

RECLAMATION

Managing Water in the West

Where is the Body?

Dreissenid Mussels, Raw Water Testing, and the Real Value of E-DNA

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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

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 m²
- 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**

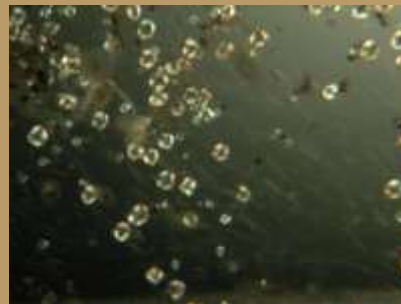
Joe Kubitschek, Leonard Willett, and Sherri Pucherelli in cooperation with Renata Claudi (RNT Consulting Inc.)

- **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.



Reclamation Detection Laboratory for Exotic Species (RDLES)



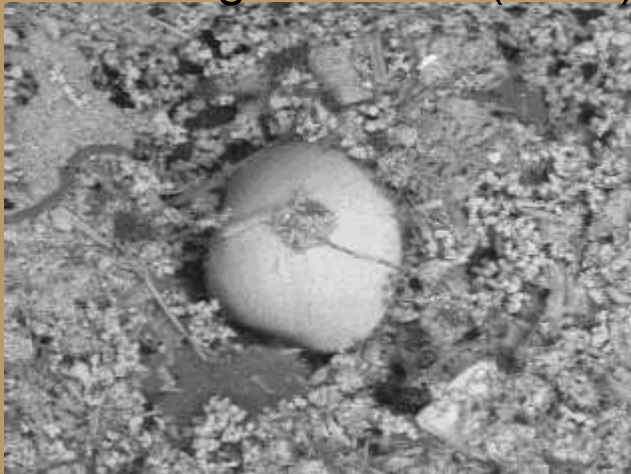
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Detection Tests:

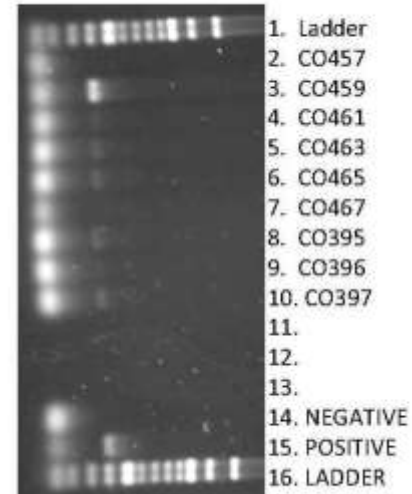
Cross Polarized (XPL)



Scanning Electron (SEM)

