The Feasibility of Using Fish Aggregating Devices (FADs) Off Puerto Rico

DAVID FEIGENBAUM, CARVEL BLAIR, ALAN FRIEDLANDER AND MARK BUSHING
Department of Oceanography
Old Dominion University
Norfolk, VA. 23508

ABSTRACT

En junio de 1986, se desplegaron en la costa noroeste de Puerto Rico seis FADs hechos con gomas de tractor. Estos fueron observados por un período de tiempo comprendido desde junio a septiembre de 1986. Tres de la unidades que se usaron tenían un diseño semirrígido de anclaje y fueron desplegadas con una media milla de separación a lo largo de una linea de 50 brazas de profundidad, aproximadamente 5 1/2 millas afuera de la costa. Los otros tres FADs tenían un diseño de "anclaje con cadena invertida". Fueron puestos con una milla de separación entre sí, a 300 brazas de profundidad y a 9 1/2 millas de distancia de la costa. La efectividad de los FADs fue evaluada mediante observaciones con SCUBA y pesca. Las variables observadas fueron: profundidad (50 brazas vs. 300 brazas) tipo de atractor de superficie (2 tipos, más 1 con soga liza). Adema ás, se estudiaron la posición de estos arreglos en relación a la corriente y se examinaron diferentes tipos de pesca, así como los factores económicos en la construcción y el uso de los FADs. Resultados preliminares (al tiempo de escribir este resumen) mostraron que los FADs desarrollaron rápidamente una población de peces de carnada y atrajeron atún de aleta negra, atún de aleta amarilla, peto, y dorado, así como barracudas. Los resultados de este estudio serán utilizados en el desarrollo de los recursos pelágicos costeros en Puerto Rico, y deben ser aplicables a través del Caribe.

INTRODUCTION

Fish Aggregating Devices known as FADs, have been employed in a number of places, principally in the tropical Pacific, to attract migratory pelagics for recreational and commercial fishing (Wickham *et al.*, 1973; Matsumoto *et al.*, 1981; Preston, 1982; Bergstrom, 1983). The nature of their attractiveness is not fully understood. Within days of their placement, often before significant fouling has taken place, FADs attract large numbers of small fishes. Larger predatory species may come to prey on these using an innate sense to forage around objects in the pelagic realm (Hunter, 1968; Klima and Wickham, 1971; Seki, 1983).

FADs have been placed in the Atlantic from Virginia (Feigenbaum *et al.*, 1986) to the Caribbean (de Silva, 1982; McIntosh, 1986; Clavijo *et al.*, 1987) including North Carolina (Murray *et al.*, 1985), South Carolina (Myatt, 1985) and Florida (McIntosh, 1985). For various reasons, including unit failure, their effectiveness has not been well documented. In the present study we set out to fill this void and to evaluate the effectiveness of FADs in a Caribbean Tropical island environment.

