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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

April 16, 2012

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OFC. OF ENVIRONMENTAL QUALITY CONTROL

Director Hooser
Office of Environmental Quality Control
Department of Health, State of Hawaii
235 S. Beretania Street, Room 702
Honolulu, HI 96813

Dear Director Hooser:

With this letter, the Department of Land and Natural Resources hereby transmits the final programmatic environmental assessment and finding of no significant impact (FPEA-FONSI) for the Hawaii Fish Aggregating Device situated Statewide for publication in the next available edition of the Environmental Notice.

The Department of Land and Natural Resources has included copies of comments and response that it received during the 30-day public comment period on the draft programmatic environmental assessment and finding of no significant impact (FPEA-FONSI).

Enclosed is a completed OEQC Publication Form, two copies of the FPEA-FONSI, an Adobe Acrobat PDF file of the same, and an electronic copy of the publication form in MS Word. Simultaneous with this letter, we have submitted the summary of the action in a text file by electronic mail to your office.

If there are any questions, please contact Mr. Alton Miyasaka, Division of Aquatic Resources, at 587-0092.

Sincerely,

William J. Aila

Publication Form
The Environmental Notice
Office of Environmental Quality Control

Instructions: Please submit one hardcopy of the document along a with determination letter from the agency. On a compact disk, put an electronic copy of this publication form and a PDF of the EA or EIS. Mahalo.

Name of Project:	Hawaii Fish Aggregating Device System
Applicable Law:	
Type of Document:	Final Programmatic Environmental Assessment
Island:	Statewide offshore
District:	
TMK:	
Permits Required:	
Name of Applicant or Proposing Agency: Address City, State, Zip Contact and Phone	Division of Aquatic Resources; Department of Land and Natural Resources; State of Hawaii; 1151 Punchbowl Street, Room 330; Honolulu, HI 96813; Mr. Francis Oishi, Fisheries Program Manager; 587-0094
Approving Agency or Accepting Authority: Address City, State, Zip Contact and Phone	Department of Land and Natural Resources, P.O. Box 621; Honolulu, HI 96809; Mr. William J. Aila, Jr. Chairperson; 808-587-0400
Consultant Address City, State, Zip Contact and Phone	Kim N. Holland Ph.D.; Hawaii Institute of Marine Biology; PO Box 1346; Kaneohe, HI 96744; (808) 236-7410

Project Summary: Summary of the direct, indirect, secondary, and cumulative impacts of the proposed action (less than 200 words).

During the previous 25 years of operation of the existing Fish Aggregating Device (FAD) system, there have been no reports of deleterious interactions with any protected species. FAD sites range from 2 to 15 miles offshore. Based on this fact and the design of the FAD components, it can reasonably be stated that the proposed action will not affect the various marine mammals and turtles known to frequent Hawaiian waters. This PEA determines that, based on current data and past performance, the 54 FADs in waters around the main Hawaiian Islands will have no significant negative impact on the quality of the environment or cultural resources.

FINAL

Programmatic Environmental Assessment

Hawaii Fish Aggregating Device System

April 2012

Lead agency:	Division of Aquatic Resources Department of Land and Natural Resources State of Hawaii 1151 Punchbowl Street, Room 330 Honolulu, HI 96813
Responsible agency:	Department of Land and Natural Resources P.O. Box 621 Honolulu, HI 96809
Prepared by:	Kim N. Holland Ph.D. Senior Research Fellow, Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa Researcher, Hawaii Institute Marine Biology
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Summary

This Programmatic Environmental Assessment (PEA) was prepared in accordance with National Environmental Policy Act of 1969 (42 U.S.C. §4321, *et seq.*), as implemented by the Council of Environmental Quality regulations (40 C.F.R. §1500-1508); and NOAA Administrative Order Series (NAO) 216-6, *Environmental Review Procedures for Implementing the National Environmental Policy Act*, of May 20, 1999.

The objective of the Proposed Action is to continue to facilitate recreational fishing opportunities in the State and help perpetuate traditional Hawaiian activities by maintaining a FAD network to help fishers increase their catch and reduce time and fuel spent searching for fish schools. The proposed action is based on the successful long-term performance of a network of 54 fish aggregating devices (FADs) currently deployed in waters around the main Hawaiian Islands and the desire to promote continued fishing success in an economic environment where prices for fuel and other commodities are rapidly increasing.

The locations of the 54 FADs are based on recommendations from fishers throughout the State and are designed to accommodate as many types of angler as possible (from small non-motorized vessels to large offshore sport fishing boats) and to reduce competition at any one site. Deployment sites range from 2 to 15 miles offshore. The proposed action will maintain and improve recreational and economic benefits for Hawaii's fishers. The preponderance of scientific data indicates that fish caught around Hawaii's FADs are a combination of fish spawned locally and fish that arrive from other regions of the Pacific. The harvest of fishes from Hawaii is thought to have an insignificant impact on the overall status of fish stocks – especially when compared with the commercial harvest of these species throughout the Pacific region. During the previous 25 years of operation of the existing system, there have been no reports of deleterious interactions with any protected species. Based on this fact and the design of the FAD components, it can reasonably be stated that the proposed action will not affect the various marine mammals and turtles known to frequent Hawaiian waters. Hawaii FADs have supported cutting edge research into pelagic fish biology and cooperative federal-state-private research into FAD technology and the management of pelagic fisheries will continue. Alternatives to the proposed action, such as termination of the Hawaii FAD System, no action, deployment of unanchored or subsurface FADs were considered, but none of these can provide a cost-effective means of enhancing fishing opportunities in the State. The FAD network will continue to comply with all federal, state and US Coast Guard requirements. This PEA determines that, based on current data and past performance, the 54 FADs in waters around the main Hawaiian Islands will have no significant negative impact on the quality of the environment or cultural resources.

Contents

List of figures and tables

Acronym	**Full description**
DAR	State of Hawaii, Division of Aquatic Resources
DLNR	State of Hawaii, Department of Land and Natural Resources
FAD	Fish Aggregating Device
FCZ	Fishery Conservation Zone
FEP	Fisheries Ecosystem Plans
FMP	Fisheries Management Plans
HFAD	Hawaii Fish Aggregating Device System
MFCMA	Magnuson Fishery Conservation and Management Act
NMFS	National Marine fisheries service
NOAA	National Oceanic and Atmospheric Administration
PRIA	Pacific Remote Island Areas
PIRO	Pacific Islands Regional Office, NMFS
WESPAC	Western Pacific Regional Fishery Management Council

1 Project Background

The deep clear waters surrounding the Hawaiian Islands are the habitat of several species of tuna and other pelagic fishes such as dolphinfish (mahimahi) and billfishes that are economically important and which are also the key species in the local sport fishery. These fishes are often widely distributed and some are migratory. Their high mobility and patchy distribution (both in space and in time) can make them difficult to locate. Because of this, fishers must often resort to trolling techniques that cover large areas of ocean in order to locate the target species. However, these pelagic species are attracted to floating objects and exploiting this behavior can make it easier for fishers to find and catch their target species. Fish aggregating devices (FADs) are used to "hold" pelagic fishes in an area to enhance fishing.

Fishers have long known that tunas and other pelagic fishes are attracted to and congregate around natural floating objects such as logs and manmade flotsam such as abandoned fishing nets, water heaters and cargo pallets. In fact, all around the world, fisheries have been developed based on the tendency of certain pelagic fishes to aggregate around floating objects. These fisheries range from subsistence and sport fishing to industrial methods that use pole-and-line and purse seining techniques. In Hawaiian waters, commercial and recreational fishers watch for floating objects and eagerly fish around any log or flotsam encountered by chance.

