



OPEN OCEAN CAGE CULTURE

Principal Investigator: Charles Helsley
University of Hawai'i Sea Grant College Program



Introduction

Over the last 20 years, an increasing demand for seafood products has collided with a decreasing supply from depleted fishing grounds worldwide. Hawai'i's seafood consumption rate is three times that of the U.S. mainland and, despite its mid-Pacific location, Hawai'i imports 75 percent of the fish it consumes.

The University of Hawai'i Sea Grant College Program, partnering with the Oceanic Institute, has been working with government and private organizations in Hawai'i since 1999 to examine the biological, environmental, and economic feasibility of offshore aquaculture in the Pacific region.

These efforts led to the nation's first successful demonstration of offshore culture of a tropical marine fish species in a single, commercially sized cage under the National Oceanic and Atmospheric Administration-funded Hawai'i Offshore Aquaculture Research Project (HOARP).

Building on nearly three decades of UH Sea Grant-funded research in Pacific threadfin (moi) husbandry and the development of broodstock, the HOARP produced more than 130,000 moi in two successful sea cage trials without the use of antibiotics or growth-stimulating hormones.

To avoid delays associated with leasing an open-ocean site, HOARP researchers pursued the alternate route of securing a research permit. With help from the Hawai'i Aquaculture Development Program, this avenue paved the way for changes in Hawai'i's offshore leasing laws for commercial aquaculture ventures.



The HOARP experimental sea cage is submerged 40 feet below the surface and designed to withstand 25-foot waves. The cage acts as a fish aggregating device.

Airport. Anchored at a 100-foot depth by a four-point mooring system, the cage was fully submerged about 40 feet below the water's surface.

1999-2003 Sea Grant Funding

UH Sea Grant: \$655,825; matching funds: \$35,501

Activities

The overarching goal of demonstrating the potential feasibility and practicality of offshore aquaculture in Hawai'i state, which could eventually serve as a national research and demonstration test model, included:

- Demonstrate that offshore aquaculture in Hawai'i is environmentally compatible
- Develop a cooperative, effective, and coordinated partnership among key project contributors
- Conduct test marketing of aquaculture products derived from project activities both locally and worldwide

- Identify and examine issues that might constrain future industrial development

Currently depleted in Hawaiian waters, moi is a high-value, ethnically desirable and locally endemic fish. While they are culturable year-round and grow well in captivity, moi are surf-zone fish. One goal of the demonstration project was to determine how these fish would grow at deeper depths, including:

- Demonstrate feasibility of submerged growout of moi
- Develop means of underwater feeding and harvesting

Results/Impacts

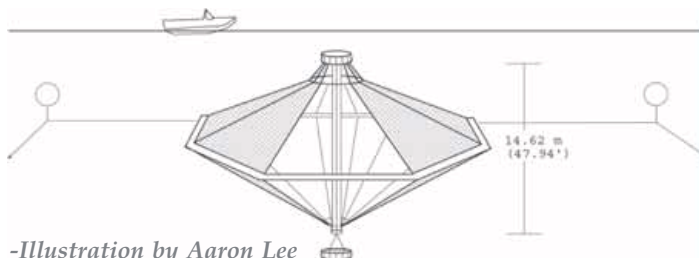
Although the fish are naturally adapted to very shallow water, the experiment successfully demonstrated the feasibility of growing moi at depths of 15 to 30 meters in an economically viable way with no adverse environmental impact to the water column, sea floor, or nearby coral reefs.



Oceanic Institute

Divers survey Sea Station 3000

Made from steel and NASA-developed mesh, the \$90,000, 50-by-80 foot bi-conical experimental sea cage, called Sea Station 3000, was anchored two miles offshore and about four miles west of Honolulu International



-Illustration by Aaron Lee

In the first trial, researchers stocked the offshore cage with 70,000 moi. Harvesting began in late August of 1999, about 4.5 months after the fish were introduced into the cage, and continued on an incremental basis until October. Both the growout and harvest were done while the cage was submerged. Fish reached market size at 12 to 24 ounces and, by the end of the first season of growout, 52,000 fish weighing more than 19 tons were harvested.



The moi stocking density was doubled for the second year follow-up experiment conducted by the Oceanic Institute, producing a harvest of nearly 34.5 tons.

Food supplied to the cage was carefully monitored to minimize feed waste and establish a baseline protocol for feeding and harvesting of the fish. Researchers discovered that, similar to artificial reefs, the cage became a popular fish-aggregating device. This helped absorb some potential environmental impacts from unconsumed fish feed.

Industry Applications

Now commercial, the technology has been transferred to Hawai'i's \$22 million-aquaculture industry. Offshore fish farming could boost those figures substantially, adding to the current worldwide open-ocean aquaculture industry valued at \$4 billion.

After participating in the Phase I and Phase II HOARP research efforts, Cates International, Inc. applied for a lease near the research site and established the first fully permitted open-ocean aquaculture site in the U.S. The first commercial harvest of fish began in January 2002.

Under a 15-year lease with Hawai'i, Cates International, Inc. may install a total of four cages and potentially harvest from one million to two million pounds of fish per year. Currently the site consists of three cages, including the original research cage, and more than 600,000 fish.

UH Sea Grant researchers continue to monitor the environment around the commercial farm site for any adverse impacts.



Selected Publications

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Ostrowski, A.C. and C.E. Helsley. 2003. The Hawai'i Offshore Aquaculture Research Project: Critical Research and Development Issues for Commercialization, in Open Ocean Aquaculture: From Research to Commercial Reality, Bridger, C.J. and B.A. Costa-Pierce, editors, The World Aquaculture Society, Baton Rouge, LA, USA p.119-128.

Helsley, C.E. A Numerical Study of the Initial Mixing Zone Downstream of a Submerged Fish Cage, *Proceedings of the 21st International Conference of Offshore Mechanics and Arctic Engineering, Oslo, Norway*. 2002.

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Tamaru, C.S., C. Carlstrom-Trick, C.E. Helsley, Aquaculture in Hawai'i: Lessons from the Past, in Open Ocean Aquaculture '97 *Charting the Future of Ocean Farming*, Proceedings of an International Conference, April 23-25, 1997, Maui, Hawai'i. Charles E. Helsley, proceedings ed., University of Hawai'i Sea Grant College Program, pp. 257-278 (1998).

Partners

- National Oceanic and Atmospheric Administration
- Oceanic Institute
- Cates International Inc.



During his four-year tenure as UH Sea Grant director, Charles E. Helsley spearheaded Hawai'i's first experiment in open-ocean aquaculture, which successfully demonstrated the feasibility of farming fish in an open-ocean environment and has become a national model for offshore cage culture.

Prior to his 1995 Sea Grant appointment, Helsley served as director of the UH Institute of Geophysics for 18 years. He also held a post as professor in the UH Department of Geology and Geophysics, and served as acting dean at the UH School of Ocean and Earth Science and Technology, now the third largest oceanographic research institution in the country by grants awarded.

Helsley studied geology and geophysics at the California Institute of Technology and later at Princeton University, where he earned a Ph.D. in geology.

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