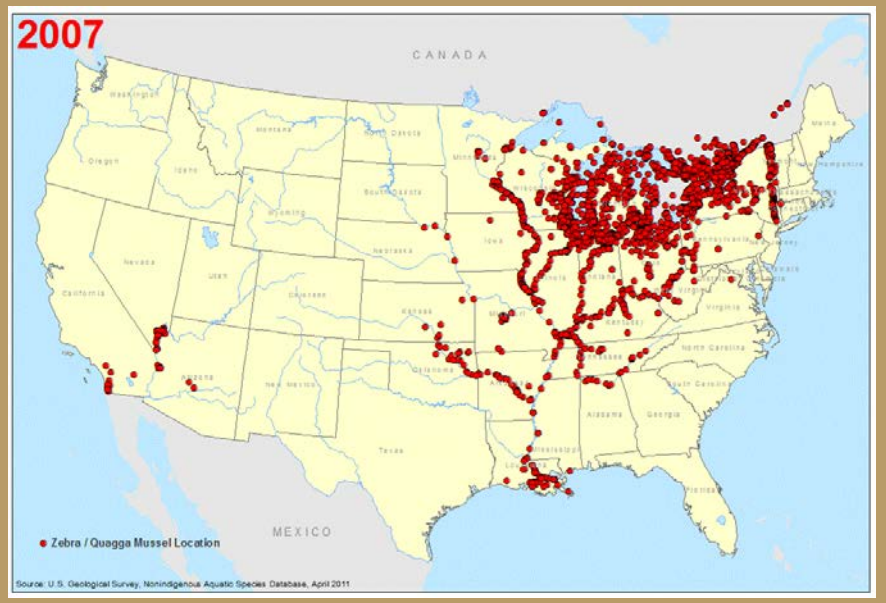

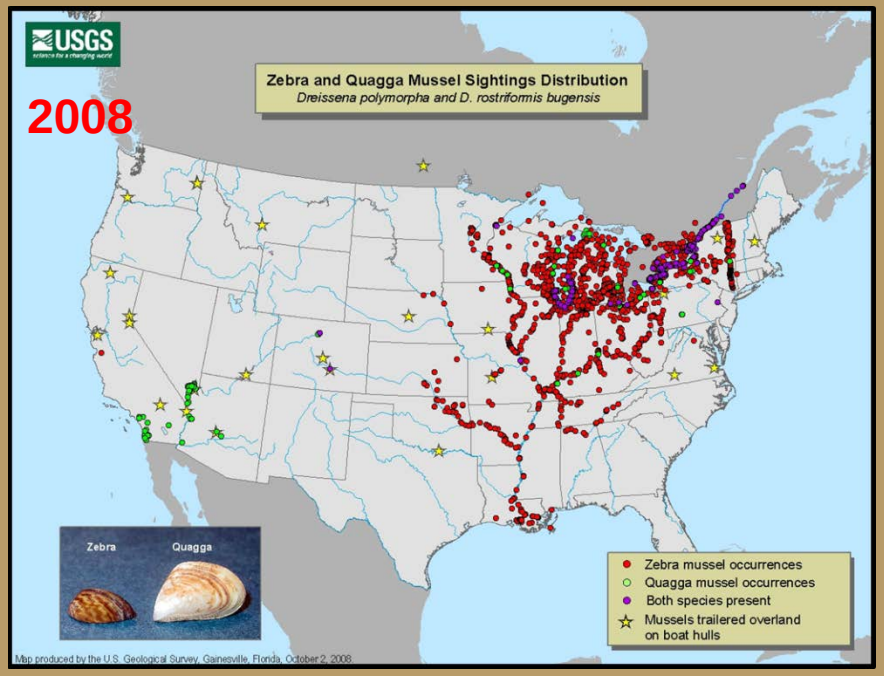

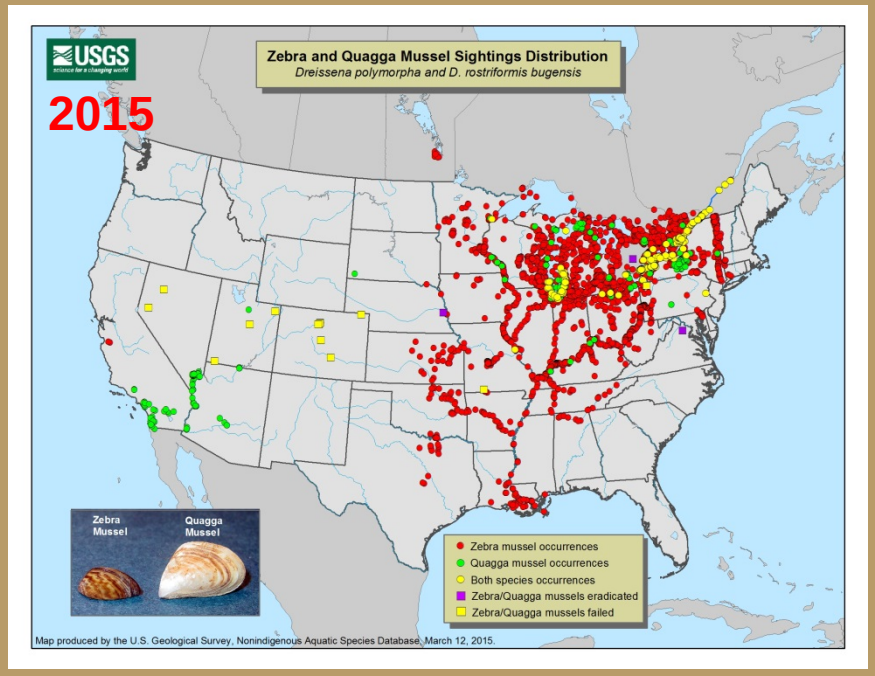

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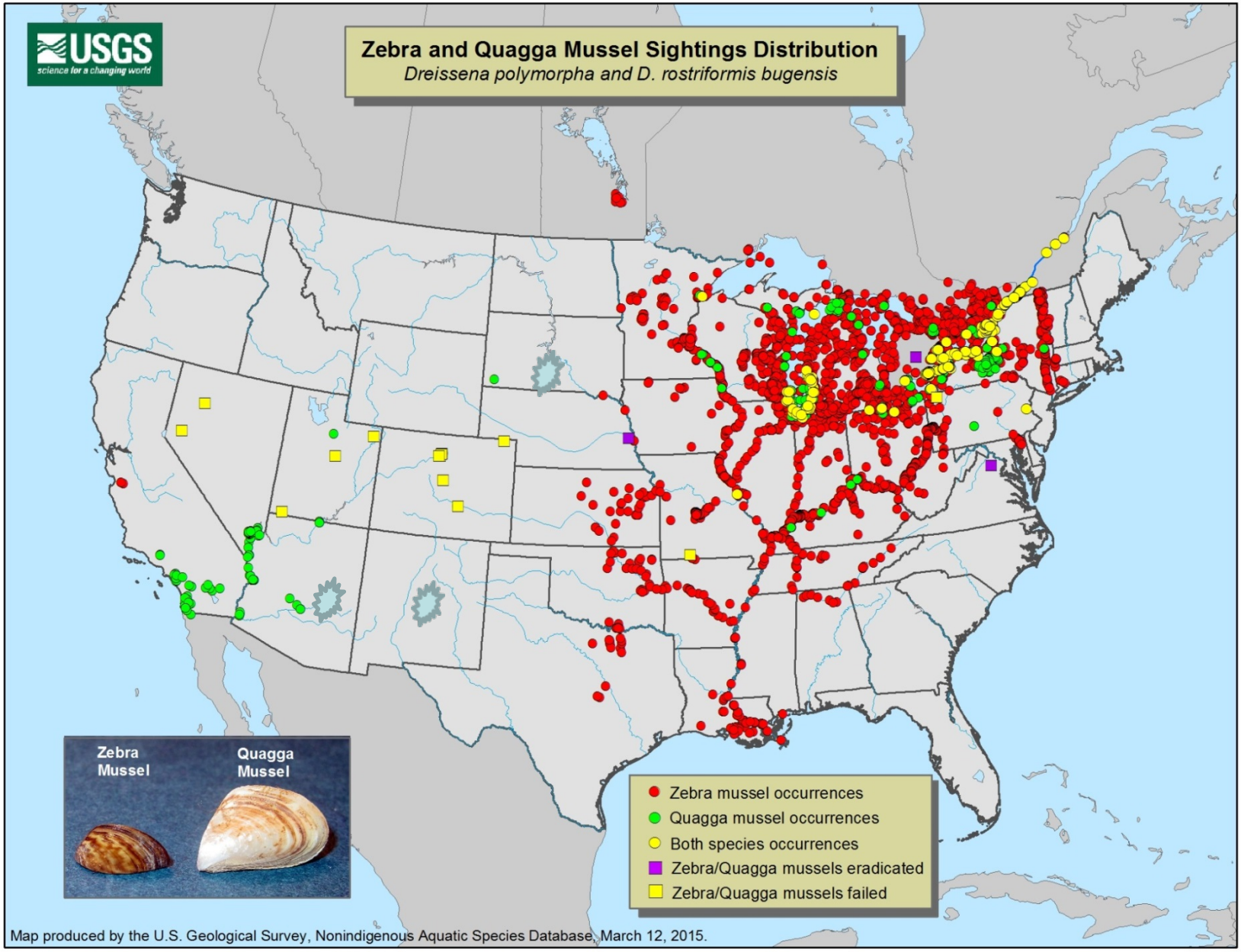

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FWS Test Protocol 2009 & 2011

- **2 double-blind round-robin tests: XPL the most sensitive and accurate method**
- **PCR results were less sensitive and less reliable than XPL (75.8% vs. 96.3%)**
- **For presence/absence: PCR 7x more likely to produce an incorrect result**
- **False NEGATIVES were the most common error for all methods**