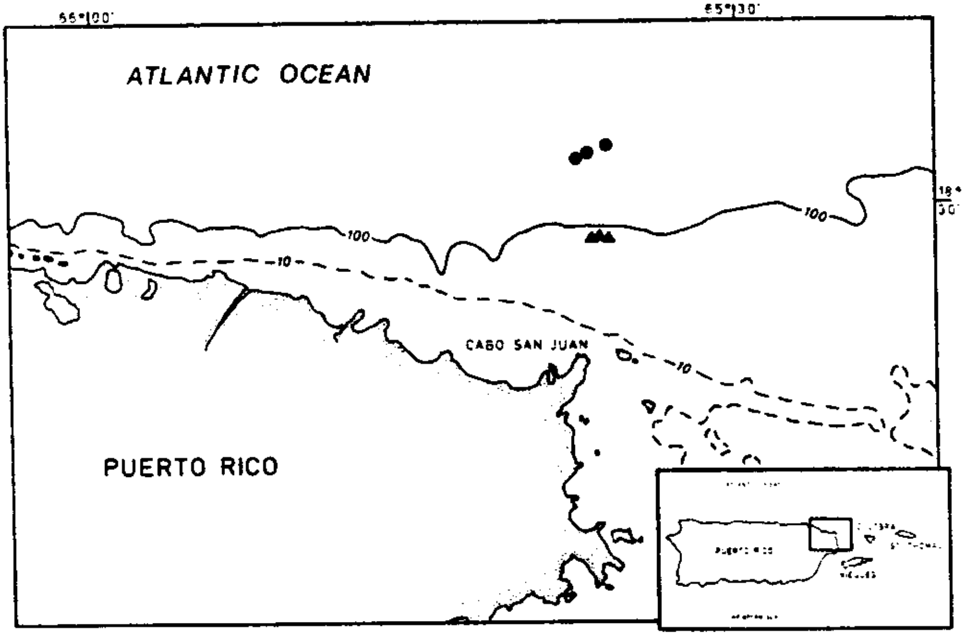

Figure 1. Location of the FADs. Depths are in fathoms. The semi-taut units are indicated by triangles, the inverse-catenaries by circles.

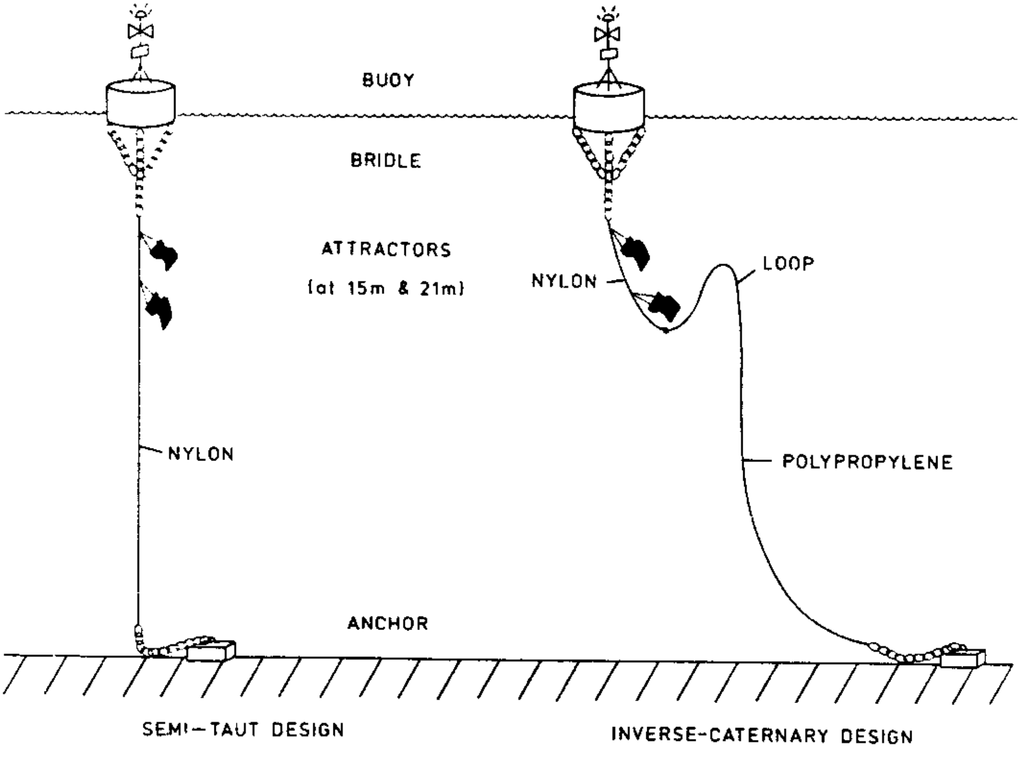

Figure 2. Details of the FAD designs.

MATERIALS AND METHODS

Six mooring systems were deployed off the northeast corner of Puerto Rico in two lines of three each (Figure 1). Within a line the moorings were approximately 1—3 km apart. The inshore FADs were placed in approximately 90 m of water and used a semi-taut mooring design. The offshore units were placed in approximately 550 m and employed an inverse-caternary system. Plans for the moorings were adopted from Boy and Smith (1983) and Boy (1985). The two types are shown schematically in Figure 2.

The surface buoys were made of tractor tires 1.2 m in diameter by 0.4 m wide. These were filled with closed cell polyurethane foam and covered top and bottom with 0.3 cm steel plates. A 1.2 m x 5.1 cm galvanized pipe was braced and welded to the top plate and carried a small battery powered lantern, radar reflector, and numbered day marker (Figure 3). Below the surface, the buoys were connected by a three piece chain bridle to the main mooring line. The anchor for each mooring was a block of concrete, 0.75 m on aside, which weighed approximately 1 mt.