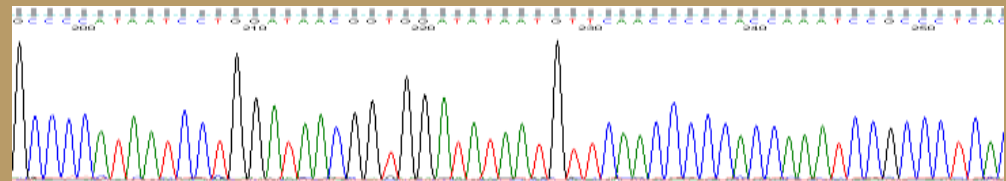


PCR Gel



Date: 6/14/2012
Sample: QM GEL 2

PCR Gene Sequencing



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**

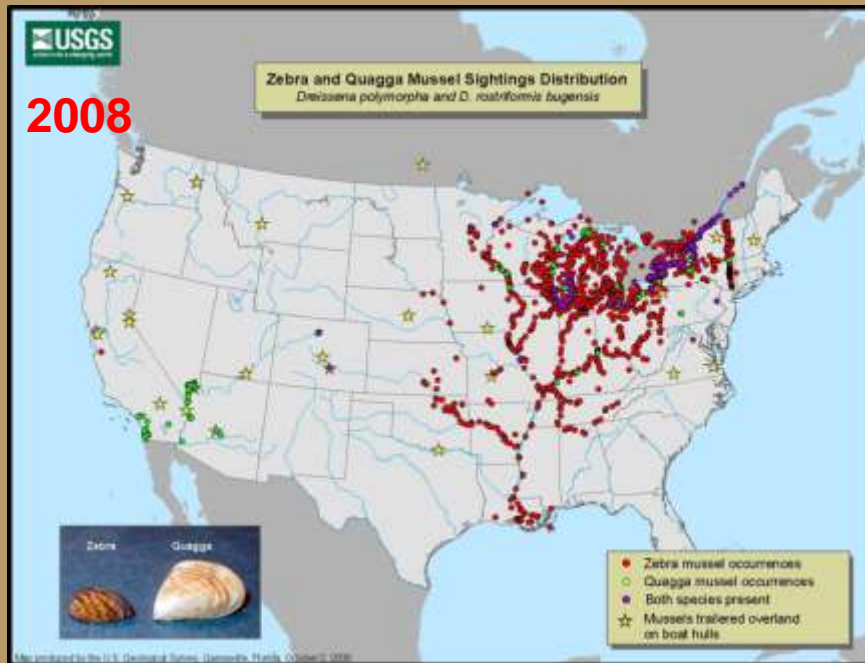
1986



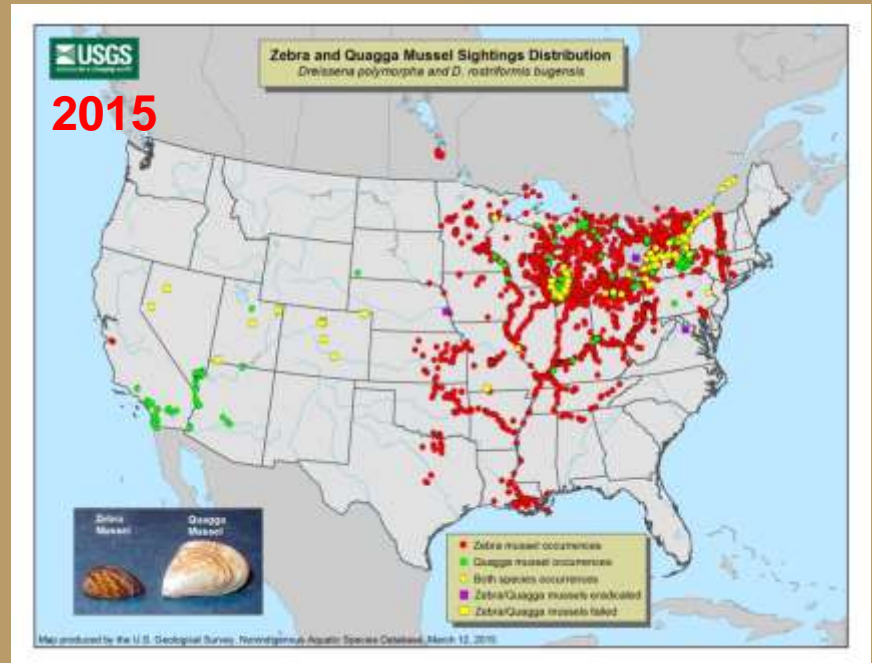
2007



2008



2015



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Zebra and Quagga Mussel Sightings Distribution

Dreissena polymorpha and *D. rostriformis bugensis*



- Zebra mussel occurrences
- Quagga mussel occurrences
- Both species occurrences
- Zebra/Quagga mussels eradicated
- Zebra/Quagga mussels failed

Map produced by the U.S. Geological Survey, Nonindigenous Aquatic Species Database, March 12, 2015.

