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BioInspire.19 07.18.04

Restorer Eco-Machines for the Culture of Aquatic Animals and the Restoration of Polluted Aquatic Environments

By John Todd

John Todd Research and Design, Inc.

Is it possible to bring a dead lake back to life? And, is it possible to use natural biological systems to do it? These questions came to mind when my colleagues and I considered the plight of the pond adjacent to our wastewater treatment facility on Cape Cod.

The fifteen-acre pond also abutted a landfill; twenty million gallons a year of contaminated wastewater flowed from the landfill into the pond. The water was contaminated with bacteria and laced with several of the EPA's priority pollutants. Pond conditions were especially bad in the summer when the oxygen content of the water at the bottom of the pond dropped to zero and normally present bottom-dwelling animals were absent from many areas.

The pond was nearly comatose and needed a dramatic solution to bring it back to health. A water cleansing system based on the way that nature naturally functions had been designed by my colleagues and me for the treatment of sewage and septic tank wastes. That eco-machine was successfully treating wastes, but it was housed in a greenhouse. Would it be possible to create a floating version of the eco-machine?

Like the greenhouse system, the raft-based technology would have to be designed to house a diversity of life forms in a variety of specialized sub-environments. The "treatment cells" would have to support a diversity of microorganisms, algae and higher plants including shrubs and trees, and they would have to provide internal habitats of water-cleaning animals, including fresh-water clams.

The first Restorer powered by an electricity generating windmill and an array of solar panels, was launched in the fall of 1992. Up to 100,000 gallons per day of water from near the bottom of the pond were circulated through nine separate treatment cells.

Improvements in the pond's condition could be seen as early as the following year. A positive oxygen regime had returned to the pond and the EPA priority pollutants were absent. By 1995 sediment depth had been reduced by over two feet and there were large reductions in phosphorus, ammonia and organic nitrogen compounds. The overall health and biodiversity of the pond continued to improve. In 2002, after a decade of operation, the aging Restorer was removed.

Currently the pond has two windmills mounted on floats that oxygenate the water. It is our hope that this modest intervention is enough to sustain the revived pond.

Since that first experiment we have built Restorers in three other states and in China. One of the largest was installed in Maryland in 2001 on a nine million-gallon wastewater treatment lagoon that receives over one million gallons per day of high strength waste from poultry processing plant. The Restorer had twenty-five thousand plants, comprising twenty-five species of native plants, growing on it in special floating racks.

The Restorer provided three significant benefits to the poultry processing plant's waste treatment facility: (1) dramatically reduced sludge removal needs, (2) reduced electrical requirements, and (3) the facility came into compliance with its discharge permit. Both the company and the wildlife and human users of the Chesapeake Bay watershed are the beneficiaries.

Along a sewage-laden canal in the southern Chinese city of Fuzhou a similar Restorer technology was designed. The canal was putrid, filled with garbage, raw sewage and a variety of wastes including fats and grease.

The Restorer built to cleanse this canal was a half-mile in length. Its effect on the canal has been dramatic. Long gone are the putrid smells and the filthy canal. Now the water is quite clear and home to several species of Chinese fishes. The plants on the Restorer are host to butterflies and birds long missing from the inner city. An exciting fringe benefit of the cleansed canal is we hope to begin treating the canals of Shanghai in time for the 2008 Olympics.

My favorite Restorer story has taken place on the big island in Hawaii at an upscale resort. Restorers were designed to cleanse an unsightly, algae-laden five-acre pond in the middle of a golf course. The pond was filled with brackish or salty water.

The Restorers cleansed the pond water and then went on to greater heights. They now support the culture of marine animals for the resort. Currently the pond contains 80,000 Pacific white shrimp, 300,000 oysters and 60,000 fish. A former liability at the resort has become one of its major assets.

