

# RECLAMATION

*Managing Water in the West*

## **Evaluation of the Effects of UV Light Treatment on Quagga Mussel Settlement and Veligers at Davis Dam**

**Sherri Pucherelli**  
**Bureau of Reclamation**  
**and**  
**Renata Claudi**  
**RNT Consulting INC.**



U.S. Department of the Interior  
Bureau of Reclamation



- Dense quagga mussel populations in lower Colorado River
- Settle in generator cooling systems in hydropower facilities
- UV treatment: passive and no discharge permitting
- UV effectiveness
  - $UV \text{ dose} = \text{intensity} \times \text{exposure time}$
  - Water transmittance, suspended solids

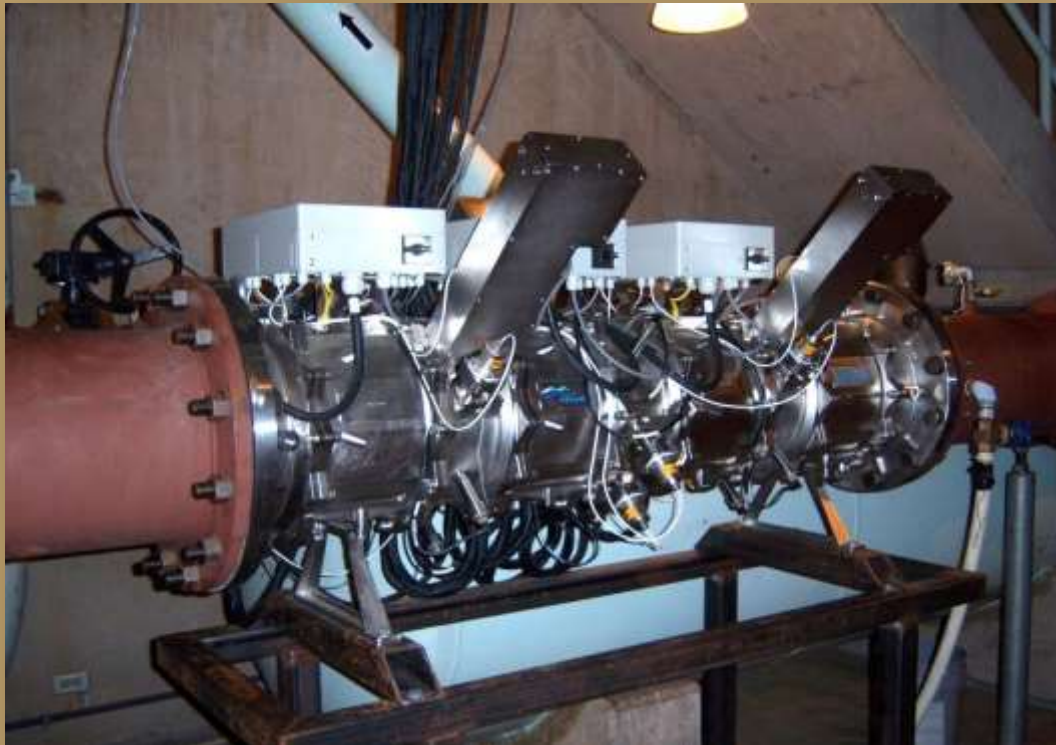


**Goal:** To determine the effectiveness of several UV doses for prevention of quagga mussel settlement in generator cooling systems at Davis Dam, AZ, USA



# Atlantium Technologies Ltd. medium pressure UV unit installed on hydropower generator cooling line at Davis Dam

- Treats 3,500 gallons/min
- In-line UVT, flow, and temperature sensors adjust lamp output to achieve selected dose
- Internal reflective properties



# Settlement Tests

- Two bioboxes
  - 2 GPM flow through
  - Settlement plates analyzed after one month
- Tested 20, 40, 50, and 100 mJ/cm<sup>2</sup> UV doses



# Veliger Mortality Tests

- Same 4 doses tested
  - Each tested in early and late summer
- Veliger mortality observed at 24 hour intervals for 120 hours post UV exposure
  - 100 veligers per size class
    - straight-hinged, umbonal, pediveliger
  - Petri dishes maintained at 16°C for 120 hours in water bath
- Veliger only considered dead with tissue degradation



- Water quality readings, including UVT, were collected from the bioboxes and Davis Dam forebay during each test.