Program Results



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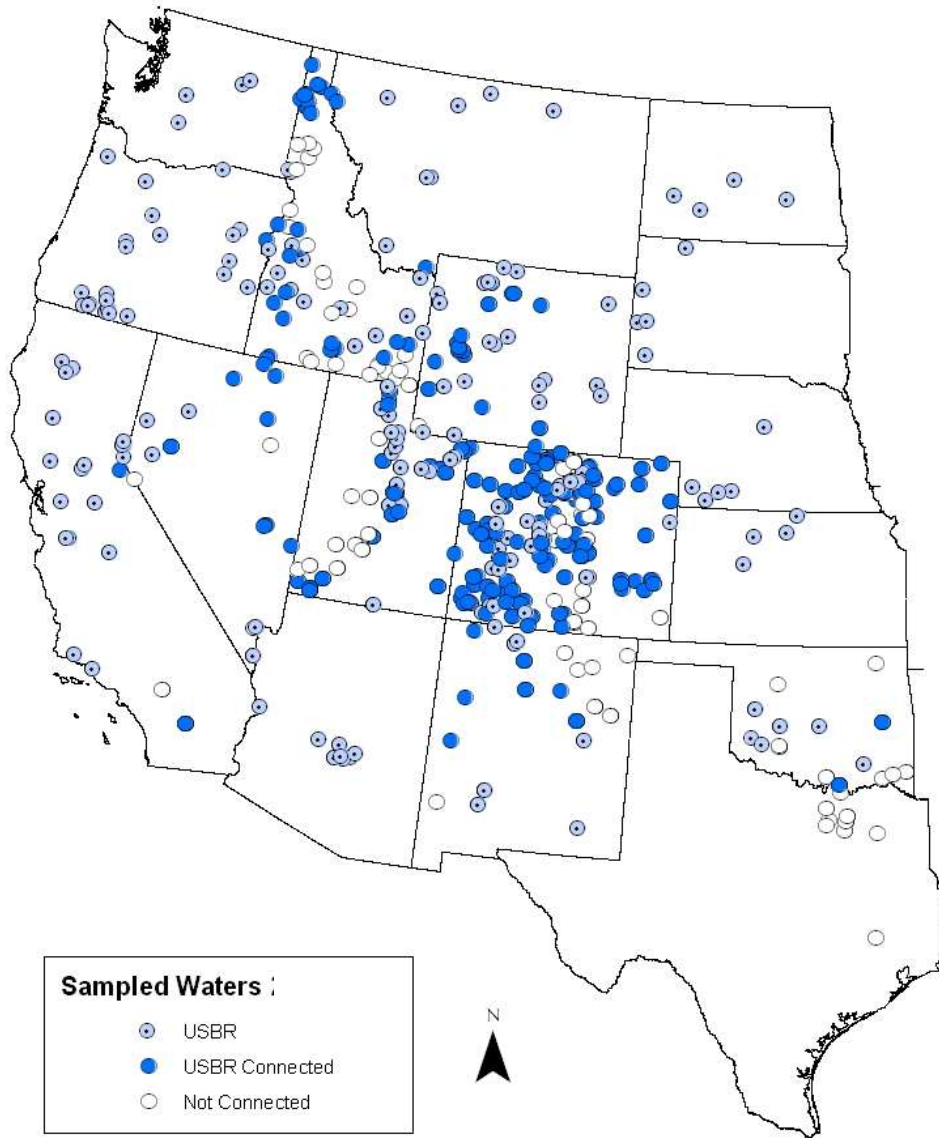
2007-2015

**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**



Map Date 12/30/2011

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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

46

2

17

>3

20

(Each water body has 3-4 sample locations)

Where do we find them?

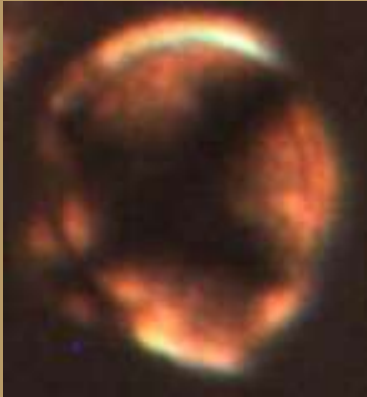
- Of 327 water samples, statistical analysis revealed that **59.3%** positives occurred at a marina/boat launch. Zehfuss (2008)
- Samples analyzed from 2009 to 2012:
Samples analyzed: 11,683
Positive samples: 419 or 4%

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%

Veliger Degradation

Buffered sample (XLM): pH 8



24 hours



7 days



14 days

Unbuffered sample (XLM): pH 5



24 hours



7 days



14 days

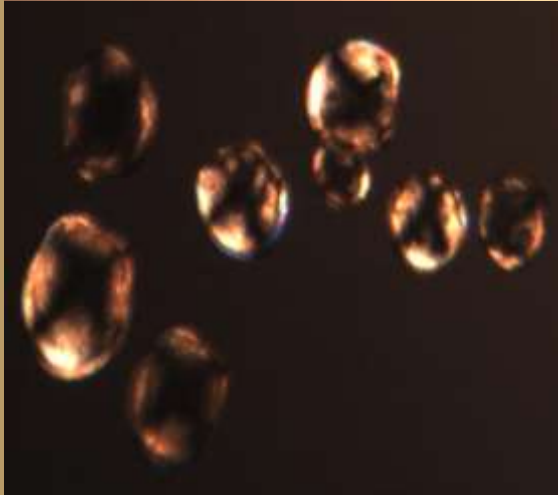
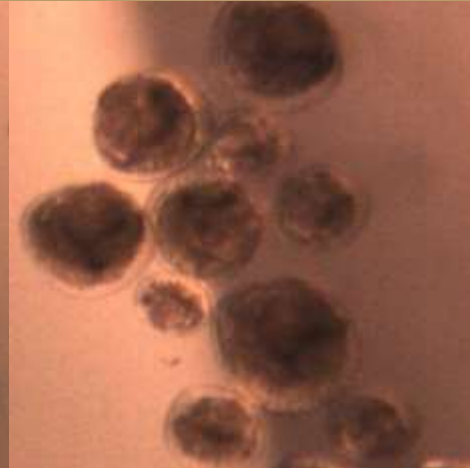
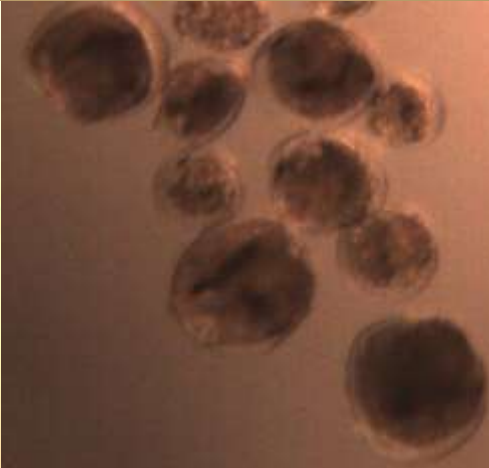
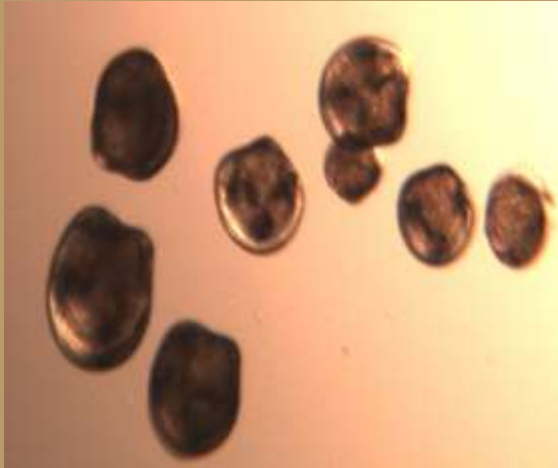
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Macro View of Birefringence Loss: Unbuffered Samples pH 5

