ARTIFICIAL REEFS: THE FLORIDA SEA GRANT CONNECTION

- SCIENCE SERVING FLORIDA'S COAST -

By
William Seaman[1] and Aaron Hoover[2]

Research, education, extension and communications efforts concerning artificial reefs have been a part of the Florida Sea Grant College Program[3] for a number of years. As interest continues to grow, both in the public and private sector, Sea Grant continues to support investigators and activities in this area. Today Florida coastal waters are home to about half of all artificial reefs in the United States.

Florida Artificial Reefs

Artificial reefs in Florida have been especially popular since the 1970s. With the advent of State Legislative funding in the 1990s, numerous local government and private interests have been able to develop reefs. The principal purpose is to enhance recreational fishing opportunities. But there are an increasing number of reefs being built as scuba diving sites and also to repair or mitigate damage to ocean habitat such as coral reefs. While there has been a historical reliance on so-called "materials of opportunity," which were available free or at low-cost to volunteer or governmental interests, more recently some use of designed structure is happening. Establishment of a state agency office to coordinate reef deployment — now in the Florida Fish and Wildlife Conservation Commission — has fostered a loose network of reef builders, users, managers, scientists and other interests.

G. Relini

The theory behind some reef construction is that the human-made structure will mimic the natural ecosystem.

Florida Sea Grant Reef Programs

Beginning in the 1970s with local workshops on responsible practices for reef-building, the faculty of Florida Sea Grant's Extension Program to this day continue to advise anglers, divers, government planners and others on technologies for reef planning, construction and monitoring. Meanwhile, research projects conducted at several universities since the 1980s have provided scientific understanding of reef ecology, engineering and socioeconomics, in order to undergird and improve the reef deployment, design and evaluation process. This fact sheet summarizes some of the success of outreach, research, and information synthesis.

Florida Sea Grant Extension

Faculty members of Florida Sea Grant who live and work along the state's coastline have contributed to the evolution of artificial reefs by providing technical support and scientific information to the reef-building community. They have been responsive to what the times demand. For example, FSG sponsored a reef advisory team to travel the state at a time when no other reliable sources of information on reef siting were available. Also, publications on reef siting made reef-building a more scientific process. The Florida Sea Grant directory of artificial reefs in Florida's coastal waters proved to be a "best-seller." FSG extension agents regularly assist various interests at the county level to plan or build reefs, in the permitting process and in their deployment.

[1] William Seaman is professor, Fisheries & Aquatic Sciences, and associate director, Florida Sea Grant College Program, University of Florida, Gainesville.
[2] Aaron Hoover is coordinator, Information and Publications, University of Florida.
[3] Florida Sea Grant is the only statewide, university-based coastal research, education, extension/outreach and communications program in Florida. Address: Box 110400, Gainesville, FL 32611-0400, www.flseagrant.org.

Sea Grant Florida

Meetings and Technology/Information Transfer

The one-on-one interaction between FSG extension and research faculty and individuals interested in reefs is augmented by conferences, workshops and publications that disseminate technical information to larger audiences. Under the auspices of FSG:

- The first *Florida Reef Summit* was conceived and held (1987).
- The *Fourth International Conference on Artificial Habitats for Fisheries* was organized and hosted (1987).
- Numerous individual and multi-county reef program leader workshops have been conducted, including *West Coast Artificial Reef Coordinators Workshop*, held annually over the past several years.
- Scuba divers have been trained as volunteers in monitoring various physical, chemical and biological attributes at reef sites, and formal reef research organizations have been created.
- The national *Symposium on Future Artificial Reefs in the U.S. Coastal Ocean: Can Science Resolve the Biological Enhancement Question?* was organized (1995), and the scientific papers were disseminated in a special issue of Fisheries, published by the American Fisheries Society (1997).
- The first in a series of workshops was presented to over 50 scientists and reef program managers as the program *Artificial Reef Evaluation: Criteria and Methods for Documenting Performance in Southern Seas* (2001), based on a book produced by Sea Grant scientists.