The plan called for three types of attractor regimes: Ultralite, McIntosh, and void (no attractor). In the first two types, the attractors were placed at 15 m and 21 m below the buoy. Both attractors on a given mooring were of the same type. At the start of the study each type of attractor was selected at random and the plan was to move the attractors, after an initial aging period, in a randomly assigned sequence (without replacement) every month. Thus, the variables involved with the FAD layout and design were:

Figure 3. A surface buoy ready for deployment aboard the vessel Jean A.

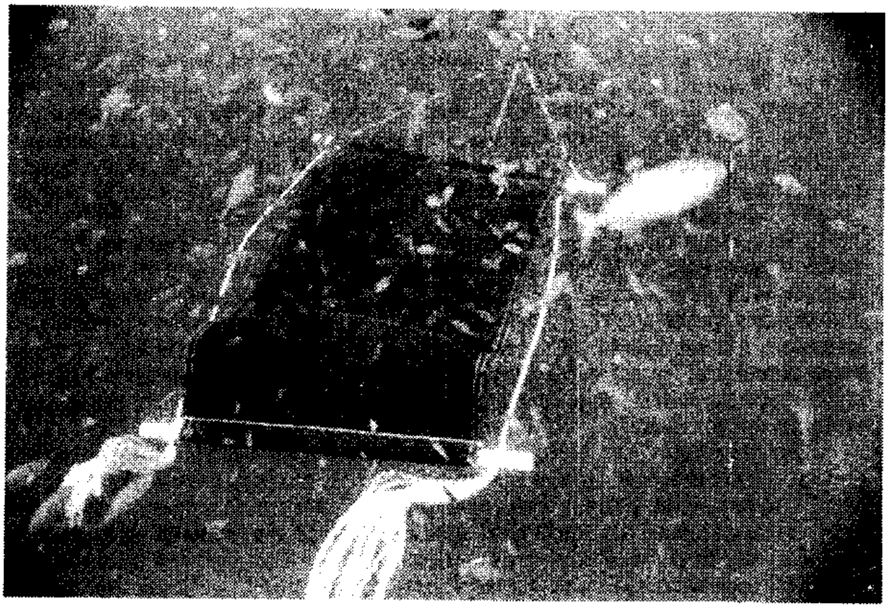

Figure 4. Opaque Ultralite attractor.

1. Inshore vs offshore.
2. Type of attractor.
3. Position of the mooring in the array. Seasonality was also a variable in the study.

The FADs were deployed in early June (inshore) and mid-June (offshore), 1986. At the time of this conference, three are in place.

Evaluation was by trolling, both with natural (ballyhoo, mullet, etc). and artificial bait, using both surface and subsurface rigging (monofilament vs monel line or weights), and by SCUBA observation and photography. In addition, the inshore FADs were fished commercially with live bait at night. We monitored the catch of the boat out of Fajardo. In recent months we paid these fishermen to spend half their time on a control site. Experimental vertical longlines were also set, primarily near an inshore FAD.

RESULTS AND DISCUSSION

The semi-taut mooring design is very depth sensitive and we lost the first FAD placed because the water was too deep. We also believe the last FAD was lost because it was placed in too shallow a depth, allowing the nylon line to abraid on the bottom. The inverse-caternary design, used offshore, is not nearly so depth sensitive because of the excess line in the loop (Figure 2).

Another disadvantage of the inshore, semi-taut moorings is pronounced vertical movement of the FADs. Surface swells and wave action are transmitted directly to the bottom with little or no damping. This caused rapid failure of the McIntosh attractors which are not designed for motion in this direction. In an effort to reduce the forces we inserted a 0.9 m piece of rope between the mooring line and the plastic attractor head. This delayed failure for a few days, but did not cure the problem. Further offshore, where the inverse caternary designs transmitted less wave motion, the McIntosh attractors survived a little longer. They too eventually failed due to vertical forces. This attractor was originally made for stable subsurface moorings which are oblivious to surface motion.

