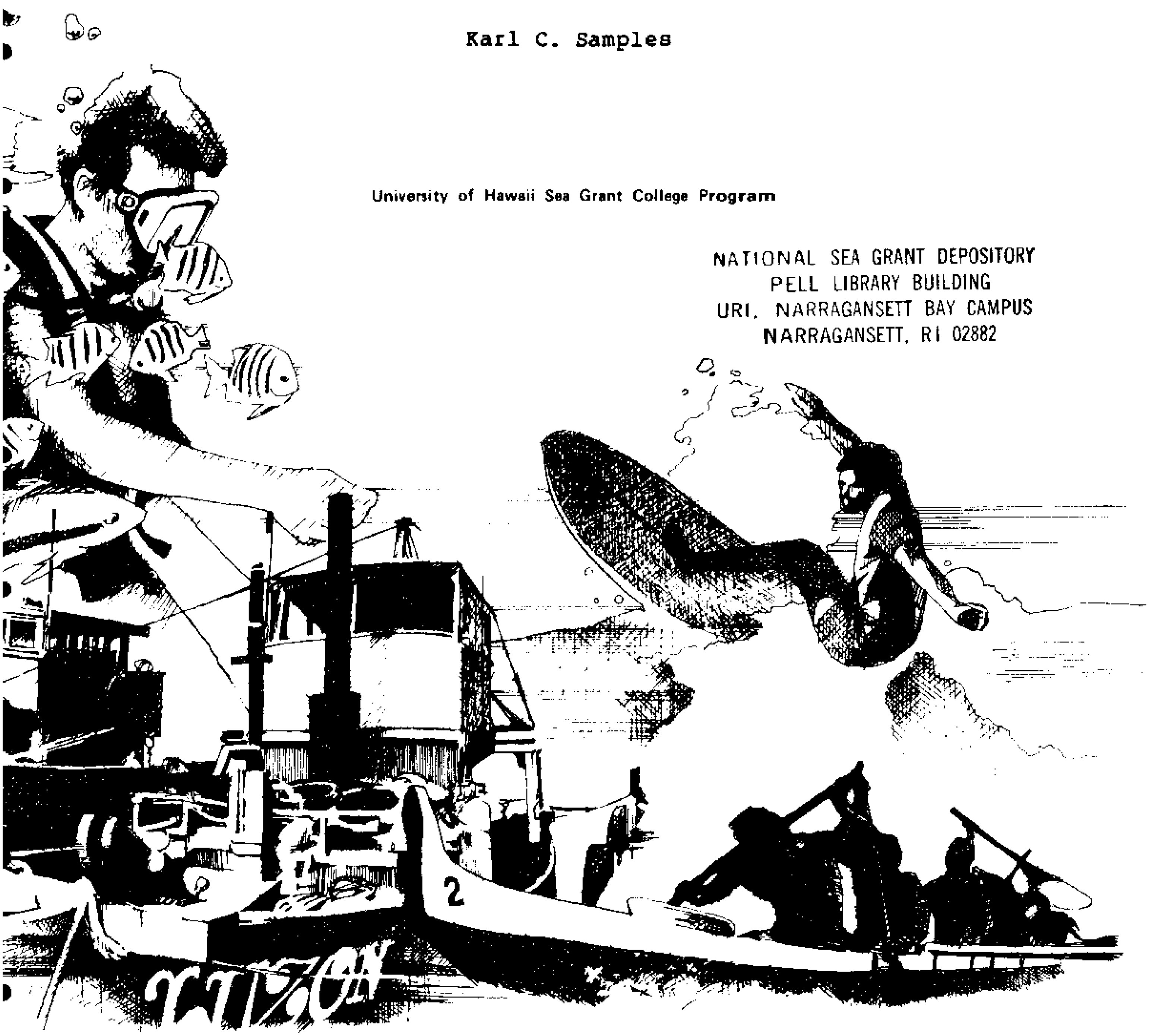
Studies on Marine Economics

A SOCIOECONOMIC APPRAISAL OF FISH AGGREGATION DEVICES IN HAWAII

Karl C. Samples



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ABSTRACT

Fish aggregation devices (FADs) have been deployed in nearshore Hawaiian waters for the benefit of commercial and recreational fishermen. This report describes the socioeconomic characteristics, attitudes, and motives of FAD users based on a 1984 survey. It also describes the costs of Hawaii's FAD program and the monetary benefits that accrue to users. The 622 surveyed fishermen made 13,819 visits to FADs, or 26.4 visits each during a 12-month period in 1983-84. An average of 4.4 fish, consisting primarily of various tuna species, were caught per FAD visit. Fishermen generally claimed that fish catch and overall fishing fun were improved around FADs, but they also frequently identified crowding as a detracting factor. Statistically significant differences exist between commercial and recreational fishermen using FADs in terms of their fishing activity, vessel type, catch, and attitudes about the effectiveness of the devices. A benefit-cost analysis of Hawaii's FAD program shows that, on an annual basis, users' willingness to pay for FADs ($184,906) slightly exceeds estimated average annual program costs ($182,000).

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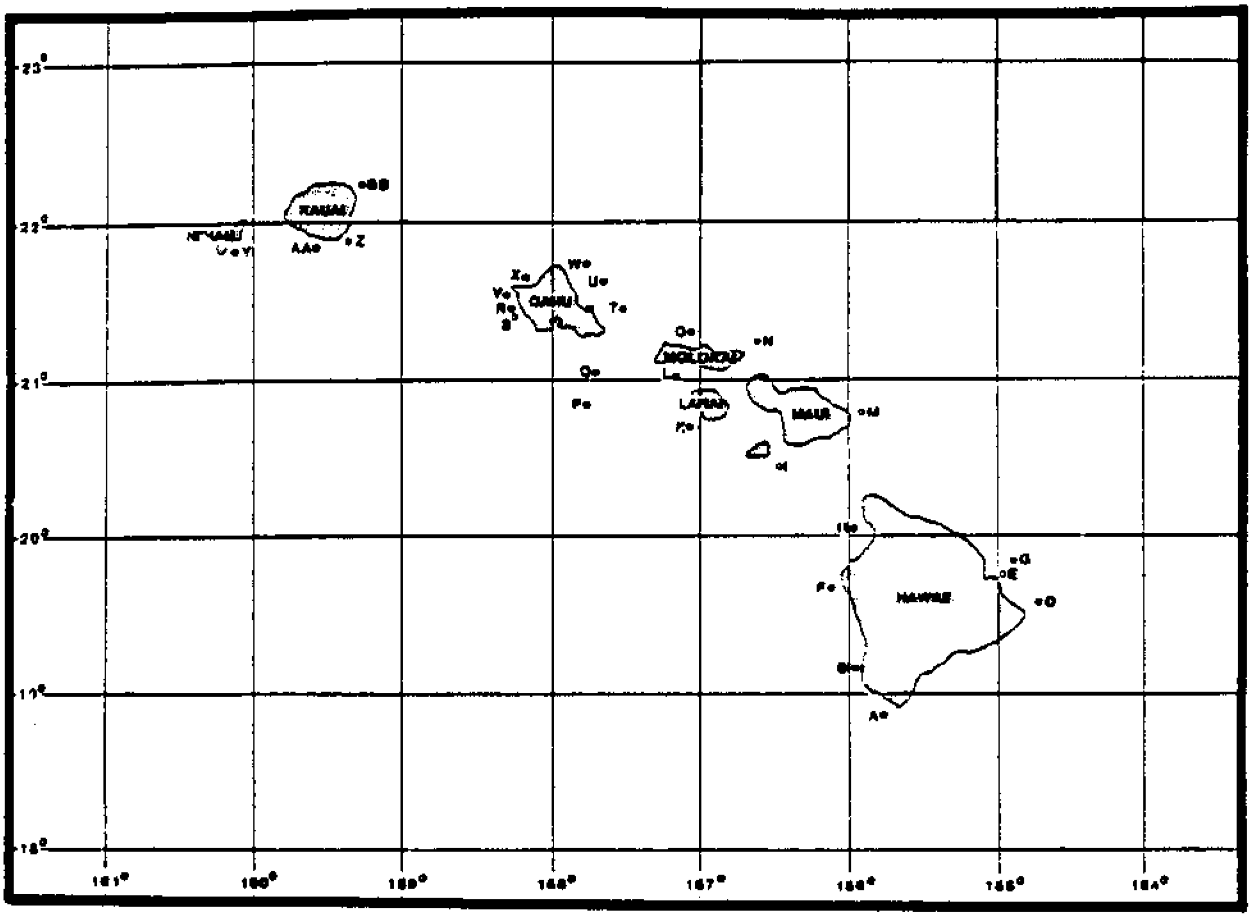
INTRODUCTION

The attraction of pelagic fish to floating objects in the open ocean is well documented. Fishermen around the world have capitalized on this phenomenon. For example, it has been reported that commercial fishermen have experienced increased harvests as a result of fishing around drifting logs, algae, and other free-floating objects (Gooding and Magnuson, 1967; Greenblatt, 1979). Also, fishermen on recreational and charter fishing vessels have realized relatively higher catch rates while fishing in proximity to fabricated floating structures (Wickham et al., 1973; Matsumoto et al., 1981).

Buoys and rafts have been anchored in coastal areas to supplement naturally occurring flotsam and to achieve more human control over fish aggregation behavior (Shomura and Matsumoto, 1982). Such is the case in Hawaii where a network of buoys specifically designed to attract pelagic fish is moored around six of the main islands at a mean depth of 960 m and at varying distances of approximately 8 to 40 km offshore (DAR, 1983). The buoys, or fish aggregation devices (FADs) as they are commonly called, were first deployed in 1977 on an experimental basis by the Honolulu Laboratory of the National Marine Fisheries Service Southwest Fisheries Center. A full-scale system of 26 buoys was deployed beginning in mid-1980 by the Division of Aquatic Resources, Hawaii Department of Land and Natural Resources. The geographic layout of the 26-buoy system is provided in Figure 1. In 1985, the system was nearly doubled in size to include 48 FAD stations.

One purpose of the FAD project was to increase the fishing productivity of commercial and recreational fishermen. In addition, it was anticipated that FAD installation would reduce the fishermen's inputs of time and fuel needed to catch a given quantity of fish. To date, few facts have been assembled about the characteristics of FAD users in Hawaii and the benefits which they derive from fishing around the devices. Scattered information is available about certain small user groups such as charter boat operators (Samples et al., 1984; Samples and Schug, 1985a, 1985b) and pole-and-line tuna fishermen (Sproul, 1984). However, information about the wider population of recreational and commercial fishermen who visit FADs is virtually nonexistent.

The primary objective of this report is to provide baseline documentation concerning the socioeconomic characteristics, attitudes, motives, and user values of fishermen who use FADs in Hawaii. A secondary objective is to provide a comparison between the annual benefits that accrue to fishermen as a result of having access to FADs and the annual costs of the buoy program. It is anticipated that achievement of these objectives will yield information useful for FAD system management in Hawaii, as well as in other localities where FAD deployment is being considered as a fisheries enhancement option.



Source: Division of Aquatic Resources, DLNR (1982)

Figure 1. Geographic Distribution of FADs in Hawaii: 1983-84

SURVEY DESIGN AND FIELDING

Collection of socioeconomic and valuation data is complicated because FAD users in Hawaii are not easily identifiable. Access to FADs is open to anyone willing and able to travel the distance to the site. No special use permits or fishing licenses are required. Licensed commercial fishermen are the only user group required to file reports of fish caught near FADs. However, catch reports filed with the Division of Aquatic Resources are confidential, along with all socioeconomic information included on commercial fishing license applications. Other users, notably recreational and subsistence fishermen, have been asked by the Division of Aquatic Resources to report FAD fishing effort and catch on a voluntary basis. Such voluntary reporting has been sporadic and therefore the data are incomplete.

The best available estimate of the total number of vessels fishing around FADs is from Skillman and Louie (1984). Their 1983 enumeration study of 12,578 registered and documented vessel owners in Hawaii revealed that 1,705 of them fished around FADs.

However, due to survey nonresponse, this figure probably represents a lower-bound estimate. For example, none of Hawaii's 12 pole-and-line tuna boat owners responded to the survey. A reasonable upper-bound estimate can be obtained by extrapolating Skillman and Louie's findings to the population of registered vessel owners in Hawaii. Approximately 72 percent of the respondents used their boats for commercial, recreational, or subsistence fishing purposes. Of these respondents, 35 percent reportedly fished near FADs. By extrapolation, therefore, the population of vessel owners using FADs in recent years could have been as high as 3,170 (0.72 x 0.35 x 12,578).

Lack of existing data sources prompted a mail survey of FAD users to be conducted. A decision was made to draw a sample from the 1,705 vessel owners who identified themselves as FAD users in Skillman and Louie's survey. Use of this sampling strategy was convenient because names and addresses of fishermen who used FADs in 1983 could be readily obtained. The strategy precluded sampling individuals who no longer fished at FADs for whatever reason, as well as those who were planning to use FADs but were not users in 1983. Potential sampling bias due to exclusion of these individuals was deemed unimportant because a sample of active FAD fishermen would likely represent both new and outgoing users.