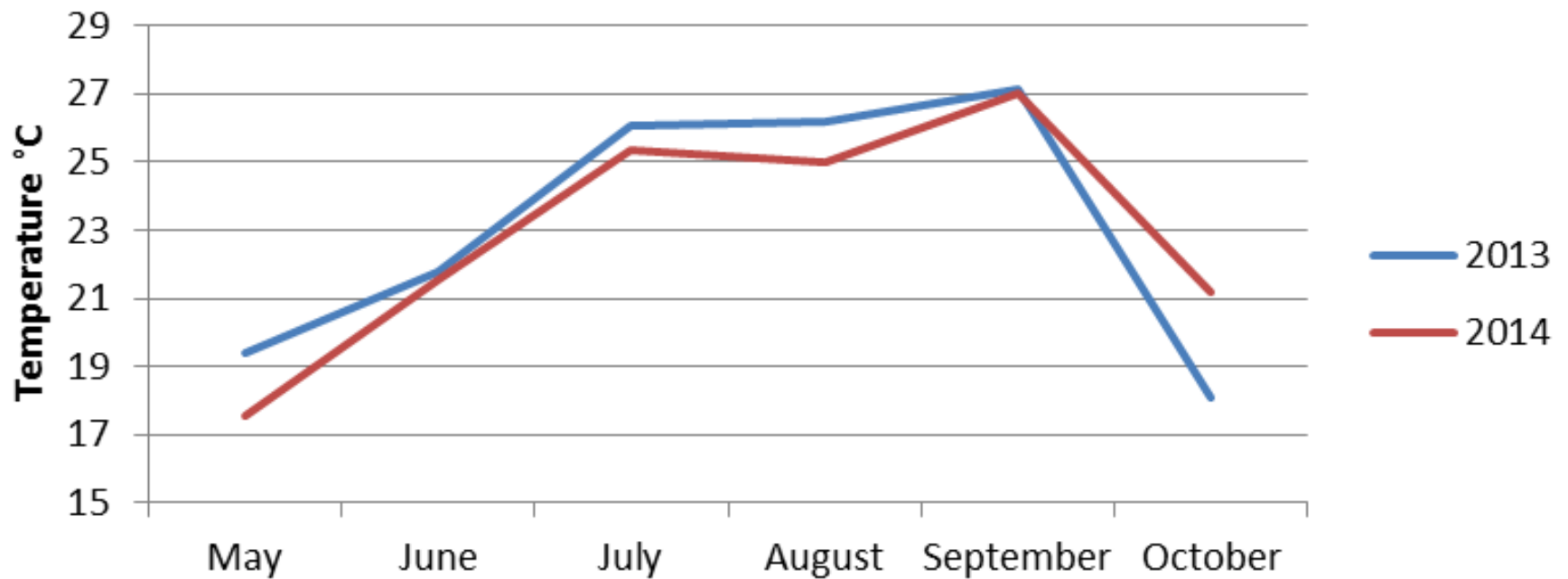
- An EKM omnimeter power use data logger installed on the UV power supply
  - Power usage recorded during the 20 and 3, 40 mJ/cm<sup>2</sup> settlement tests

# Power Consumption

- 20 mJ/cm<sup>2</sup>
  - 4.21 kWh/100,000 gallons
  - Total annual (11 months) electricity use=65,000 kWh
  - Generating cost for electricity= 3 cents per kWh
  - Annual operating cost=\$1,950
- 40 mJ/cm<sup>2</sup>
  - 6.90-9.43 kWh/100,000 gallons
  - Total annual (11 months) electricity use=160,000 to 145,000 kWh
  - Annual operating cost=\$3,150- \$4,350



