SpiroFlo: Mending Fresh Water Intrusion in Coastal Marshes and Oyster Beds

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ABSTRACT

In an effort to combat the massive 2010 BP oil spill, Louisiana state officials opened gates along the levees of the Mississippi River. Though this succeeded in keeping the oil out, it flooded the oyster beds with fresh water—a move that dramatically reduced the necessary salinity oyster beds need to survive, killing off 60% of the oysters in one of the most productive parts of the Barataria Bay. Low estimates figure that a killed estuarine reef might return to production within two years (if intertidal reefs were still viable). In that time, hundred of millions of dollars of Louisiana's economy, along with thousands of jobs, are put on hold, and the longer the fresh water dilutes the salt water, the more oyster beds are at risk.

The SpiroFlo solution reintroduces salt water into oyster bed habitats with minimal disruption, allowing them to re-attain the necessary salinity to thrive. Most easily described as creating a tornado in a pipe, the SpiroFlo device contains no moving parts (meaning there is nothing to wear out) and requires no additional energy source (keeping operational costs low). This device mixes the fresh and salt water into a gentle, spiraling, homogenous flow that serves to gradually increase the salt content of the water in the oyster beds. Since the SpiroFlo solution has a wide coverage area upon discharge to atmosphere, this solution is able to cover large areas. SpiroFlo is also environmentally neutral with no chemicals involved, and when combined with an eductor (jet) pump, a subsurface version of the SpiroFlo device aids in gently aerating the water with minimal shock to the marine ecosystem. Users can easily operate the system with little training and no required protective gear, encouraging local employment.

The patented SpiroFlo solution is proven, commercially available (with over 1,400 tools sold into the oil and gas industry) and ready for immediate deployment.

The Need

Due to fresh water intrusion, several oyster beds in the brackish marshes of southern Louisiana are dead and many more are at risk.

In April, soon after the massive Deepwater Horizon oil spill occurred, Louisiana state officials started opening gates along the levees of the Mississippi River. This controlled action, designed to keep the approaching oil at bay (a move sanctioned by the Louisiana governor's office and consented to by the Army Corps of Engineers), pumped massive amounts of river water through manmade channels to the coastal marshes.

> By most accounts, the strategy succeeded in minimizing the amount of oil that entered the fertile and lucrative estuaries. But oyster farmers and scientists say it appears to have had one major side effect: the deaths of large numbers of oysters, water-filterers whose simplicity and sensitivity makes them early indicators of environmental influences that ultimately could hit other marsh dwellers too. [1]
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> Some marshes have been so inundated with fresh water that their salinity has plummeted to levels oysters can't easily survive, some scientists say. Deprived, at least temporarily, of the salty water they need, large numbers of the two-shelled crop that has defined this region's economy and culture for generations are dying off - even in parts of the Louisiana coast that appear to have been untouched by the spilled oil itself.
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> Full-strength seawater typically contains roughly 35 parts salt per thousand parts water, scientists say. Some of the southern Louisiana waters most productive for oysters contain 15 or more parts salt per thousand parts water, said Earl Melancon, a biologist at Nicholls State University in Thibodaux, La.
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> But in recent weeks, Mr. Melancon said, some waters in the vicinity of southern Louisiana's Barataria Bay have been found to have salinity levels below five parts salt per thousand parts water. Even the hardiest oysters, he said, have trouble surviving in that.
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> "They're dead, and they're dead because of fresh water," said Nick Collins, 38, an oysterman in Golden Meadow, La., citing government measurements of reduced salinity levels in the area. [1]
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> Patrick Banks, the biologist at the Louisiana Department of Wildlife and Fisheries who oversees the state's oyster fishery, said his office recently tested the waters in one of the most productive parts of Barataria Bay and found that roughly 60% of the oysters had died. In other areas of the bay, he said, the mortality level was around 10%.One die-off a few weeks ago was so extensive that visible masses of oyster meat were floating on the bay's surface. "It looked like a fish kill," said Mr. Banks, explaining the kill occurred "so fast and was so large that the predators that normally would eat up the