FADs were introduced to Hawaiian waters in 1977 when the Honolulu Laboratory (Southwest Fisheries Center) of the National Marine Fisheries Service, with funds from the Pacific Tuna Development Foundation (later, the Pacific Fisheries Development Foundation), installed a few experimental fish aggregators off Oahu, Lanai, and West Hawaii. Skipjack tuna (aku) catches of 5-10 tons were reported frequently around these FADs; the largest catch was over 15 tons. Also, the aku pole-and-line fishing vessels reported using less than the usual amount of bait thereby enabling them to make more fishing trips per week. Sport fishers experienced large daily catches of mahimahi at these FADs (Matsumoto et al. 1981).

In 1979, following the Honolulu Laboratory's successful experiment on FADs in Hawaiian waters, Governor George Ariyoshi proposed establishing a system of fish aggregators as part of the State's fisheries development effort that would help revitalize our fishing industry and increase sport fishing opportunities. Subsequently, the State Legislature appropriated funds to the Department of Land and Natural Resources (Division of Aquatic Resources) for planning and implementing a Hawaiian fish aggregating device program. Additional funding for the program was sought and obtained from the Federal Aid in Sport Fish Restoration (Dingell-Johnson) Marine Development Program administered by the U.S. Fish and Wildlife Service. The FAD locations were recommended by Hawaii's fishers through statewide public meetings held in October 1979 and in April 1980, the Division of

Aquatic Resources (DAR) constructed 26 FADs and installed them in waters around the main Hawaiian Islands at distances of 2.4-25 miles offshore and in depths of 80 - 1,510 fathoms.

The success of the expanded array of FADs resulted in increased demand for an even larger network to provide greater geographical coverage of Hawaii's coastline and to reduce competition at the existing sites. This increase in the size of the array began in 1985. Currently, there are 54 approved sites around the state (Figure 1). These sites were selected based on input from the fishing community and on avoidance of high traffic zones.

Starting in October 1982, a single sphere design has been used in the construction of all FADs in the system. The single sphere produces minimum drag and causes the least rotation of the buoy thereby reducing wear on the mooring components. In line with the desire to keep strain on the mooring to a minimum, no additional components (e.g., plastic streamers or netting) are attached to the FAD. A diagram of the design used for the past 25 years is included in Figure 2. Since the mid 1990's, funding has come exclusively from the Federal Aid in Sport Fish Restoration (Dingell-Johnson) program with matching support from the University of Hawaii at Manoa.

FAD Fish Catch

Despite the obvious extremely high popularity of Hawaii's FADs, quantification of the fish catches made at FADs is notoriously difficult. This is due to the fact that the requirements for reporting catches have varied over time and reporting is only required of fishers holding commercial fishing licenses. Further, historically, there has been no way to verify the accuracy of the reports that are submitted. There have also been shifting trends in fishing techniques. For instance, over the past 25 years, the Hawaii pole and line fleet has decreased dramatically whereas small-scale hand lining has increased greatly. The 1984 Environmental Assessment document for the expanding FAD program included the following assessment of fishing activity:

Between April 1980 to August 1983, fishers reportedly made more than 7,914 fishing trips to the FADs (average number trips = 264). More than 80% of these trips produced fish. Although 1,340,721 pounds of fish were reportedly caught at the FADs based on discussions with fishers and from knowledge of unreported catches made at the FADs, the actual amount of fish landed probably exceeded 4,000,000 pounds since the FADs were installed in 1980. *The major fish species caught were yellowfin tuna (ahi) (523,945 lbs, 39%), skipjack tuna or aku (520,954 lbs, 39%), marlins (127,654 lbs, 10%) and dolphinfish or mahimahi (101,067 lbs, 8%). These comprised 96% of the total reported catch (Table 1.0-3). The major fishing gears used around the FADs were pole-and-line (496,708 lbs, 37%), handline (356,455 lbs, 27%), and trolling (331,286 lbs, 25%).*

2 Proposed Project

2.1 Continued Operation and Maintenance of a FAD Network in Hawaiian Waters

Because of the great popularity of FADs with Hawaii's fishing community and because of the rapidly rising costs associated with fishing, the Division of Aquatic Resources, in collaboration with the University of Hawaii, proposes to continue to operate a network of 54 FADs in coastal Hawaiian waters and to continue to foster collaborative federal-state-private research into FAD technology and the biology of fishes found in association with FADs.

2.2 Description of the FAD

The FADs will consist of a surface float (buoy), a mast with a navigational light, chain and synthetic rope mooring line and concrete anchors. This design has been successfully used for 25 years.

The surface float is a single 58-inch diameter steel sphere with a steel mast and a steel pipe counter weight. A U.S. Coast Guard approved flashing light pack, constructed of 32-inch plastic pipe, fits into the mast (Figure 2.2-1). The light is powered either by standard lantern batteries or by a solar panel. The FAD (without line and anchor) weighs approximately 880 pounds and has a total positive displacement of about 3,000 pounds.