## Davis Forebay Surface Temperature

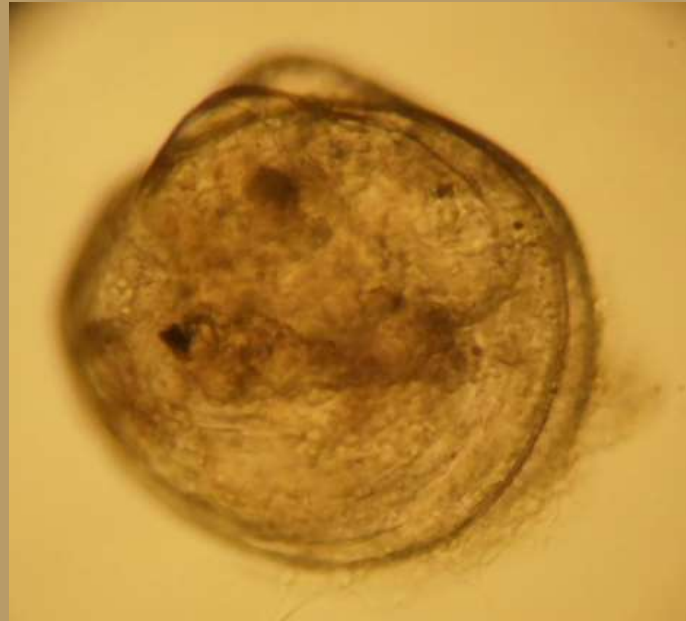


# Settlement reduction was observed at each dose tested

- 40 mJ/cm<sup>2</sup> less effective in October-November compared to July-September

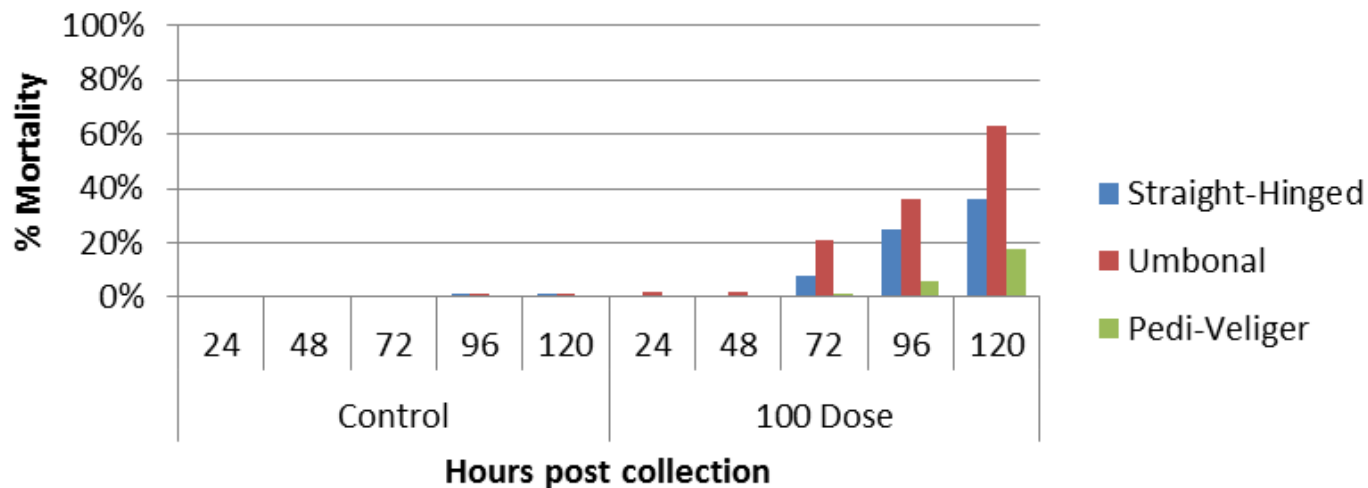
Dose	Months	Control biobox (# mussels)	UV treated biobox (# mussels)	Settlement Reduction
20	Aug-Sep	223	26	88%
40	July-Aug	386	8	98%
40	Sept-Oct	1445	18	99%
40	Oct-Nov	810	76	91%
50	June-July	160	8	95%
100	July- Aug	1314	10	99%

- All UV doses caused delayed veliger mortality
  - Smaller mussel life stages more susceptible than larger
  - Mortality greater in late summer than early summer