- **RDLES conducts research to optimize every step of the sample collection and analysis process**
  - **Field collection**
  - **Processing**
  - **Analysis**

- **Techniques can be used to monitor other invasive or endangered species**

Sample Preservation Studies

Sample preservation impacts detection of veligers by PCR

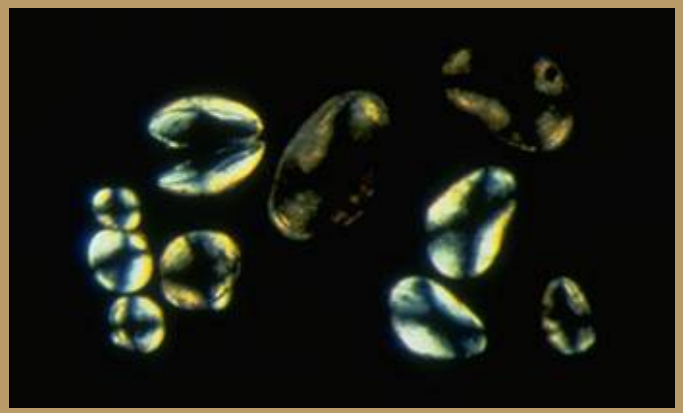
- **Samples with acidic pH**
- **Negative microscopy but positive PCR**

Tested detection after 1, 6, 21, & 42 days

- **Alcohol concentration**
- **Buffered vs. unbuffered**
- **Zooplankton concentration**

