

# ZEQUANOX™

**Microbial Molluscicide**



 **Marrone®**  
Bio Innovations

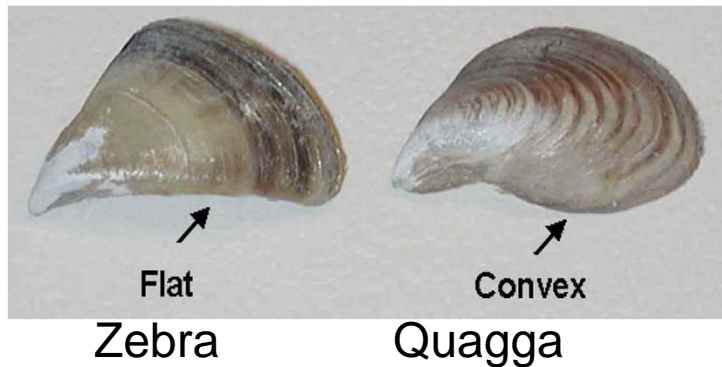


*We discover, develop, and market effective and environmentally responsible natural products (biopesticides) that fill unmet needs for weed, pest and plant disease management*

- *Currently: Regalia<sup>®</sup>, GreenMatch<sup>®</sup>*
- *Multiple pipeline products*
- *NEW: Zequanox<sup>™</sup>, an Environmentally Safe, Operator Friendly Product to control Invasive Zebra & Quagga Mussels.*



- Invasive Mussels = \$ billions in economic & environmental damage
- US, Canada, Europe are infested



clogged pipes



Attach to boat hulls, engine intakes, etc...



Fouled fresh water beach...

# ZEQUANOX™



- Microbial product –  
*Pseudomonas fluorescens*
  - Ubiquitous in the environment
  - Plant growth promoting bacterium in the rhizosphere - protect the roots of certain crops
  - Patented strain discovered in New York state
- Formulated product delivers dead microorganisms
- Highly selective product demonstrated by non-target ecotoxicology studies
- No acute mammalian toxicity as required by USEPA registration



# Clean Ecotoxicology Profile



Zooplankton  
*Daphnia magna*



Freshwater shrimp  
*Hyalella azteca*



Fathead minnow  
*Pimephales promelas*



Sunfish  
*Lepomis macrochirus*



Trout  
*Salmo trutta*



Freshwater ciliate  
*Colpidium colpoda*



7 Bivalve species:

*Mytilus edulis*, *Pyganodon grandis*,  
*Lasmigonacompressa*, *Strophirus undalatus*,  
*Lampsilis radiata*, *Pyganodon cataracta*, *Elliptio complanata*