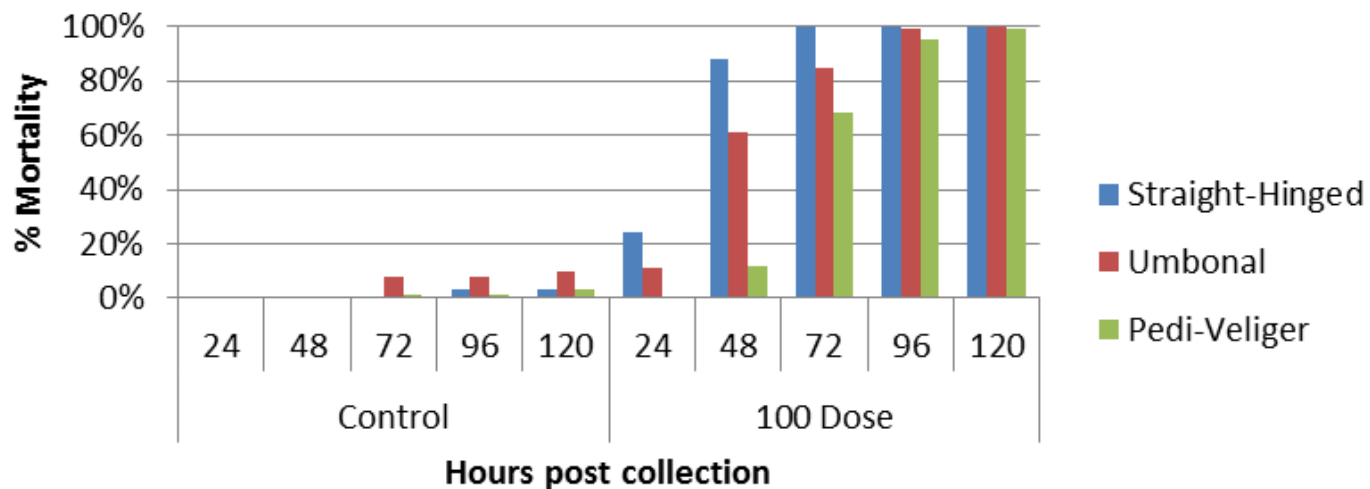


- Veligers were not physically damaged, stunned or inactivated immediately post UV exposure
  - Overtime, dying veligers began to shake with shell open and cilia exposed