To replace the McIntosh attractor, we developed an opaque version of the ultralite using black acrylic fabric (Figure 4). These "carpets" proved able to withstand the forces of the surface moorings and appeared effective in attracting bait fish. With time (on the order of a month), the fabric tore, perhaps because of fatigue. Nylon sail cloth would probably hold up better. Two modifications were made in this design: a three-dimensional version using a 0.6 m fiberglass cross piece on top and bottom, and a perforated carpet with semicircular flaps cutout. The former was an attempt to more closely resemble the McIntosh. It appeared to work well, but was lost too soon to be evaluated. The cutout carpets were developed to reduce force and damage on the fabric. They were still in place in late October, during our last observation. Small fish surround these units and were often observed swimming through the holes.

Small fish, primarily carangids, were attracted to the FADs within a few days after installation. There were far more around the offshore FADs than those inshore, perhaps because of a greater number of large predatory fishes over the shelf region. Typically, an offshore FAD would have hundreds of these

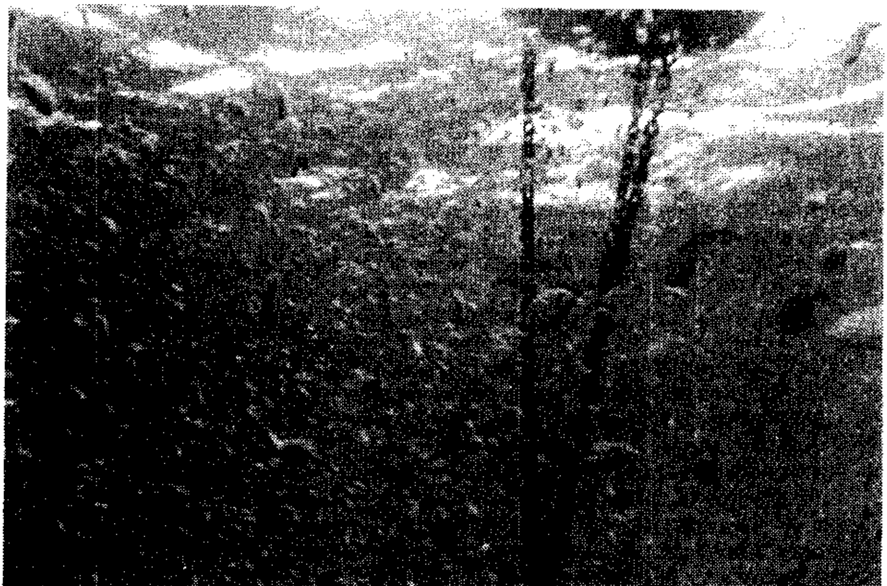

Figure 5. View of the bridle of an offshore FAD with small fishes typically attracted to it.

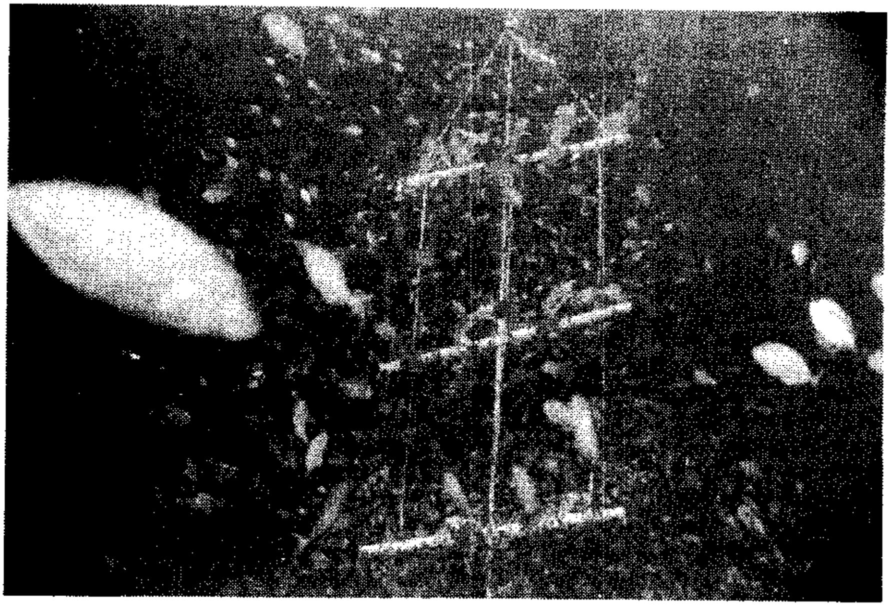

Figure 6. An Ultralite attractor. The large number of bait fish was typical for an offshore FAD.

