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Spatial Management of Fisheries

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Background

In 1999, the California legislature passed the Marine Life Protection Act, which directs the Department of Fish and Game to develop a plan for creating a network of marine reserves to better protect marine habitats and preserve ecosystems.

Though the reasons for establishing marine reserves are conservation-oriented, questions about how these reserves might affect the fishing industry is a major issue and potentially an impediment to implementing the act.

One of the many fisheries that could be affected by the creation of no-take reserves is the red sea urchin. For more than a decade, the urchin has been one of the state's top fisheries. Primarily an export fishery to Japan, its ex-vessel value was worth an estimated $11.5 million in 2001. Sea urchins are harvested for their golden, spongy gonads, a sushi delicacy called "uni."

Project

The goal of the project was to develop a computer model capable of simulating the biological and economic consequences of establishing hypothetical no-take marine reserves on the red sea urchin fishery in Northern California.

Distinguishing itself from traditional biological models, the model developed in this Sea Grant project was designed to simulate the decision-making process of urchin divers—when and where fishermen dive, given various environmental and economic variables.

The Findings

The model suggests, as many biologists have repeatedly predicted, that prohibiting fishing in an area can dramatically increase egg and larval production in that area. This increase in production was particularly evident for reserves sited in areas that had been fished heavily before being closed. Jim Wilen, a professor of economics at the University of California, Davis, and the project's lead scientist, said: "The pre-reserve exploitation level turned out to be a key factor in determining whether or not a reserve might increase overall yield from the fishery in the long run."

"If the pre-reserve fishery is severely overexploited," he said, "then a reserve will help rebuild and increase overall yields in the long run." If, however, the fishery is relatively healthy and well-managed, increased production is less likely to compensate for harvests lost in the closed areas. In other words, the economic ramifications of reserves depend on the a priori health of the fishery. What is the current status of the sea urchin fishery? "Unfortunately, at present it is difficult to determine this precisely," Wilen said.

The California Department of Fish and Game categorizes the red sea urchin as "fully exploited." Landings have declined dramatically in the last decade. In Northern California, for example, urchin harvests have hovered between 3 and 4 million pounds since 1995, compared with 30.5 pounds at the fishery's peak in 1988.

The drop in landings might seem to suggest that the fishery is unsustainable. But Wilen said, "Steep reductions in harvests are expected after a fishery first opens." The sea urchin fishery began in Northern California during the mid-1980s, as divers who could no longer make a living harvesting abalone went in search of new catches. During the

Commercially harvested sea urchins being offloaded. Photo: William B. Folsom, NMFS early, boom times of the fishery, divers were literally raking in money, as they collected hoards of older, big adults that had accumulated in amazing abundance prior to exploitation.

One piece of biological data that could shed light on the health of the urchin stock is "lifetime egg production," the number of eggs a female produces during her lifetime. "The key long-term question is whether lifetime egg production from the remaining sea urchins is sufficient to maintain the fishery," said Loo Botsford, a biology professor at University of California, Davis, and co-investigator on the Sea Grant project. "We know little about important factors such as lifetime egg production."

Despite the unresolved biological questions, the model has been highly successful in its ability to simulate how fishermen might realistically respond to new regulations and how their responses could, in turn, diminish some of the anticipated conservation goals of reserves. The model, for instance, shows that setting aside some areas can increase the intensity of fishing in remaining open areas. "Thus, some of the anticipated increases in sustainable yield are dissipated by this shift in effort," Wilen said.

Another factor that may reduce the anticipated benefits of reserves is the uneven distribution of fishing effort, with or without reserves. Economic factors govern where and how hard fishermen fish. Even without reserves, some areas are less fished than others. "These areas serve as de facto reserves, and hence overall larval production is higher than might be expected if one assumes that fishing effort is uniformly distributed," Wilen said.

Implications and Impacts

The simulations have been successful at highlighting and explaining some of the sources of controversy in establishing marine reserves. "Part of the problem with the public debate is that different groups are focusing on different impacts of reserves," Wilen said. "The conservation community is generally focusing on the manner in which reserves will increase biodiversity and population sizes of exploited populations. There is little doubt that these goals will be achieved by setting areas aside from exploitation."

But for fishermen and fishing communities, the issue at stake is sustainable harvests and economic returns. "They are not just interested in whether there will be 'some' spillover into remaining open areas, but whether the increase will be sufficient to compensate for what they may lose in closed areas," Wilen said.

Collaborators

California Department of Fish and Game

Publications

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