AQUATIC INVASIVE SPECIES

Low Frequency Electromagnetism as an Effective Method for the Control of Zebra Mussel Infestation

Final Report

>Objectives

The application of extremely low frequency (ELF) electromagnetic (EM) radiation as an effective method for the control of zebra mussel (Dreissena polymorpha) infestation will be investigated. Work will focus on monitoring the survival of zebra mussels in which the water has been irradiated by an ELF EM field. The efflux of the metal ions Ca2+, Mg2+, Na+ and K+ from zebra mussels exposed to ELF EM will be used to gauge the efficacy of this method. Quantitative mathematical models will be developed to interpret the experimental findings.

>Methodology

Animals in a closed system will be exposed to ELF EM field. The methodology of using ELF EM fields to control zebra mussels was developed in the PI's lab. Atomic absorption spectrophotometry will be used to assay the concentration of the ions Ca2+, Mg2+, Na+ and K+. Experiments will examine the application of ELF EM fields under various environmental conditions such as flow-through systems analogous to the flow in pipes, water conduits and rivers. The flow-through studies will be conducted in Lake Michigan at East Chicago, Indiana. We will study in more detail the effects of ELF EM fields on the development of juvenile mussels in a closed system. We will develop a mathematical model to interpret the interactions of ELF EM with D. polymorpha. We will begin from the observation that a magnetic field does not cause energy-level splitting for closed-shell molecules such as water, but does distort the electron density of a diamagnetic substance which can augment intermolecular interactions. For example, an increase in the water effective dipole will augment the bonding probability for ion-dipolar interactions which can enhance the solubility of CaCO3.

>Rationale

Preliminary results for a static system indicate 100% mortality was achieved of a sample of zebra mussels exposed to ELF EM fields after 10-15 days. Over this period, the dissolved calcium concentration increased from 28 ppm to over 110 ppm. There was also a 20% increase in [Mg2+] levels. Controls did not show a significant increase in dissolved [Ca2+]. The rate of change of the calcium concentration points toward the operation of process which affects the mussels' ability to assimilate calcium from water and also removes the calcium from the shells and bodies of the zebra mussels.

>Benefits

Zebra mussels threaten the shutdown of any facility that draws from infested waters. Prevention of catastrophic shutdown costs millions of dollars annually. Chemical treatments are extensively used; however, there are numerous regulatory and environmental concerns regarding the prolonged use of chemicals to control infestation. The use of ELF EM fields represents a nonchemical, economically-sound, environmentally-responsible method to control zebra mussel infestation. Because adults exposed to an ELF EM field cannot assimilate calcium, normal growth and development cannot occur. More importantly, larvae and veligers, for which the calcium demand is much greater than for adults, exposed to an ELF EM field will not be able to grow shells and thus will never be able to mature or develop.

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Research Information

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