Florida Sea Grant Research

Through its research grants, FSG has funded an average of one or two artificial reef-related research projects yearly, including 11 major studies completed since 1984. A handful of small pilot projects complement this effort. Remarkably, this modest effort still makes Florida the most active in this area of all 30 Sea Grant programs nationally. Studies by Florida oceanographers, ecologists, engineers and economists have been reported in dozens of scientific journal articles and at many conferences, workshops and hearings. Some of the major findings address reef design specifications to achieve certain biological results, the economic impact of reef development in a local area, and the environmental safety of certain materials used in reefs. The following brief accounts reflect the exciting research advances made in this field.

Major Research Projects, 1984-2002

- ***Improved Production of Stone Crabs Through Habitat Enhancement,*** (R/LR-B-14, 1984-1986). This small project found that widely spaced reefs attracted more stone crabs, higher numbers of females, and larger crabs than closely spaced reefs. It evolved into what researchers describe as the largest experimental artificial reefs system in the nation, the Suwannee Regional Reef System which spans 24 nautical miles along the Gulf coast.

- ***User Benefits and Economic Impact of Artificial Reefs in Southeast Florida,*** (R/LR-E-9PD, 1984-1986). In Florida's largest county, Dade County, slightly under a third of the fishermen who responded to a survey said they fished on artificial reefs during the six-month period, while about 13 percent of the divers who responded said they made diving excursions on artificial reefs. Both divers and fishermen indicated they would be willing to pay for new artificial reefs — as did boaters who did not even visit the reefs. The researchers estimated the economic benefit of Dade County's artificial reefs system in the mid-1980s at between $17.5 and $128.3 million, though these figures do not include the value of the reefs to operators of charter fishing and diving boats.

- ***The Effects of Man-Made Reef Deployment on Nearby Resident Fish Populations,*** (R/LR-B-20, 1985-1986). Researchers counted and identified the fishes living in a flat, sandy habitat in two study sites in Looe Key National Marine Sanctuary in the Florida Keys. Next, they built two artifical reef groups, each consisting of 12 small PVC- and concrete blocks, near the sites. They then monitored the fishes in the study sites every three months for one year. Results appear to demonstrate that, at least in this case, artificial reefs resulted in an increase in fish stocks rather than a concentration of existing stocks.

- ***Bioaccumulation of Toxic Metals by Organisms Colonizing Artificial Reefs Constructed From Fossil Fuels,*** (R/LR-B-21, 1986-1988). Concentrations of copper, zinc, vanadium and nickel in liver and flesh samples from sheepshead and gray triggerfish collected near oil ash and concrete reefs were similar to samples from fish collected near natural control areas. During this study, researchers associated with the Florida Sea Grant study also were involved in comparable work carried out at the State University of New York at Stony Brook and at the Institute of Marine Environmental Protection in Dalian, China.

UF Fisheries & Aquatic Sciences

A worldwide trend toward use of designed, science-based structure is receiving increased interest in Florida.

- ***The Relative Importance of Recruitment, Attraction, and Production of Reef Fishes on Natural and Modular Artificial Reefs,*** (R/LR-B-22, 1987-1989). Researchers found that the largest proportion of fishes (65 percent) that appeared on the reefs in Biscayne Bay were resident, while 20 percent were visitors and 16 percent were transient. Generally speaking, the larger the reef, the more fish arrived to colonize it. The study found that the amount of larvae varied in direct proportion to the amount of zooplankton in the water during the previous month — in other words, spawning and survival of fish larvae directly followed the availability of plankton for forage.

- ***Variation of Reef Dispersion to Manage Targeted Fishery Assemblages,*** (R/LR-B-23, 1988-1990). Researchers arranged concrete culvert pipes in two contrasting patterns. In one pattern, the pipes were arranged in concentrated "clumps," while in the other pattern they were more dispersed. The results provided information that may be useful to artificial reef builders in planning and designing reefs. Those interested in creating reefs for recreational diving, for example, might consider clumped reefs because of their demonstrated higher monthly diversity of fishes.

- ***Limits to Recruitment of Spiny Lobsters in Florida: Assessment of Artificial EnhancementTechniques,*** (R/LR-B-30, 1991-1992). Faculty and graduate research assistants did nearly 1000 underwater visual searches of crevices, ledges, sponges and other potential lobster habitats and captured all observed young lobsters for measurement. The data enabled the researchers to design a computer model, known as an Individual Based Model, that operates by assessing, one by one, the fates of millions of "cyber juvenile lobsters" under reduced-shelter conditions produced by sponge die-offs. The model has shown that loss of sponges resulted in increased mortality of young lobster at the time the lobsters left their algal habitat to occupy crevices, and that mortality would be highest where there was no alternative structure.