7 Days

14 Days

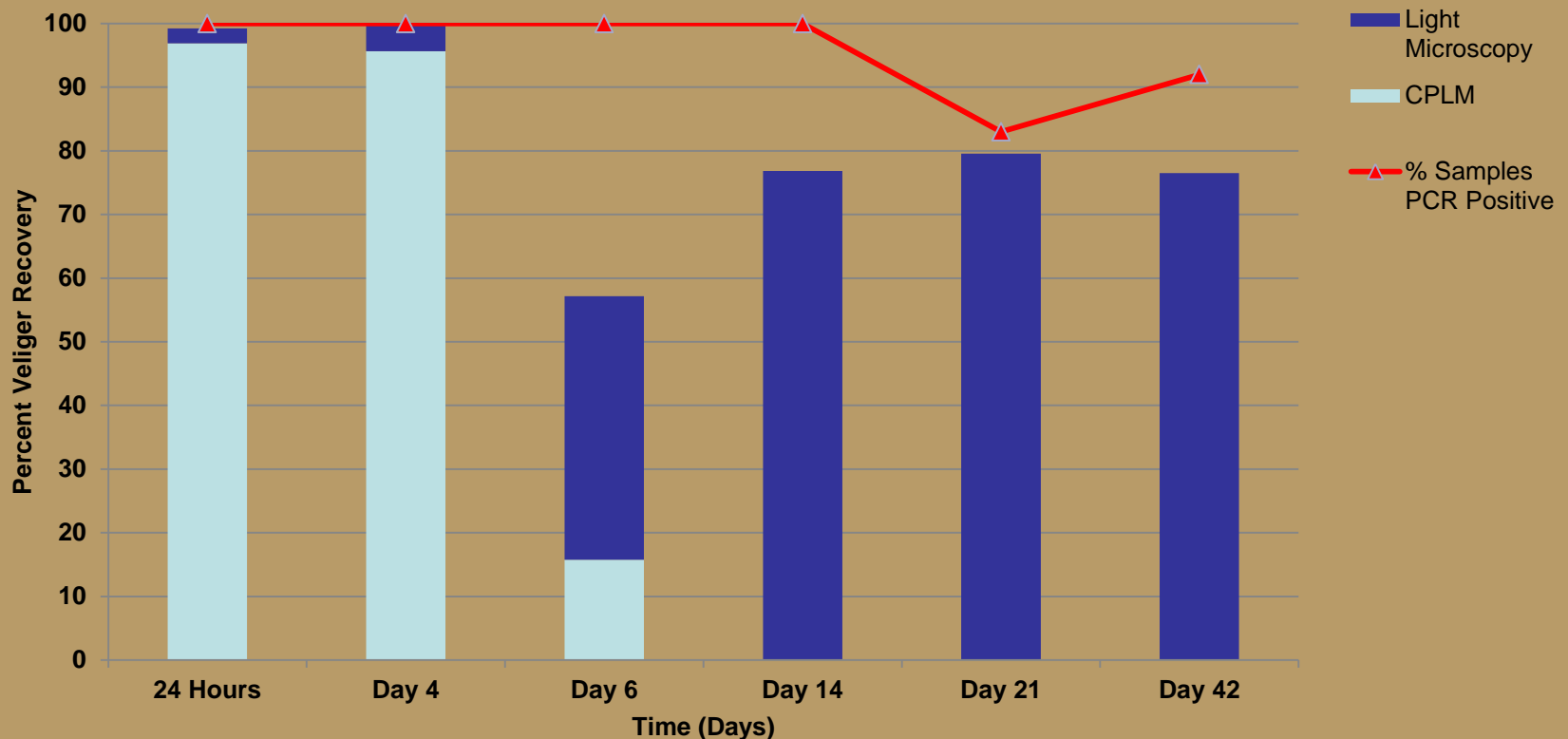
21 Days



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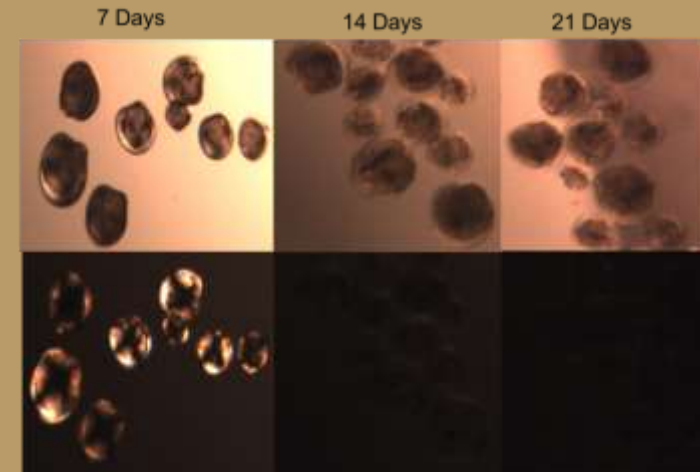
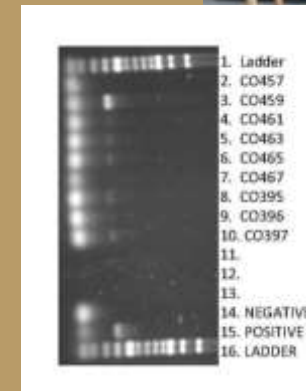
Samples Can Be PCR Positive with Veliger's that Do Not Birefringe

