ZEQUANOX®
Invasive Mussel Control

In Open Water Systems: Bio-Based Invasive Mussel Control

The Need for a New Approach

The rapid spread of invasive zebra and quagga mussels in lakes and rivers is threatening ecosystems and quality of life for homeowners, recreationists and business owners. Some examples are as follows:

- Deposits of sharp, foul-smelling shells can litter beaches.
- Colonies can sink buoys, damage docks and boat lifts, and cause expensive repairs for boat owners by fouling hulls and clogging motors.
- Anglers will see desirable fish populations decline as a result of ecological changes over time.
- As filter feeders, mussels eliminate food sources and destroy native habitat critical to other aquatic organisms, particularly native freshwater mussels.

Where invasive mussels are present, the abundance of native organisms decreases dramatically while the growth of unwanted weeds and algae increases—negatively impacting fisheries, recreational life, and property values.

Preventing the spread of invasive mussels is no longer enough. Control methods that are effective and environmentally responsible are needed to mitigate the damage these mussels are causing and to limit even further expansion of their populations.

Zequanox® Molluscicide: Leveraging the Power of Nature

Zequanox molluscicide—a naturally derived aquatic biopesticide—has proven to be effective in selectively controlling invasive zebra and quagga mussels and offers an environmentally responsible solution to this daunting ecological challenge.

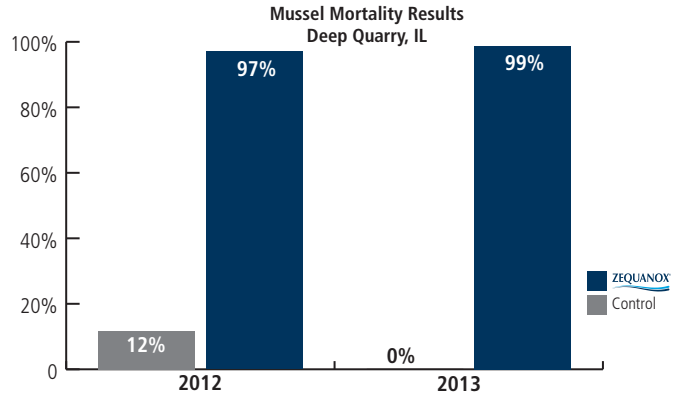
Key Characteristics of Zequanox Molluscicide

- Selectively targets zebra and quagga mussels in all life stages
- Safe for non-target organisms (e.g., humans, fish, native mussels, other aquatic species) when used according to label instructions
- No impact to biodiversity or natural ecosystems
- No bioaccumulation
- Biodegradable, doesn't persist in the environment
- EPA tolerance exempt — no concerns or restrictions for use in water that is used for recreation or for irrigating crops and turf
- Noncorrosive — poses no risk to boats or other recreational equipment

How Does Zequanox Molluscicide Work?

Zequanox molluscicide is composed of dead cells from a naturally occurring strain of the bacteria *Pseudomonas fluorescens*. Zebra and quagga mussels perceive Zequanox molluscicide as a nonthreatening food source and readily consume the product along with their normal diet. Once ingested, Zequanox molluscicide causes their digestive lining to deteriorate, resulting in death.

Mussel mortality begins within a couple of days of the treatment and continues for several weeks following exposure to Zequanox molluscicide. The rate of mortality varies with mussel metabolic (or biological) activity and water temperature. This mode of action prevents a quick mass kill, reducing the risk of causing anoxic conditions in the treated water body.



Open water trials conducted at Deep Quarry Lake in Illinois, summer of 2012 and 2013

Putting Zequanox Molluscicide to Work

Zequanox molluscicide, developed by Marrone Bio Innovations, Inc. (MBI), provides multiple solutions for lake restoration projects:

- Rapid response to prevent infestation after identification of newly formed colonies, or when prevention methods are unsuccessful.
- Rehabilitation of recreational areas, such as treating shoreline access points.
- Treatment of problematic mussel populations in marinas.
- Rehabilitation of critical habitat (e.g., fish and native mussel beds).

In addition, MBI offers a series of consultation services to aid in mussel prevention and management:

- Methods and techniques for monitoring mussel populations in infested and uninfected water bodies.
- Development of Rapid Response Plans.
- Design of a treatment program and product application and monitoring once mussels are detected in the water body.

Round Lake in Petosky, MI - Open Water Treatment

Zequanox molluscicide and Other Species

Zequanox molluscicide has been shown to be highly selective toward zebra and quagga mussels. Extensive studies have been completed on numerous species of fish, native mussels, plants, algae, crustaceans, and insects, as well as mallard ducks, with no indication of any harmful effects on any other species at treatment concentrations.[1]

Zequanox molluscicide and Recreational Water Bodies

Zequanox molluscicide is composed of dead bacterial cells, so breakdown occurs very quickly. Water treated with Zequanox molluscicide can be used for recreation as well as irrigation of crops and turf. Because it has a zero-hour re-entry interval, water can be used continuously for recreational purposes. Zequanox molluscicide is also noncorrosive, so it poses no risk to boat surfaces or equipment. Finally, *Pseudomonas fluorescens* is already prevalent in food and in surface water, so eating fish from treated waters poses no risk to humans.

Cooperative Research and Development

MBI has cooperated with the United States Geological Survey (USGS) on Zequanox molluscicide open water research trials in the United States since 2013. The USGS continues to work with MBI to optimize application strategies and further product development for invasive mussel control in an open water environment.

The Discovery

Zequanox molluscicide was discovered by New York State Museum (NYSM) scientists in search of an environmentally responsible solution to the zebra and quagga mussel problem. After screening more than 700 strains of bacteria, the scientists discovered that a specific strain of *Pseudomonas fluorescens* (CL145A), found in a river soil sample in the northeastern United States, was lethal to zebra and quagga mussels. Marrone Bio Innovations, Inc. holds the commercial license for Zequanox molluscicide and was responsible for the commercial development of the product.

Pseudomonas fluorescens species have been used in many applications, including pharmaceutical production, snow making, frost protection for strawberries, and disease protection for apples. It has also been designated as "Biosafety Level 1" by the American Type Culture Collection and the American Biological Safety Association, defining *Pseudomonas fluorescens* as "having no known potential to cause disease in humans or animals." U.S. and international health and safety regulators consider *Pseudomonas fluorescens* species to be of the lowest possible risk to human health and the environment.

Christmas Lake in Shorewood, MN - Rapid Response Treatment

[1] When used as directed on the EPA-registered label.

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For More Information
Call 1-530-750-2800 • Email zequanox@marronebio.com • Visit www.zequanox.com

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