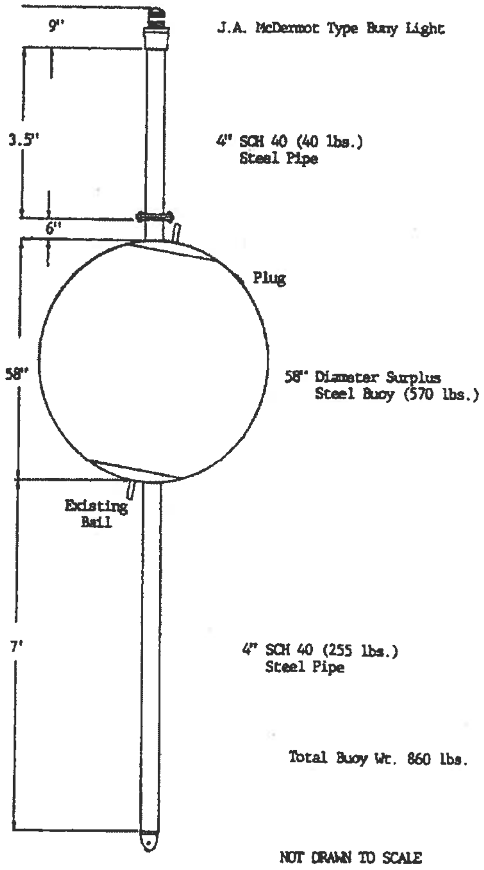

Figure 2.2-1 FAD Single Sphere Surface Float

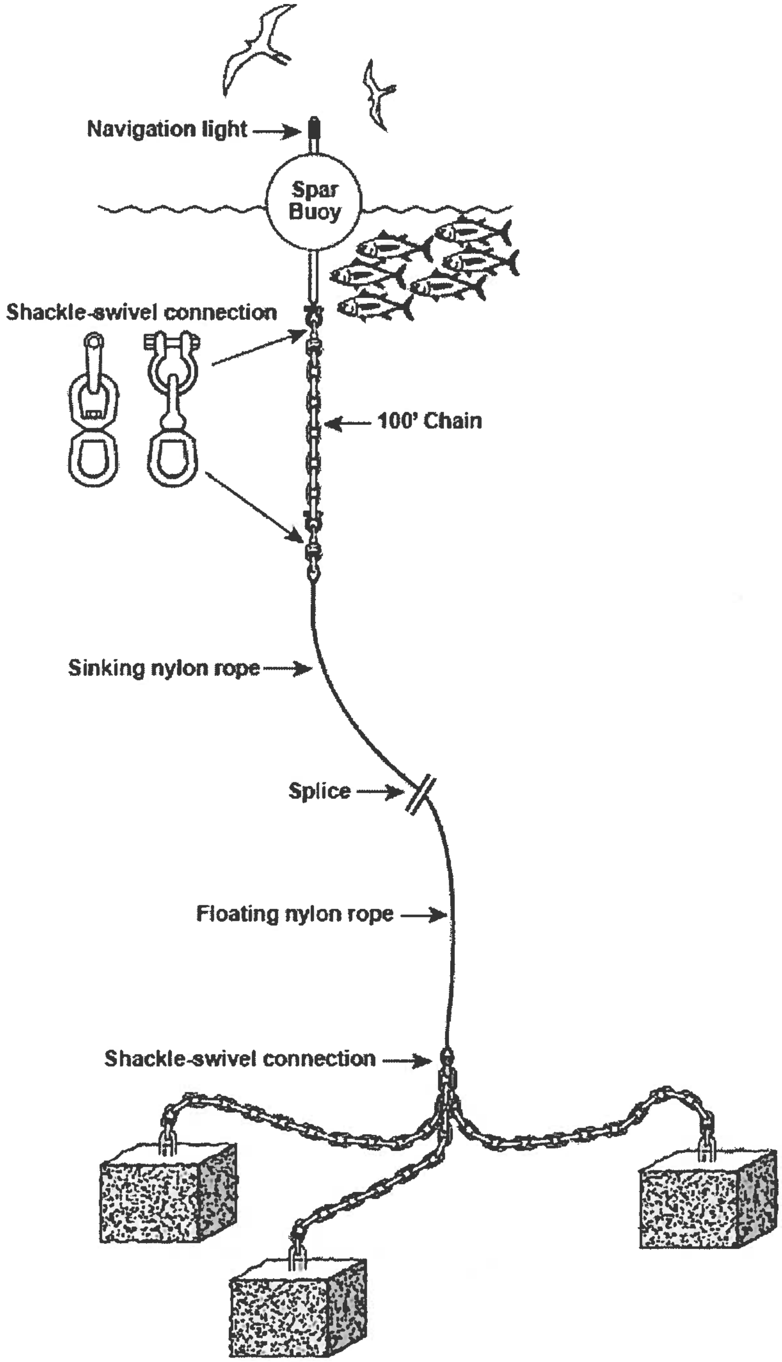

Figure 2.2-2. FAD mooring system.

The mooring for the single-sphere FAD was designed to minimize metal components subject to corrosion. There are no fixtures attached to the float so that the sphere is completely smooth. Consequently, there is no easy attachment point for vessels to tie to and it makes it impossible for marine animals to haul out or become entangled with the float. The floats are painted with yellow marine epoxy paint – no antifouling paints are used. The main portion of the mooring line consists of polyester/polyethylene sinking rope spliced into polypropylene/ polyethylene floating rope (5/8-inch diameter). The surface buoy is attached to the mooring line by a 100-foot length of chain with terminal swivels. The terminal (sea floor) portion of the line connects in a "tripod" design to three cubic concrete anchors (approximately 36" on side) via 100 foot lengths of 1/2-inch chain. Each concrete anchor weighs approximately 1800 pounds in air. The anchors are purchased ready made from a local cement manufacturing company. The length of the floating section of line is designed to float the ends of the chain attached to the anchors and thereby reduce chafing of the nylon rope on the ocean floor. This prolongs the lifespan of each mooring (Figure 2.2-2). Fabrication of the FADs and assembly of components is conducted at the University of Hawaii's Marine Center where all appropriate environmental controls are in place.

The FADs will conform with U.S. Coast Guard's Aids to Navigation marking and marine light requirements. The light and battery pack will be serviced approximately every 6 months or sooner as the need arises. Also, scientific research teams can provide unscheduled visual checks of the FADs and replacement of light packs. Construction of the FADs will take place at the University of Hawaii Marine Center located at Snug Harbor (Pier 45), Honolulu.

2.3 FAD Locations

The FAD sites currently in use and which are proposed for continued activity are substantially based on suggestions received from fishers at statewide public meetings and subsequent input. Major considerations for selecting these sites were 1) productive fishing grounds; 2) even distribution along accessible coastlines of all islands 3) avoidance of U.S Navy submarine transit lanes and operating areas, as well as offshore waters restricted by the military; 4) noninterference with heavy commercial cargo, shipping and passenger transport ocean lanes; and 5) depth (a deeper site requires more line which, in turn, increases cost).

FAD locations are available at http://www.hawaii.edu/HIMB/FADS/ and Table I and figure 2.3 provides a list of all of the current FAD locations.

2.4 FAD Network Operation and Maintenance.

The assembled FADs (buoys, mooring line and anchors) are loaded onto deployment vessels at the UH Marine Center docks where all appropriate environmental controls are operative. When feasible, multiple FADs are deployed on each trip. This reduces costs and the amount of ship time required to meet project requirements. The

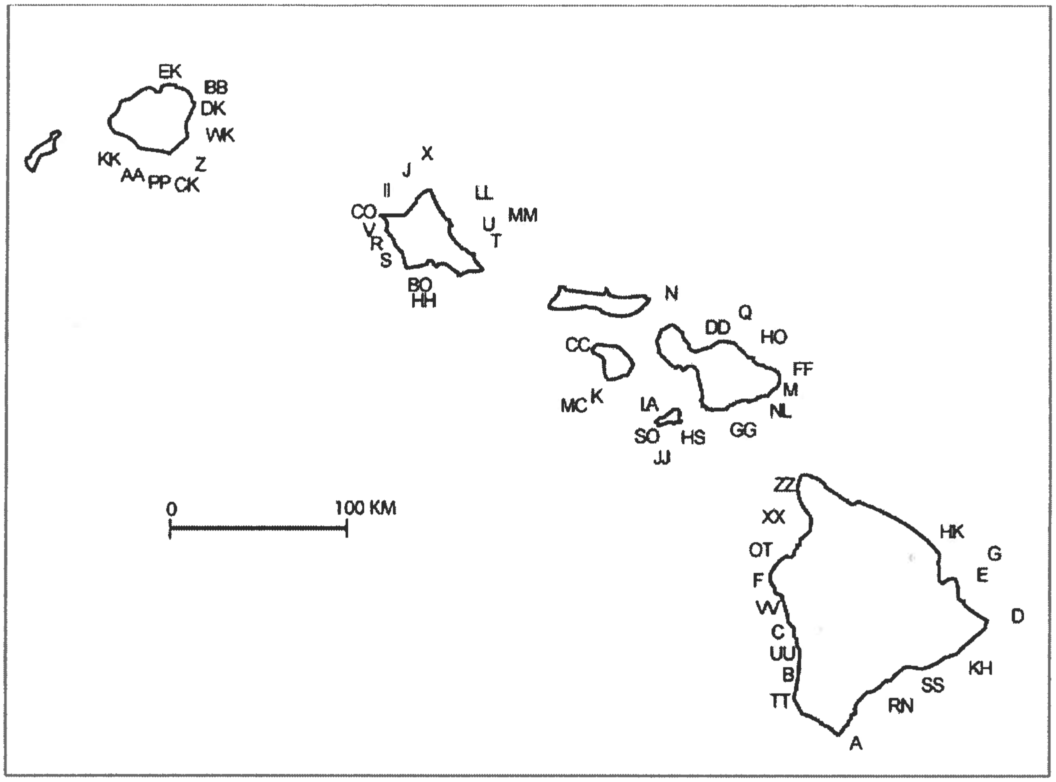

Figure 2.3. Map showing locations of FADs around the Main Hawaiian Islands.

locations of the FADs are generally in open water where the occurrence of protected species is very uncommon. Nevertheless, visual inspection of the area is made prior to deployment of each FAD to ensure that no protected species are present and to be sure that no other vessels are in the area. Deployment is accomplished by paying out the float (buoy) and mooring rope as the vessel moves slowly forward over the designated deployment site. When all the rope is deployed, the anchors are released from the stern of the vessel. This causes the anchors to drop to the ocean floor and the mooring line to come taut. Depending on sea conditions, each deployment takes between about 45 minutes and 1.5 hours. The total amount of vessel time depends on the distance of the FAD site from the UH Marine Center.

