Research Update

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Bottom Line

Ultraviolet (UV) light treatment of generator cooling system water has been found to reduce invasive mussel settlement. This research helped determine how UV exposure reduces settlement by examining the immediate and delayed effects of exposure on quagga mussel larvae.

Better, Faster, Cheaper

UV light irradiation is a valuable tool for preventing mussel settlement because, unlike conventional treatments, it does not require discharge permitting and has no detrimental effects to the environment.

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Impact of Ultraviolet Light Treatment on Quagga Mussel Larvae

Examining how ultraviolet light treatment prevents quagga mussel settlement in Davis Dam cooling lines

Problem

Quagga and zebra mussels are aggressive biofoulers that threaten water delivery and hydropower reliability. Conventional treatment methods such as chlorine or mechanical removal can be costly, environmentally adverse, and require discharge permitting. Reclamation needs innovative treatments to prevent or limit mussel colonization in our facilities.

UV unit installed at Davis Dam (Arizona/Nevada) for mussel treatment.

Ultraviolet (UV) light irradiation is a promising treatment because it does not require discharge permitting and has no detrimental effects to the environment. In 2013, a full-sized medium pressure UV system was installed on a cooling line at Davis Dam (Arizona/Nevada) to test settlement reduction. Reservoir water (containing veligers) entering the cooling system passes through the system and is treated with UV light. Claudi et al. (2014) found significant settlement reduction at 50, 40, and 20 millijoules per square centimeter (mJ/cm^2). Although the treatments were effective, the impact of exposure on veligers was still unknown. Understanding the treatments mode of action will help determine how UV can be useful in other mussel management applications.

Solution

This Reclamation Science and Technology Program research project evaluated the impacts of four doses (100, 50, 40, and 20 mJ/cm^2; previously tested for mussel settlement reduction) on veligers to understand why UV light treatments reduced settlement. Treated and untreated veliger samples were collected to determine if the doses produced physical damage, behavior changes, and/or immediate or latent mortality.

The impact of UV exposure was evaluated for each veliger stage (d-stage, umbonal, and pediveliger) to determine if one is impacted over another. Veligers were examined immediately after exposure to determine if UV caused behavior changes that might prevent settlement. Images of veligers exposed to UV light treatments were collected and analyzed with a VeligerCam™ to detect physical damage. Immediate and latent mortality of veligers exposed to each UV dose was determined by observing veligers immediately after UV exposure and at 24-hour periods for a total of 120 hours post-exposure. Mortality rates were observed in the early and late summer.

Application and Results

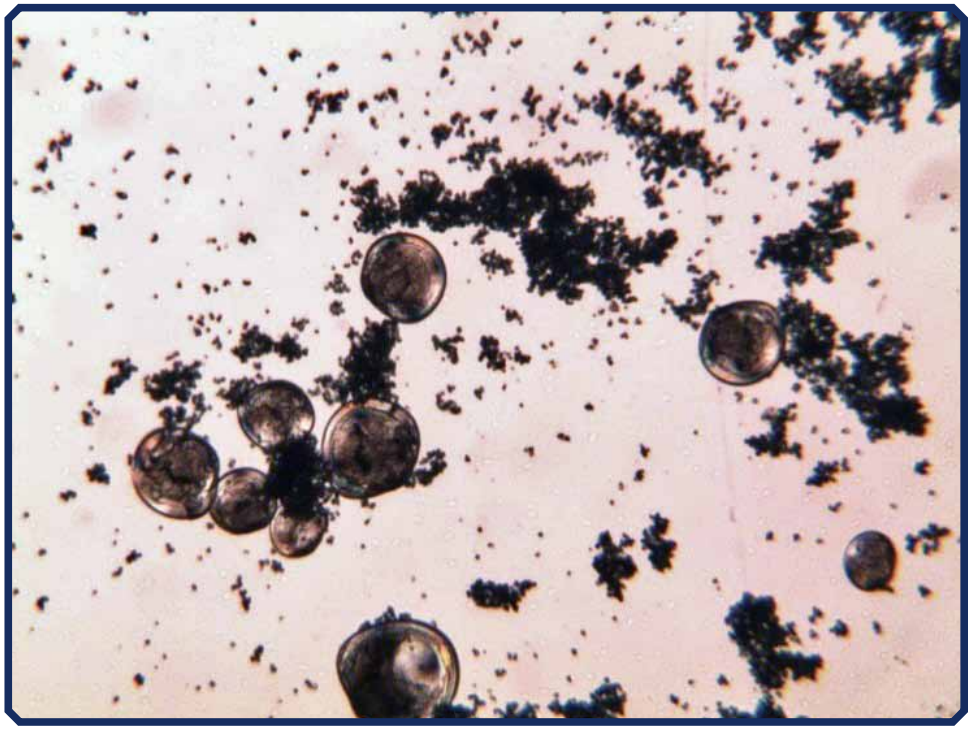
UV does not appear to impact veliger behavior or inflict visible physical damage. Settlement reduction is likely a result of delayed veliger mortality, as most veligers were alive immediately and several hours after exposure at all doses. Veliger mortality was variable at each dose, veliger size, and during each month tested. In general, smaller veligers died sooner and at greater rates than larger veligers. Treatments produced less mortality in the early summer months when compared with late summer months, even at the same dose. This variation may be due to environmental variables such as temperature, which has been found to impact mussel robustness.

Although the effectiveness of each dose tested was variable throughout the year, the significant settlement reduction should be appealing to facility managers as most do not require 100 percent settlement inhibition. The mortality and settlement rates were similar between the 50 and 100 mJ/cm^2 doses, suggesting that the lower dose could be used to reduce electrical and equipment costs.

Future Plans

Although this specific UV system was found to cause veliger mortality and limit settlement, it cannot be assumed that the same results would be achieved in every situation with every UV system, as water quality and site-specific conditions will vary. Before a UV system is deployed for mussel treatment, it is important to conduct similar testing for each specific set of circumstances.

This research, and the research conducted by Claudi et al. (2014), indicate that UV light treatment for the prevention of quagga mussel settlement in hydropower generator cooling systems is effective. The results may also be useful for water managers interested in using UV to control mussels in other applications. There are situations where immediate and complete veliger mortality is the main objective, in which case, a significantly higher dose would need to be tested.



Microscopic view of quagga mussel veligers.

"UV light treatment for the prevention of invasive mussel settlement is promising and it is important to understand how UV exposure impacts veligers so that the treatment can be used in other applications."

Sherri Pucherelli
Biologist, Reclamation's Technical Service Center

Collaborators

- **Reclamation:**
  - ◊ **Technical Service Center**
  - ◊ **Lower Colorado Region**
- **RNT Consulting, Inc.**

More information

www.usbr.gov/research/projects/detail.cfm?id=891

Claudi R., T.H. Prescott, and H. Coffey. 2014. *Atlantium Technologies Medium Pressure UV Dose Required for Minimizing Downstream Settlement of Quagga Mussel Veligers*. IDIQ Contract R13PD80500. Bureau of Reclamation.

For printable version see: www.usbr.gov/research/docs/updates/2015-12-uv-treatment.pdf