Determination of the sample size was guided by a concern to represent frequent and infrequent FAD users in correct proportions. Frequency of use was measured in terms of the average number of days per month that fishermen visited FADs. Survey results reported by Skillman and Louie showed that 64 percent of the users fished around FADs 5 days or less per month over the course of a year, while the remaining users averaged over 5 days per month. It was determined that a sample of 682 boat owners would permit 95 percent confidence that the sample proportion of frequent and infrequent FAD users would be the same as that of Skillman and Louie, with an allowable error of 10 percent. The final sample size was thus set at 800 in anticipation of an 85 percent return rate.

A further determination was made to stratify the final sample to account for suspected differences in FAD fishing motivations and behavior between commercially oriented fishermen and recreational fishermen. It was perceived that making this distinction would yield greater insight into how FAD emplacement had affected different types of fishermen. Making the distinction would also indicate whether Hawaii's FAD system should perhaps be modified or reconfigured to better accommodate the fishing needs and practices of special interest groups.

Three different groups of fishermen were identified, based on Skillman and Louie's results. The first group, accounting for 51 percent of the total, included vessel owners who did not sell any of their catch (hereinafter called "recreational" FAD users). Fishermen who sold less than half of their catch (hereinafter called "mixed" FAD users) comprised the second group, which represented 18 percent of the total. The third group, which comprised 31 percent of the total, were fishermen who reportedly sold over half of their catch (hereinafter called "commercial" FAD users). The 800 fishermen were stratified into three groups to match these percentages using the following procedure. First, the list of 1,705 names and addresses was divided into three sublists according to the commercial orientation of each boat owner. Second, survey participants were selected from each sublist by taking a randomly selected starting point and then selecting every kth name, where the constant "k" varied depending on the number needed to maintain proper sampling proportionality.

The distribution of the randomly selected sample, by island of vessel owner's residence, was as follows: Oahu -- 56 percent, Hawaii -- 27 percent, Maui -- 8 percent, Kauai -- 6 percent, Lanai -- 2 percent, and Molokai -- 2 percent. This sampling proportionality was approximately equal to the geographic distribution of registered vessel owners by island of residence (Skillman et al., 1984). It also was consistent with the relative population size of each island.

A questionnaire was developed to obtain from each respondent information about his or her (1) attitudes about FADs, (2) FAD fishing practices, (3) use rates of different FADs, (4) fish catch at FADs, (5) benefits derived from using FADs, and (6) basic socioeconomic characteristics. The survey instrument was reviewed externally and then pretested using 15 randomly selected FAD users not included in the final sample. A slight modification in format was made to enhance respondent comprehension.

On June 9, 1985, all selected fishermen were mailed the same basic questionnaire (see "Appendix"), a cover letter, and a postage-paid return envelope. After three successive follow-up mailings extending over a 3-month period, cumulative returns reached 691. This represented an overall response rate of 86 percent. However, after discounting for nondeliverable questionnaires and for returns that were blank or incomplete, the response rate dropped to 78 percent (N = 622). No statistically significant differences (at the 0.10 level) were detected in the usable questionnaire response rates for recreational (74 percent), mixed (77 percent), and commercial (83 percent) FAD users.

STATISTICAL PROFILE OF FISH AGGREGATION DEVICE USERS

Survey data revealed that FAD users in Hawaii come from diverse socioeconomic backgrounds. Respondents' ages, for example, ranged from 19 to 80 years, and their annual household income levels varied from less than $4,000 to over $48,000. In terms of occupational backgrounds, farmers, office workers, attorneys, and construction workers were included in the ranks of those fishermen who visited Hawaii's FADs during 1983-84. Retirees comprised 15 percent of the sample group.

Despite the vast differences in types of FAD fishermen, the following typical characterization emerges. The typical user is a 43-year-old male with a high school education, along with some college training. More than likely he is a skilled worker or a self-employed businessman with an annual household income exceeding $30,000. The typical FAD fisherman is thus in the top 35 percentile income bracket for the state of Hawaii as a whole (DPED, 1985). This profile is quite similar across recreational, mixed, and commercial FAD users.

Total years of offshore fishing experience for individuals ranged from 1 to 76 years. FAD users who responded to the survey averaged 12 years in Hawaii waters up to the time of the survey. The group of mixed FAD users averaged 10.7 years, which was statistically different (at the 0.10 significance level) from that of recreational and commercial FAD users who averaged 12.5 and 12.1 years, respectively. Roughly a fifth of all respondents began offshore fishing since the deployment of the large-scale FAD system in 1980. It could not be determined from the survey results whether the existence of FADs was a factor encouraging these individuals to participate in offshore fishing. For example, a simple user turnover rate of 5 percent would give a similar outcome.

The number of years of FAD fishing experience for survey respondents varied (Figure 2). The average for all respondents was 3.6 years. This implies that the typical user participated in offshore fishing for 7.4 years (12 total years of experience minus 3.6 years at FADs) before the buoy system was deployed. A majority (63 percent) of users had been fishing around Hawaii FADs since 1982, but only 11 percent since the initial deployment on an experimental basis in 1977. No statistically significant differences (at the 0.10 level) could be detected in years of FAD fishing experience among the three groups.

The composition of Hawaii's FAD fishing fleet reflects a predominance of relatively small-sized trailerable boats with short fishing ranges. Boats used by respondents to visit FADs ranged from 10 to 62 m in length, but most were in the 18 to 27-m range and the average was 20 m. Approximately 6 percent of the respondents used boats over 27 m in length. Of these larger boats, 68 percent were owned by commercial fishermen.

Most vessels were powered either by inboard gasoline engines (40 percent) or by outboard gasoline engines (45 percent) with a mean horsepower of 151. Recreational fishing boats tended to be equipped with outboard gasoline engines with lower horsepower than those used by commercial fishermen. Commercial fishing boats were more frequently powered by inboard gasoline or diesel engines.

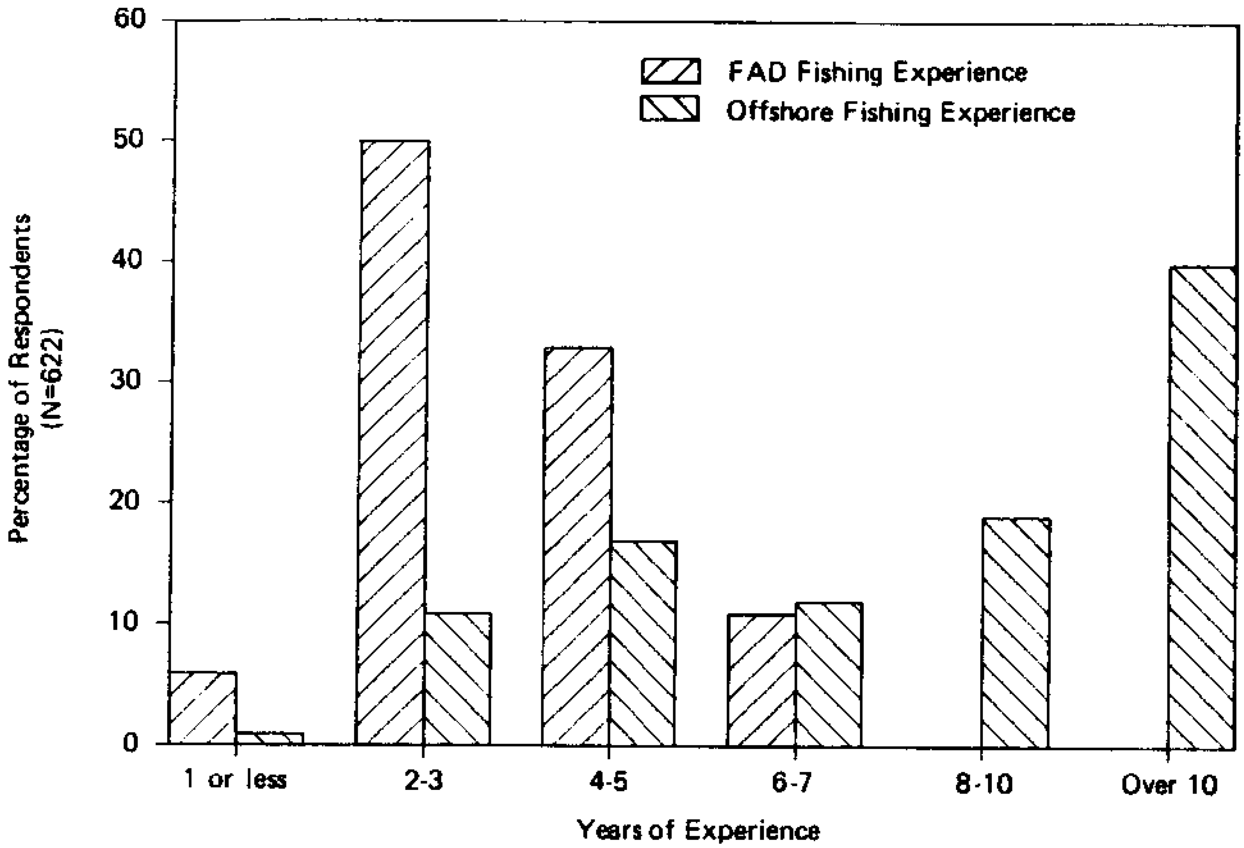


Figure 2. Years of Offshore and FAD Fishing Experience for all Survey Respondents

Overall, vessels were similarly equipped with navigation, communication, and electronic fishing equipment. Almost all FAD fishing boats (94 percent) had a two-way radio and compass. Depth-finders were installed on 57 percent of the boats. Nineteen percent of the respondents indicated that they fished with the aid of electronic fish finders. In terms of sophisticated electronic navigation equipment, only 3 percent of the respondents had Loran and 1 percent utilized radar.

In view of the predominance of relatively small vessels and engines used by FAD fishermen, it was not surprising to find that most respondents confined their offshore fishing excursions to within eyesight of land. There were, however, important exceptions to this general rule. In order to better understand fishermen's willingness to travel offshore to visit FADs, questions were asked about the normal and farthest distance traveled from shore. Although FAD fishermen normally fished at an average distance of 16 km from shore (range was from 1.5 to 967 km), 45 percent of the respondents reported that they normally fished within 8 km from shore. No statistically significant difference (at the 0.10 level) was detected for average distances traveled from shore among the three groups of FAD users. In terms of the farthest distance from shore fished, the range for all respondents was from 2 to 1,129 km, with the average being 45 km. Commercial fishermen tended to venture significantly farther out to sea. On the average, they reported maximum fishing distance traveled from shore of 53 km, as compared with 45 km for recreational and mixed FAD users. Furthermore, only 10 percent of the commercial fishermen indicated that they traveled no farther than 16 km from shore, as compared with 27 percent of the recreational FAD users.

About one out of every four respondents indicated that they had changed their fishing frequency since FADs were deployed in 1980. A few fishermen reported that they were fishing less frequently, but a greater number indicated that they were fishing more (Table 1). A large majority, however, reported that they have not changed their frequency of fishing, perhaps owing to external constraints on available free time. Statistically significant differences (at the 0.10 level) were observed in responses to this question across the three groups under study. The mixed group contained the largest percentage of fishermen who fished more frequently since FADs were installed. Also, compared with recreational fishermen, commercial fishermen reported fishing more frequently.

TABLE 1. EFFECTS OF FADS ON FISHERMEN'S FREQUENCY OF OFFSHORE FISHING TRIPS: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

	% of All Respondents (N=622)	% of Recreational Users (N=278)	% of Mixed Users (N=138)	% of Commercial Users (N=206)
Fishing Less Since FADs Installed	2	2	2	1
Fishing More Since FADs Installed	24	19	32	25
Fishing the Same Since FADs Installed	72	76	64	72
No Response	2	3	2	1
Total	100	100	100	99*

*Deviation from 100% due to rounding error

FAD Visitation Practices

Conceivably, a fisherman could have visited at least one FAD on every fishing trip. However, survey data show that 64 percent of all respondents visited FADs on one-half or less of their offshore trips (Table 2). A "visit" as used here is defined as a period of time, of unspecified duration, spent fishing within 0.8 km of a FAD. Approximately a third of the respondents visited FADs on 20 percent or less of their offshore fishing trips. These fishermen nearly balance in number those who fished around FADs during 51 percent or more of their fishing trips. Only 4 percent of all respondents visited FADs on every fishing trip. No statistically significant differences (at the 0.10 level) were detected in FAD use rates, as a proportion of total fishing trips, across the three groups.

TABLE 2. FREQUENCY OF FISHING TRIPS MADE TO FADS AS A PERCENTAGE OF TOTAL TRIPS

% of Total Trips	% of All Respondents (N=622)
Less Than 10	18
10-20	16
21-30	10
31-40	8
41-50	12
51-60	11
61-70	3
71-80	7
81-90	6
91-99	3
100	4
No Response	2
Total	100

The number of individual FADs visited during 1983-84 was quite large even though fishermen generally do not visit a FAD on every trip. Overall, respondents reported visiting Hawaii's FADs 13,819 times during 1983-84, or an average of 26.4 visits per respondent annually. These figures include visits to a number of different FADs during a single offshore fishing trip. The annual number ranged from 1 to 720 visits for the 523 respondents who provided information on FAD visitation practices (Table 3). The median number was 15 and the mode was 6. Approximately 40 percent of the total sample group reportedly made 10 or less FAD visits during the 12-month period prior to the survey.