The overall average lifetime of each deployment of the current design is approximately three years with the longest being 12 years (Holland et al. 2000). FADs located on the windward side of the islands have shorter life spans than those on the leeward coasts. Most FAD losses have been attributed to corrosion and wear of FAD mooring components but losses are also due to fish or shark bites, constriction by fishing line wrapped around the mooring line and increased strain on the moorings caused by vessels tying up to the FAD buoys. Short deployment durations have been attributed to collision with tugboats and tow lines from tugs attempting to fish as they pass the FADs.

For the past decade, approximately 15 FADs were replaced each year (range 13 – 23). These replacements and occasional replacement of the light packs are accomplished using both chartered and scientific vessels for between 25 and 40 trips per year. Private-sector vessels are awarded FAD deployment contracts based on a competitive bid protocol administered through the University of Hawaii. Similarly, a combination of private and University of Hawaii vessels are used to recover FADs when they are reported drifting or off-station.

The FAD program maintains a web page and a 24 hour telephone "hotline" for the boating/fishing/scientific community to inform the program of FADs that are missing or in need of maintenance. This has proved to be such a reliable way of getting information about the entire network of FADs that no regularly scheduled vessel time is used by the program for monitoring the FAD network. When problems are reported, appropriate measures are used to correct the situation. This includes compensating private vessels for recovering drifting FADs.

2.5 FAD-related Research

By allowing scientists access to the FADs, The Hawaii FAD program has fostered collaborative scientific research into the biology of pelagic fishes and the influence of FADs on the behavior and movement patterns of species that are found in association with FADs. Much of this research has been comprised of tag-and-recapture and electronic tracking (telemetry) experiments. These are aimed at understanding the size of the "catchment area" that underpins the Hawaii coastal and nearshore fishery. A list of some of the publications from Hawaii-based research is presented in Appendix I.

3 Environmental setting without the project

Because the existing FAD locations are between two and 15 miles offshore and in depths of 200 -1,500 fathoms, the setting is considered to be "oceanic" rather than "coastal." This section provides a description of the FAD sites based on selected studies and accounts of Hawaii's offshore waters and deep sea benthos.

3.1 Physical Setting

Northeast trade winds generate the prevailing surface waves in the region around Hawaii and drive surface currents in a westward direction at 0.4 to 0.6 knots (20 to 30 cm sec^{-1}). Current patterns, wave characteristics, salinity, and water temperature in this part of the North Pacific gyre, vary moderately for most of the year, though the tropical storms of the Northern Hemisphere move closer to the Hawaiian Islands during winter. Nearshore currents are greatly affected by the local topography and tidal water movement, which fluctuate less than 3 feet.

Within Hawaii's interisland channels, strong trade winds produce high waves. For example, a 25-knot wind can generate 4-10 foot waves in the channels (Haraguchi 1979). Tropical storms and hurricanes, generated in the Eastern Pacific, generally lose strength before reaching Hawaii (Haraguchi 1979). Tsunamis occurred 112 times between 1813 and 1979 of which only 16 were destructive (Haraguchi 1979). The largest recent tsunami occurred in March 2011 and resulted in moderate damage in localized parts of the islands. No impact was observed on the FAD network.

Temperature-depth profile of Hawaiian waters may be described as 24.6 ± 2.2°C at the surface, 12.4 ± 3.7°C at 158 fathoms, and 2.1 ± 0.2°C at 1093 fathoms. Also, the greatest range of temperature change was detected between 108 fathoms and 163 fathoms (Chamberlain and Brock 1968). The thermocline off Diamond Head, Oahu, was observed to be between 33-50 fathoms by Avery et al. (1963).

Gundersen, et al. (1976) observed the base of the photic zone (defined as one percent light depth and discontinuance of photosynthetic carbon fixation) in Hawaiian waters to be approximately 75 fathoms deep. They also noted that at 136 fathoms, the water was only 70 percent saturated with oxygen. The reduction in oxygen saturation increased with depth. The salinity of the open ocean waters around Hawaii averages 35°/I000, with changes attributable to seasonal and diurnal patterns, and prevailing weather conditions (Seckel 1962).

The FAD anchors are situated on deep submarine terraces, escarpments, or gradual sloping ocean plains. The sediment here consists of carbonates and detritus, calcareous ooze, and deep ocean brown clay. The substrate at these deep depths is mostly fine clay material although patches of coarse sand areas and current-scoured bottom may be encountered. Ferromanganese deposits may also occur at sites below 200 fathoms (Armstrong 1983). The distribution of marine sediments is dictated by turbidity currents (Fan and Greenwald I971). Bottom currents in waters west of Kauai at depths of 437-1203 fathoms have been described as tidal at a velocity of about 0.25 knot (Fan and Greenwald 1971).

3.2 Biological Setting

Recent discoveries indicate that marine bacteria significantly augment the role of nanoplankton as primary producers in Hawaiian waters (Karner et al., 2001). Larger phytoplankton also contribute to primary productivity (Gundersen, et al. I976).

Copepods are most likely to be the dominant zooplankton (U.S. Army Corps of Engineers 1977); other important zooplankters include chaetognaths, ostracods, amphipods, euphausids, and molluscs. Minor assemblages of the zooplankton community include mysids, isopods, salps, coelenterates, larval invertebrates and fishes (Environmental Center 1976). Hawaiian zooplankton and micronekton organisms have previously been studied by King and Hida (1954), Nakamura (1967), and Amesbury (1975). Deep scattering Layer (DSL) organisms such as shrimps, cephalopods and myctophid fishes play an important role as a forage base for species such as yellowfin and bigeye tuna and spinner dolphins

The major pelagic fishery resources around the project sites are skipjack tuna ("aku" (Katsuwonus pelamis) yellowfin tuna ("ahi" - Thunnus albacares), bigeye tuna (T. obesus), mahimahi (Coryphaena hippurus), wahoo ("ono" - Acanthocybium solandri), billfishes (Xiphiidae and Istiophoridae), and oceanic sharks.

Skipjack tuna (aku) vary in abundance throughout the year and may be found in schools as large as 50 tons or more. They are found predominantly in the surface mixed layer of the ocean (i.e., down to about 40 fathoms). Sizes range from less than a pound to about 20 pounds with larger specimens found on occasion. Aku used to be the chief contributor to the commercial fish landings in Hawaii but their significance has declined due to the drastic decline in the size of the fishing fleet targeting this species.