"bait fish" under the buoy in the vicinity of the bridle (Figure 5), and thousands around each of the two attractors. It was not possible to count these moving fish, but there seemed to be little difference in the number at 15 m vs 21 m. The opaque attractors (McIntosh and carpet) may have had slightly more fish around them than the open styled ultralites shown in Figure 6. The control FAD, without attractors, had few if any fish below the bridle.

Dolphin, *Coryphaena hippurus*, were frequently seen around buoys from the surface. They numbered from 1 to more than 20 on a given day, but usually shied away from divers. We were able to photograph them underwater a few times.

Each FAD usually had a single barracuda, *Sphyraena barracuda*, hovering around. If caught, a repalcement always seemed to show up for our next visit. The observation of other large fishes were rare. However, a school of skipjack tuna, *Katsuwonus pelamis*, was observed offshore at 24 m in October and a marlin was seen near an offshore FAD in August.

The fish most often caught in our trolling surveys were dolphin, locally known as "dorados," with barracuda, yellowfin and blackfin tuna, *Thunnus albacares* and *T. atlanticus*, and wahoo, *Acanthocybium solanderi*, in descending order. In addition to the marlin sighting, a marlin was billed (but not hooked) within a few miles of the offshore FADs. Trolling data from June through September is shown in Figure 7. Only one strike (and no catch) were registered over the control site. Most "hits" were made as the bait/lure came close to a buoy. However, the two largest tuna were caught while trolling near

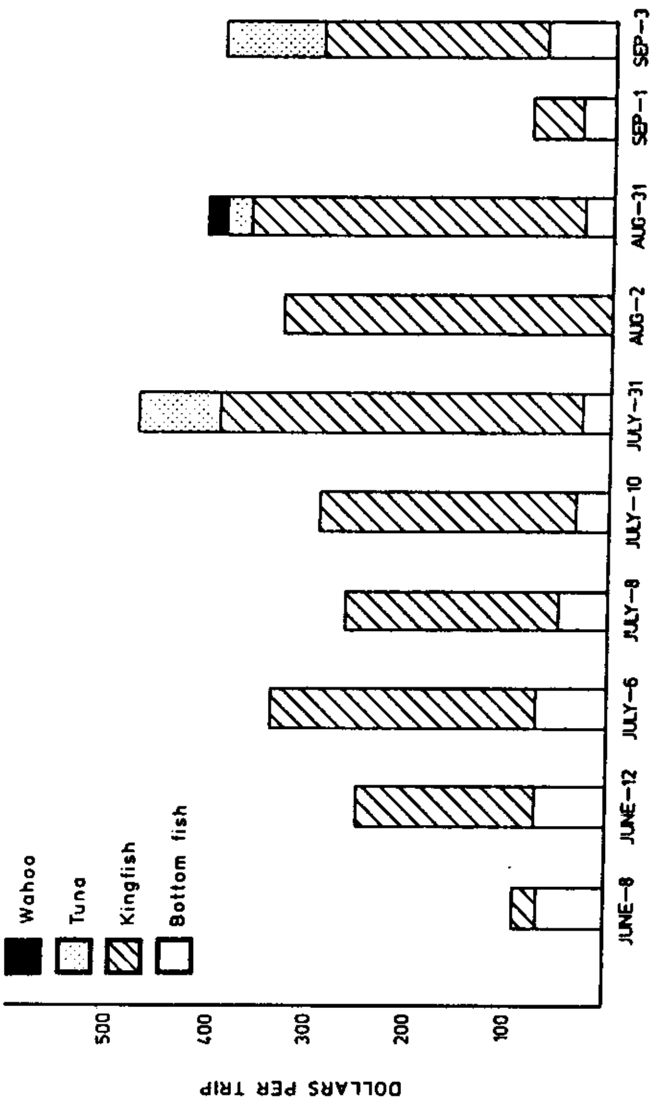
Wahoo
Tuna
Kingfish
Bottom fish
DOLLARS PER TRIP
500
400
300
200
100
JUNE-8
JUNE-12
JULY-6
JULY-8
JULY-10
JULY-31
AUG-2
AUG-31
SEP-1
SEP-3

Figure 8. Commercial fishermen in Fajardo, Puerto Rico, bringing fish caught near the FADs at night to the weighing room.

feeding birds about 2 km from the inshore FADs. At this time we are still gathering fishing data and our analysis is incomplete.