TABLE 3. FREQUENCY OF INDIVIDUAL FAD VISITS MADE DURING 1983-84: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

Number of Fad Visits Made	% of All Respondents (N=523)	% of Recreational Users (N=229)	% of Mixed Users (N=123)	% of Commercial Users (N=171)
1-10	39	47	31	34
11-20	23	23	23	23
21-30	14	14	15	14
31-40	6	6	3	7
41-50	6	4	11	5
51-100	9	6	11	11
101-150	1	0	3	2
Over 150	2	0	3	4
Total	100	100	100	100

A statistical analysis was conducted to determine if frequent and infrequent FAD users shared similarities in terms of vessel types and years of fishing experience. Respondents who made 29 or more FAD visits were designated as "heavy" users; those who visited 6 or fewer FADs were classified as "light" users. Heavy and light users each comprised 25 percent of all respondents -- for a total of 50 percent of all respondents. However, heavy users accounted for 67 percent of total FAD visits and light users only 4 percent.

Statistically significant differences (at the 0.10 level) existed between mean boat length and engine horsepower for the two groups. Vessels of heavy FAD users were, on the average, 16 percent longer than those of light FAD users and were powered by 11 percent greater horsepower. Differences also existed in terms of years of fishing experience. Light FAD users tended to have less total offshore fishing experience and less experience fishing at FADs. Heavy users were more likely to have increased their fishing activity because of FADs. Heavy users also visited FADs on a significantly larger proportion of their total trips.

Recreational fishermen had a FAD visitation rate (17.8 times annually) that was significantly lower than averages for the other two groups. The mixed user group averaged the highest FAD use rate (37.1 visits annually), followed by commercial fishermen (31.5 visits annually, on the average). It is suspected that differences in the number of FAD visits made by the three groups simply reflect the fact that commercially oriented fishermen fish more often than recreational fishermen. This supposition is based on the finding, stated above, that fishermen tend to use FADs on a roughly equal proportion of their total fishing trips, regardless of commercial status.

Use of FADs varied among respondents depending on their island of residence. Fishermen residing on Oahu made 60 percent of the total statewide FAD visits, followed by Hawaii-based fishermen with 22 percent. Users on each of the other islands made less than 10 percent of the total number of trips. In large part, this is due to the geographic distribution of the survey sample. Average use per respondent, however, was highest for Maui (31 trips), followed by Oahu (28 trips), Kauai (27 trips), Hawaii (23 trips), Lanai (13 trips), and Molokai (9 trips).

A count was made of the total number of different FADs that surveyed fishermen visited during the 12-month period prior to the survey. Each fisherman visited 2.4 different FADs, on the average. Eighty-five percent visited less than 3 different FADs. Nearly all (99 percent) fished at less than 6 different FADs.

Results of pairwise t-tests support the hypothesis that commercially oriented fishermen visited significantly more FADs than recreational fishermen did. The group of mixed fishermen visited 14 percent more individual FADs than did the group of recreational fishermen, who visited the fewest number. Commercial fishermen also fished at statistically significantly (at the 0.10 level) more FADs than did recreational fishermen, but the difference amounted to only 10 percent. Overall, these results suggest that, compared with recreational fishermen, commercially oriented fishermen tend to be wider ranging in their FAD visitation practices.

The surveyed fishermen were queried concerning the months of the year that their FAD usage was heaviest. The results are summarized in Figure 3. Overall, fishermen visited FADs most frequently during May, June, July, and August. This summer period coincides with the relative increased availability of target pelagic fish. It is also a popular vacation period. The next most important months in terms of heavy FAD usage were November, December, and January. Attraction of fishermen to FADs during this period is probably motivated by high commercial dockside fish prices during the holiday season. Compared with recreational and mixed fishermen, commercial fishermen use FADs throughout the year more regularly. However, commercial fishermen still report periods of peak FAD usage during summer and winter months. This probably reflects the part-time nature of commercial fishing as an occupation in Hawaii.

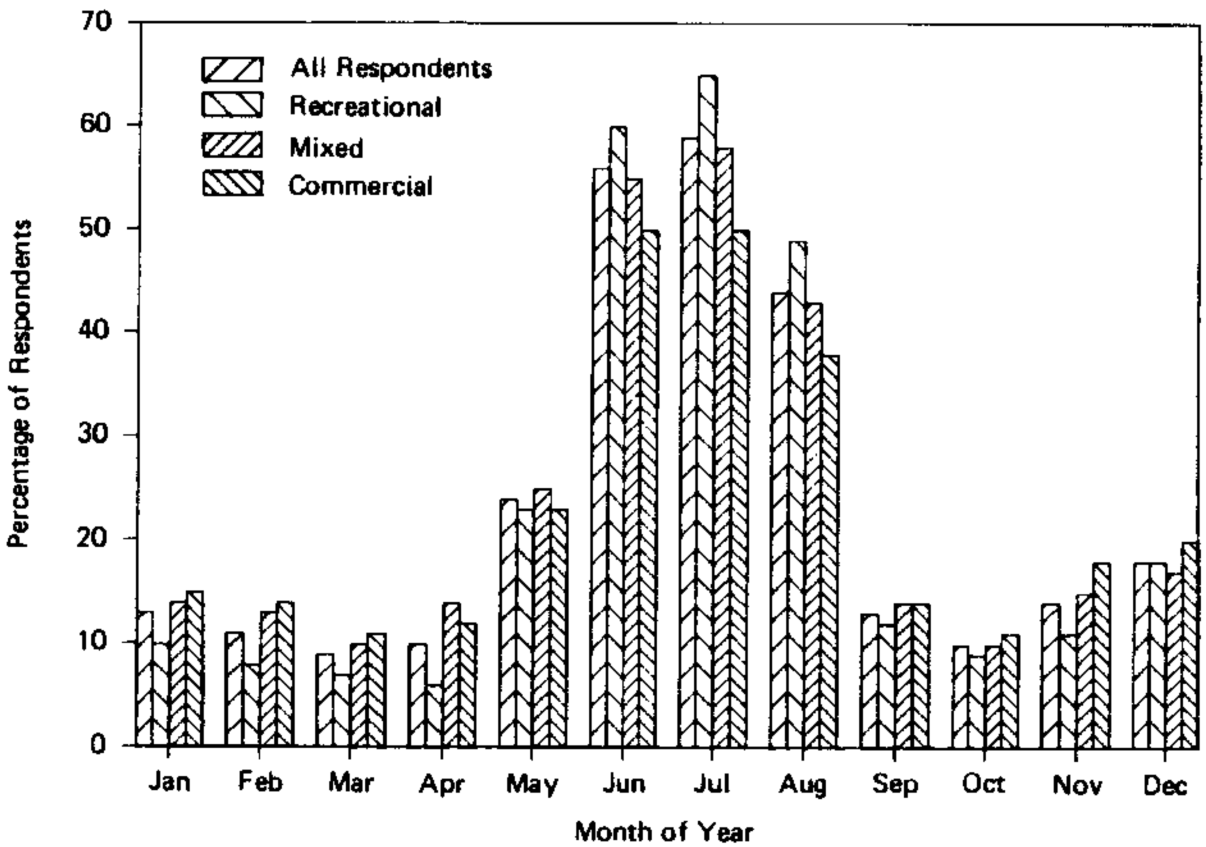


Figure 3. Months of Year Indicated by Respondents as Being Periods of Relatively Frequent FAD Visits

Fishermen's visitation rates for various FADs appeared also to differ. As shown in Table 4, certain FADs seem to attract relatively more fishermen than others. However, this varied according to type of fishermen. A summary of the percentage of total trips made by the three groups to various FADs is also given in Table 4. Overall, the most frequently visited FADs were the R, S, T, U, and V buoys -- all anchored around Oahu. Fishing pressure at these five FADs amounted to 51 percent of all visits reportedly made by the respondents. Other popular FADs were the F, G, and OTEC buoys off the island of Hawaii and the K buoy off the island of Lanai.

TABLE 4. PERCENTAGE OF TOTAL TRIPS TAKEN TO VARIOUS FADS DURING 1983-84: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

County	FAD ID*	% of Total Trips†			
		All Respondents	Recreational Users	Mixed Users	Commercial Users
HAWAII	A	§	§	2	§
	B	3	1	2	6
	OTEC	4	3	4	6
	ZZ	§	1	0	§
	D	§	§	§	1
	E	2	2	2	3
	F	6	4	5	9
	G	5	2	7	7
	H	2	3	3	§
MAUI	I	2	2	0	2
	K	5	3	0	11
	L	§	0	1	1
	M	§	§	0	§
	N	2	§	0	4
	O	§	§	0	2
HONOLULU	P	2	2	2	2
	Q	§	1	0	1
	R	12	20	11	6
	S	11	19	11	5
	T	7	4	12	5
	U	9	6	13	7
	V	12	19	12	6
	W	5	2	6	6
	X	2	3	1	2
KAUAI	Y	§	0	§	0
	Z	2	2	2	3
	AA	2	1	3	1
	BB	3	§	1	5

*See Figure 1 for FAD locations
†Total trips for the sample group during 1983-84 are as follows: all respondents - 13,819 trips; recreational users - 4,080 trips; mixed users - 4,412 trips; and commercial users - 5,327 trips.
§Less than 1 percent

Exact reasons for the high use rates of certain FADs could not be determined from the survey data, but proximity to population centers is undoubtedly relevant. Nearly all (98 percent) FAD visits were made to buoys anchored off the fishermen's island of residence. This explains why FADs anchored off Oahu received the highest overall visitation rates. Maui-based fishermen were the most willing to travel to other islands to fish at FADs; they reportedly made trips to Hawaii and Oahu for this purpose. However, these trips amounted to only 5 percent of all FAD visits made by Maui residents. Other factors that may help explain variances in use rates include: (1) proximity to launch ramps; (2) level of difficulty in locating at sea; (3) prevailing fish catch rates, sizes, and types; and (4) general weather and sea conditions during the summer months when fishing pressure is highest. All other things being equal, FADs which were visited most frequently were located near population centers, were close to launch ramps, were easy to locate by fishermen, and were positioned on the leeward side of islands where generally calm sea conditions prevail during the summer months.

Visitation rates to individual FADs also differed among recreational, mixed, and commercial user groups. This is measured by observed differences in the proportion of total visits made by each group to the various FADs. For example, the B buoy was used more frequently by commercial fishermen relative to recreational users. Six percent of the commercial group's trips were made to the B buoy, as compared with only 1 percent of the recreational group's trips. A somewhat similar situation was evident for trips to the OTEC, F, K, W, and BB buoys. Conversely, the R, S, and V buoys off Oahu were visited relatively more frequently by recreational fishermen as a proportion of their total FAD fishing trips. For example, the R buoy received 20 percent of the recreational fishermen's FAD visits, but only 6 percent of those of the commercial fishermen. The group of mixed fishermen used the T and U buoys off Oahu with relatively greater frequency than either of the other two groups. This is probably linked to the proximity of these two buoys to windward Oahu launch ramps.

Visitation practices were also investigated. The surveyed fishermen were asked when during their most recent offshore fishing trip had they visited a FAD. A practice of many fishermen (64 percent), regardless of commercial fishing orientation, was to visit FADs at the beginning of their fishing trip (Table 5). Twenty-three percent made visits only at the beginning of their trip and 9 percent only at the end. Multiple FAD visits during a single trip were made by 28 percent of the respondents. Survey data showed that 19 percent used FADs at both the beginning and end of their trips. Very few fishermen fish at the beginning, middle, and end of their trips.

TABLE 5. FISHERMEN'S USE OF FADS DURING VARIOUS STAGES OF LAST OFFSHORE FISHING TRIP: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

	% of All Respondents (N=622)	% of Recreational Users (N=278)	% of Mixed Users (N=138)	% of Commercial Users (N=206)
FAD Visited at Start of Last Trip				
Yes	64	58	69	68
No	34	39	31	31
No Response	2	3	0	1
FAD Visited at End of Last Trip				
Yes	34	38	31	29
No	65	59	69	70
No Response	2	3	0	1
FAD Visited Several Times During Last Trip				
Yes	28	24	32	32
No	70	73	68	67
No Response	2	3	0	1

Statistically significant differences (at the 0.10 level) were detected in FAD fishing strategies among groups. Compared with recreational fishermen, commercial and mixed fishermen tended (1) to fish at FADs during the early phases of their trips and (2) to visit FADs several times during the course of a trip. One explanation for this behavior is that commercially oriented fishermen who troll for pelagic fish proceed more directly to FAD locations where live baitfish (small tunas) are found. Visits to FADs during the beginning of a trip could also be a way to reduce the downside risk of a zero-catch trip.