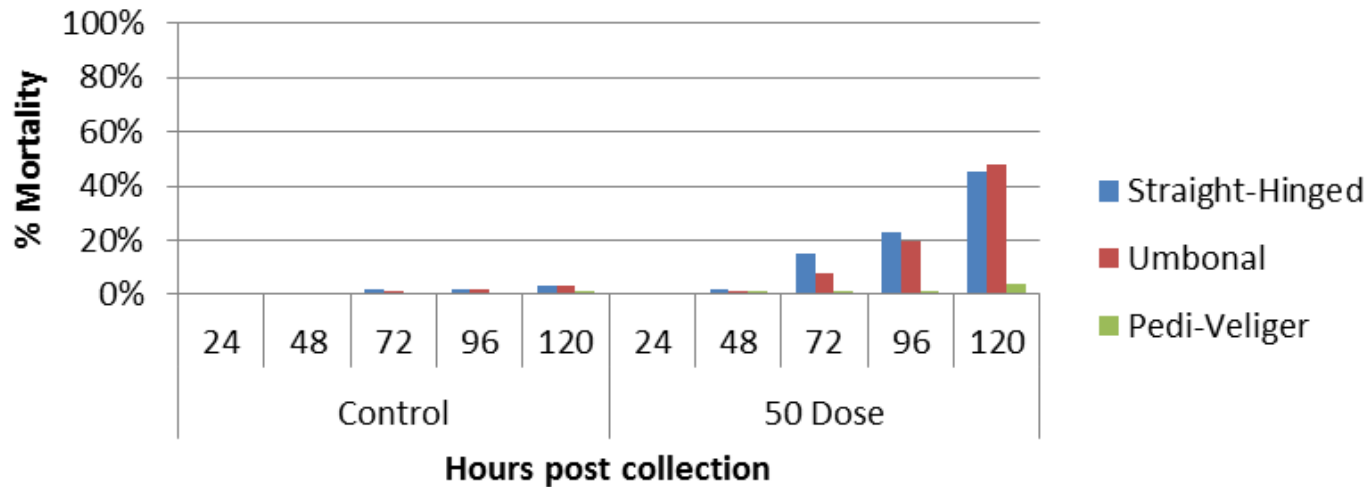
## 100 mJ/cm<sup>2</sup>, May 24th



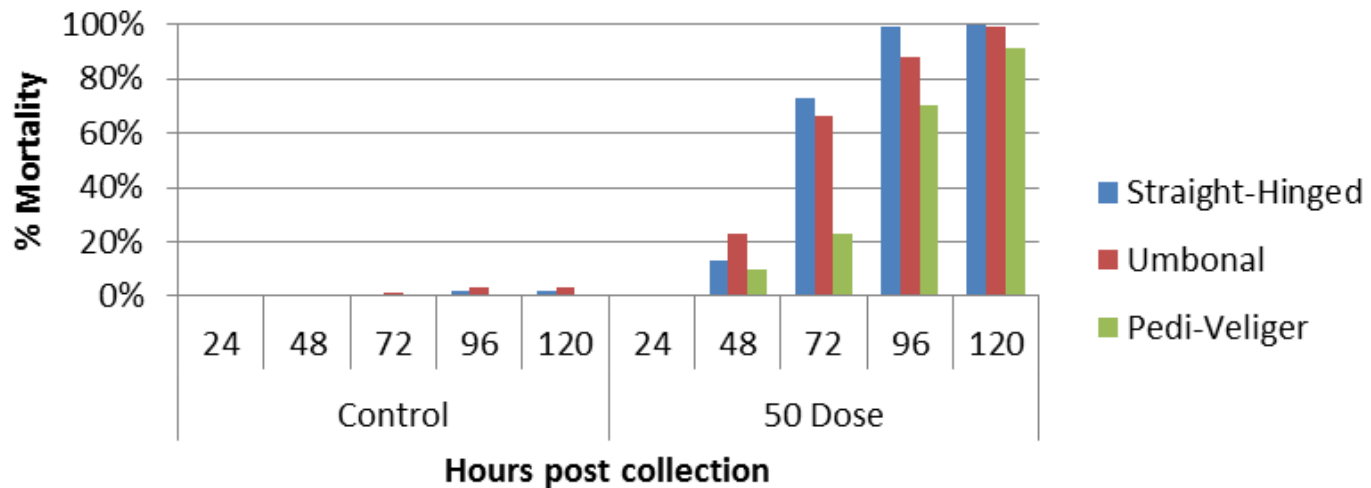
## 100 mJ/cm<sup>2</sup>, August 25th



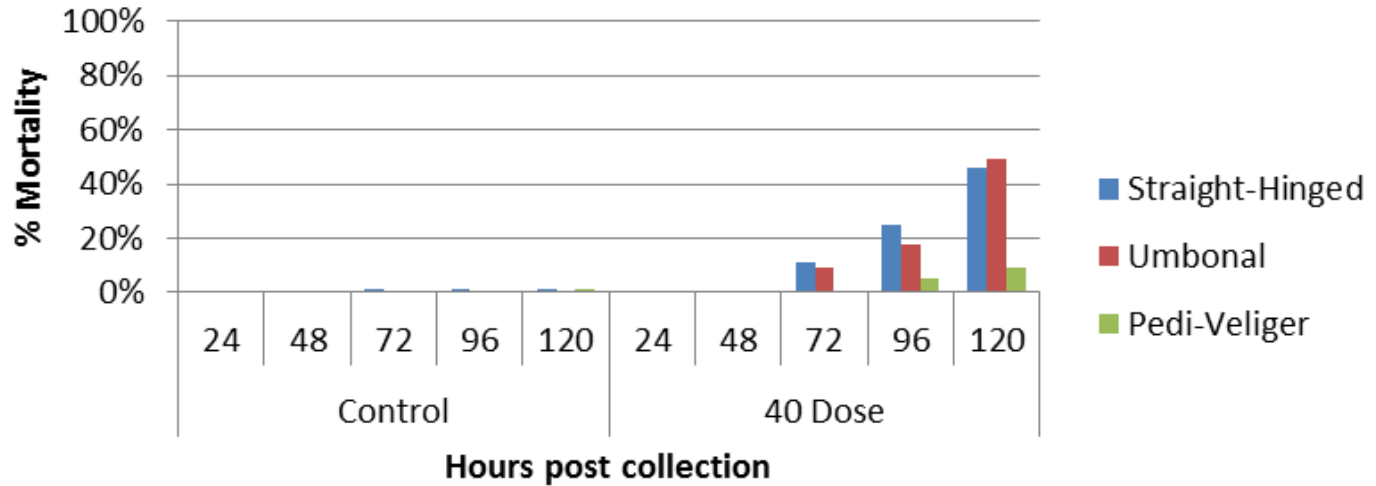
## 50 mJ/cm<sup>2</sup>, July 28th



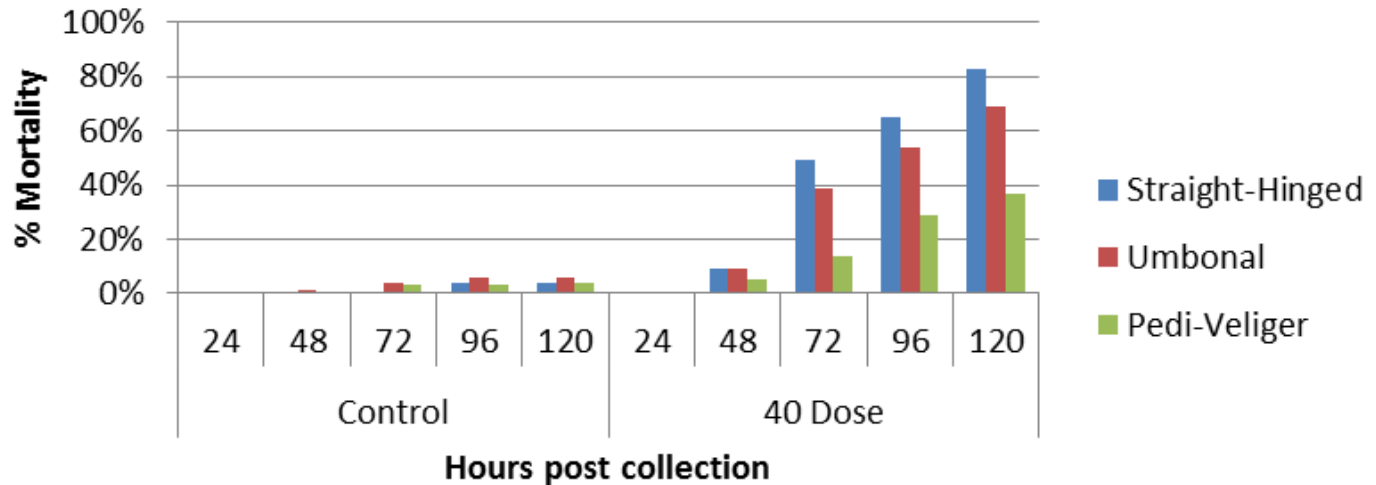
## 50 mJ/cm<sup>2</sup>, August 11th



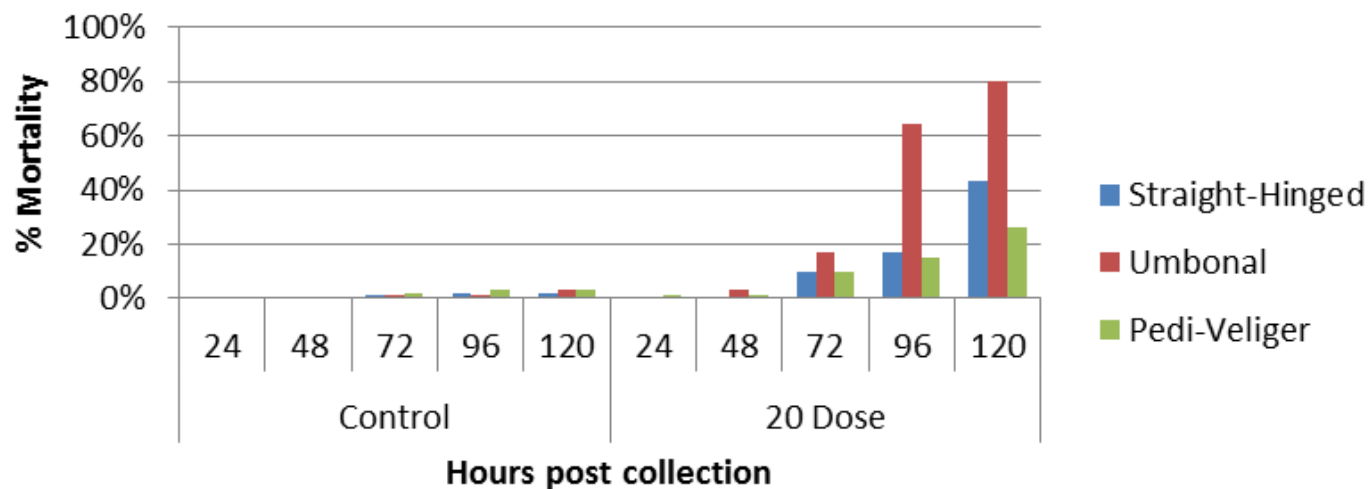
## 40 mJ/cm<sup>2</sup>, July 28th



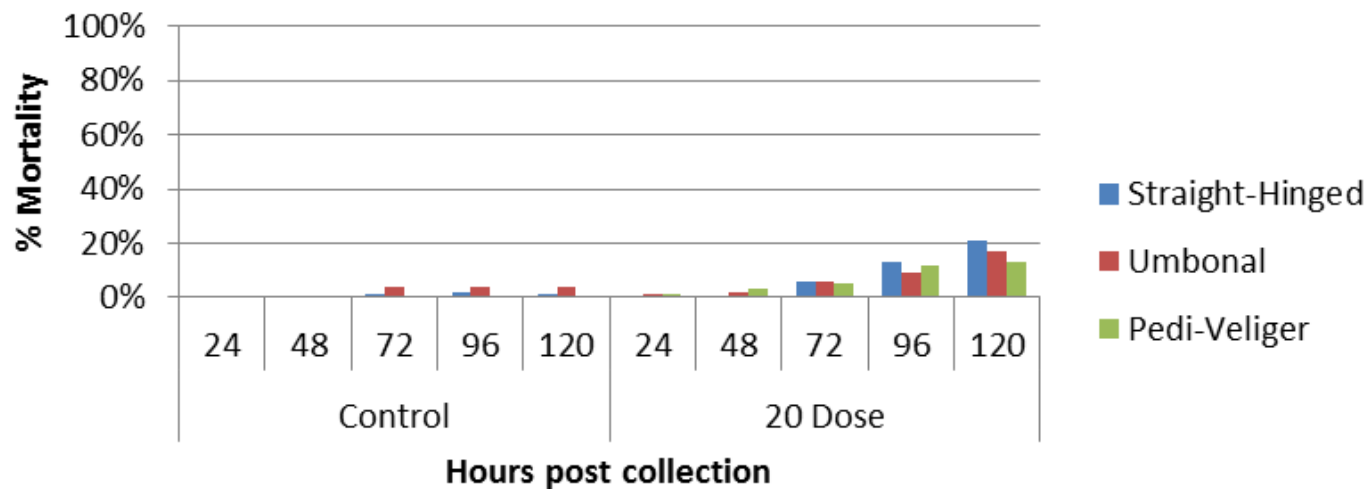
## 40 mJ/cm<sup>2</sup>, August 11th



## 20 mJ/cm<sup>2</sup>, June 3rd



## 20 mJ/cm<sup>2</sup>, August 4th



# Conclusions

- UV treatments successfully reduced mussel settlement, but effectiveness can be variable at different times of the year
- Variation in settlement reduction and veliger mortality may be due to environmental variables
  - Temperature has been found to impact mussel robustness
  - Less robust veligers may experience mortality sooner and to a greater degree
- Significant settlement reduction was observed during months when mortality was low
  - Veliger mortality likely continues past 120 hours



# Conclusions

- Generator cooling water has a short residency time within the dam ( $\approx 20$  min)
  - Delayed effects of UV treatment still appear to be effective
  - Pediveligers may be able to settle in dam, but will die before grow to problematic size
  
- Results only applicable to the specific UV unit tested and the site specific conditions and water quality at Davis Dam
  - Variables such as turbidity may limit UV penetration and impact effectiveness
  - Immediate and 100% mortality will require higher doses
  - Important to test effectiveness at site specific conditions

# Contact Information

Sherri Pucherelli

Bureau of Reclamation

Denver, CO, USA

(303) 445-2015

spucherelli@usbr.gov

Renata Claudi

RNT Consulting INC.

Picton, Ontario, Canada

(613) 476-7994

rnt@direct.com