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Marine fish aquaculture breakthroughs in U.S., Caribbean

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Offshore cage systems among the most environmentally sustainable methods

Cobia swirl inside a submerged sea cage. These fish are showing one of the fastest growth rates ever recorded for teleosts fish.

A combined effort between the private sector, universities, and the United States government led to major breakthroughs in marine fish aquaculture in the southeastern United States and Caribbean in 2002. Improved techniques for spawning, larval rearing, nursery, and grow-out of various species of tropical marine fish are bringing the prospect of an environmentally sustainable and commercially viable marine fish aquaculture industry to reality.

During the last four years, the Aquaculture Center of the Florida Keys, Inc. (ACFK) joined efforts with the Aquaculture Program of the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS) to refine hatchery technology of high-value species of marine fish. The research and development effort, partially funded by the National Oceanic and Atmospheric Administration, has focused on scientific aspects leading to improved hatchery technology of mutton snapper (*Lutjanus analis)* and cobia (*Rachycentron canadum)*.

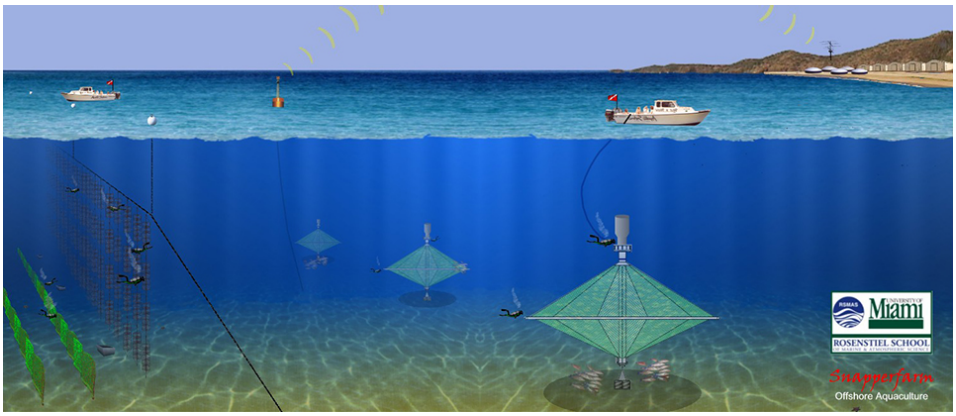
Seedstock production

The main bottlenecks for the development of an industry for farming marine food fish in the United States are the consistent spawning of broodstock fish and the raising of larvae and fingerlings in hatcheries. The development of a breeding program for mutton snapper and cobia – with application to other marine fish species – has been a key determinant to the success of the entire hatchery and grow-out operations.

Remarkably, mutton snapper broodstock have spawned millions of fertilized eggs on and off season throughout the year, including November and December. This was the first time that captive mutton snapper and cobia spawned naturally on the sole basis of manipulating environmental cues, such as varying the water temperatures between 20 and 28 degrees-C.

During the summer, tens of thousands of cobia and mutton snapper fingerlings were successfully reared at the ACFK hatchery in Marathon, Florida Keys. The fingerlings were transported and stocked into two offshore cages submerged in deep waters off the coast of Culebra Island, Puerto Rico.

Snapperfarm demonstration project



Stocked cages inevitably generate nutrients and suspended solids. To offset this, scientists plan to place downstream from the cages several rafts and longlines with filter-feeder mollusks and banks of macroalgae to absorb the nutrients released by the system

Snapperfarm, Inc. is developing the offshore aquaculture demonstration project in Puerto Rico with technological support from RSMAS and the assistance of the Puerto Rico Industrial and Development Corp. The Culebra Fishermen Association is also collaborating, with the University of Puerto Rico conducting the environmental assessment and social and economic studies related to the development of the operation.

Offshore cage system

The Snapperfarm operation has two enclosed, submerged cages stocked with around 10,000 cobia and 10,000 mutton snappers. The offshore cage system is completely submerged to preserve the aesthetic aspects of the area surrounding the island of Culebra, which is located equidistant between San Juan and the U.S. Virgin Islands.

The 27-meter depth of the site and steady current of 0.25 to 1.0 knots maintain water movement in a downstream direction, dispersing any organic and inorganic waste that might be associated with the operation. No coral reefs are present in the area surrounding the cage systems, but there are sparse patches of *Halimed,* a macroalgae characteristic of nutrient-poor environments, on the sandy bottom.

Stocked with cobia and mutton snappers, these cages inevitably generate a certain amount of nutrients and suspended solids. To offset this, scientists plan to place downstream from the cage site several rafts and longlines with filter-feeder mollusks and banks of macroalgae to absorb the nutrients released by the system.

Cobia (top) and snappers 45 days after hatching. The cobia reflects an impressive growth rate.

Feeds and feeding

Fish are fed twice a day, with feed-conversion ratios less than 1.0 using a delivery system developed and manufactured by Cates International, Inc. in Hawaii. In the near future, automated feed hoppers loaded with feed will automatically dispense precalculated rations to ensure the highest assimilation and fish growth rates, with minimal wasted feed, feces, and nutrients.

Ongoing results

Growth and survival have been excellent in both cages. Cobia in these offshore cages are showing one the fastest growth rates ever recorded for teleosts fishes. Fingerlings grew in length from 5 to 10 cm to 25 to 30 cm, and in weight from 2 to 12 grams to 300 to 400 grams in 45 days, with survival rates close to 100 percent. Six months after stocking, cobia average 1.6 kg in weight. Rate projections indicate these fish will grow to 6 to 8 kg in one year.

Environmental quality and sustainability

For the environmental assessment conducted by the University of Puerto Rico, water samples are manually collected by divers at three depths in six locations around the cages. To date, water quality parameters show no traces of any negative environmental impact caused by organic and/or inorganic nutrients and solids generated by the system. The operation is leaving no noticeable footprint on the area.

A key determinant in the success of major aquaculture operations is the ability to monitor the biomass and water quality parameters – such as temperature, salinity, oxygen, pH, suspended solids, and nutrients – to determine whether feeds are being dispensed at the optimum rate. Snapperfarm is teaming up with the International Seakeepers Foundation to install an independent, autonomous monitoring device with several sensors in the cage system. The device will gather and transmit real-time data via satellite to computerized systems in a control room of the lab and, conceivably, make the data and images available on the Internet.

Conclusion

Offshore aquaculture is a sustainable and profitable alternative to traditional methods. When properly developed, in addition to producing valuable species of marine fish, it can produce organisms like algae and mollusks, which feed low on the food chain, while removing organic and inorganic nutrients.

The hatchery production of high-value marine fish and grow-out using submersible offshore cages have been widely recognized as major breakthroughs. According to Dr. Jim McVey, NOAA Sea Grant aquaculture director and manager of the National Marine Aquaculture Initiative, the milestones achieved in Florida and Puerto Rico in 2002 are shifting the paradigm from traditional, land-based and coastal aquaculture offshore.

Unlike some traditional aquaculture practices that can have negative impacts on marine environments, the offshore cage systems are among the most environmentally sustainable methods for commercial marine aquaculture because they are located farther from shore. Greater depths and strong currents there make pollution less of an issue due to the carrying capacity of the ocean for absorption of nutrients and dispersion of solids.

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