Certain FADs tend to be visited more often during the beginning, middle, or end of users' fishing trips. This appears to be closely related to the proximity of the buoy to ports and boat launch areas and accessibility vis-a-vis other buoys. For example, the S buoy is near the Pokai Bay Small Boat Harbor. It was fished frequently at the beginning and end of trips. In contrast, the V buoy was typically visited at the end of most trips, most probably because it is the farthest buoy routinely fished by boats departing from Pokai Bay. The P buoy, located at a considerable distance from other buoys and ports, was fished during the middle of trips only.

The survey data show that a majority of the respondents visited two or more FADs during their last trip (Table 6). Multiple buoy use was significantly higher (at the 0.10 level) for recreational fishermen than for commercial fishermen. The recreational fishermen's willingness to visit a number of FADs during a trip is understandable in view of the sporting nature of their activity. Commercial fishermen on the other hand, generally have to be more cost conscious. Furthermore, they may have more information about fishing conditions at certain FADs and therefore do not have to spend as much effort visiting several FADs to learn about the types and quantities of fish being caught.

TABLE 6. NUMBER OF FADS VISITED BY FISHERMEN DURING LAST OFFSHORE FISHING TRIP: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

No. of Fads Visited	% of All Respondents (N=622)	% of Recreational Users (N=278)	% of Mixed Users (N=138)	% of Commercial Users (N=206)
1	45	32	50	56
2	40	45	37	35
3	15	20	13	9
4	*	3	0	0
Total	100	100	100	100

*Less than 1%

Certain FADs tended to be visited in sequence more often than others. Included in this group are the OTEC, D, and E buoys off the island of Hawaii; the R, S, T, V, W, and X buoys off Oahu; and the Z buoy off Kauai. It appears that FADs located close to one another tended to be fished in sequence. Also, FADs which are situated between a port and a popular non-FAD offshore fishing area tended to be visited in conjunction with other similarly placed devices.

On the average, respondents spent about 2.5 hours fishing in proximity to FADs during their most recent fishing trip that involved a FAD visit. This time represented about a third of the 8 hours reportedly spent for their entire fishing trip (Table 7). The range of time spent at FADs was from 0.20 to 12 hours. A series of pairwise t-tests were constructed to test for differences in the average FAD fishing times for the three groups under study. The results support the hypothesis that recreational fishermen spend relatively less time fishing around FADs compared with commercially oriented fishermen. No statistically significant difference (at the 0.10 level) could be found in average fishing time for mixed and commercial FAD users.

TABLE 7. TIME SPENT ON MOST RECENT FISHING TRIP IN TOTAL AND WHILE FISHING IN PROXIMITY TO FADS: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

	All Respondents (N=591)	Recreational Users (N=261)	Mixed Users (N=132)	Commercial Users (N=198)
Total Hours Spent on Most Recent Fishing Trip*	8.01 (17.17)†	6.20 (5.22)	7.80 (7.00)	10.55 (28.34)
Hours Spent Fishing Near FADs on Most Recent Fishing Trip	2.49 (2.06)	2.22 (1.66)	2.60 (2.33)	2.77 (2.31)
Ratio of Total Fishing Time to FAD Fishing Time	0.31	0.36	0.33	0.26

*Includes transit time to and from fishing areas
†Values in parentheses are sample standard errors

Information was also obtained about the type of fishing techniques employed during the most recent FAD fishing trip taken by respondents. Nearly all (95 percent) of the respondents reported that they trolled. Twenty-six percent engaged in drift fishing or handlining, and 13 percent cast jigs or live bait near FADs. Fifty-two percent of all the fishermen surveyed used only one method; the rest indicated that they used a combination of methods such as trolling and handlining. Seventeen percent said they used three fishing methods. Fishing techniques used by the three groups differed significantly at the 0.10 level. Commercial and mixed fishermen were less inclined to troll relative to recreational fishermen; they more commonly used handline techniques.

User Attitudes and Motives

The survey provided an opportunity to better understand fishermen's attitudes about Hawaii's FAD system and about their motives for visiting FADs. In addition, it was anticipated that insights about the social value of FADs could be ascertained from a broader understanding of users' attitudes and motives. Toward this end, fishermen were first asked to compare the quality of fishing in proximity to FADs with the quality of offshore fishing away from FADs. Respondents were exposed to six different quality indicators and asked to rank each on a three-point scale: "quality better at FADs," "no difference in quality," and "quality worse at FADs." The exact wording of the question can be found in the "Appendix."

A clear majority (70 percent) of the respondents reported that overall fishing fun was of higher quality when fishing near FADs (Table 8). This is probably related to the fact that an almost equal percentage of fishermen thought that fish catch was higher while fishing around FADs. Only 3 percent felt that FAD fishing was inferior to non-FAD fishing in terms of overall fishing fun and number of fish caught. In terms of size and types of fish caught, many respondents believed that FAD fishing either offered no difference in quality or was inferior. The only factor that most respondents reported as being worse was crowding. Seventeen percent of all respondents also indicated that the distance they traveled for fishing was worse for FAD trips.

TABLE 8. FISHERMEN'S ATTITUDES ABOUT THE QUALITY OF FISHING NEAR FADS AS COMPARED WITH OFFSHORE FISHING AWAY FROM FADS

Quality Factor	% of All Respondents (N=622)				
	Better At Fads	No Difference	Worse At Fads	No Response	Total
Overall Fishing Fun	70	23	3	5	101*
Number of Fish Caught	69	23	3	5	100
Size of Fish Caught	31	54	7	8	100
Types of Fish Caught	49	39	4	8	100
Crowding	15	18	60	6	99*
Distance Traveled Before Fishing	41	34	17	8	100

*Deviation from 100% due to rounding error

In general, no statistically significant differences (at the 0.10 level) were observed in responses to these attitudinal questions for the three groups, except for the distance factor. Significantly more commercial and mixed fishermen rated the quality factor, "distance traveled before fishing," as being better at FADs. This appears to be consistent with the finding that commercially oriented fishermen tended to visit FADs at the beginning of their trips. They also tended to spend less time traveling between FADs during the course of a fishing trip.

Respondents were further asked to indicate whether they agreed, disagreed, or had no opinion about a series of five general statements concerning FAD locations, numbers, and productivity. The results, summarized in Table 9, indicate that 35 percent of the respondents felt that FADs are located too far from shore, whereas 15 percent believed that FADs are too close. Presumably, the remaining respondents, amounting to a simple majority, are satisfied with FAD locations. Response to the crowding question verified that a large majority felt that FADs are getting more crowded. The crowding problem could likely explain why 9 out of 10 fishermen agreed that more FADs are needed.

TABLE 9. FISHERMEN'S ATTITUDES ABOUT FAD LOCATIONS, NUMBERS, AND PRODUCTIVITY

Statement	All Respondents (N=622)				
	% Agree	% Disagree	% No Opinion	% Blank	Total
FADs Are Too Far From Shore	35	47	15	3	100
FADs Are Getting Crowded	78	11	9	2	100
FADs Have Made My Fishing More Productive	58	16	23	2	99*
FADs Are Too Close to Shore	15	61	20	4	100
More FADs Are Needed	87	4	8	2	101*

*Deviation from 100% due to rounding error

A series of statistical tests were conducted to measure whether the three groups shared similar attitudes about FAD locations, numbers, and productivity (Table 10). The results suggest that statistically significant differences (at the 0.10 level) exist in attitudes about crowding and FAD locations. Commercially oriented fishermen, as compared with recreational fishermen, generally felt that FADs are placed too close to shore. Furthermore, commercial and mixed fishermen appeared to

TABLE 10. STATISTICAL TESTS OF RELATIONSHIP BETWEEN COMMERCIAL ORIENTATION OF FAD USERS AND THEIR ATTITUDES ABOUT FAD LOCATIONS, NUMBERS, AND PRODUCTIVITY

Statement	Recreational Users			Mixed Users			Commercial Users			Calculated Chi-Square Statistic
	% Agree	% Disagree	% No Opinion	% Agree	% Disagree	% No Opinion	% Agree	% Disagree	% No Opinion	
Most FADs Are Too Far From Shore	40	41	19	33	54	13	33	54	12	11.2*
FADs Are Getting More Crowded	75	14	11	84	9	7	85	9	6	7.3*
FADs Have Made My Fishing More Productive	56	18	26	56	20	24	65	13	22	5.6
Most FADs Are Too Close To Shore	9	69	22	16	64	20	23	56	21	18.4*
More FADs Are Needed	91	3	6	87	4	9	86	5	9	2.8

*Significant at 0.1 level

be more concerned about the increased crowding problem at FAD locations.

Fishermen's reasons for using FADs were studied by determining their motives for making their last FAD visit. Overall, a majority were motivated by the improved chances of catching fish and other catch-related factors such as past fishing success at FADs (Table 11). Ease of locating a good fishing spot motivated

TABLE 11. FACTORS MOTIVATING FISHERMEN TO VISIT A FAD DURING LAST FISHING TRIP: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

Motivating Factor	% of Respondents Indicating Motivating Factor Was Important			
	All Respondents (N=622)	Recreational Users (N=278)	Mixed Users (N=138)	Commercial Users (N=206)
Better Chance to Catch Fish	65	63	74	62
Easy to Locate	31	31	33	29
Reports of Good Fishing	51	50	54	51
Past Experience at FADs	54	46	59	62
Save on Costs	16	9	21	23
Opportunity to Fish by Other Boats	3	3	2	2

roughly a third of the respondents, regardless of their commercial orientation. In general, respondents from all groups rated each motivating factor similarly. However, statistically significant differences (at the 0.10 level) were observed between commercial and noncommercial fishermen regarding cost-savings motives. Apparently, recreational FAD users deemed cost-savings potential less important than commercial users did.

Fishermen's attitudes about the impact of FADs on fishing costs were explored in a series of questions where respondents compared the cost of fishing in proximity to FADs vis-a-vis fishing away from FADs. The surveyed fishermen were asked to consider costs for fuel, oil, fishing gear, ice, and bait. They generally felt that costs associated with fishing gear replacement, ice, and bait were not affected by FAD use (Table 12). Those who reported these costs as being reduced were counterbalanced by others who thought the costs were increased. Less consensus existed with regard to fuel cost. Overall, more respondents felt that their fuel costs were reduced, but 36 percent indicated no change. Statistically different (at the 0.10 level) responses to the fuel and bait cost questions were provided by commercial, mixed, and recreational fishermen (Table 13). Relatively more commercial and mixed fishermen tended to think that FADs usage had decreased fuel costs compared with recreational fishermen. This difference in outlook may be directly related to the tendency of recreational fishermen to

TABLE 12. FISHERMEN'S ATTITUDES ABOUT THE EFFECT OF FADS ON FISHING COSTS PER TRIP

Trip Cost Item	All Respondents (N=622)				Total
	% Increased	% No Change	% Decreased	% No Response	
Fuel	18	36	43	4	101*
Oil	12	48	34	7	101*
Fishing Gear	6	75	13	6	100
Ice	9	73	12	6	100
Bait	14	63	17	7	101*

*Deviation from 100% due to rounding error

TABLE 13. STATISTICAL TESTS OF RELATIONSHIP BETWEEN COMMERCIAL ORIENTATION OF FAD USERS AND THEIR ATTITUDES ABOUT THE EFFECTS OF FADS ON FISHING COSTS PER TRIP

Trip Cost Item	Recreational Users			Mixed Users			Commercial Users			Calculated Chi-Square Statistic
	% Increased	% No Change	% Decreased	% Increased	% No Change	% Decreased	% Increased	% No Change	% Decreased	
Fuel	21	41	38	19	33	48	15	36	49	7.6*
Oil	14	53	33	12	47	41	11	52	37	3.9
Fishing Gear	6	80	14	8	77	15	7	80	13	0.9
Ice	9	81	10	11	73	16	10	76	14	3.1
Bait	14	73	13	14	65	21	16	61	23	8.6*

*Significant at 0.10 level

utilize more fuel while visiting several adjacent buoys. In regard to bait cost savings, relatively more commercial and mixed fishermen indicated that FAD usage had led to a cost reduction compared with recreational fishermen. One explanation is that commercial fishermen are more likely to visit FADs to catch small tuna for use as trolling bait; recreational fishermen tend to use artificial lures. Alternatively, perceived bait savings by commercially oriented FAD users may simply reflect greater cost consciousness.

Attitudes and motives of heavy and light FAD users were also significantly different (at the 0.10 level). A greater proportion of heavy FAD users believed that (1) the size of fish caught at FADs was better than that of fish caught away from FADs; (2) the type of fish caught was better at FADs; (3) fishing fun was better at FADs; (4) fuel, oil, and bait costs were reduced by fishing at FADs; and (5) FADs had made fishing more productive. On the other hand, relatively more light FAD users believed that (1) FADs had made fishing more crowded; (2) fishing around FADs had increased their traveling distances; and (3) FADs were located too far from shore.

CATCH AT FISH AGGREGATION DEVICES

Fishermen were queried concerning the type and amount of fish caught at FAD locations during (1) their most recent fishing trip that involved a FAD visit and (2) the previous 12-month period (approximately July 1983 through July 1984). Both lines of questioning had advantages and disadvantages. An advantage of collecting data about FAD catches during the most recent fishing trip was that, for 30 percent of the respondents, the most recent FAD visit predated the receipt of the questionnaire by 1 month or less. Memory recall errors for these individuals would expectedly be minimal. Seventy-one percent of the total survey group had taken their most recent trip within 6 months prior to the survey.