> oyster meat just couldn't keep up." He blamed the deaths on the combination of summer heat and the salinity drop triggered by the opening of the fresh-water channels, known as "diversions"—a decision made by officials in another state office who were attempting environmental triage. "The state took the measure to try to protect the interior marshes," Mr. Banks said. "These are just some of the effects of that." [1]
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> Mr. Melancon, the Nicholls State biologist, is attempting to measure the extent of oyster deaths from the fresh-water diversions. "Have these diversions created more harm than good?" he asked. "I am not going to be the person to make that determination. But it certainly has harmed the oyster industry more than the oil." [1]

Oysters and Saltwater

Oysters use saltwater to make their shells and need it to keep their vital membranes working properly. They can tolerate small doses of fresh water for perhaps a couple of weeks, but they will die if they suck in too much. The surface to which they attach becomes their home for life. They feed by opening their shells, pulling in and filtering plankton and algae from as much as 100 gallons of the surrounding water each day.

When that happens naturally due to floods or torrential rains, the impacted reefs are rebuilt from spat—young oysters—supplied by the intertidal oysters, which survive because they are next to the salty Gulf of Mexico.

"The intertidal oysters are our defense against catastrophe," Melancon said. "When catastrophic conditions destroy reefs in our estuaries, we depend on for the spawn from the intertidal oysters to rebuild.[2]

> Oysters are broadcast spawners, meaning they release eggs and sperm into the water. Fertilized eggs become tiny hard-shelled larvae within a day, and begin floating across an estuary with tidal currents and wind, feeding on plankton. They are seeking homes on hard-surfaced bottom structure, and are drawn to existing reefs by chemical signals released by the adult oysters.[2]
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> Under good conditions, an estuarine reef killed might return to production in two years—if intertidal reefs were still viable. The impacts of a long-term disruption in the region's oyster population would have ripple through the local and national economy. According to industry figures, Louisiana produces up to 40 percent of the oysters consumed in the nation. The industry employs about 3,500 people and has a $318 million annual impact on the state economy.[2]

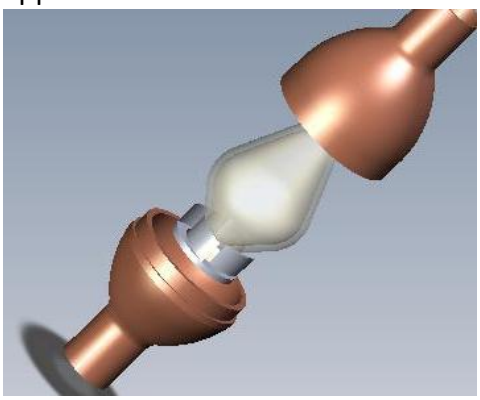
The Challenge

The challenge to restoring adequate salinity levels in oyster beds appears to consist of solving two problems:

1. Persuading state and federal officials to stop pumping fresh-water into the marshes; and
2. Developing a plan to quickly restore the salinity to levels where oysters can prosper, but do so without creating significant roiling and turbidity thereby destroying the marshes in the process.

The SpiroFlo Solution

The SpiroFlo technology represents a significant breakthrough in the area of liquid moving and mixing. The SpiroFlo device (exploded diagram pictured below left) is proposed for use in the application of the controlled reintroduction and recirculation of salt water into oyster bed habitats within the marshes that have been subject to fresh water intrusion.



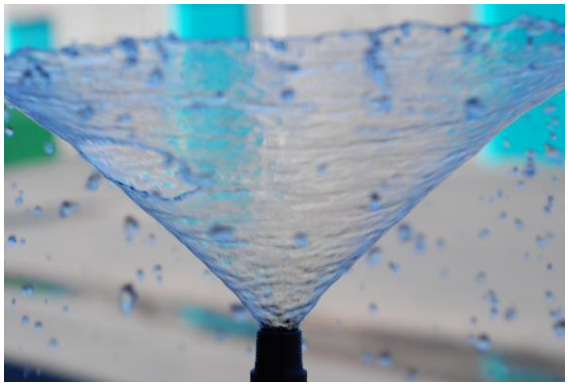
Most easily described as a "tornado in a pipe," the SpiroFlo technology initially develops a spiraling helix causing the entire flow to spin. Given the spiraling flow, two liquids (in this case fresh and sea water) can be easily mixed to create a homogenous flow and serve to gradually increase the salt content in the water in the oyster beds.