The ahi, or yellowfin tuna, is most abundant in Hawaii during the summer months whereas the bigeye tuna is caught more frequently during the winter months. Yellowfin tuna range from under two pounds to over 200 pounds. Bigeye tuna tend to be larger and may exceed 300 pounds. Yellowfin tuna are found predominantly in the surface mixed layer of the ocean (i.e., down to about 40 fathoms) whereas adult bigeye tuna usually occur around 125 fathoms during the day but come closer to the surface at night (Holland et al., 1990).

The mahimahi, or common dolphin fish, is an extremely popular sport fish and an island delicacy. It is often found in schools of 20 or less, although schools of more than 100 fish may be encountered. Mahimahi can be caught almost year-round, but is generally more abundant during the spring, summer and early fall. The average size of mahimahi is approximately 15 pounds; males grow to be larger (up to 70 pounds) than females (up to 45 pounds). They are frequently found in association with floating debris and are a key component of the FAD fishery.

The ono or wahoo is found in oceanic waters as well as in shallow, coastal waters (less than 100 fathoms) and ranges in size from 10 to 40 pounds. Unlike the tunas and mahimahi, it is usually a solitary predator. It too is commonly found around floating debris and FADs.

The billfish species of importance in Hawaiian waters are the blue marlin (Makaira nigricans) and the striped marlin (Tetrapterus audax). These fish are usually solitary predators. The blue marlin average 100 - 400 pounds but have been known to exceed 1,500 pounds. It is the most sought-after big game fish in the Central Pacific (Squire and Smith 1977) and is a powerful, fast-swimming predator capable of catching and feeding on tunas. Although present in Hawaiian waters year round, blue marlin is most abundant during the summer months when males arrive to mate with the larger females.

According to commercial catch statistics, the striped marlin has its peak abundance during Spring and Fall although sport fishers usually encounter this species during the winter (November to April). Juveniles dominate the catch and range between 30 and 90 pounds. The striped marlin is an esteemed food fish in Hawaii (Squire and Smith 1977).

Although pelagic sharks are not considered valuable as a commercial commodity in Hawaii, there is an emerging sport fishery that targets bigeye thresher sharks (Alopias supercilliosus). Sharks play a key role as apex predators in the open ocean. The pelagic species usually found in Hawaiian waters are the oceanic white-tip shark (Carcharhinus longimanus), silky shark (C. falciformes), great blue shark (Prionace glauca), bigeye thresher sharks (Alopias supercilliosus) and mako shark (Isurus oxyrinchus). Little is known about the life history or the abundance of these sharks.

Other species that may be found in the areas of the ocean in which FADs are deployed include smaller pelagic species such as rainbow runners (Elagatis bipinnulatis), flying fish (Exocoetidae), squid and mackerel scad ("opelu" - Decapturus macarellus). The latter species supports an important fishery – both for consumption and for bait.

All marine mammals in Hawaiian waters are protected under the federal Marine Mammal Protection Act of 1972; sperm whales and humpback whales are also protected under the Endangered Species Act of 1973. Marine mammals observed around the main Hawaiian Islands are rough-toothed dolphin (Steno bredanensis), slender-beaked spotted dolphin (Stenella attenuata), spinner dolphin (S. longirostris), common dolphin (D. delphis), (Pacific) bottlenose dolphin (T. truncatus), false killer whale (Pseudorca crassidens), killer whale (Orcinus orca), short-finned pilot whale (Globicephala macrorhynchus), melon-headed whale (Peponocephala electra), pygmy killer whale (Feresa attenuata), pygmy sperm whale (Kogia breviceps), sperm whale (Physeter macrocephalus), Cuvier's beaked whale (Ziphius cavirostris), and humpback whale (Megaptera novaeangliae) (Leatherwood et. al. 1982).

A portion of the North Pacific population of humpback whales winters in Hawaiian waters for mating and calving purposes. The population of humpback whales is thought to be increasing. Humpback whales annually migrate to Hawaii, arriving here around November and departing by early June. They tend to congregate in waters between 100 fathoms depth shoreward to shallower areas. They occur throughout the main Hawaiian Islands although the highest numbers apparently occur in the Auau Channel bounded by Maui, Lanai and Kahoolawe and on the Penguin Banks and off Niihau and Kauai (Norris and Reeves 1978).

The Hawaiian Islands Humpback Whale National Marine Sanctuary consists of five areas abutting parts of the main Hawaiian Islands. The sanctuary is jointly administered by NOAA and the State of Hawaii. Some areas of the sanctuary (particularly around Kauai) overlap areas where FADs are deployed.

The three species of marine turtles found in Hawaiian waters are hawksbill turtle (Eretmochelys imbricata), leatherback turtle (Dermochelys coriacea), and green sea turtle (Chelonia mydas). The hawksbill and leatherback turtles are listed as endangered species; the green sea turtle is federally listed as a threatened species. The Pacific Ridley turtle (Lepidochelys olivacea) appears occasionally in Hawaiian waters. The green turtle is by far the most common and its range is almost entirely coastal but is oceanic during its migrations to and from nesting sites in the Northwest Hawaiian Islands.

There are few studies of deep sea animals in Hawaiian waters. At depths of 130-160 fathoms, Polymixia japonica, lutjanids (Aphareus rutilans, Etelis carbunculus), and muraenid eels have been observed (Clarke 1972). Heterocarpus ensifer (175-250 fathoms), a deepsea shrimp, are common and widespread inhabitants on the ocean floor at these depths. Other deep-water marine shrimps in Hawaiian waters are Penaeus marginatus (100-125 fathoms) and H. laevigatus (250-360 fathoms) (U.S. Army Corps of Engineers 1977).

The benthic environment at the project sites (200-1,500 fathoms) is dark, cold, low in oxygen content, and with high hydrostatic pressure. However, the fauna here are remarkably well-adapted to the harsh conditions (Sanders and Hessler 1969). Precious corals, echinoderms, foraminifera, burrowing annelids and other epifaunal and infaunal creatures are known to occupy this habitat.

To date, nine species of deep-water precious corals have been identified in Hawaiian waters: pink coral (Corallium secundum, C. regale, C. laauense), gold coral (Gerardia sp., Callogorgia gilberti, Narella sp., Calyptrophora sp.) and bamboo coral (Lepidisis olapa, Acanella sp.).

Three precious coral beds have been identified around the main Hawaiian Islands at depths of 166-266 fathoms (Draft EIS-FMP Precious Coral Fisheries, 1979). These beds are on hard substrate swept by fast currents. Based on studies of the Makapuu Point (Oahu) bed, the average densities of precious coral beds were estimated to be 89 colonies/acre for pink coral, 40 colonies/acre for gold coral, and 12 colonies/acre for bamboo coral (Draft EIS-FMP Precious Coral Fisheries 1979).

3.3 Economic-Social-Political Setting

Ocean-related activities play vital roles in Hawaii's cultural heritage and economic well being. The offshore waters are used extensively by both residents and visitors for recreational and commercial purposes. Economic benefits derive both from harvesting of natural resources and from recreational activities of which sport fishing is a major component.

Pre-contact Hawaiian society placed heavy emphasis on fishing and on the cultural practices surrounding fishing. This emphasis has continued to the present day. Two of the species found around FADs - skipjack tuna ("aku" – Katsuwonus pelamis) and yellowfin tuna ("ahi" - Thunnus albacares) were of particular importance. Skipjack were important for food and as cultural symbols and yellowfin tuna were caught for sport by Hawaiian chiefs (Titcomb, 1972). Thus, The Hawaii FAD program can be seen as helping to perpetuate a long standing cultural tradition of the Hawaiian people.