A disadvantage of this approach was that the surveyed fishermen's catches during their most recent trip were probably not typical of trips over the course of the remaining months of the year. This is because of the relatively high frequency (83 percent) of last trips taken during the 6-month period between March and August. Time series data compiled by NMFS (1983) indicate that the commercial catch of pelagic fish species in Hawaiian waters exhibits marked seasonality, with peak catches occurring between March and August. It is suspected that this variation reflects seasonal changes in species relative abundance. The difference in the monthly commercial catch for various fish types during March through August, as compared with an annual average, is as follows: marlin -- 8 percent higher, mahimahi (Coryphaena hippurus) -- 21 percent higher, ono (Acanthocybium solanderi) -- 27 percent higher, and tuna -- 35 percent higher. Requesting annual FAD catch data was a means of avoiding this seasonality problem, but it raised the question of data integrity due to memory recall errors. Recall errors may have been minimal, however, because many respondents had access to catch records. Commercial fishermen are required by law to submit catch records, including information about whether fish were caught in proximity to FADs. It is also reported that many recreational fishermen (up to 40 percent) maintain records on catches and fishing locations (SMS Research, 1983).

Data on catches around FADs during the most recent fishing trip revealed that at least one fish was caught by 62 percent of the respondents. No significant differences (at the 0.10 level) could be found among groups in regard to the relative percentage of successful versus zero-catch trips. The number of fish caught ranged from 0 to 231; the median was 2. Seventy-five percent of all respondents reported catching 10 fish or less. In total, 5,513 fish were reportedly caught, implying an average catch rate of 9.1 fish per fisherman. The average catch rate for fishermen who reported fish catch was 14.9. No significant difference (at the 0.10 level) in average fish catch was observed between fishermen who made multiple FAD visits and those who visited a FAD only once during their most recent offshore fishing trip. In terms of species composition, the breakdown of the respondents catching various types of fish was as follows: tuna -- 54 percent, mahimahi -- 18 percent, ono -- 9 percent, and marlin -- 5 percent. The overall catch rate averaged 5.6 fish per hour, but this rate was highly variable, ranging from 0 to 125. No statistically significant differences (at the 0.10 level) were detected in the fish catch rates across groups.

The number and type of fish caught during the previous 12-month period were also reported. For 85 percent of the respondents this included the period from July 1983 through July 1984. The total number of fish caught near FADs by 444 respondents who reported annual catch data was approximately 52,000.

Fishermen caught, on the average, a total of 117 fish (Table 14), or about 4.4 fish per visit (assuming 26.4 FAD visits annually). This estimate of catch per FAD trip is roughly half of the 9.1 average calculated for the surveyed fishermen's most recent trip. This could be due to underreporting or because catch rates averaged over an entire year are less than those experienced by fishermen during the spring and summer months.

TABLE 14. AVERAGE NUMBER OF VARIOUS TYPES OF FISH REPORTEDLY CAUGHT BY SURVEY RESPONDENTS NEAR FADS DURING PREVIOUS 12 MONTHS: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

Fish Type	Average No. Caught By Survey Respondents			
	All Respondents (N=444)	Recreational Users (N=194)	Mixed Users (N=108)	Commercial Users (N=142)
Aku	79	34	86	134
Ahi*	21	8	18	42
Mahimahi	8	5	9	11
Bottomfish*	4	5	6	2
Ono	3	2	3	3
Marlin*	1	†	1	2
Shark*	1	†	†	2
Barracuda	†	†	†	†
Total	117	54	123	196

*Catch data not available on individual species
†Less than 1 fish

Nevertheless, the annual catch rate estimate compares closely with troller catch rates for the period from June 1977 to July 1979 reported by Matsumoto et al. (1981). According to their study, trolling boats based out of Kewalo Basin, Oahu recorded 606 FAD visits and 2,087 fish caught, for an overall average of 3.44 fish per visit. During 1978, the average catch rate reached 4.44 fish per visit.

Statistical relationships between annual FAD catch and catch per trip were evaluated within the context of linear regression models. No statistically significant (at the 0.10 level) relationships could be detected between total fish catch and (1) years of FAD fishing experience, (2) years of overall offshore fishing experience, (3) boat length, (4) boat horsepower, or (5) percentage of total trips that included a FAD visit. These five variables also did little to explain fish catch per FAD visit.

Statistically significant (at the 0.10 level) relationships were detected between commercial orientation of respondents and quantity of fish caught near FADs. Based on linear regression results, pairwise comparisons between average catches for the three groups were made. The average total number of fish caught by commercial fishermen was significantly different (at the 0.10 level) from the average caught by mixed and recreational FAD users. Commercial fishermen reported catching 363 percent more fish, on the average, than recreational fishermen did. A significant share of this difference stems from dissimilar volumes of tuna catches. Results of pairwise t-tests also supported the hypothesis that mixed fishermen caught more fish than recreational fishermen did. The difference in average catches between these two groups amounted to 218 percent of the lower value.

Overall, pelagic fish dominated FAD catches and accounted for 97 percent of the total. Of these, aku and ahi catches amounted to 68 percent and 18 percent, respectively. Bottomfish catches represented only 3 percent. The relative importance of various fish types as a percentage of total annual FAD catch did not vary significantly among groups. This is probably due to the high proportion of trollers in all three groups.

The species composition of catch differed, however, from the 1977-79 FAD catch composition of Kewalo Basin trollers (Matsumoto et al., 1981). Trollers fished at three prototype FADs located off Penguin Bank between Oahu and Molokai. Mahimahi, aku, and ahi represented 86 percent of their catch, with the former contributing 37 percent to the total. Furthermore, kawakawa (*Euthynnus affinis*) was caught with considerably more frequency (9 percent of catch), as compared with the current survey sample. Catch composition differences between the current sample and the Kewalo Basin trollers 5 to 7 years earlier could be due to many factors, including location of FADs and oceanographic phenomena. However, the relative decline in catch rates for high-valued mahimahi and ahi, and the relative increase in catches of low-valued aku, may reflect the outcome of increased aggregate fishing pressure at FAD locations.

The proportion of landed fish entering commercial channels is documented in Table 15. On the average, respondents reportedly sold 9.5 percent of the fish caught near FADs over a 12-month period. The average proportion sold was highest for mahimahi and lowest for shark. With the exception of marlin sales, no significant difference (at the 0.10 level) existed between the proportion of various fish sold by mixed and commercial fishermen.

TABLE 15. AVERAGE PERCENTAGE OF REPORTEDLY SOLD FISH CAUGHT NEAR FADS DURING PREVIOUS 12 MONTHS: BY COMMERCIAL ORIENTATION OF SURVEY RESPONDENTS

Fish Type	Average % Sold By Survey Respondents			
	All Respondents	Recreational Users*	Mixed Users	Commercial Users
Aku	8.5	0	16.3	14.7
Ahi†	12.9	0	20.6	25.2
Mahimahi	15.8	0	27.1	29.8
Bottomfish†	0.6	0	1.4	0.9
Ono	10.6	0	20.2	18.3
Marlin†	11.0	0	14.3	23.6
Shark†	0.6	0	0	1.9
Barracuda†	0.8	0	1.4	1.4

*By definition, recreational anglers do not report any fish sold
†Catch data not available on individual species

VALUE OF FISH AGGREGATION DEVICES TO USERS AND COMPARISON WITH PROGRAM COSTS

FADs have been deployed in Hawaii's waters at the taxpayers' expense for the benefit of commercial and recreational fishermen. Although the social costs of the FAD program are fairly easy to identify and measure, understanding social benefits is not so straightforward. In part this is due to the wide diversity of types and interests of fishermen who use FADs. The range extends from recreational fishermen who use FADs sporadically for sheer enjoyment to commercial pole-and-line tuna fishermen who routinely visit FADs for pure profit motives. Understanding the value of Hawaii's FAD program is further complicated by the fact that users, regardless of their characteristics and motives, are not obligated to reveal how much they personally benefit from having access to FADs. Moreover, fishermen in Hawaii, regardless of commercial orientation, do not pay an admission price or license fee to use FADs.

Concept of Value and Estimation Approaches

Fishermen do not directly pay for access to FADs. Nevertheless, they realize value from use of the devices. In a fishery with recreational and commercial participants, the social value of a FAD system arises from three general sources: (1) value stemming from increased fish catch, (2) value resulting from creation of operating cost-savings, and (3) value stemming from enhanced recreational fishing opportunities.

FADs are deployed to attract fish to be harvested by fishermen. The link, therefore, between aggregate fish catch and the social worth of a FAD system is close. It is also complex. One value stems from fishermen landing more fish than previously for a given outlay of effort. Value is also derived if fishermen are able to decrease their total costs of landing a specified quantity of fish. Whichever is the case, it is clear that if the total quantity of fish caught at FAD locations is relatively small, then the value of FADs to recreational and commercial users is probably correspondingly insignificant. Conversely, if catches near FADs are large, the social value of FADs could be sizable.

The quantity of fish caught in proximity to FADs also provides a measure of fishing intensity occurring at the devices, at least in the early expansion stages of a FAD fishery. Significant fish catches indicate high public demand for FADs. Strong preference for fishing near FADs, as evidenced by large catches, could be the result of an influx of new participants, increased fishing pressure by incumbent fishermen, or a general redirection of fishing effort toward FAD locations.

It is important to qualify these remarks, however, by noting that the quantity of fish harvested at FADs is at best an imperfect indicator of social worth. This is in part because aggregate catches do not reflect the marginal value, or price, that society assigns to fish harvests. If, for example, the fish caught near FADs are relatively low-priced either because of size or type, large harvest quantities may have little social value. A second qualification is that data on quantity of fish harvested do not account for opportunity costs associated with FAD fishing, particularly harvesting costs and displaced fishing activities. Harvesting cost considerations are of greatest importance in commercial FAD fisheries where the social value of fish harvested is properly measured by the contribution to the fishermen's profits, and not simply by the contribution to gross earnings. In other words, if commercial fishermen catch $100 worth of fish at FADs and the cost of harvesting the fish equals $90, then the social value of the harvest is only $10, and not the gross amount of $100. Opportunity costs associated with displaced fishing activities must also be taken into consideration if fishermen are redirecting effort from traditional fishing areas toward FADs. If so, significant FAD catches would generate relatively little social value if the fish would have been caught anyway, albeit at perhaps a slightly higher cost.

Cost savings are another type of value potentially realized by both commercially oriented and recreational fishermen. This value arises when fishermen are able to reduce the amount of inputs needed to produce either a given fish catch or a given level of fishing satisfaction. The potential for realizing fuel, oil, ice, and bait cost savings was a factor used to justify Hawaii's FAD program. However, based on survey response, it appears that cost savings are minimal for many fishermen owing to their fuel-intensive FAD fishing strategies.

A third way that FAD emplacement generates social value is by enhancing recreational fishing opportunities. Enhancement can be accomplished by altering the quality or quantity of recreational fishing experiences. FADs can augment the quality of recreational fishing trips by positively affecting catch rates of preferred species and reducing the chances of zero-catch trips. All other things being equal, an increase in the quality of offshore fishing translates directly into a positive social value associated with FADs. In addition to changes in quality, there is also a quantity dimension of fisheries enhancement. FAD emplacement may enable fishermen to take trips with greater frequency than previously. Reductions in average travel distance could be a contributing factor in this regard. New entrants may also be encouraged to begin offshore fishing for the first time for similar reasons. Increases in the quantity of trips taken by recreational fishermen imply positive values associated with FAD emplacement, even under circumstances when fishing quality remains unchanged.

There is a wide gulf between value identification and value estimation. Faced with the need to examine social tradeoffs in resource use, economists over the last two decades have developed techniques for indirectly measuring social values of unpriced public investments. A useful summary of conceptual and empirical work in this area can be found in Freeman (1979) and Sinden and Worrell (1979). A class of commonly used valuation techniques involves directly asking people how much they would be willing to pay to be able to have access to a resource at given prices and income, rather than do without it altogether. The logic of the "willingness to pay" criterion, as it is called, is that people would be equally satisfied with paying a cash amount and having access to a resource versus not having the resource at all. Recreational fishermen would be expected to pay no more than the monetary value they assign to the additional satisfaction received as a result of fishing near FADs. Commercial FAD users would be willing to pay an amount up to the extra profits stemming from their FAD fishing activities. Therefore, the value of the resource (or public fisheries enhancement project) equals what people in aggregate would be willing and able to pay to keep the resource (or project) available for use. Presumably willingness to pay includes all values, regardless of source, that accrue to those who utilize the resource in the first place.