While it is vital to increase the salinity to 15 or more parts salt per thousand parts water, it is also important to do so, without causing direct shock to the oysters or their environment.

Surface Spray

The gentle spray pattern of the SpiroFlo nozzle creates a constant flow of mixed and aerated water on the surface. Upon discharge to atmosphere, the surface spiral expands to deliver a solid stream in a hollow cone (with a ring-shaped impact area). Since the water droplets are spinning on discharge, impact and coverage are maximized. A ¾" SpiroFlo device can create a spray area which provides 12 feet by 12 feet of coverage, so the ability to deliver a solution to large areas simultaneously is enhanced with the SpiroFlo solution.

Top view of SpiroFlo device on surface



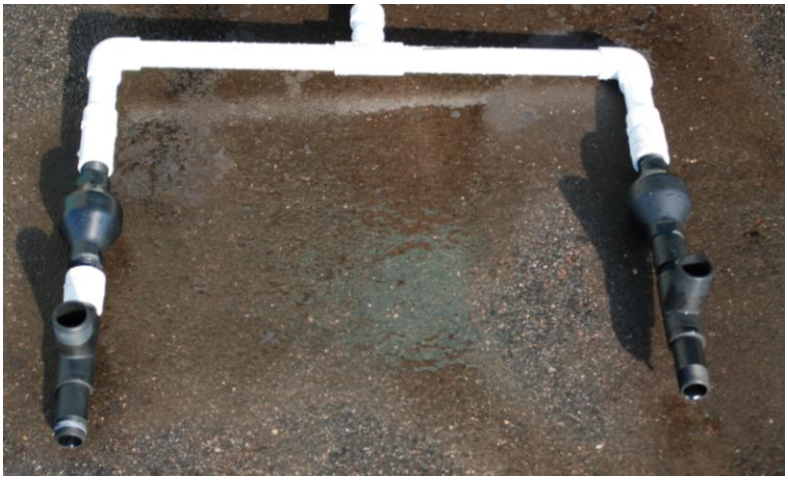
Side view of SpiroFlo outlet – 36-42" wide coverage

Subsurface Flow and Aeration

In addition, SpiroFlo would propose a subsurface swirling organized flow to penetrate the areas surrounding the oysters while minimizing turbidity and roiling. This high velocity subsurface flow would help deliver concentrated seawater levels to the stressed habitat of the oysters. The SpiroFlo device will provide an increase in salinity levels and also increased levels of oxygen in the water through the aeration aspect of our solution.

Multiple Outlet Configurations

SpiroFlo envisages using a barge with a pump in the salt-water source and then deliver the water (with a variable level of fresh water adjusted as needed) to the oyster beds through a series of SpiroFlo devices. A single 2" line from the barge could feed up to 12 SpiroFlo outlets, which would be mounted in a series of four spray bars each with two surface and two subsurface devices.



Dual-outlet subsurface SpiroFlo device with aeration

Eductor pump aeration attachment

The SpiroFlo device can be operated with off-the-shelf pumps and standard piping. The process is easy and inexpensive to operate. There are no moving parts in the SpiroFlo device and wear issues are expected to be minimal with this product application. The device is virtually maintenance free, offering clog-free spraying, low energy costs and simple operation.

The SpiroFlo device is protected by U.S. and overseas patents and is proudly manufactured in the U.S.A.

Sources

1. Ball, Jeffrey. "Fresh Water Aimed at Oil Kills Oysters" 21 July 2010. *Wall Street Journal.* Page 3. Available: http://online.wsj.com/article/SB10001424052748704720004575377503611992306.html
2. Marshall, Bob. "Oysters are uniquely sensitive to Gulf of Mexico oil spill" 25 May 2010. *The Times-Picayune*. Available: http://www.nola.com/news/gulf-oil-spill/index.ssf/2010/05/oysters_are_uniquely_sensitive.html

Additional Resources

The "SpiroFlo Solution for Marsh and Wetlands Clean-Up" document gives more expansive details of the SpiroFlo solution and is available on request.