Several major fishing methods are used in the offshore Hawaiian waters. The live-bait, pole-and-line method used to account for over 95% of the commercial aku (skipjack tuna) landed in Hawaii but this fleet is in steep decline due to non-replacement of older vessels and the closing of the cannery which used to underpin this fishery. On the other hand, the Hawaii based longline fleet has expanded rapidly. This fleet primarily targets yellowfin and bigeye tuna and swordfish. Incidental catches such as mahimahi, ono, albacore tuna (Thunnus alalunga), and oceanic sharks are also taken by these vessels. However, this fleet operates at distances greater than 50 miles offshore and therefore does not overlap with the FAD sites.

There is a variety of types of fishing techniques that utilize smaller vessels for both commercial and recreational fishing in Hawaii. One major general category is handline fishing. Three types of handline fisheries target tuna. The "ika-shibi" method is conducted at night mainly off the island of Hawaii (Yuen 1979) but has expanded throughout the islands. The method involves using night lights to catch live squid which are then used as bait to catch fish attracted to the lights of the boat. The "palu-ahi" method is employed during the day and usually along the 100-fathom shelf. The method involves using a chum bag to attract fish to the hook. The third handline method involves vertical jigging of small lures and is usually concentrated around FADs. Ahi and bigeye tuna are the principal fishes caught by these methods. The bottomfish handline fishery targets species associated with the ocean bottom at depths of 25 to 166 fathoms. Various snappers and groupers are caught depending on the depth fished. The most important commercial species are the opakapaka (Pristipomoides filamentosus), uku (Arion virescens}, onaga (Etelis coruscans), ehu

(Etelis carbunculus), and hapuupuu (Epinephelus quernus). Various goatfish and carangids are also caught.

Hawaii is one of the best big game fishing grounds in the world and plays host to numerous billfish tournaments year round. Big game fishing involves trolling for marlins and tunas with artificial lures or natural bait. Sport fishing – either on charted vessels or privately owned boats - represents a major recreational activity in Hawaii. Sport fishing is an iconic component of the tourist experience in Hawaii and is an important source of revenue. It has been estimated that more than 10,000 trolling trips are made annually in Hawaii (Western Pacific Regional Fishery Management Council 1978) at distances 1 to 20 miles offshore. Today, there are more than 2,000 vessels that troll for yellowfin tuna, marlin, mahimahi, ono, and kawakawa.

Hawaii's fishing vessels can be categorized as sport fishing charter boat, non-charter recreational/commercial, or commercial. The distinctions between recreational and commercial fishing boats are obscured because many of Hawaii's recreational fishers sell their catches to recover their costs (Western Pacific Regional Fishery Management Council 1978).

Other major ocean activities that occur at the FAD project sites include recreational sailing, blue water recreational diving, commercial transport, surface and subsurface military exercises, and scientific research.

Most FAD sites are within the 200-mile Fishery Conservation Zone (FCZ) established by the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976. The FCZ extends from Territorial waters out to 200 nautical miles. The Western Pacific Regional Fishery Management Council (WESPAC) is responsible for management of resources within the FCZ. In 2010, fisheries management plans (FMPs) developed by WESPAC were replaced with Fisheries Ecosystem Plans (FEP) which are focused on specific locations. The five FEP's are;

1. American Samoa

2. Hawaii

3. Mariana

4. Pelagic

5. PRIA (Pacific Remote Island Areas)

The Hawaii FAD network will be deployed in areas covered by the "Pelagic" and "Hawaii" FEPs

4 Potential environmental impacts of the proposed project

4.1 Physical Effects

The proposed FADs should have very little, if any, impact upon the currents, temperature profile, photic level, and salinity at the project sites. The metallic parts (mast, chain, anchor, hardware) of the FADs will undoubtedly corrode resulting in minute additions of oxidized products to the ocean. These will have insignificant adverse impact upon the ocean environment. The anchors and lines used for mooring the FADs are made from inert materials. In total, the mooring line is negatively buoyant which causes the line to sink to the bottom if the buoy breaks loose from the mooring. Similarly, although repeated deployments of anchors occur, they represent in insignificant physical presence on the seafloor – each anchor system covers about 60 square feet. The locations where the anchors are deployed are in deep water where the bottom is generally typified as low relief silt and mud plains where damage from the anchors and line can reasonably be expected to be very limited.

4.2 Biological Effects

The purpose of the FADs is to concentrate fishery resources at specific locations by taking advantage of the natural tendency of pelagic fishes to associate with floating objects. Why floating objects attract pelagic fishes is still not well understood (Matsumoto et al. 1981). This topic has been central to ongoing scientific research in Hawaii and has resulted in the publication of several papers covering this topic (see Appendix I). Certainly, the association of tuna with moored, manmade objects is derived from behavior that evolved around natural drifting objects such as logs. Two major hypotheses have emerged to explain the evolution of this behavior. First, the "Indicator Log" hypothesis suggests that floating objects become entrained in regions of the ocean that have enhanced nutrient levels which, in turn, lead to increased forage organism densities. Thus, fish associating with logs would experience enhanced feeding success. The "Meeting Point" hypothesis suggests that logs facilitate the formation of fish schools after individuals participate in nighttime foraging. Logs may allow smaller schools to merge into larger ones which have increased hunting efficiency. Research in Hawaii has found support for both of these hypotheses (Dagorn et al., 2007). It is certain that tuna are not feeding on the epipelagic species (e.g., oceanic trigger fishes, rainbow runner) that also aggregate around the FADs.

FADs could affect the local distribution and migration of pelagic fishes and it has been suggested that FADs might even constitute an "ecological trap" wherein FADs alter the large scale behavior of fish such that they abandon their natural movement patterns. Research conducted in Hawaii finds little support for these concerns. Tagging and tracking studies have shown that the visitation patterns of yellowfin tuna are characterized by quite brief visits to FADs and that most fish do not 'hopscotch' from one FAD to another. These results indicate that although tuna are attracted to FADs, this behavior is predominantly transitory in nature and, although some fish do spend extended periods associated with FADs, most visit quite briefly and spend most of their time beyond the influence of the FADs. In other words, the influence of FADs is probably overshadowed by the 'island effect' wherein the natural attributes of the coastal ecosystem are the dominant factor in shaping the movements of pelagic fishes such as tuna (Dagorn et al., 2007). Some species may actually benefit from associating with anchored FADs. Diet analysis of yellowfin tuna indicate that they have better feeding success at coastal FADs than they do when not near FADs or even when found in association with seamounts (Holland et al 2003, Grubbs et al, 2002)

Other than pole and line commercial aku boats, there are no high volume commercial fisheries that operate around Hawaii's FADs and the pole and line fishery is in rapid decline – there is only one commercial boat left. Occasionally, there is commercial-scale handline fishing on certain FADs when they are 'holding' aggregations of large bigeye tuna. However, overall, the FAD fishery in Hawaii does not have the capacity to remove large amounts of tuna and the harvest is extremely small when compared with the purse seine and longline fisheries of adjacent areas of the Pacific. For Pacific tropical tuna stocks in general, the most recent assessments indicate that skipjack populations are in very good condition and yellowfin are probably being harvested within sustainable levels. Bigeye tuna are probably being overfished but this is primarily due to excessive removal of subadullts by purse seiners. Recently emerging scientific results suggest that yellowfin tuna caught in coastal Hawaiian waters are a combination of fish spawned locally and fish immigrating from more southerly spawning areas (D. Itano, personal communication). The dual source of Hawaii's ahi probably helps to buffer its population from possible overexploitation.