In the specific case of Hawaii's FAD program, users would expectedly be willing to pay some positive amount to keep the buoys in the water, provided that user benefits are being realized. Individuals who receive large cost savings, along with catch and satisfaction benefits, would be willing to pay larger amounts than those who benefit only marginally from FADs. In this vein, the following open-ended question was posed to all surveyed fishermen: "If donations were needed to keep the buoys around, what is the most you would be willing to donate each year to keep the buoys around?" A total of 451 respondents (73 percent) stated a willingness to donate between $1 and $360 annually (Table 16). The average for the sample, including zero donation amounts, was $29. The median was $15. The 95 percent confidence interval around the sample mean donation amount was $23 to $31.

TABLE 16. FISHERMEN'S WILLINGNESS TO DONATE MONEY TO CONTINUE FAD PROGRAM ON AN ANNUAL BASIS*

Annual Payment Amount ($)	% of All Respondents (N=622)
0	27
1 - 5	12
6 - 10	17
11 - 20	11
21 - 30	12
31 - 50	12
51 - 100	7
Over 100	2
Total	100

*Exact wording of question was: "If donations were needed to keep the buoys around, what is the most you would be willing to donate each year to keep the buoys around?"

A statistical analysis was conducted to determine if donation amounts were related to annual number of trips taken, annual FAD fish catch, commercial status of respondent, income level, and experience. A simple linear regression model was estimated using ordinary least squares to simultaneously test the effects of each of these variables on annual donations. With the exception of commercial status, all explanatory variables were statistically insignificant at the 0.10 level. Pairwise t-tests were used to determine if statistically significant differences existed between mean donation amounts for recreational, mixed, and commercial FAD user groups. Amounts for commercial and mixed fishermen, which averaged $33 and $38, respectively, were not significantly different (at the 0.10 level). However, both were significantly higher than the recreational fishermen's average amount of $21. This difference was expected because commercially oriented fishermen probably benefit more from FAD usage as a result of additional profits stemming from fish sales.

Fishermen were also asked whether they would be willing to pay a specified dollar amount in order to keep the FADs around for a year. Each was randomly assigned a specified dollar amount and asked to simply indicate "yes" or "no" regarding his/her willingness to donate the amount, which ranged from $1 to $2,200. The percentage of the respondents indicating a willingness to donate specified dollar amounts is given in Table 17. These data were used for valuation purposes in two ways within the context of the logit valuation model discussed above. First, the data were used to estimate the average amount that respondents would donate to keep FADs around for a year. The amount estimated was $89. The second way the data were used was to estimate the amount that a simple majority of the respondents would be willing to donate to keep FADs around for a year. The amount estimated was $57.

In this study, three different point estimates of annual FAD user values were obtained. Several explanations can be offered for the fact that they differ from one another by as much as 330 percent. First, the estimates were generated from different questioning approaches, including an open-ended valuation question and a dichotomous choice ("yes" or "no") question. Second, wording differed between questions. For example, in the open-ended question fishermen were asked to state a donation amount they would be willing to pay each year to keep FADs on station. The dichotomous choice question concerned a one-time-only donation that would keep FADs around for 1 year. Third, different statistical estimation procedures were employed.

Despite these procedural differences, the estimates are well within the same order of magnitude. If the average of the three estimated values ($29, $89, and $57) were used to indicate the annual value of FADs to the typical user, then the aggregate user value for a population of 3,170 vessel oweners would be $184,906 ($58.33 x 3,170). This is likely a lower-bound estimate of the "true" annual social value of FADs for two important but unrelated reasons. First, the willingness to pay measure has been shown to underestimate the user values which would arise in countinized market transactions (see, for example, Bishop and Heberlein, 1979). Fishermen may understate actual willingness to

TABLE 17. FISHERMEN'S WILLINGNESS TO DONATE VARIOUS SPECIFIED DOLLAR AMOUNTS TO CONTINUE FAD PROGRAM FOR ANOTHER YEAR*

Specified Payment Amount ($)	% of Sample Cell Indicating Amount Is Agreeable
1	85
10	72
35	38
70	42
150	13
310	8
550	5
850	8
1,600	2
2,200	2

*The exact wording of the question was: "The buoy program costs money each year to keep going. If you were asked to make a cash donation of $________ to keep the buoys around for another year, would you make the donation?"
On the average, sample cells included 60 fishermen.

pay for a number of reasons, including (1) fear of being coerced into actually having to pay large amounts for FAD access, (2) opposition to having to pay anything at all for a public fisheries enhancement project, (3) lack of familiarity with having to pay for public investment projects, and (4) apprehension about motives underlying the valuation process. It is expected that these incentives overwhelm other incentives that may also exist to overstate actual willingness to pay. For example, if fishermen believe they can influence FAD deployment policies, then they may strategically overstate their willingness to pay for FADs simply to ensure continuity of the program. This outcome is more likely to occur if they do not expect to be obligated to pay the stated dollar amount.

A second reason why the calculated value of $184,906 is probably a lower-bound estimate is because the values of at least two important groups of FAD users are not accounted for in the analysis. One excluded FAD user group is the passengers who fish alongside the 3,170 boat owners. According to survey data, the typical boat owner had 2.6 passengers on board during his most recent offshore fishing trip that involved a FAD visit. Presumably, these passengers, amounting to perhaps as many as 8,242 (2.6 x 3,170) individuals, are willing to pay some positive amount each year to keep Hawaii's FADs on station. If so, the total willingness to pay figure calculated above is clearly an underestimate of the user values accruing to both owners and passengers.

A second group of FAD users -- pole-and-line tuna boat owners -- was also not included in the sample. An evaluation of the impact of FAD installation on profitability of Hawaii's commercial pole-and-line tuna fleet was recently completed by Sproul (1984). Personal interviews were conducted with skippers and owners of 7 of the 12 aku boats which comprised the fleet in 1983-84. The interviews were aimed at determining how FAD installation had affected annual vessel profitability via changes in total catches, fuel use, baitfish requirements, and other operating costs. Sproul found that FAD usage had generated additional annual catch revenues (net of crew shares and additional ice costs) which amounted to $3,351 per boat, on the average. Fuel cost savings added an additional $2,502 to average profits. Bait savings were determined to be inconsequential. Therefore, on the average, vessel profitability increased by $5,853 per year as a result of FAD utilization. This increase is equivalent to approximately 3 percent of the annual profits realized by a typical Hawaii pole-and-line tuna boat. By multiplying the estimated average increase in profit ($5,853) by 12 boats, Sproul arrived at an estimate of total fleet benefits of $70,236. These extra user benefits would significantly inflate the extrapolated aggregate willingness to pay estimate of $184,906.

FAD Program Costs

Costs to install a system of FADs in Hawaii waters by the state were first incurred in 1978, during the initial planning and engineering phases of the project. Actual deployment of the full-scale FAD system did not begin until April 1980. Between early 1978 and August 1984, an estimated $796,000 was spent on the FAD program (Table 18). If April 1980 is taken as the project beginning date, annual project costs have therefore averaged $182,000 up until August 1984. Program costs have been paid from state and federal funding sources, with the state's total contribution amounting to roughly a third. A few in-kind contributions to the program by the private sector have also been made, but are not included in program cost calculations. These include expenses incurred by fishermen to tow drifting buoys and to assist in buoy deployment. Also not included is at least 1

TABLE 18. BREAKDOWN OF HAWAII'S FAD PROJECT COSTS FOR THE PERIOD FROM JANUARY 1, 1978 TO AUGUST 30, 1984*

Item	Estimated Project Cost ($)	% of Project Cost	Estimated Average Annual Cost Per Buoy on Station† ($)
Fixed Costs			
Planning and Engineering	10,000	1	100
Buoy Design	28,000	4	280
Salary and Overhead	264,000	33	2640
Total Fixed Costs	302,000	38	3,020
Variable Costs			
Buoy Construction and Moorage Components	322,000	40	3,220
Deployment	94,000	12	940
Maintenance	78,000	10	780
Total Variable Costs	494,000	62	4,940
Total	796,000	100	7,960

Note: Data assembled from project accounting records maintained by the Division of Aquatic Resources, Hawaii Department of Land and Natural Resources

*Data were collected on total project costs incurred through August 30, 1984, and not on the distribution of costs through time. Hence, costs could not be adjusted to account for inflation that occurred during the reporting period. In view of historic inflationary trends, the costs reported here are therefore understated in terms of the purchasing power of 1984 dollars.

†Represents the average annual cost of keeping a buoy continuously on station (assumes a 20-buoy system continuously on station for 5 years)

day of U.S. Navy shiptime to deploy the OTEC buoy (platform) off Keahole Point, Hawaii.

A substantial portion (38 percent) of estimated total project costs is associated with project overhead, buoy design, planning, and engineering. Although these fixed costs do not generally vary with the number of buoys deployed, they nevertheless should be considered in a benefit-cost analysis framework. Between April 1980 and August 1984, 108 buoys have been deployed. Included in this figure are replacements for lost FADs and the gradual redeployment of three generations of different buoy types. The FADs themselves, along with the necessary mooring line and hardware, cost $322,000 in total. Deployment and maintenance by chartered boats have added another $170,000 toward total program costs. The average total cost per buoy deployed is $7,370 ($796,000/108). Of this amount, average construction and deployment costs amount to $4,160. Variance of procurement and deployment costs for specific FADs around this average is primarily associated with differences in mooring depth and buoy design characteristics.

Compared with other FAD systems in place in the southwestern Pacific, Hawaii's FADs are slightly above average in terms of construction and moorage costs. Shomura and Matsumoto (1982) estimated the average cost per FAD and mooring to be $2,418 for their sample, which included 11 islands and 11 different FAD designs. At $3,220 in construction costs for each, Hawaii's FAD costs are 33 percent higher than average for the region. In large part this is due to average deployment depths being greater in Hawaii, with a consequent increase in mooring costs. Greater labor and deployment costs are other factors.

FAD system costs can be better understood by considering the average annual cost of keeping a buoy on station. Included in this measure are administrative overhead costs as well as construction, deployment, maintenance, and replacement costs. The cost of maintaining a buoy on station does not equal the average cost of a buoy (including required mooring materials) because buoy losses must be taken into account. The average lifespan of a FAD is reported to be approximately 9 months (DAR, 1983). Hence, on the average, 1.3 buoys must be deployed in a typical year to keep a FAD continuously on station. During the past 5 years, attempts were made to maintain 26 buoys continuously on station. However, long lapses between replacements of lost buoys have significantly reduced the average number of buoys on station at any given time. Inspection of FAD installation and replacement schedules, as reported by DAR (1983), suggests that the average number of buoys kept continuously on station is closer to 20 than to 26. Assuming 20 stations have been maintained on a continuous basis for 5 years, the estimated maintenance cost for each buoy station becomes $7,960 per annum (see Table 18). Of this amount, $4,940 is associated with buoy construction, deployment, and maintenance. The remaining $3,020 is largely the average annual administrative overhead cost of keeping a buoy on station.

CONCLUSIONS

Much detailed information has been presented in this report about Hawaii's FAD program. Without attempting to summarize the material presented herein, conclusions can be drawn in three general areas: (1) impact of FADs on Hawaii fisheries, (2) implications for managing Hawaii's FAD program, and (3) implications for FAD deployment elsewhere in the world.

Results of this study lead to the conclusion that the deployment of 26 FADs has had a profound impact on offshore pelagic fishing in Hawaii. The emplacement of nearshore FADs has attracted many individuals to engage in fishing for the first time and has encouraged experienced fishermen to fish more often. The survey response of a majority of fishermen has indicated that FADs have enhanced the quality of offshore fishing experiences in terms of fish catch and overall fishing fun. These impacts are evidenced both by the high level of fishing activity directed at FADs (over two trips per month, on the average) and by the large number of users.

Although Hawaii's FAD program is generally regarded as an important step toward offshore fisheries enhancement, results of this study suggest that positive opinions about FAD emplacement are not universally shared. At one end of the spectrum are frequent FAD users who perceive significant advantages in terms of FAD emplacement. These individuals make most of the trips to FADs. Counterbalancing this group are fishermen who visit FADs less than three times per month, on the average. This group, which constitutes the bulk of Hawaii's FAD fishing population in terms of numbers, contains disgruntled members who are discouraged by FAD emplacement being generally too far from shore. They also are concerned about congestion at FAD locations.

FAD installation has affected the activities of commercial and recreational fishermen alike. However, distinct differences exist between both groups in regard to FAD use patterns, catch rates, and fishing motives. Recreational fishermen use FADs with less overall frequency, but tend to visit more different FADs on a single trip. They generally catch less fish than commercially oriented fishermen. Furthermore, they realize less benefits in the form of cost savings from FAD usage. This apparently follows from the fact that, for many recreational fishermen, FAD emplacement has tended to encourage more fuel-intensive fishing search patterns and strategies. Survey results suggest that these fishermen use FADs as destination targets and navigational reference points during the search process. This ultimately contributes toward making trips longer in duration and farther from shore than previously.

The effectiveness of the FAD program as a fisheries enhancement tool is evident by the large catches being made throughout the year at FAD locations. Fishermen caught an average of just over four fish per FAD visit during the survey period. Catch was comprised almost entirely of skipjack, yellowfin, and bigeye tunas. However, the positive outcome of increased fish catches is somewhat overshadowed by the declining size of tuna landed. A complete interpretation of the impact of FADs on fishermen's harvesting capabilities is difficult to make because of the relatively recent initiation of the program. One factor is that the dynamics of fish aggregation to FADs in Hawaii is still in flux and no equilibrium has been reached. Furthermore, FAD deployment has stimulated much experimentation with new fishing techniques and strategies. Techniques such as drift fishing and handlining are still evolving as fishermen learn more about fish behavior around FADs.