Best Preservation Method

- **20% alcohol per volume**
- **0.2 g baking soda per 100 mL**

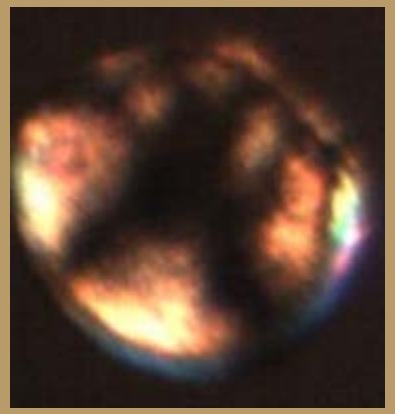


Veliger Degradation

Buffered sample (XLM): pH 8

24 hours

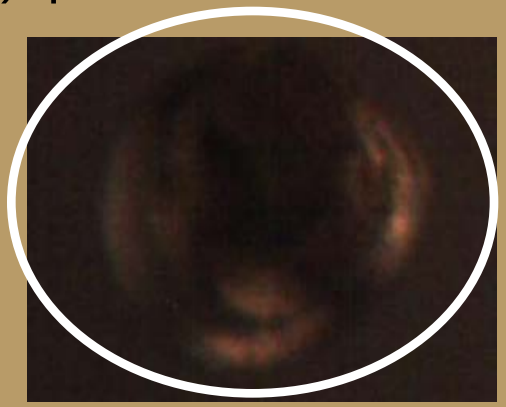
7 days



14 days

Unbuffered sample (XLM): pH 5

24 hours



7 days

14 days

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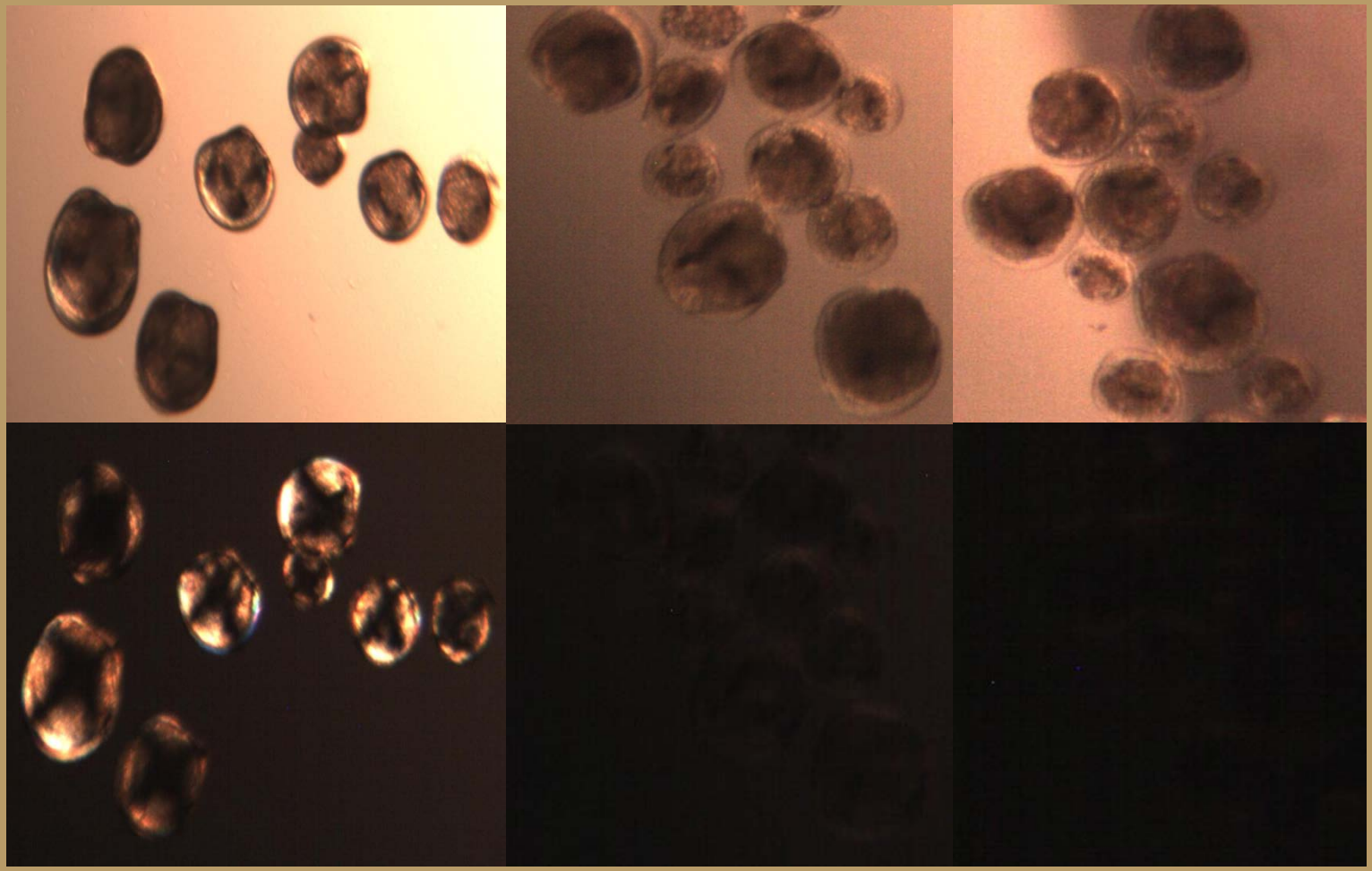
Macro View of Birefringence Loss: Unbuffered Samples pH 5

7 Days | 14 Days | 21 Days



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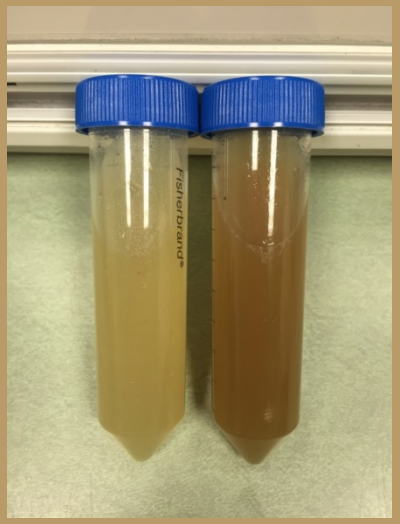
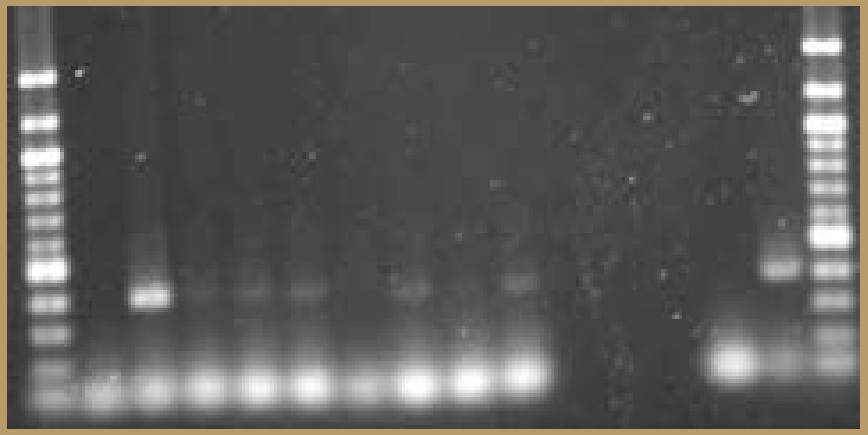
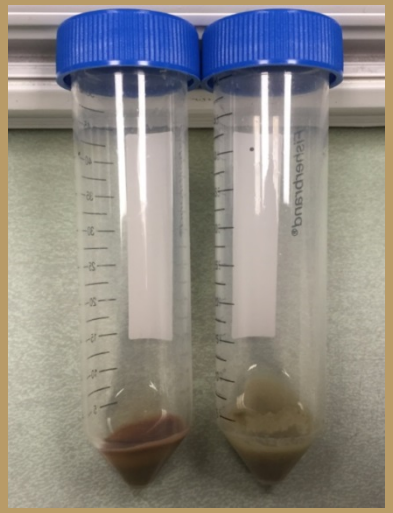
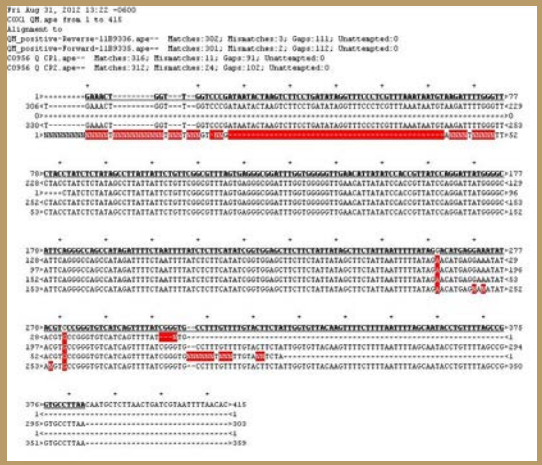
Optimization of PCR Analysis for Invasive Mussels