Concerns have been raised that high catch of small tunas may be occurring around Hawaii's FADs but, for the reasons stated above, the harvest would probably not impact the overall population although there is the possibility of localized depletion. To address the concerns of overexploitation of small tuna, Hawaii has established a 3lb minimum weight for the sale of yellowfin and bigeye tuna.

Pelagic animals such as dolphins, whales and sharks may be affected by the FADs and groups of dolphins and pilot whales and oceanic sharks are sometimes found in close proximity to the FADs. During the 25 years of deployment of the current design of the FADs, there have been no reports of any entanglement issues with any threatened, endangered or protected species. The design of the FADs has been refined to eliminate any components such as plastic streamers or netting that might contribute to entanglement. The heavy anchors and heavy gauge mooring line insure that the mooring line is kept taut and this probably further reduces the possibility of entanglement of marine mammals. A Section 7 Consultation with NMFS PIRO personnel resulted in the determination that the FAD system would not negatively impact protected species.

The deep ocean benthic habitat may be affected by the FAD mooring lines and 3,000 pound anchors. Each anchor assembly covers an area of approximately 60 square feet on the sea floor. Given repeated deployments of FADs (on average, once every three to four years), several anchor assemblages may be found in the same general area. Some benthic organisms could be displaced and sessile forms may be initially destroyed by arrival of the anchors. However, the direct impact would be confined to a very small area. Relative to the total area of the Hawaiian deep sea floor, the impact of the FAD anchors should be negligible and in fact might enhance local benthic biodiversity in the same way as artificial reefs. The depth of the FAD sites is greater than the diving depths of green turtles, dolphins and humpback whales when they are in Hawaiian waters. Pilot whales and beaked whales may dive to these depths but these species are hunting when at these depths and can almost certainly use their echolocating skills to distinguish rope from legitimate prey. There have been no reports of interactions with any protected species over the previous twenty five years of operation of the FAD program.

4.3 Economic, Social, Cultural and Political Impacts

Potential adverse impacts of the proposed project may involve interference with surface and subsurface military exercises and operations, navigational hazards to commercial waterborne and recreational activities, and conflict between user groups of the FADs.

The U.S. Navy has designated certain areas around the Hawaiian Islands as submarine transit lanes, and training and operating areas. If not properly situated, the FADs could interfere with Navy operations and might threaten the safety of military personnel. The FAD sites that have been in operation are not located within these restricted areas and, over the entire existence of the present system, no complaints or reports of incidents has been made by the US Navy to the operators of the FAD system.

Any sizable floating object in the ocean presents a potential hazard to navigation and there is no assurance that the FADs will remain on station. Therefore, FADs may pose some hazard to unwary vessels if the marine warning light fails, or if the FADs break free. There have been incidents of inter-island barge traffic running over and cutting off FAD buoys. In response to these incidents, FAD sites have been changed and barge operators asked to give FAD locations a wide berth. Drifting FADs are regularly recovered and towed into harbors by fishers, scientific vessels and vessels chartered by the FAD program. Buoys that drift ashore are recovered as soon as possible and reused. There is a possibility of damage to fringing reefs but, to date, no significant or irreparable damage has been reported. The light packs on the buoys have been converted to solar powered units thereby increasing the reliability of the navigation light and reducing the need for replacement.

Conflicts may arise between user groups as a result of competitive use of the FADs. Disagreements over use of the FADs may involve commercial and recreational fishers competing for resources attracted to the FADs, conflicts over perceived "ownership" rights of FADs between local users versus "outsiders," crowding at the FADs, and entangling of fishing gear. However, as the aku fleet has declined and as fishers have become more sophisticated in the techniques they use around FADs, user conflicts have become fewer and entanglement of fishing gear with the FAD mooring less frequent. Users tying their boats to the FADs, which is illegal*, have been blamed for causing excessive strain on the mooring line and premature loss of FADs but these instances also seem to be less frequent.

Fishing for pelagic fish species was a significant part of traditional Hawaiian culture. Pelagic fishes were caught for food and for recreation (Titcomb, 1972). The FAD program helps to perpetuate this experience for Hawaii's residents.

5 Environmental impact preventative and mitigating measures

Negative environmental impacts that can be prevented or mitigated by the project include animals being entangled in the FAD mooring line, hazards to navigation and military operations and conflicts between the various FAD user groups.

The spherical design of the FAD floats and the absence of additional appendages such as netting or plastic mesh reduce the chances of turtles or monk seals becoming entangled to virtually zero. Similarly, the extreme weight of the anchors and the high buoyancy of the FAD floats result in the mooring line having no slack at any time. This greatly reduces the chances of entanglement by marine mammals such as whales and no entanglement incidents have been reported for the entire history of the FAD program.

The FADs will be placed in locations away from submarine transit lanes and submarine operation areas adjudged to be critical by the U.S. Navy. Every effort will be made to avoid placement of FADs that would interfere with maritime commerce and ocean activities. The previous 25 years of operation has caused the network to evolve to the current deployment sites which are charted and well known and where interactions with military and commercial shipping are minimized.

The FADs will conform to Aids to Navigation requirements of the U.S. Coast Guard. Current positions of the FADs are shown on official navigation charts. Any new locations will be published in the Coast Guard's Notice to Mariners to inform local seafarers. Adoption of solar powered units has resulted in continuous operation of the warning lights and reduced the need for replacements. FAD research has identified weak components and allowed for instituting corrective measures. For example, the swivels have become more robust and the ropes now used are more resistant to abrasion.

It may be difficult to control the catch of immature tuna from the FADs, especially with regard to recreational fishing. Although the market for small tuna is limited and a 3 lb minimum sale weight has been instituted, this would not defer the taking of these fish by recreational fishers. If it is found that regulation of the catch of small tuna is necessary, then regulatory measures could be promulgated to prohibit the commercial sate or the possession of undersized fish such as those under three pounds. However, the best available science indicates that the amount of fish taken by Hawaii's sport fishery (and the commercial fleet that very rarely uses the FADs) does not have a significant impact on the overall stock status of these species.

Maintaining the sport fishing experience is desirable and perpetuates a core component of Hawaiian culture. In addition to the recreational value of sport fishing, this component is a major contributor to the local economy. In a study entitled "The Economic Impact of Fish Aggregating Devices on Hawaii's Charter Boat Fishing Industry," Samples and Schug (1984) found that approximately one-third of the charter boat skippers in Hawaii used the FADs if only for a brief visit during a trip. The amount of use by this fleet has certainly increased since that report was published. Sport fishing charter boat captains indicated concrete economic benefits are being realized by using the FADs.

6 Unavoidable environmental impacts

Impacts which cannot be avoided include relatively small amounts of oxidized FAD products (metallic corrosion) added to the ocean, minor perturbation of the sea floor substrate and displacement of benthic organisms around the FAD anchor sites and accumulation of anchor blocks at FAD sites. However, the sites where anchors and lines are situated are in very deep water on low relief plains characterized by low biodiversity. Concrete blocks are inert and do not pose a contamination risk.