FAD installation has apparently generated a variety of benefits for Hawaii's fishermen, including cost savings for fuel, oil, and bait; increased profits from fish catch; and increased fishing satisfaction. A simple comparison of estimated annual benefits and costs associated with Hawaii's 1984 FAD program shows that benefits only slightly outweigh costs. The difference amounts to about $2,906 ($184,906 - $182,000), or 1.6 percent of estimated total benefits. This small margin is easily overshadowed by errors in the estimate of average user benefit ($58) and the estimated FAD user population size (3,170). Sproul's (1984) findings about the effects of FAD deployment on Hawaii's pole-and-line tuna fleet therefore play an important role in comparing FAD system costs and benefits. If his estimate of increased profits due to FAD use (equal to $70,236 annually) is taken at face value, then it would appear that Hawaii's FAD project is fully justified in terms of economic efficiency.

This comparison of program benefits and costs applies strictly to the 26-FAD system in place during 1983-84. The location and number of FADs comprising the system is taken as given. An alteration in the FAD system, in terms of geographic emplacement or number of stations, could significantly affect estimated benefits and costs. For example, consider a simple change such as relocating a relatively underutilized FAD from off Kauai to off Oahu where fishing pressure is especially great. This change in network configuration could conceivably increase benefits for the population of FAD users as a whole. Although analysis of changes such as these is beyond the scope of this study, the point being made is that the rudimentary analysis of program benefits and costs presented here is peculiar to a given FAD configuration. It should not be interpreted as an economic assessment of FAD systems in general.

Aside from the benefit-cost analysis, results of this study have direct implications for managing Hawaii's FAD program. Notable in this regard are suggestions for network design. However, it appears that FAD program managers have anticipated a number of fishermen concerns. Many possible suggestions for improvement have already been incorporated in the expansion of the network during 1985. The addition of 22 new FAD stations has probably changed the level of overall congestion because fishing effort is now more dispersed. The use of more distant-water FADs, which is being experimented with in the new system, could be an effective way of reducing fishing conflicts by geographically separating user groups. Distant-water FADs will probably be most attractive to commercial fishermen who are willing to travel greater distances, as compared with recreational fishermen. Crowding at such locations from weekend and occasional fishermen should therefore be greatly reduced. However, emplacement of distant-water FADs may encourage recreational fishermen to travel farther than they otherwise would have. This may cause a major problem in terms of vessel safety because most recreational fishing boats are not equipped with electronic navigation equipment.

The recent emplacement of additional nearshore buoys may overcome recreational fishermen's urges to travel to distant-water FAD sites. Additional nearshore buoy stations may also reduce fishing effort directed at existing stations. By dispersing effort over a wider area, average catch rates may increase. This would tend to increase the benefits fishermen derive from using FADs. For example, greater cost-savings benefits may have been generated because the average distance between ports (or launch sites) and FADs has been diminished with the emplacement of additional buoy stations.

Against these potential extra benefits must be weighed the marginal costs of deploying and maintaining the expanded FAD system. The cost analysis presented here suggests that the marginal cost of adding 22 additional FADs is approximately $108,680 annually ($4,940 x 22). This does not account for any additional fixed costs that may arise. The extra benefits stemming from the new system will have to be at least this great to justify system expansion on economic grounds.

The results of this study provide the basis for three conclusions about FAD system design and management in general. First, it is apparent that the characteristics of user groups must be carefully considered in FAD system deployment. A system configuration that is ideal for recreational fishermen is probably not ideal for commercial fishermen. This raises possibilities for heated conflicts among multiple user groups. Such conflicts can most easily be resolved through careful FAD network design. For example, inclusion of both distant-water and nearshore FAD stations in the network may overcome many user conflicts. Even though complaints about congestion and poor location will probably always be voiced by fishermen, careful consideration of network design will likely lead to improved benefit-cost ratios and a more popular program. A second general conclusion stems from concerns raised by Hawaii fishermen about the declining size of tuna caught near FADs. Their comments serve to indicate that the heavy fishing pressure exerted at FAD locations can potentially jeopardize future yields. Finally, it is clear from this case study that FAD installation can have significant effects on fishermen's behavior. Just as FADs affect the behavior of fish, so too do they affect that of fishermen. This can generate unexpected results that are contrary to the objectives of the program. A case in point is the increased use of fuel by recreational fishermen in Hawaii as a result of FAD usage. Instead of saving on fuel costs, the program has created incentives whereby more money for fuel may be expended. Hopefully, results of studies such as this one will provide the empirical basis for anticipating and planning for these sorts of changes in fishermen's behavior that arise when FAD systems are deployed.

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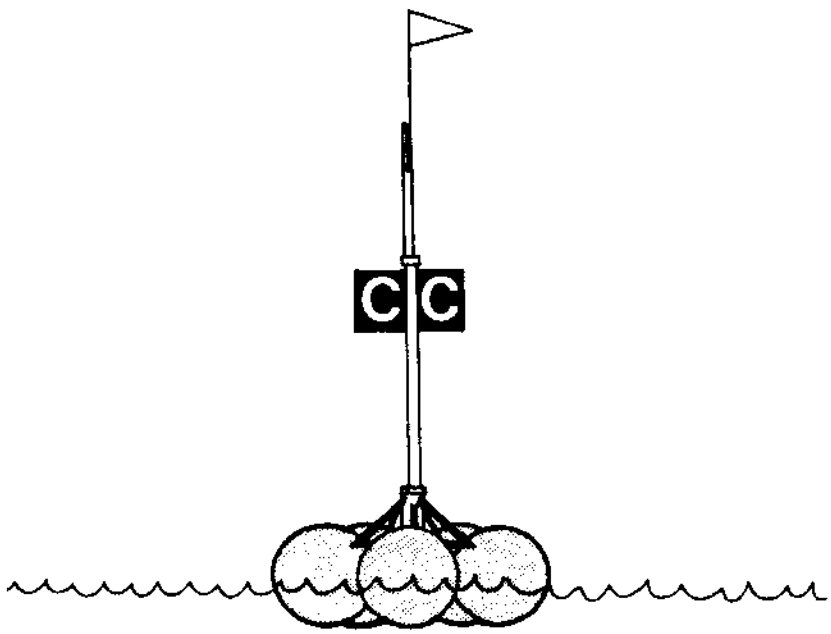
APPENDIX

SURVEY FORM

SPECIAL HAWAII FISHING BUOY SURVEY



THE PURPOSE OF THIS SURVEY IS TO LEARN MORE ABOUT FISHERMEN'S USE OF THE FISHING BUOYS. WE ARE ALSO INTERESTED IN LEARNING FISHERMEN'S IDEAS ABOUT THE EFFECTIVENESS OF BUOYS.

THIS STUDY IS SPONSORED BY THE UNIVERSITY OF HAWAII AND BY THE U.H. SEA GRANT COLLEGE PROGRAM. RESULTS WILL BE USED BY THE DIVISION OF AQUATIC RESOURCES, DEPARTMENT OF LAND AND NATURAL RESOURCES FOR THE FISHING BUOY PROGRAM. YOUR HELP IN COMPLETING THE SURVEY IS VERY MUCH NEEDED AND APPRECIATED. IF YOU HAVE ANY QUESTIONS, PLEASE CALL:

Karl C. Samples
Department of Agricultural and Resource Economics
University of Hawaii
948-8360

IN THIS SECTION WE ARE INTERESTED IN LEARNING YOUR GENERAL FEELINGS ABOUT THE FISHING BUOYS.

1 First, how many years in total have you been using the fishing buoys in Hawaii? (FILL IN THE BLANK)

_____ Years.

2 How many years in total have you been fishing offshore in Hawaii? (FILL IN THE BLANK)

_____ Years.

3 In what ways is the quality of fishing at the buoys different than the quality of offshore fishing away from the buoys? (CIRCLE ONE ANSWER FOR EACH ITEM)

	Better at the Buoys	No Difference	Worse at the Buoys
Overall fishing fun	+	0	-
Number of fish caught	+	0	-
Size of fish caught	+	0	-
Types of fish caught	+	0	-
Crowding while fishing	+	0	-
Distance traveled for fishing	+	0	-

4 Has the amount of fishing trips you take each year changed because of the buoys? (CHOOSE ONE)

_______ I'm fishing less often because of the fishing buoys.

_______ I'm fishing more often because of the fishing buoys.

_______ I'm fishing about the same amount.

5 Are your fishing costs different when you go fishing at the buoys compared to when you go offshore fishing away from the buoys? (CIRCLE ANSWER FOR EACH ITEM)

	Buoy Fishing Costs More	No Difference	Buoy Fishing Costs Less
Fuel cost per trip	+	0	-
Oil cost per trip	+	0	-
Fishing gear cost per trip	+	0	-
Ice cost per trip	+	0	-
Bait cost per trip	+	0	-

6 How do you personally feel about each of the statements below? Do you agree or disagree? (CIRCLE THE ANSWER THAT IS CLOSEST TO THE WAY YOU FEEL)

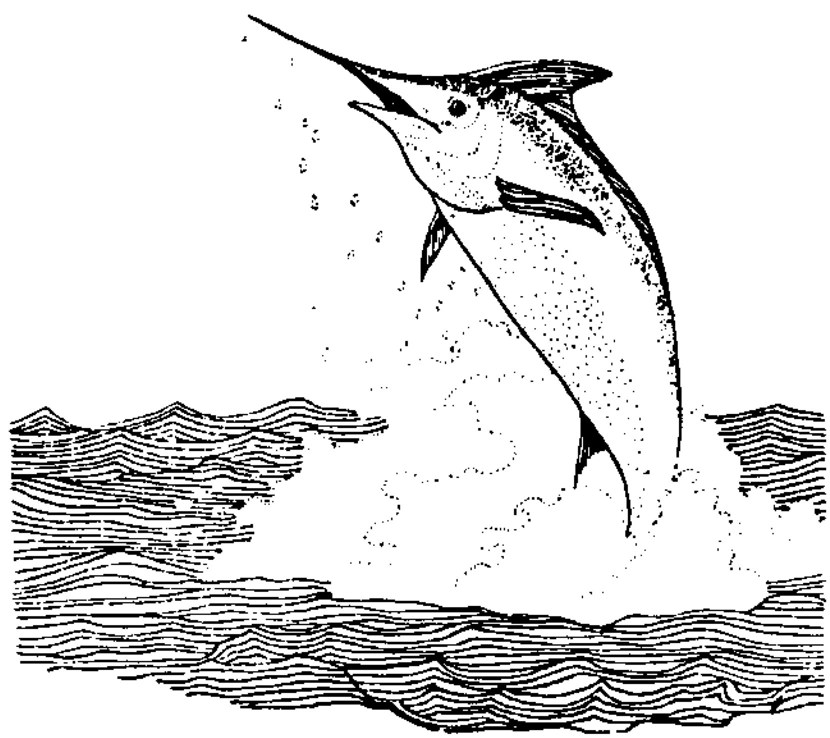
Statement	Agree	Disagree	No Opinion
Most fishing buoys are located too far from shore.	A	D	N
Fishing buoys are getting more and more crowded.	A	D	N
If necessary I would pay $_____ per year to keep the fishing buoys around.	A	D	N
Fishing buoys have made fishing in Hawaii more productive for me.	A	D	N
Most fishing buoys are located too close to shore.	A	D	N
More fishing buoys are needed.	A	D	N

7 What <u>three</u> months of the year do you visit the fishing buoys most often? (CHECK ONLY THREE)

_____ January	_____ July
_____ February	_____ August
_____ March	_____ September
_____ April	_____ October
_____ May	_____ November
_____ June	_____ December

8 Some fishermen fish the buoys everytime they go out. Other fishermen hit the buoys only on about 10 percent of their trips. Out of all the offshore fishing trips <u>you</u> took during the last twelve months, what portion included some fishing <u>within 1/2 mile</u> of a fishing buoy? (CHOOSE ONE)

_____less than 10 percent of my trips
_____10 to 20 percent
_____21 to 30 percent
_____31 to 40 percent
_____41 to 50 percent
_____51 to 60 percent
_____61 to 70 percent
_____71 to 80 percent
_____81 to 90 percent
_____91 to 99 percent
_____100 percent



THINK BACK TO YOUR LAST FISHING TRIP WHEN YOU FISHED AT A BUOY.

IN THIS SECTION WE ARE INTERESTED IN FINDING MORE ABOUT THAT PARTICULAR FISHING TRIP.