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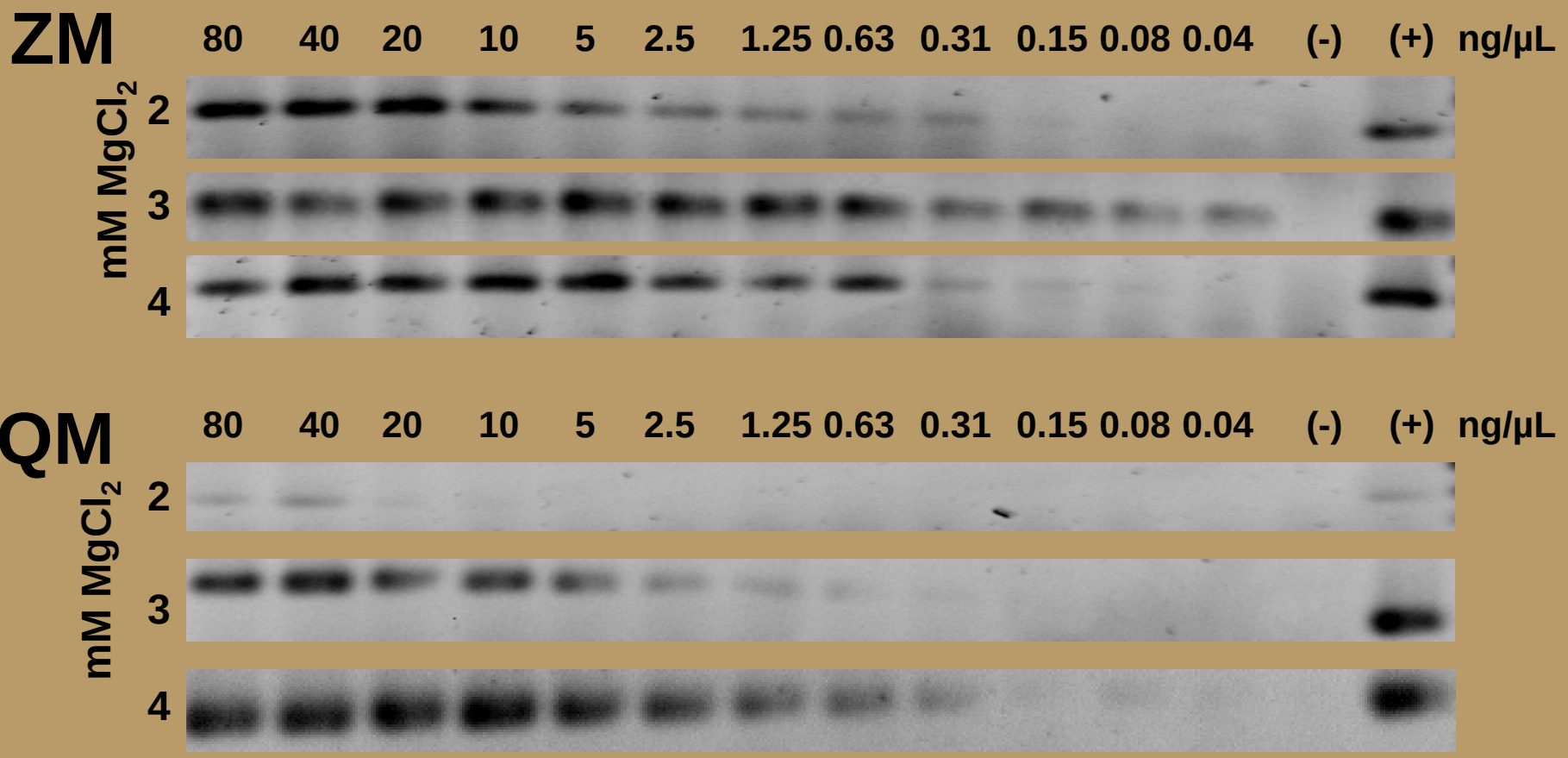
ZM/QM Concentrations in DI Water



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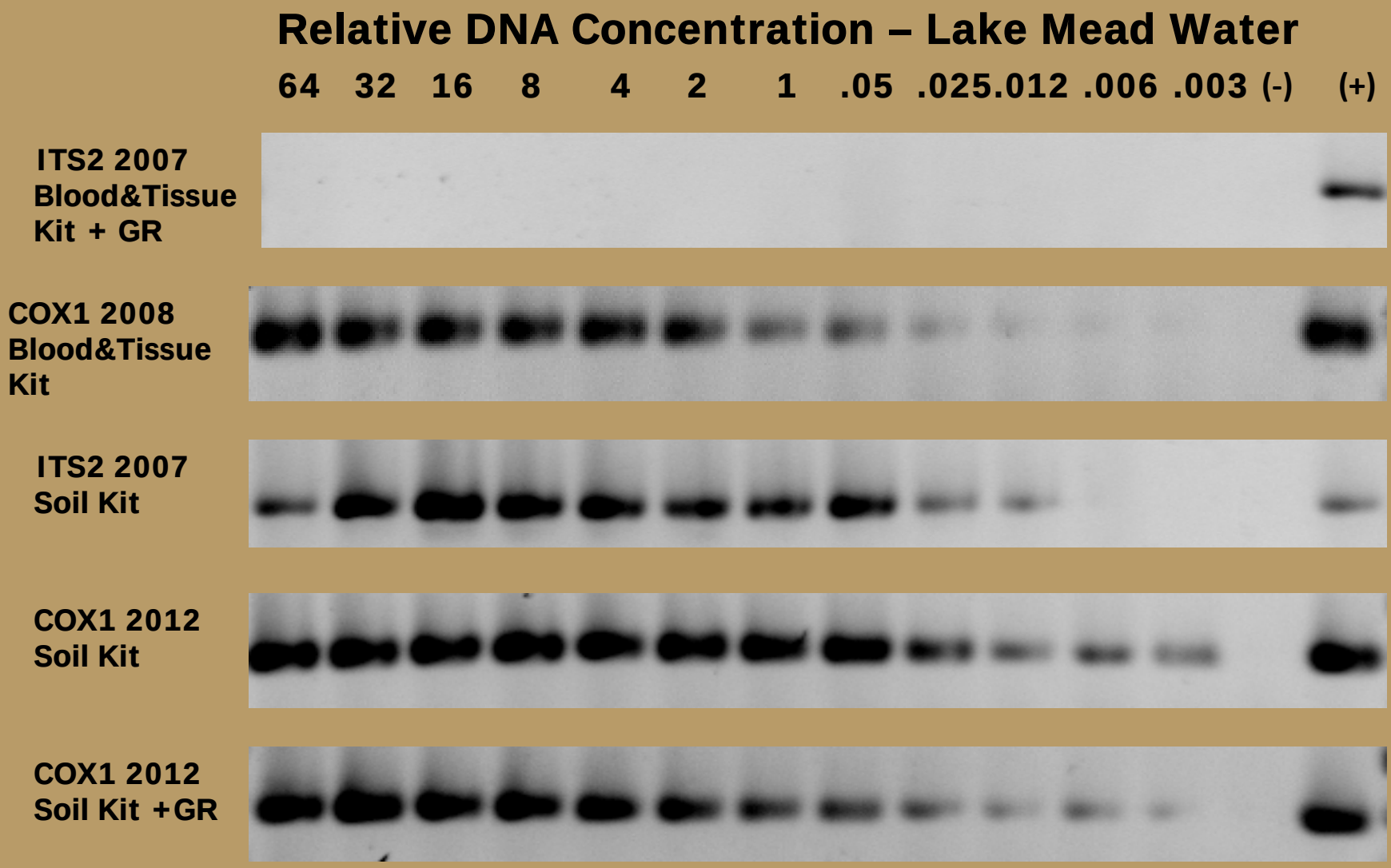
Evolution of PCR Methods