Commercial fishermenn began fishing near the inshore FADs soon after their placement. Using live bait at night, preferably without a moon, the boat out of Fajardo often landed more than 100 kg of kingfish, *Scomberomorus cavalla*, and yellowfin and blackfin tuna (Figure 8). One wahoo was caught in late August and recently sharks are being landed. The value of these fish to the fishermen is shown in Figure 9. These data also are still being gathered.

Commercial fishermen prefer the inshore FADs because they can anchor in the 90 m depth and bottom fish at the same time. They also do not feel comfortable taking their small boats (6—7m) far offshore at night. In contrast, recreational fishermen we talked to showed more interest in the offshore FADs because they prefer to fish for billfish. While this difference in preference may require more FADs to satisfy everyone, it also reduces potential conflict among different user groups.

We only caught a few fish (barracuda and tuna) on the experimental longline. Though this method does not seem to be economically feasible in the study area, it has the potential to provide information about species depth distribution.

FADs have been lost throughout the study. Two were replaced and, as of this writing, three FADs (two offshore and one inshore) are still functioning. Except for the first, lost during deployment, and perhaps the last, which may have been placed too shallow, the others were probably lost in collisions with

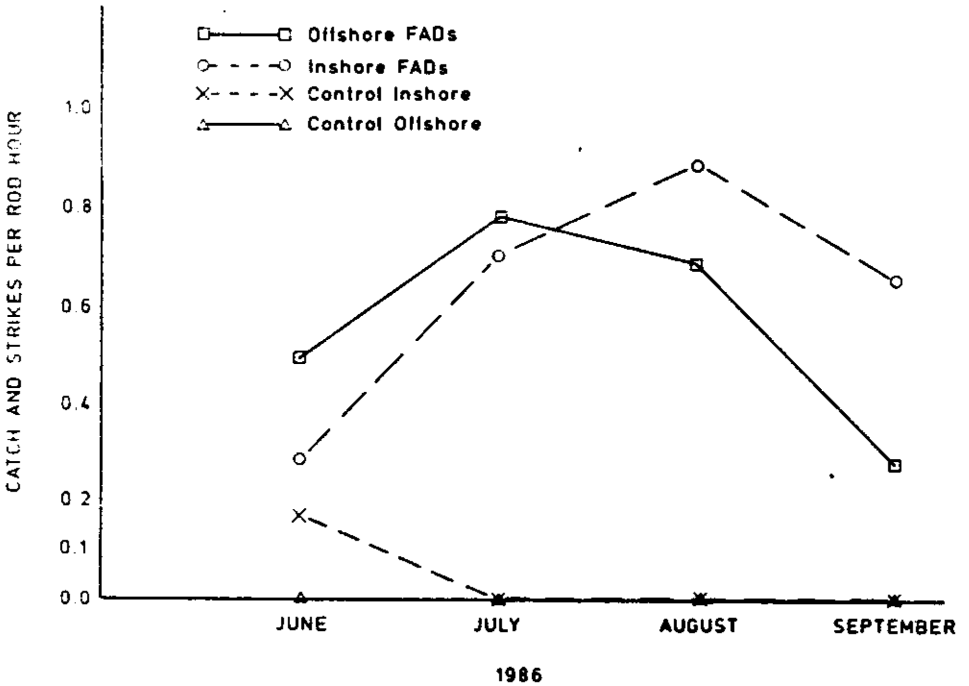

Figure 9. The commercial value (ex-vessel) of fish caught near the FADs by one boat from Fajardo.

ships. One of our inshore buoys showed signs of ship damage (damaged radar reflector, anti-fouling paint) and we frequently observed large vessels traversing near or through the FAD areas. In addition, buoy losses occured in calm weather. Any FAD program must either find a way to keep ships out of the buoy area or select sites of low ship traffic to be successful.