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*Chapter 13-73 <u>Fishing Aggregating Devices,</u> Hawaii Department of Land and Natural Resources.
1982. (See Appendix)

Fringing reefs may incur temporary damage due to strikes from stranded FAD buoys. Past experience indicates these impacts are minor and infrequent and quickly overgrown. Temporal and spatial changes to the local distribution patterns of pelagic fish stocks may occur which might impact feeding success. However, recent research has indicated that effects on movement patterns are modest or non-existent (Dagorn et al., 2007) and there appears to be no negative impact on the feeding success of yellowfin tuna associated with coastal FADs (Holland and Grubbs, 2007; Grubbs et al. 2002). There will be insignificant changes to the aesthetics of the open ocean. These impacts are considered to be acceptable in view of the potential benefits derived from the project.

7 Alternatives to the proposed project and their impact

7.1 Withdrawal

This alternative calls for a withdrawal from the current statewide FAD system. No replacement of FADs in Hawaiian waters would take place, and the operation of the present 54 FADs would be terminated. The environmental impacts described in section D (Potential Environmental Impacts of the Proposed Expansion) would be eliminated. This action would severely retard State's effort to develop and improve recreational fisheries in Hawaii and prevent optimum use of the marine resource. There would be negative economic consequences both from reduced activity in the sport fishing sector and reduction in federal and international grants in support of FAD-related research.

7.2 New Project

(A) Unanchored expendable FADs could be deployed instead of the proposed anchored types. Although free-floating aggregators may initially be less costly than the currently proposed anchored FADs, total benefits to be derived from them would be small. Most of the fishers would still need to depend on chance encounters with the free-floating aggregators and this would require larger fuel consumption. To be effective, this alternative would require the release of many FADs in Hawaiian waters which will be costly in the long run and pose much greater hazards to navigation. Also, the prospect of many of these FADs being washed ashore and creating a nuisance must be considered.

8 Conclusion

The continued operation of FADs in waters around the main Hawaiian Islands will not result in significant adverse environmental impacts. As discussed in this document, potential impacts resulting from the project will be minimal, amenable to mitigation, or entirely prevented. None of the alternatives considered can provide better or more cost-effective fishing opportunities for Hawaii's sport fishers – whether residents or visitors.

The proposed project will provide substantial recreational benefits to our fishers without jeopardizing the marine environment or other established ocean activities. In fact, by reducing fishing pressure on reef and benthic ecosystems, the FAD program enhances environmental quality of coastal areas and recreational fishing in those areas. Continued support of successful recreational fishing will result in continued economic benefits derived from this activity and will help perpetuate fishing activities that are an important part of Hawaii's cultural heritage. Furthermore, the project will maintain the opportunities for cooperative federal-state-private research and development of fish aggregating technology and the management of pelagic fisheries. Hawaii has established itself as a leader in this field.

The project will not affect fishery management prerogatives of the Western Pacific Regional Fishery Management Council. Required federal permits (U.S. Army Corps of Engineers, U.S. Coast Guard), approval (U.S. Navy), and state permit (Department of Land and Natural Resources) and approval (Department of Transportation) are already in hand or will be obtained prior to initiation of the project.

9 List of agencies and persons consulted

9.1 Federal Agencies

9.1.1 Western Pacific Fisheries Management Council

Mr. Eric Kingma, Coordinator of WESPAC's FAD programs

9.1.2 NMFS PIRO

Mr. Donald Hubner, Endangered Species Biologist, NMFS PIRO

9.1.3 US Fish and Wildlife Service

Mr. Edward Curren, USFWS liaison, Hawaii Division of Aquatic Resources

9.2 State Agencies

9.2.1 State of Hawaii Division of Aquatic Resources

Mr. Michael Fujimoto, State FAD program liaison
Mr. Alton Miyasaka, permitting specialist

9.2.2 University of Hawaii

Mr. Warren Cortez, FAD program lead technician

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APPENDIX I

Scientific Literature Arising from Hawaii FAD research

Refereed Publications

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Table 1. Details of FADs deployed around the Main Hawaiian Islands.

FAD #	Island	Latitude	Longitude	Bottom Depth (fathoms)
A	Hawaii	18-57.35' N	155-33.40' W	700
B	Hawaii	19-11.9' N	155-56.9' W	850
C	Hawaii	19-23.1' N	155-59.2 W	969
D	Hawaii	19-37.5' N	154-46.7' W	950
E	Hawaii	19-46.1' N	154-54.8' W	920
F	Hawaii	19-30.4' N	156-09.4' W	1592
G	Hawaii	19-51.2' N	154-54.4' W	600
SS	Hawaii	19-06.8' N	155-14.5' W	515
TT	Hawaii	19-04.6' N	155-57.4' W	700
UU	Hawaii	19-16.8' N	155-57.1' W	650
VV	Hawaii	19-35.1' N	156-01.9' W	600
XX	Hawaii	20-02.2' N	156-06.2' W	641
OTEC	Hawaii	19-52.6' N	156-11.6' W	714
KH	Hawaii	19-20.9' N	154-52.8' W	940
RN	Hawaii	19-07.8' N	155-23.5' W	733
ZZ	Hawaii	20-09.5' N	155-57.5' W	214
HK	Hawaii	19-58.6' N	154-59.0' W	890
GG	Kahoolawe	20-32.0' N	156-16.0' W	400
JJ	Kahoolawe	20-24.2' N	156-38.0' W	900
K	Lanai	20-40.1' N	157-02.6' W	319
CC	Lanai	20-55.3' N	157-10' W	500
MC	Lanai	20-35.9' N	157-08.5' W	575
M	Maui	20-44.9'N	155-50.5'W	690
Q	Maui	21-08.5' N	156-07.7' W	907
DD	Maui	21-02.1' N	156-15.4' W	203
FF	Maui	20-50.12' N	155-43.9' W	828
HO	Maui	20-56.4' N	156-00.8' W	550
LA	Maui	20-41.0' N	156-42.5' W	110
NL	Maui	20-32.9' N	156-09.5' W	664
N	Molokai	21-20.9' N	156-35.0' W	940
HS	Maui	20-27.0' N	156-29.1' W	680
SO	Kahoolawe	20-31.4' N	156-52.3' W	240
J	Oahu	21-50.0' N	158-08.8' W	960
P	Oahu	20-46.4' N	157-48.7' W	286
R	Oahu	21-27.5' N	158-16.9' W	460
S	Oahu	21-23.8' N	158-14.8' W	460
T	Oahu	21-30.2' N	157-25.8 W	1000
U	Oahu	21-34.9' N	157-41.5' W	554
V	Oahu	21-32.3' N	158-18.8' W	309

X	Oahu	21-51.8' N	157-59.6' W	945
CO	Oahu	21-33.7' N	158-26.8' W	1010
HH	Oahu	21-02.1' N	158-02.1 W	647
II	Oahu	21-44.8' N	158-13.3' W	985
LL	Oahu	21-44.9' N	157-45.3' W	1140
MM	Oahu	21-36.4' N	157-31.2' W	1355
BO	Oahu	21-09.0' N	158-09.1' W	850

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Table 1 ctd.

FAD #	Island	Latitude	Longitude	Bottom Depth (fathoms)
Z	Kauai	21-52.5' N	159-18.5' W	892
AA	Kauai	21-49.3' N	159-36.6' W	960
BB	Kauai	22-13.6' N	159-13.9' W	1000
CK	Kauai	21-48.4' N	159-21.5' W	825
DK	Kauai	22-07.5' N	159-13.7' W	700
EK	Kauai	22-19.6' N	159-29.5' W	1000
PP	Kauai	21-47.7' N	159-34.2' W	950
WK	Kauai	22-01.3' N	159-12.9' W	915
KK	Kauai	21-51.9' N	159-43.9' W	960