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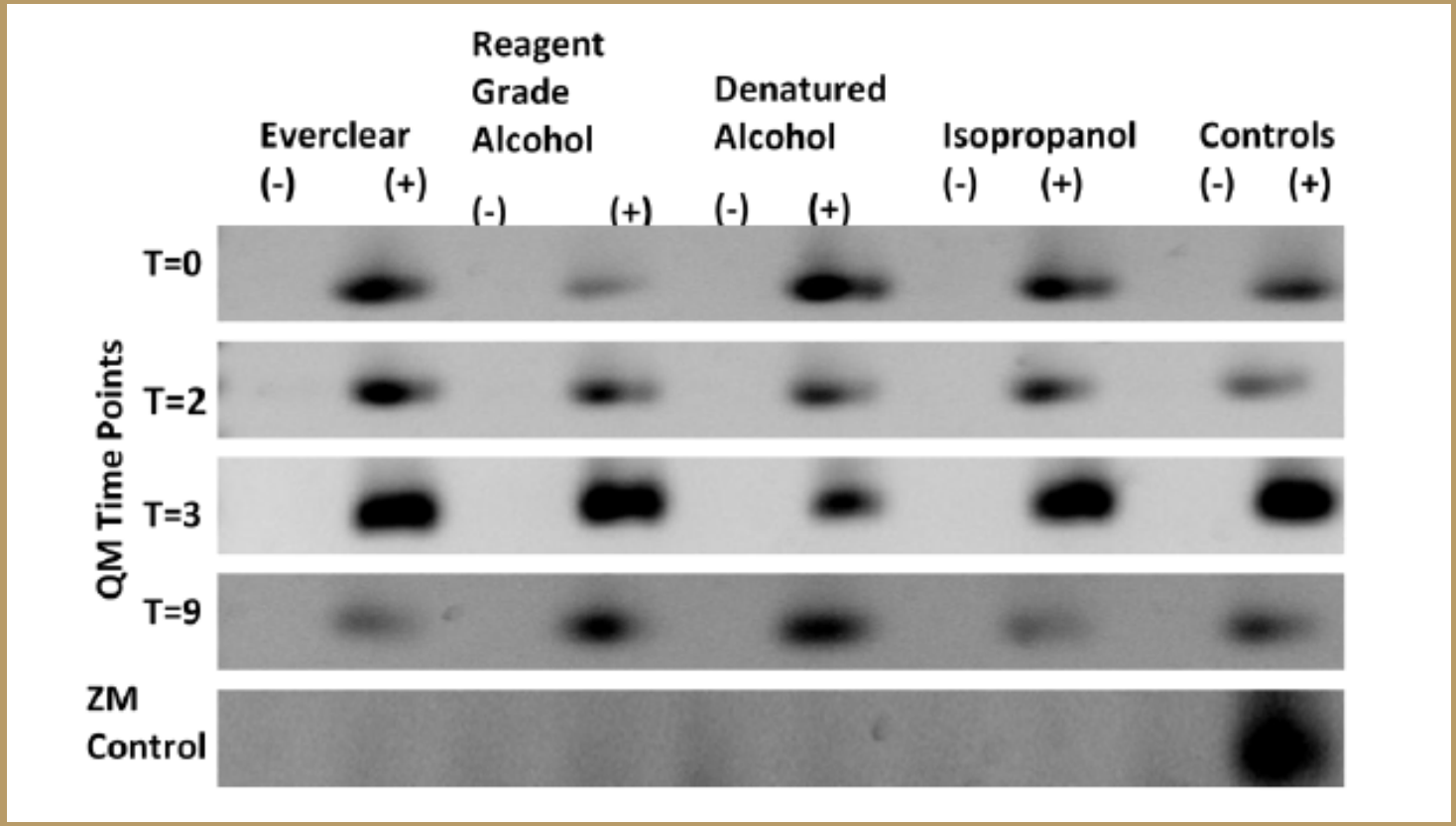
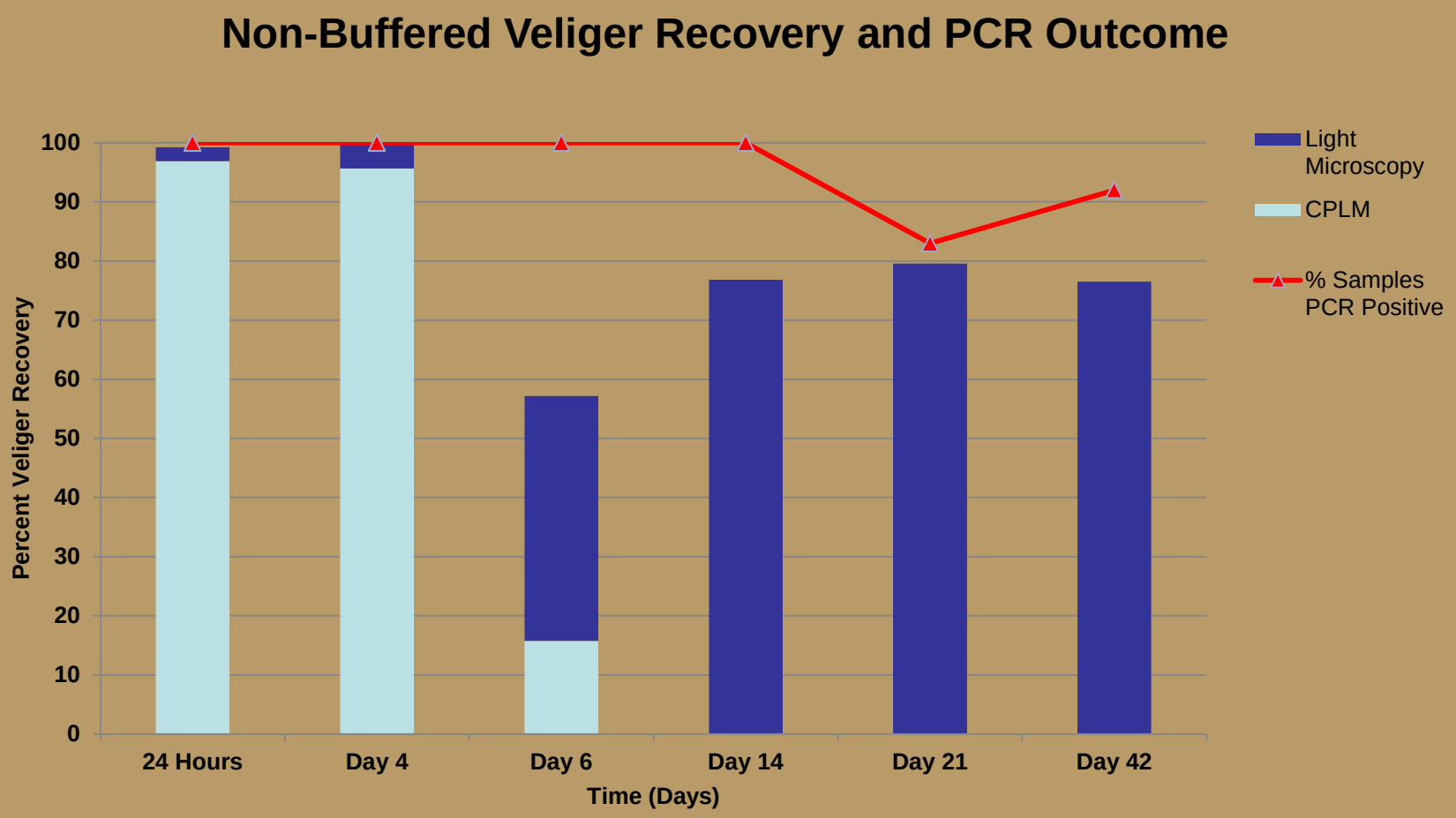
Different Types of Alcohol Used to Preserve the Samples