Non-Buffered Veliger Recovery and PCR Outcome

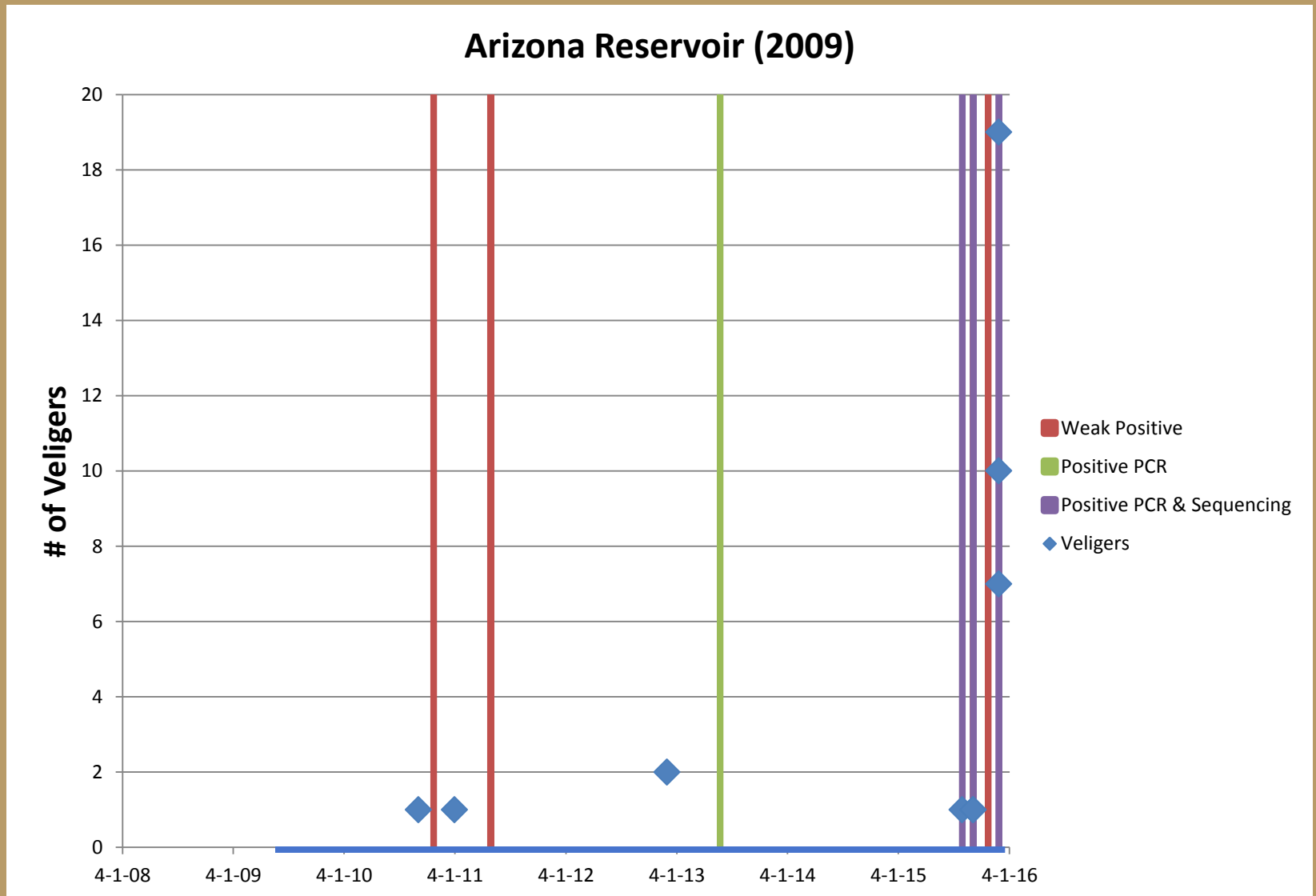


RDLES Advances 2012

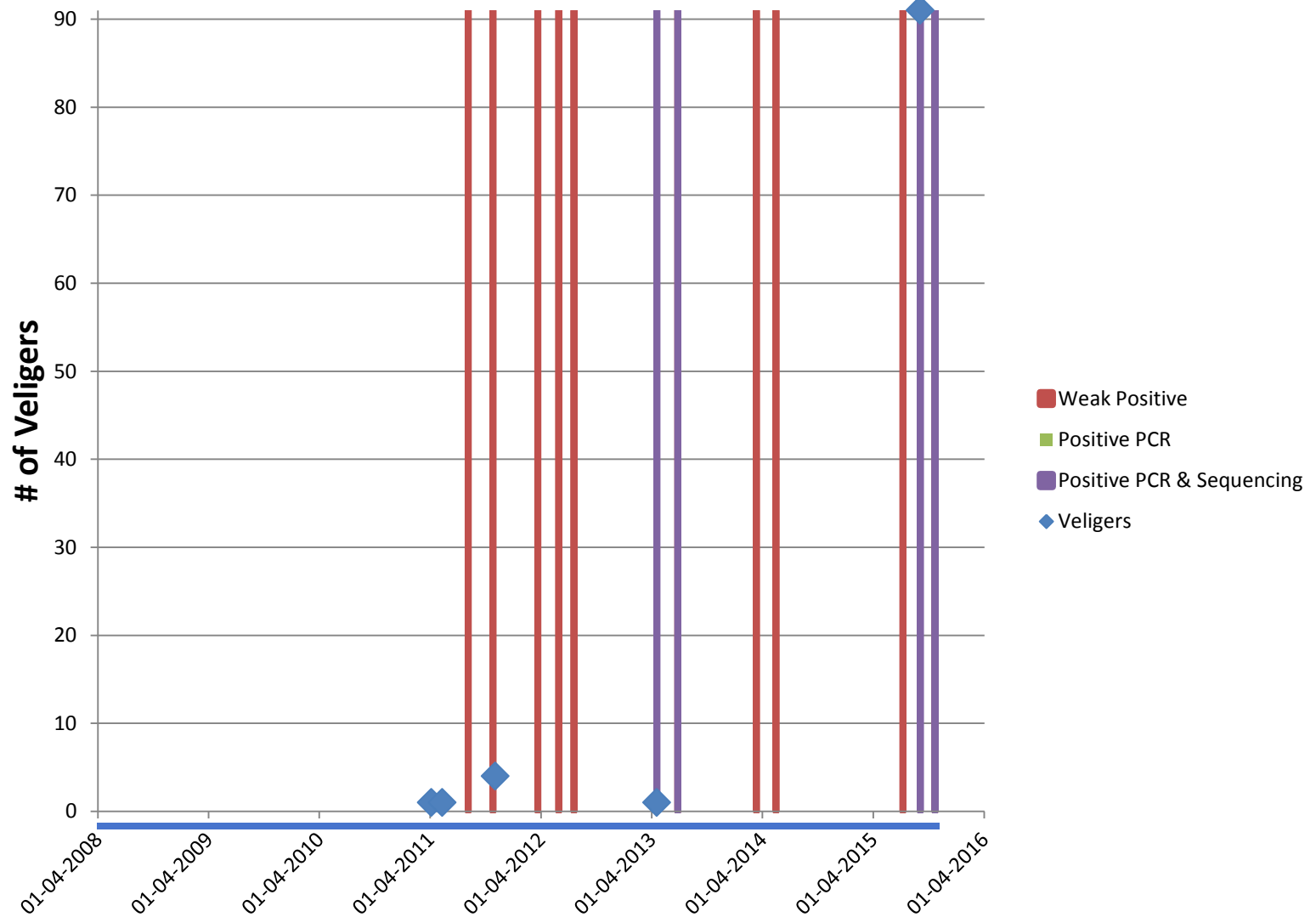
- **Modified and Improved Microscopic Procedures**
- **Modified existing PCR, increasing sensitivity 100X**
- **Improved DNA extraction methods,**
- **interferent studies**
- **DNA Barcoding analysis for identification of a wide range of organisms from fish to hydroids**
- **Utilizing eDNA for the detection of invasive, endangered, and rare aquatic organisms**
- **Improved sample preservation for improved detection of mussel larvae by both microscopy and PCR**