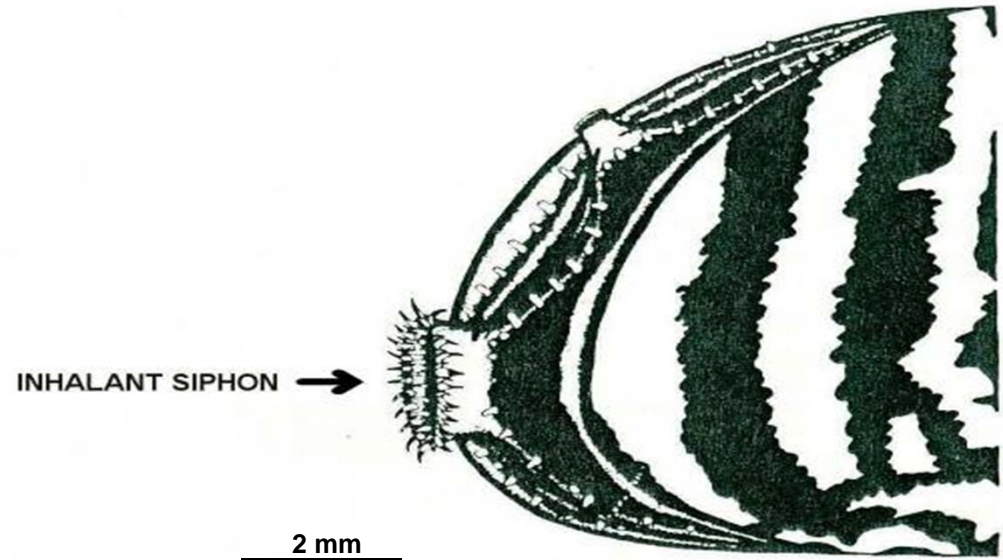


Mallard  
Duck

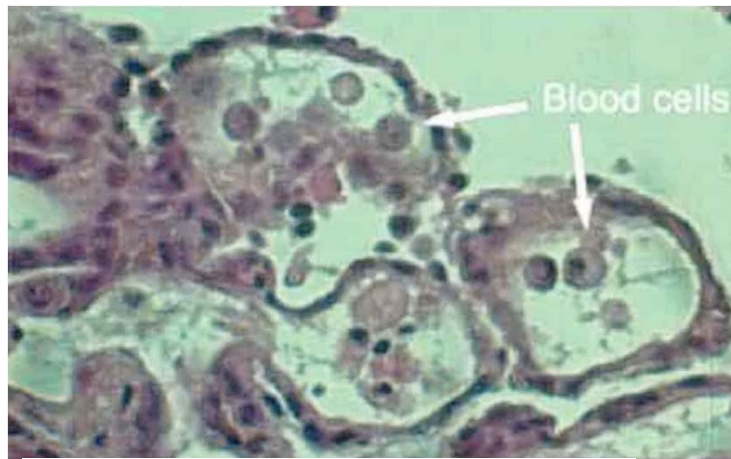
# Zequanox Mode of Action



*Pseudomonas fluorescens*



Adapted from Morton 1993

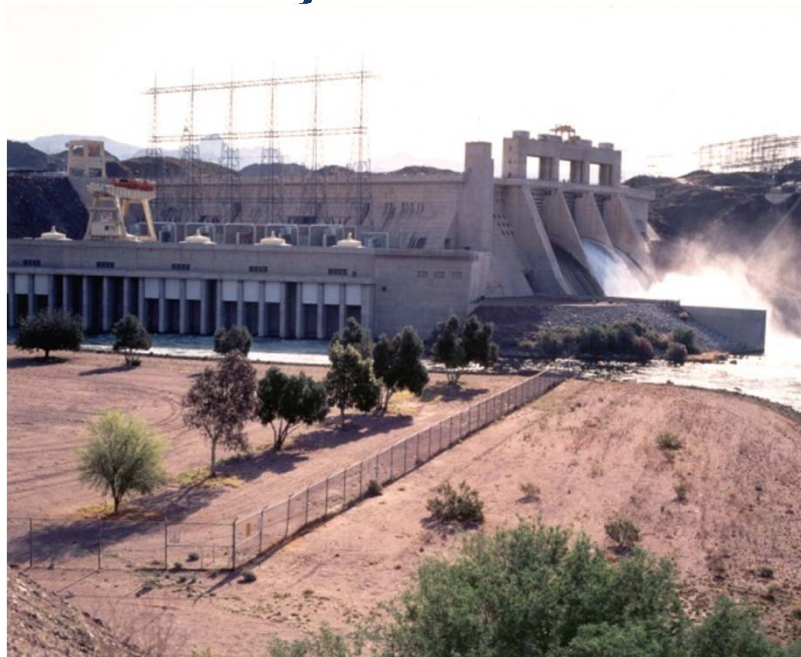


Ruptured gut cells

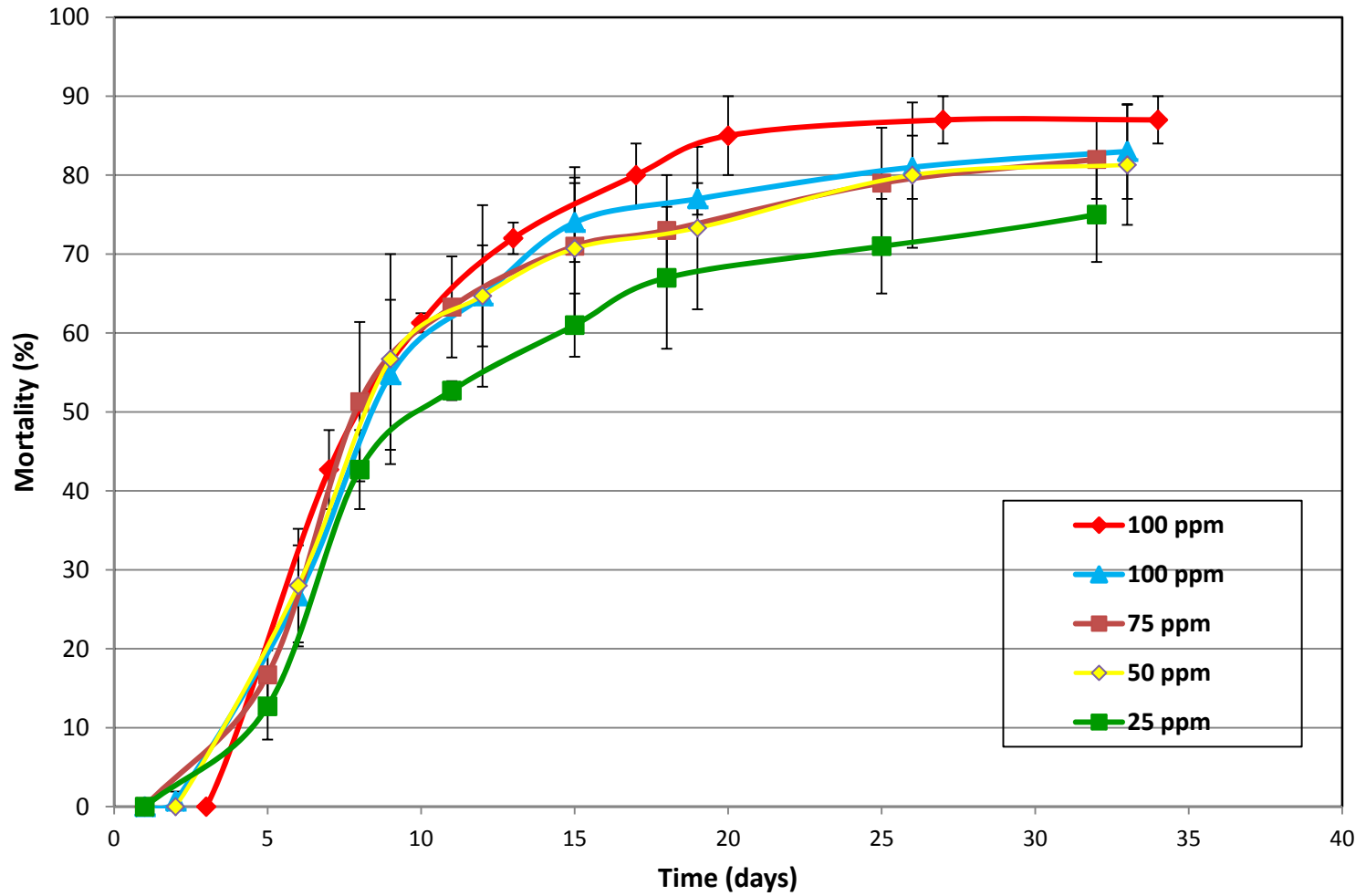
Invasive *Dreissena* spp. die following ingestion of large quantities of *P. fluorescens* cells

# Product Testing and Validation

- **Laboratory** acute toxicity tests – jar bioassays
- **Pilot Scale** - flow through biobox trials and by-pass pipes
- **Demonstration scale** - partial facilities
- **Full Facility** treatment



# Biobox Trial Rate Study





Today:



- Physical removal
- Quaternary ammonium compounds
- Aromatic hydrocarbons
- Endothal
- Chlorine

**Tomorrow:**

**ZEQUANOX™** 

- **Direct Replacement**
- **Environmentally friendly**
- **Applicator safety**
- **No toxic byproducts**
- **Tolerance exempt**





**Active on 2 life stages:**

- **Lethal to attached adults**
- **Veliger (juvenile) settlement prevention**
  
- **Target Customers:**
  - Hydropower, Nuclear, Coal
  - Industry
  - Conveyance channels & Irrigation systems
  - Drinking water facilities
  - Open-water (reservoirs, lakes)
  - Aquaculture





# Zequanox Regulatory Status

- Pending full US EPA approval
- Granted Section 18 – Emergency Use Permit – Submitted by United States Bureau of Reclamation
- Pending Canada PMRA approval
- Preparing regulatory submission in EU

# Acknowledgements



# Questions?

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