Samples Can Be PCR Positive with Veliger's that Do Not Birefringe



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eDNA Assays

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Program Results

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Where do we find them?

- Of 327 water samples, statistical analysis revealed that 59.3% positives occurred at a marina/boat launch. Zehfuss (2008)

- Samples analyzed from 2009 to 2012:
  Samples analyzed: 11,683
  Positive samples: 419 or 4%

52 positives water bodies (excluding known positive waters)	
8 at dam	15%
31 at marina/boat launch	60%
12 at midlake	23%
1 at hatchery	2%
Total	100%

85 positive water bodies (including known positive waters)	
14 at dam	17%
41 at marina/boat launch	48%
13 at midlake	15%
2 at no boating reservoirs	2%
2 at hatchery	2%
4 at a canal	5%
9 in a river	11%
Total	100%

Detection ≠ Infestation

Positive Results 2008-2016:

Total Samples: 15,915

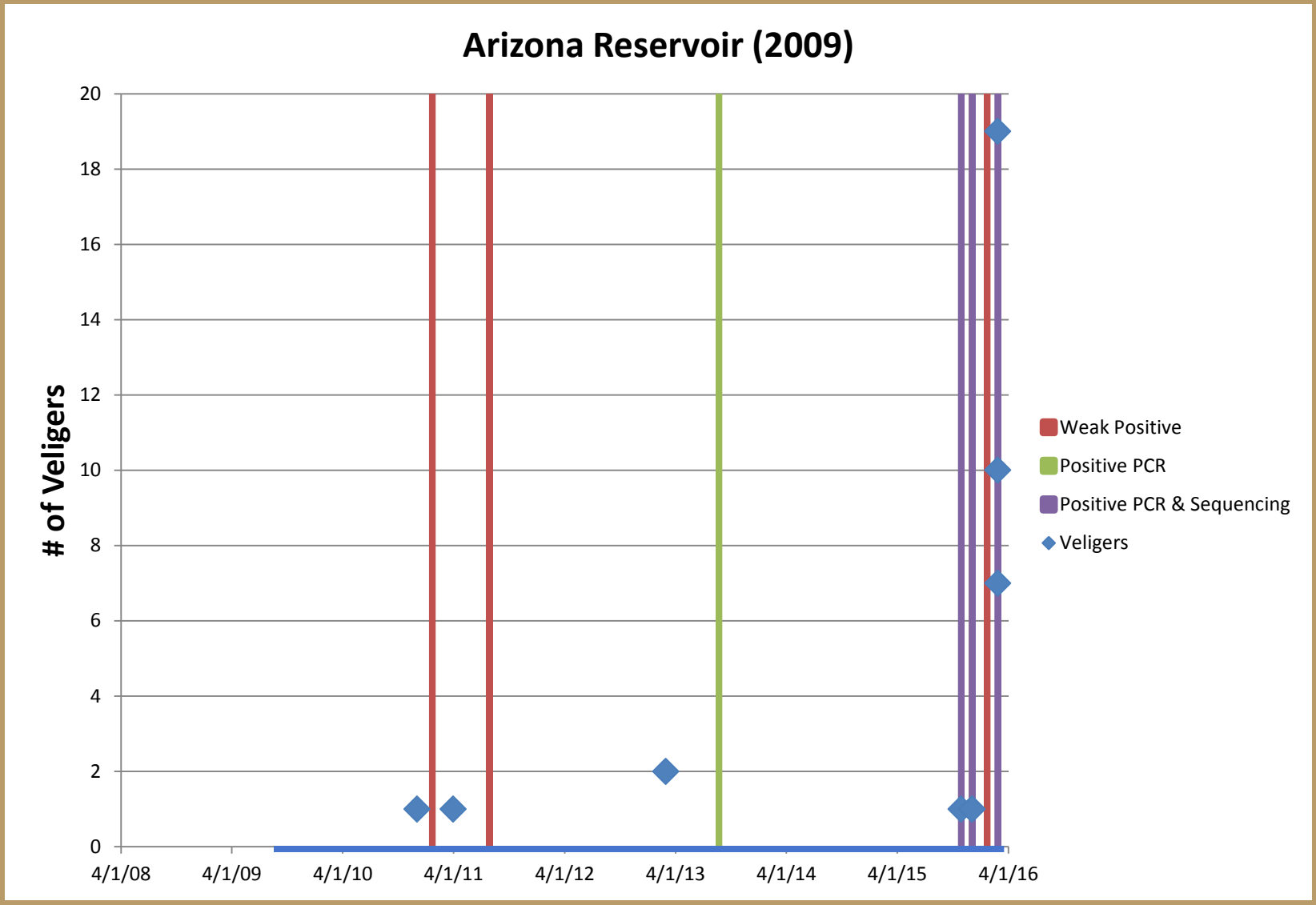
Total Positives: 790 samples in 11 states
(By microscopy = 67 water bodies)

Positives at each water body:

1	2	>3
46	17	20

(Each water body has 3-4 sample locations)

……and the value of eDNA without the body:



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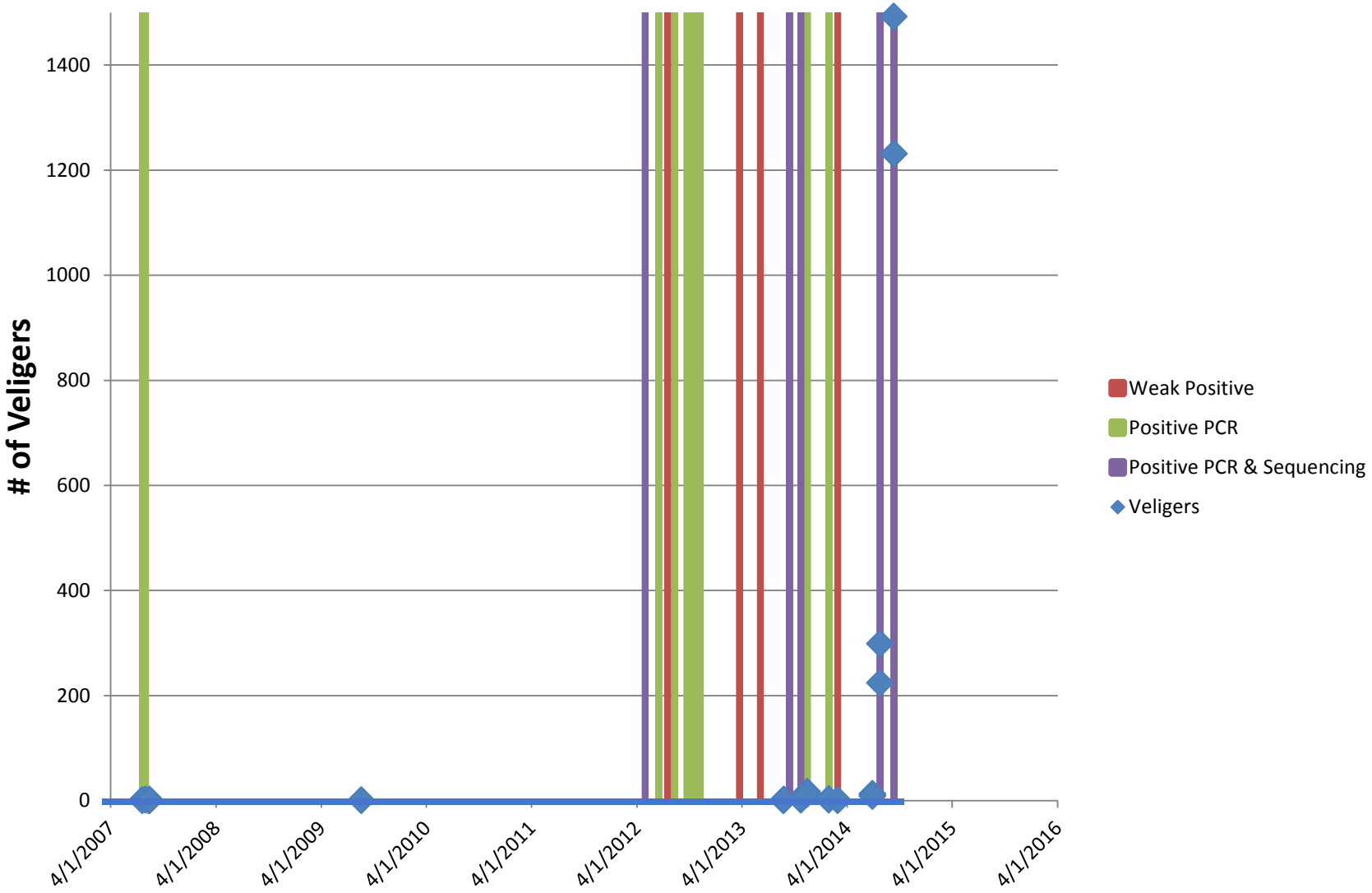

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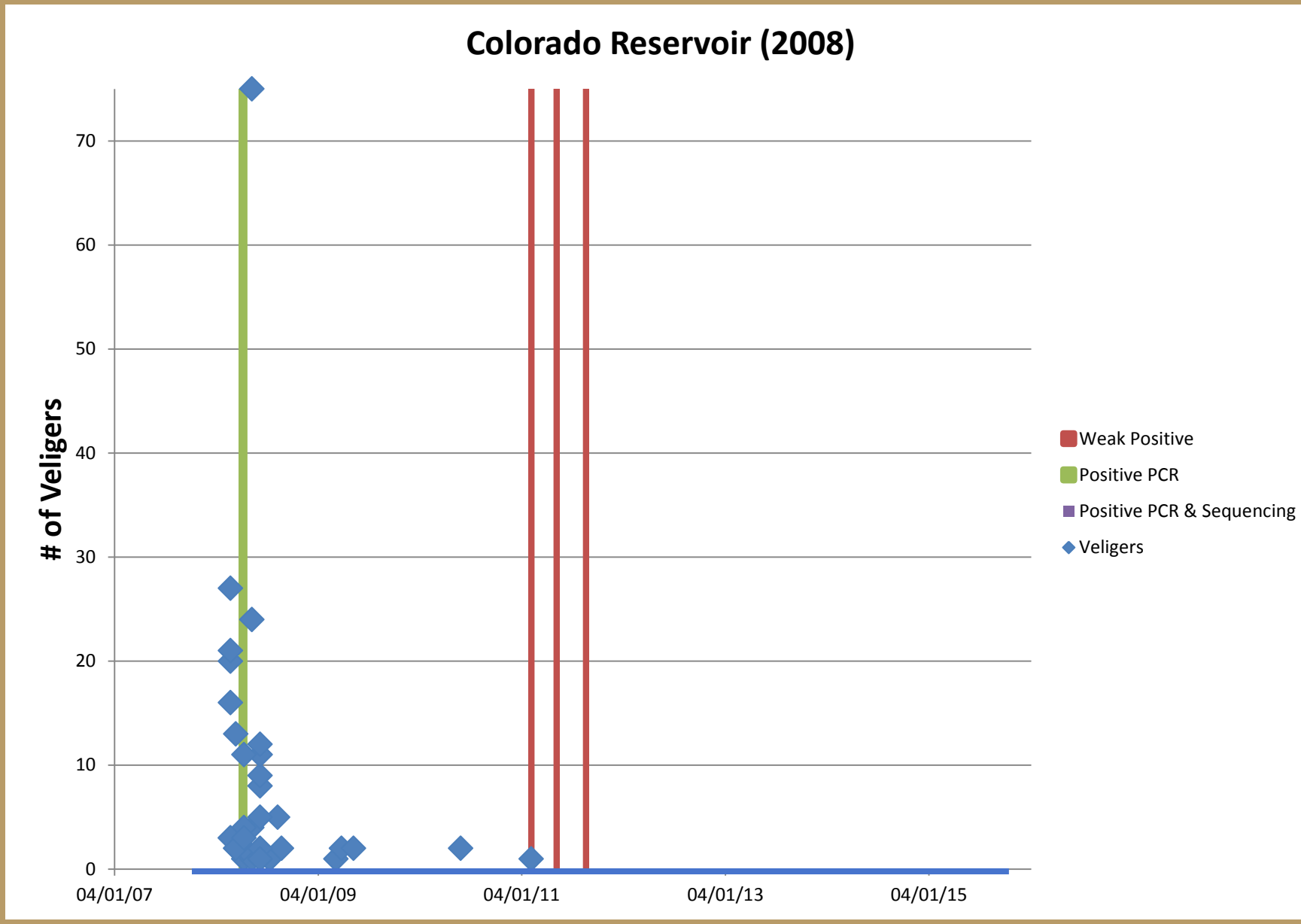