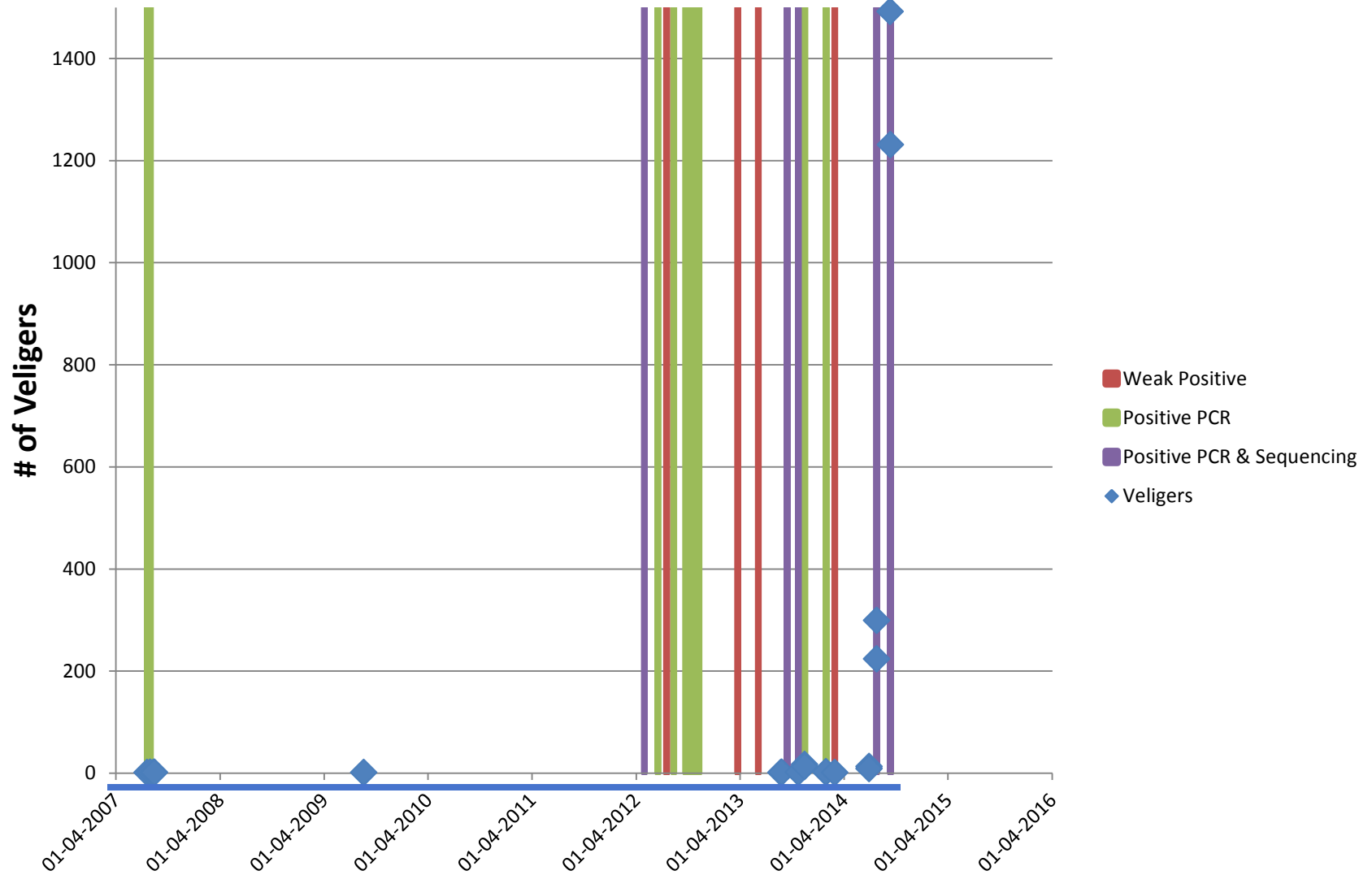
.....and the value of eDNA without the body:



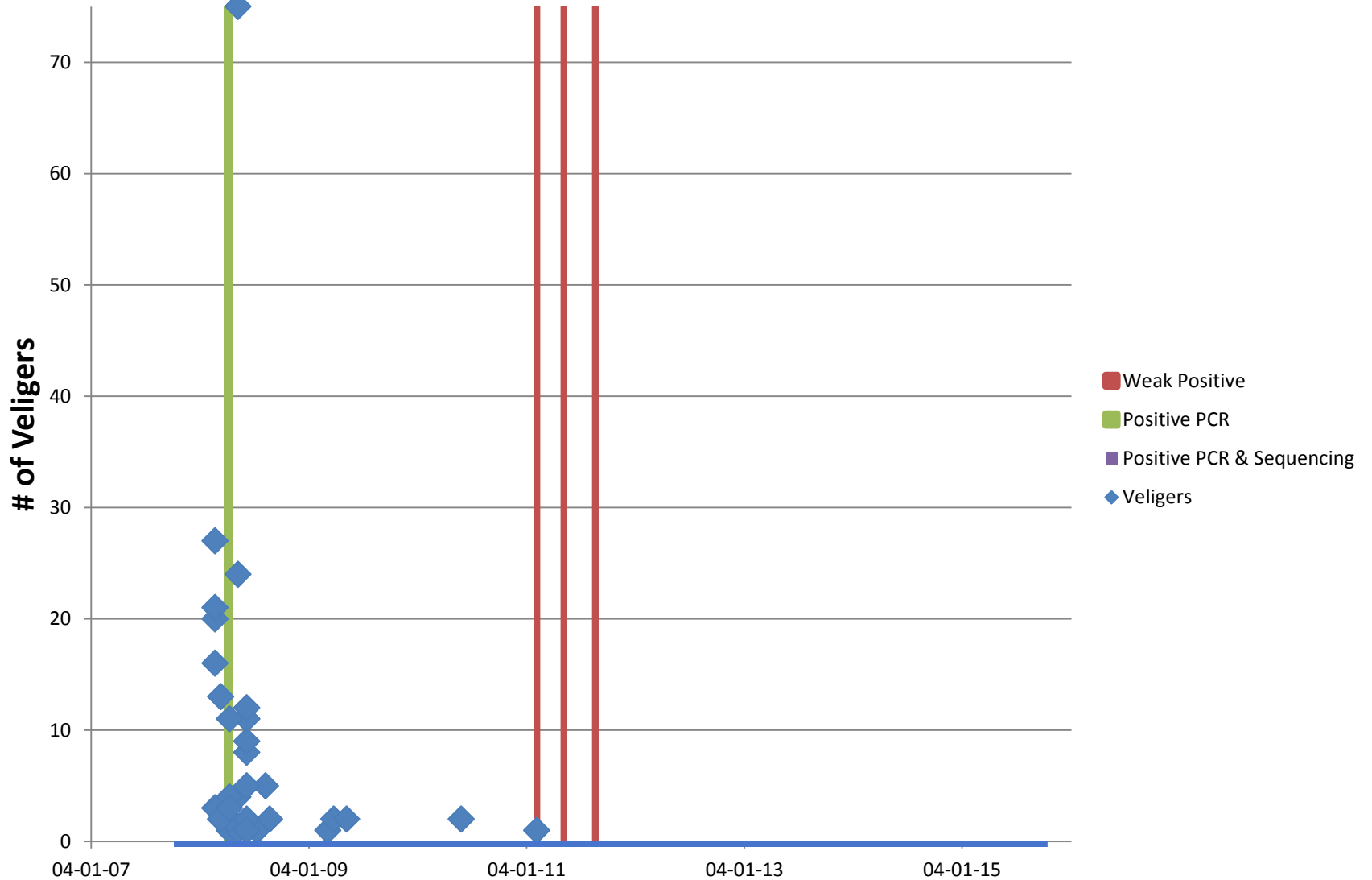
New Mexico Reservoir (2007)



Utah Reservoir (2007)



Colorado Reservoir (2008)



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>

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Questions?



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