The future for the Restorer is expanding. I see them being widely used in fish culture. I am currently designing systems that combine marina docks for pleasure boats with Restorers so that harbor-front waters can be cleansed. The City of Toronto plans to build a Restorer on its waterfront, right at the heart of downtown. The goal is to make sections of the waterfront clean enough to meet swimming standards. If we can design a Restorer to do that, life on the water in our cities in the summer will never be the same.

Definitions

What is an eco-machine?

An eco-machine (also known as a Living Machine) is a constructed device that borrows biological techniques nature has already perfected to cleanse contaminated water. The Restorer is a eco-machine that is physically located in the middle of a water body, rather than on land.

Eco-machines essentially replicate a river system, including the final filter of wetlands. But they house a higher concentration of the life forms that naturally purify water, in an enriched environment that maximizes the efficiency of their work.

Eco-machines have a series of treatment cells that are populated with hundreds of species of microbial, plant and animal life forms in ecologically engineered aquatic food chains. Contaminated water is pumped into the first treatment cell, where the living organisms begin the cleansing process, and then flows by gravity through the cells. In each subsequent treatment cell, increasingly higher life forms become involved.

Wastes generated by the microorganisms, bacteria, algae, mollusks, fishes, flowers, shrubs, trees and other animals in one cell flow with the water and become food for the inhabitants of the next. In this manner, using sunlight as the primary source of energy, compounds are broken down and the contaminated water is being purified.

In other words, eco-machines use ecological knowledge to speed up and enhance the age-old processes by which nature cleans itself. Eco-machines are able to degrade pollutants, assimilate nutrients, sequester heavy metals and break down various toxic organic compounds. In a pond, a Restorer "jump starts" the pond ecology, enabling organisms to metabolize nutrients in the pond. The Restorer helps the pond ecology repair itself by creating important habitat, adding oxygen and re-circulating water within the pond, while increasing over-all biological diversity.

REFERENCE:

Todd, J., E. Brown & E. Wells 2003. Ecological design applied. Ecological Engineering 20 (2003) 421-440.

Contact information:

John Todd Research and Design, Inc.

508/548-2545

jtodd@cape.com

Author biography:

John Todd

JOHN TODD is an internationally recognized biologist and the author of over two hundred technical and popular articles on biology and planetary stewardship. He was Assistant Professor of Ethology at San Diego State University and assistant Scientist at the Woods Hole Oceanographic Institute and is now a professor at the University of Vermont.

In 1969 he co-founded the New Alchemy Institute to create a science and practice based upon ecological precepts and was its President until 1981. In 1980, he co-founded Ocean Arks International. He also co-founded Living Technologies Inc., an ecological design, engineering, and construction firm in Burlington, Vermont, and Living Technologies in Findhorn, Scotland. He sits on a number of environmental and technical boards.

Todd is a leader in the field of ecological design. He has described his work in a series of book! s: The Village as Solar Ecology (1980), Tomorrow is Our Permanent Address. (1980), Reinhabiting Cities & Towns: Designing for Sustainability (1981) and Bioshelters, Ocean Arks, City Farming: Ecology as the Basis of Design. (1984). This last has been revised and published as From Eco-cities to Living Machines (1994).

Dr. Todd has received numerous accolades for his work. Most recently he was profiled in **Inventing Modern America**, a publication of the Lemelson-MIT Program for Invention and Innovation, which features the development of his signature ecological waste treatment systems.

He was awarded an Honorary Doctorate from Green Mountain College in 2000 and received the Bioneers Lifetime Achievement Award two years previous. Also in 1998, he and Nancy Jack Todd together received the Lindbergh Award in recognition of their work in technology and the environment.

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ABOUT THE PUBLISHER:

John Mlade is a green building professional researching and teaching biomimicry at Colorado State University and is a research assistant at the Institute for the Built Environment (www.ibe.colostate.edu). He is also a member of the Biomimicry Guild. Visit www.biomimicry.net for more information.

TO CONTACT THE PUBLISHER:
Email John Mlade at BioInspire@yahoo.com

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