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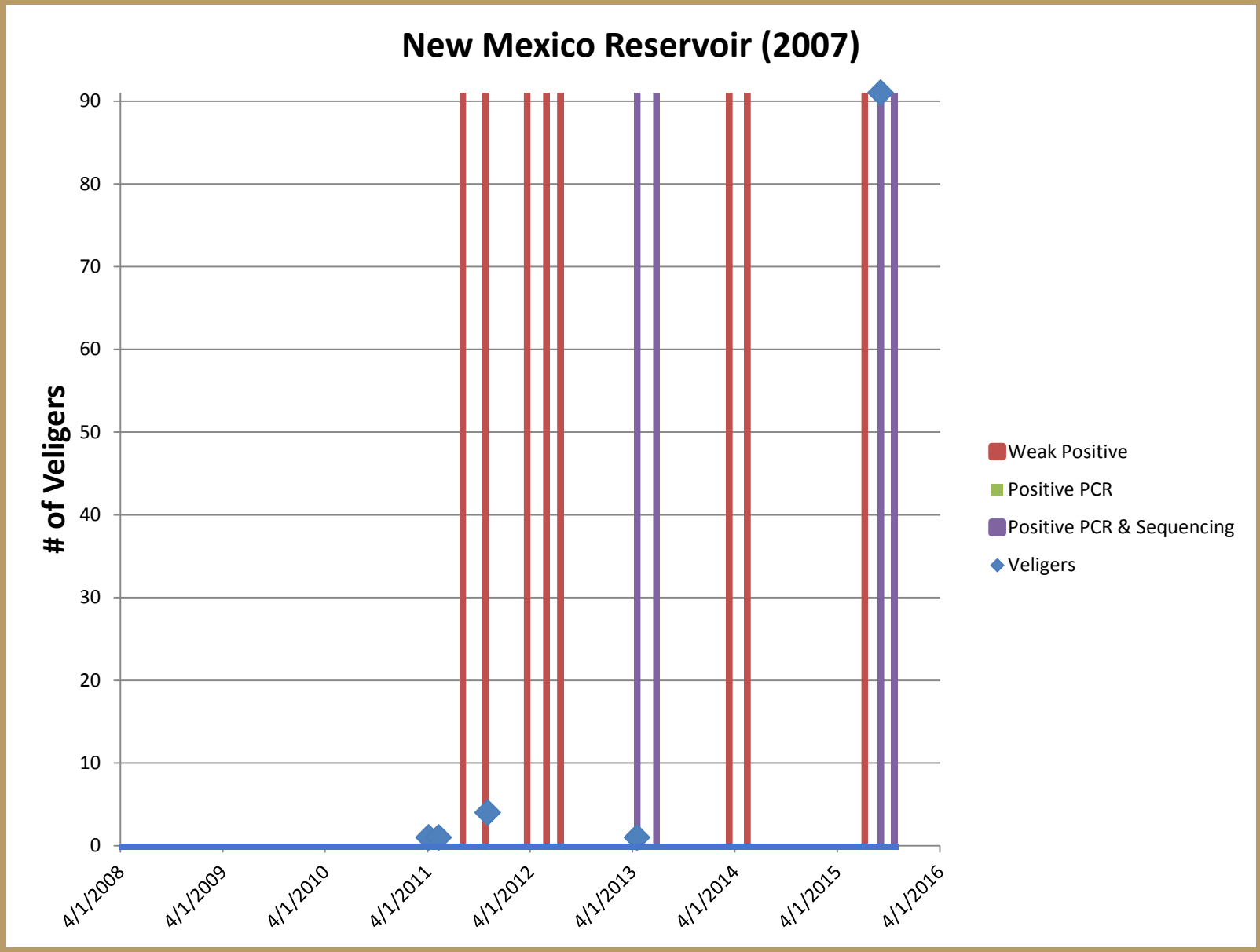

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Reclamation Invasive Mussel Research

Focused on improving detection , facilities protection, and assessing ecological impacts

- **Has been a priority area of Reclamation's Science & Technology (S&T) Program since 2008**
- **Collaborative efforts between Reclamation's Research & Development Office, LC Region, and Technical Service Center**
- **Also collaborating w/ other agencies and private industry where possible**

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Research Projects

- Foul release coatings
- Predictive modeling
- Turbulence for control
- UV testing
- Improved fish screens
- Life history and impacts

New Research Projects

- Standard Operating Procedures for Detection
- eDNA for invasive and endangered
- Genetic studies
- Advanced Coatings
- Cyclone separators to mitigate mussel shell debris

Directed Research Projects

- Pulsed Pressure
- Impacts and costs study at LCDO facilities
- Literature review and synthesis

Internet Resources:

www.usbr.gov/research

- **The Knowledge Stream**

www.usbr.gov/mussels

- **Mussel Facts**
- **Prevention**
- **Research**
- **Detection**
- **Coatings**
- **Facility Assessments**

Invasive Mussel Issue Fall 2015

http://www.usbr.gov/research/publications/newsletters.html

Special thanks to:

Research and Development Office, Lower Colorado Dams Office, Jacque Keele, Yale Passamaneck, Diane Mench, Sherri Pucherelli, Scott O'Meara, Curt Brown, Joe Kubitschek, Chris Holdren, Jamie Carmon, Kevin Bloom, Kyle Rulli, and all RDLES staff not mentioned above.

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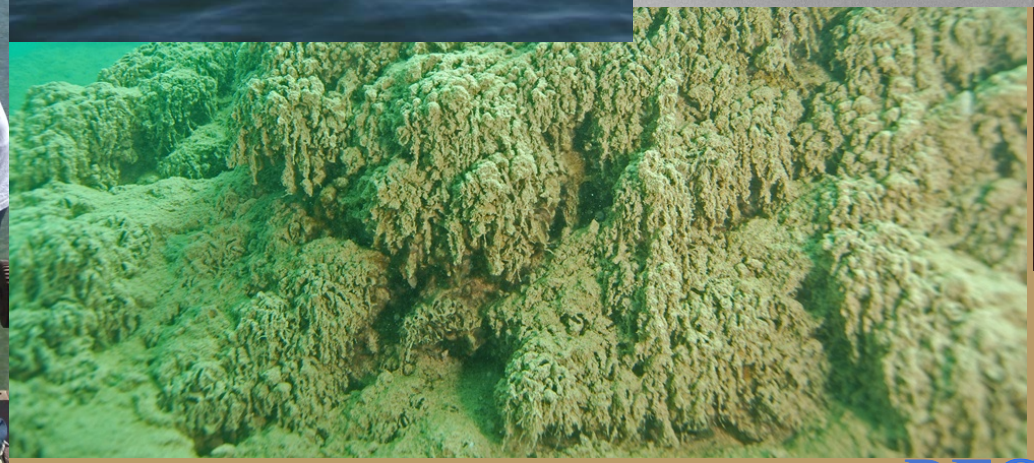
Questions?



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