- ***Nutrient Cycles and Optimum Productivity of Shallow-Water Artificial Reefs***, (R/LR-B-34, 1991-1992) and ***Influence of Artificial Reef Shelter Characteristics on Fish Community Structure and Production***, (R/LR-B-36, 1993-1995). Researchers sank four sets of pyramid-shaped artificial reefs off Palm Beach County, leaving one set hollow and filling the other three with concrete rubble. They painted one of the filled reefs with anti-fouling paint to prevent all primary production. In what researchers ranked as their most important findings, they found that the filled reefs had more fishes, and a higher diversity of species, than the reefs lacking any structure. They also found that reefs protected by predator cages had many more juvenile fishes, suggesting that shelter is an important characteristic for growing fishes.

- ***Optimizing Artificial Reef Design: Feeding Habits and Forage Area Interactions of Fish Assemblages***, (R/LR-B-35, 1993-1995). What do fish eat at artificial reefs and where exactly do they feed? Overall, the study determined that the most important prey items were fishes followed by xanthid crabs, while algae was not an important reef fish food. The study also determined that feeding fish could be organized into seven distinct groups, according to food selection.

Reef Research Team

Well-trained volunteer divers who can monitor reefs offer an important connection between research and those who use and manage natural resources.

- ***The Future of Florida Spiny Lobster: Developing a Predictive Model and Putting Artificial Shelters to the Acid Test***, (R/LR-B-38, 1996-1998). Experimental concrete shelters rapidly recruited both new settlers and older juvenile immigrants, with lobster abundances typically exceeding sponge-free sites and comparing well to the sites with good sponge cover. Although it needs further testing, researchers said the model has promise as an effective tool for predicting future fishery stock. The research also seems to indicate artificial shelters could be used for mitigation and enhancement.

- ***Hydrodynamic Process at Artificial Reefs and Effects on Plankton and Baitfish Abundance***, (R/LR-B-43, 1997-1999) Do artificial patch reefs have different hydrodynamic conditions — such as different degrees of turbulence or upwelling or masses of suspended sediments – depending on their size? Researchers found no correlation between the total suspended solids in the water and tidal currents or wind and waves, nor did they find evidence of elevated levels of phytoplankton or particulate organic carbon around the reef. However, there was evidence that particulate organic carbon concentrations near the bottom correlated with current velocities. That observation supports the idea that sediment resuspension is dependent on current velocity.

New Projects in Progress or Anticipated

- ***Habitat-Mediated Predator-Prey Interactions: Implications for Sustainable Production of Gag Grouper in Eastern Gulf of Mexico***, (R/LR-B-49, 2000-2001)
- ***Fisheries Habitat: A Field Assessment of the Effects of Artificial Reefs and Their Role in Fisheries Management,*** (R/LR-B-52, 2000-2001)
- ***Bioenergetic Response of Gag Grouper to Reef Habitat Configuration***, (R/LR-B-53, 2002-2003)

Global Extent of Reef Technology

Deployment of reef materials is a centuries-old practice. For example, small-scale fishing for subsistence continues to use tree branches, logs and bamboo poles as shelter for marine fishes and shellfish in parts of Southeast Asia, Africa and the Caribbean Sea. In the last 50 years, meanwhile, Japan has made very large investments to augment its seafood supply using commercial reefs of steel, concrete and fiberglass. Recreational fishing and diving at many artificial reef sites are popular in Australia, North America and parts of Europe and Asia. And a few businesses have started submarine tours to reefs in the clear tropical waters of Hawaii, Mexico and the Bahamas. Recently, environmental management applications of reef technology have been attempted to restore aquatic habitat and conserve biodiversity. By collaborating with scientists in other nations, Florida Sea Grant is able to obtain technical information to assist local Florida efforts. Participation in various conferences and in national planning and research efforts in places such as Canada, Korea and Europe furthers this exchange.

This fact sheet was prepared for the 2001 Florida Reef Summit. A subsequent extended version will be posted on the Florida Sea Grant website in 2002, giving links to related programs, titles of publications, and contacts with research projects. Suggestions for material are invited.