At this time we can draw only preliminary conclusions, since we are still gathering data. It appears that FADs placed in 50—100 m would greatly benefit a commercial fishery aimed principally at kingfish. The tuna harvest would also be improved, and the boats would not have to search large areas. Recreational catches, particulary of dolphin, would also be enhanced. Although we did not catch large numbers of other species, the abundances of bait fish attracted to the FADs must be a significant overall benefit.

ACKNOWLEDGEMENTS

This research was funded by the National Marine Fisheries Service, Project NA85-WC-D-06171, with matching funds and services provided by Old Dominion University and CODREMAR. We thank the Puerto Rico Department of Natural Resources for the use of their vessel, Jean A, to deploy the FADs. We are grateful to the many people of CODREMAR who aided us in this project and especially to Jose (Cuco) Rivera and Jaime Gonzalez whose advice and help were essential to its success.

LITERATURE CITED

Bergstrom, M. 1983. Review of experiences with and present knowledge about Fish Aggregating Devices. Bay of Bengal Programme, Develop., Small-Scale Fish., BOBP/WP/23, 54p.

Boy, R.L. 1985. FAD mooring systems for moderate to shallow depths. Rep. South Pac. Comm. 17th Region. Tech. Meeting Fish., New Caledonia. 17p.

Boy, R.L. and B.R. Smith. 1983. An improved FAD mooring line design for general use in Pacific Island communities. Rep. South Pac. Comm., 15th Region. Tech. Meeting Fish., New Caledonia 76pp.

Clavijo, I.E., J. LaPlace and W. Tobias. 1987. Construction and evaluation of a midwater FAD design in the U.S. Virgin Islands, *Proc. Gulf Carib. Fish. Inst.* **38:** 714-722.

deSilva, D.P. 1982. Potential for increasing artisanal fisheries production from floating artificial habitats in the Caribbean. *Proc. Gulf. Carib. Fish. Inst.* **34**: 156-167.

Feigenbaum, D., C. Blair, M. Bushing, L. Parker and D. Devereaux. 1986. Artificial reef study. Final rept. Old Dominion Univ. Tech. Rep. No. 86-2.

Hunter, J.R. 1968. Association of fishes with flotsam in the offshore waters of Central America. *Fish. Bull.* U.S. **66**: 13-29.

Klima, E.F. and D.A., Wickham. 1971. Attraction of coastal pelagic fishes with artificial structures. *Trans. Amer. Fish. Soc.* **100**: 86-99.

Matsumoto, W.M., T.K. Kazama and D.C. Asted. 1981. Anchored fish aggregating devices in Hawaiian waters. *Mar. Fish. Rev.* **43**(9): 1-13.

McIntosh, G.S. Jr. 1985. To design, construct, deploy and monitor a pelagic Fish Aggregating Device (FAD) in the Southeast Region of the United States. Rep. submitted to Nat. Mar. Fish. Ser. (unpubl). 14p.

-------------. 1986. Progress with the development of Fish Aggregating Devices in the Caribbean. *Proc. Gulf Carib. Fish. Inst.* 37: 64-66.

Murray, J.D., D.G. Linquist, D.C. Griffith and J.K. Howe. 1985. The use of Fish Aggregating Devices to attract marine fish at two North Carolina piers. Working Paper 85-1, UNC Sea Grant Publ., UNC-SG-WP-85-1, 54p.

Myatt, D.D., III. 1985. Midwater fish attractors. In: Frank M. D'Itri (ed.), *Artificial Reefs, Marine and Freshwater Applications.* Lewis Publ., Chelsea, MI, pp. 303-315.

Preston, G. 1982. The Fijian experience in the utilization of Fish Aggregating Devices. Working Paper 25, South Pac. Comm., 14th Reg. Tech. Meeting. Fish., 61p.

Seki, M.P. 1983. Summary of pertinent information on the attractive effects of artificial structures in tropical and subtropical waters. Southwest Fish. Center, Admin. Rep. H-83-12, 49p.

Wickham, D.A., J.W. Watson, Jr. and L.H. Ogren. 1973. The efficacy of midwater artificial structures for attracting pelagic sport fish. *Trans. Amer. Fish. Soc.* 102: 563-572.