1 When did your last trip to a fishing buoy take place? (FILL IN BOTH BLANKS)

_______________ Month _________ Year

2 On your last fishing trip that you visited a buoy, how much time in total did you spend on the fishing trip from when you first left port to the time when you returned to port? (FILL IN THE BLANKS)

_______Hours + _______Minutes

3 On your last fishing trip that you visited a buoy, how much time did you spend fishing within 1/2 mile of a fishing buoy? (FILL IN BLANKS)

_______Hours + _______Minutes

4 On your last fishing trip that you visited a fishing buoy, what fishing methods did you use around the buoys? (CHECK ALL THAT ARE TRUE FOR YOU)

_____ Trolling
_____ Drift Fishing
_____ Handlining
_____ Net
_____ Casting
_____ Other _____________________

5 How many people went out with you in your boat on your last fishing trip that you visited a buoy? (FILL IN BLANK)

_______ People

6 On your last fishing trip that you visited a fishing buoy, which port or launch area did you begin your trip from? (FILL IN BLANK)

____

7 On your last fishing trip that you visited a fishing buoy, when did you fish at the buoys? (CHECK ALL THAT ARE TRUE FOR YOU)

_____ At the start of the trip
_____ At the end of the trip
_____ Several times during the trip

8 On your last fishing trip that you visited a fishing buoy, which buoys did you fish at? (GIVE LETTERS OF BUOYS YOU FISHED AT)

Buoy ______ Buoy ______
Buoy ______ Buoy ______

** NOTE **
FOR YOUR HELP, A MAP SHOWING BUOY LOCATIONS IS INCLUDED IN THIS BOOKLET.

9 On your last fishing trip that you visited a buoy, did you catch any fish within 1/2 mile of a buoy? If so, what kind and how many? (ANSWER WHAT IS TRUE FOR YOU)

_____ Yes →

Fish Type	Number Caught

_____ No fish caught within 1/2 mile of the buoys on last trip

10 On your last fishing trip that you visited a buoy, how many other boats were out by the buoy(s) with you? (FILL IN THE BLANK)

_____ Other boats

11 What motivated you to fish by a buoy during your last fishing trip that included a buoy visit? (CHECK ALL THAT ARE TRUE FOR YOU)

_____ Better chances of catching fish
_____ Easy fishing spot to locate
_____ Reports of good fishing at buoy
_____ Past experiences at buoy
_____ Wanted to save on fishing costs
_____ Wanted to fish by other boats

12 On your last fishing trip that you visited a buoy, how long did it take you to travel from port to the buoy? (FILL IN THE BLANK)

_______ Hours + _______ Minutes

13 Suppose that on your last fishing trip that you visited a buoy, all the fishing buoys had been moved farther out to sea for some reason. Would you be willing to travel an extra _______________ in your boat to be able to fish at the buoy? (CHOOSE ONE)

_____ Yes
_____ No

14 Suppose you were leaving for a fishing trip one day and someone offered you a cash payment of $_____ if you agreed not to use any fishing buoys that day. Would you accept the cash reward and not use the fishing buoys for the day? (CHOOSE ONE)

_____ Yes
_____ No

15 The buoy program costs money each year to keep going. If you were asked to make a cash donation of $_____ to keep the buoys around for another year, would you make the cash donation? (CHOOSE ONE)

_____ Yes
_____ No

16 If donations were needed to keep the buoys around, what is the most you would be willing to donate each year to keep the buoys around? (FILL IN THE BLANK)

$______ is the most I would pay each year to keep the buoys around.

IN THIS SECTION WE ARE INTERESTED IN LEARNING MORE ABOUT THE BOAT YOU USED FOR FISHING DURING THE LAST TWELVE MONTHS. IF YOU HAVE CHANGED BOATS, OR ARE A NEW BOAT OWNER, GIVE THE INFORMATION FOR YOUR CURRENT BOAT.

1 What is the overall length of your boat? (FILL IN BLANK)

_____ Feet

2 How many gallons of fuel does your boat use per hour of running time? (FILL IN BLANK)

_____ Gallons per hour

3 What is the farthest distance out to sea that you have ever taken your boat in Hawaii? (FILL IN BLANK)

_____ Miles

4 Where do you normally store your boat when you are not out fishing? (CHOOSE ONE)

_____ Home.
_____ Business.
_____ Moored at _______________________ (Place of Moorage)

5 What is the horsepower of your boat engine? (FILL IN BLANK)

_____ Horsepower

6 What type of engine do you have? (CHOOSE ONE)

_____ Inboard diesel _____ Inboard gasoline _____ Outboard gasoline

7 What is the fuel capacity on your boat? (FILL IN BLANK)

_____ Gallons

8 What special navigation/communication equipment do you have on board your boat? (CHECK ALL THAT ARE TRUE FOR YOUR BOAT)

_____ Compass
_____ Depth finder
_____ Loran
_____ Radar
_____ 2-way radio
_____ Fishfinder

9 How far from shore do you normally fish in your boat? (FILL IN BLANK)

_____ Miles average distance

IN THIS SECTION WE ARE INTERESTED IN LEARNING HOW OFTEN YOU FISHED AT DIFFERENT FISHING BUOYS DURING THE LAST TWELVE MONTHS. WE ALSO NEED TO KNOW YOUR USUAL LAUNCH LOCATION FOR EACH BUOY. USE THE MAP ON THE OPPOSITE PAGE TO HELP YOU FIND THE CORRECT BUOYS AND PORTS.

1

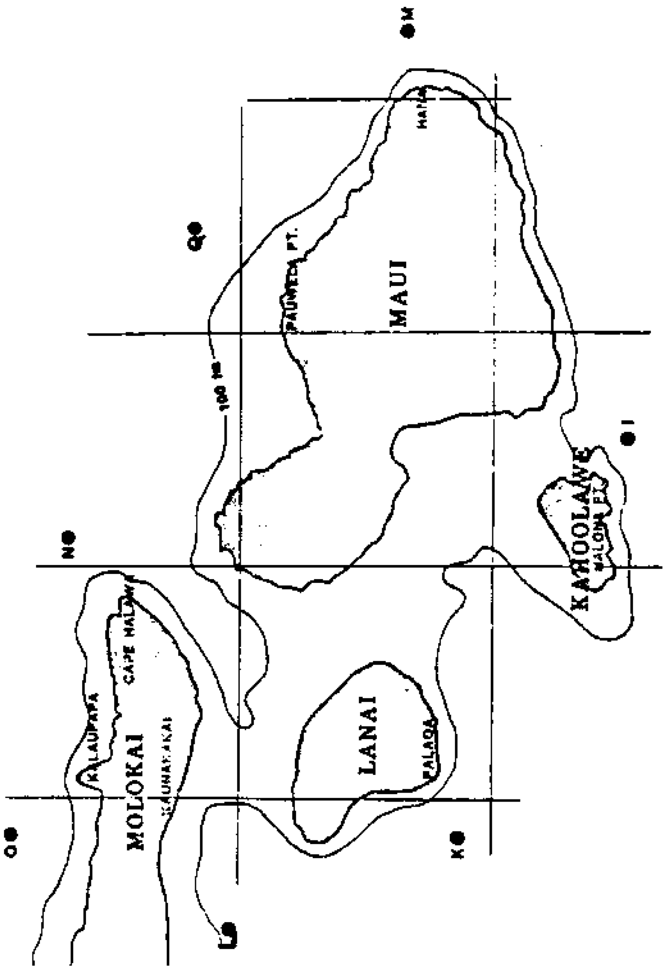
Buoy ID	Number of trips in last 12 months	Normal Launch Location	Buoy ID	Number of trips in last 12 months	Normal Launch Location
A			O		
B			P		
OTEC			Q		
ZZ			R		
D			S		
E			T		
F			U		
G			V		
H			W		
I			X		
K			Y		
L			Z		
M			AA		
N			BB		

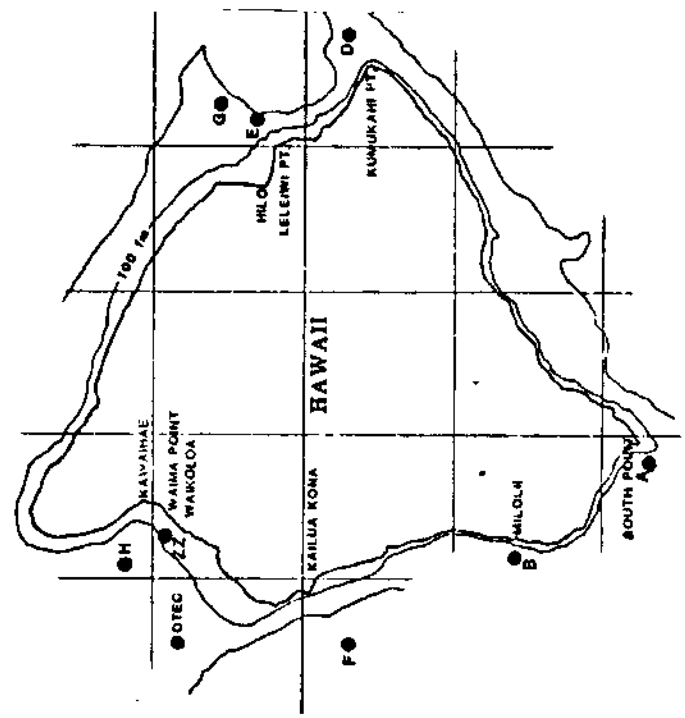
2 If one of the buoys you fished during the last twelve months was lost forever and not replaced, which one would you miss the most? (PUT BUOY ID LETTER IN BLANK)

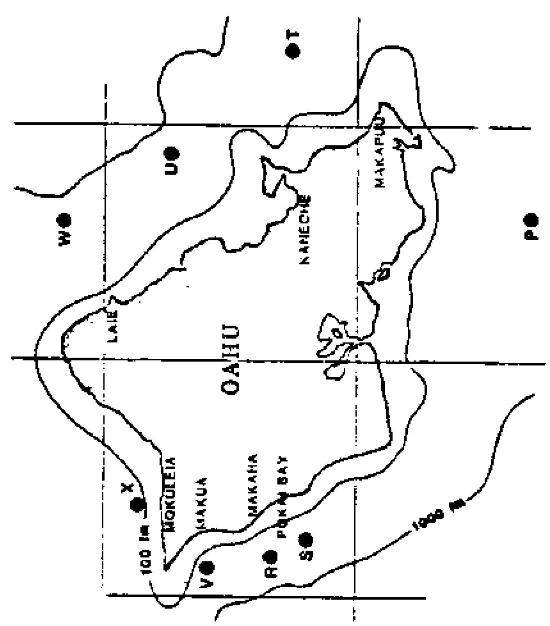
_____ Buoy is the one I would miss the most.

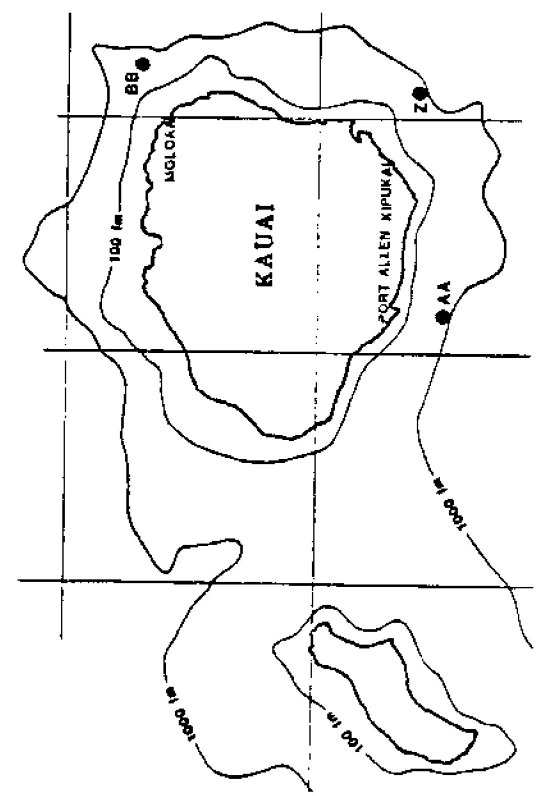
3 Which of the buoys you fished during the last twelve months would you miss the least if it was lost forever and not replaced? (PUT BUOY ID LETTER IN BLANK)

_____ Buoy is the one I would miss the least.


MAUI
MOLOKAI
LANAI
KAHOOLAWE
KALAUPAPA
CAPE HALAWA
KAUNAKAKAI
HANA
100 fm


HAWAII
HILO
LELEIWI PT.
KUMUKAHI PT.
KAWAIHAE
WAIMA POINT
WAIKOLOA
KAILUA KONA
MILOLII
SOUTH POINT
OTEC
100 fm


OAHU
LAIE
KANEOHE
MAKAPUU
MOKULEIA
MAKUA
MAKAHA
POKAI BAY
100 fm
1000 fm


KAUAI
MOLOAA
PORT ALLEN
KIPUKAI
100 fm
1000 fm

IN THIS SECTION WE ARE INTERESTED IN LEARNING ABOUT THE TYPES AND NUMBER OF FISH YOU HAVE CAUGHT DURING THE PAST TWELVE MONTHS AT THE FISHING BUOYS:

FISH TYPE	Number caught within 1/2 mile of a fishing buoy	Number sold
Aku		
Ahi		
Mahimahi		
Ono		
Marlin		
Barracuda		
Bottomfish		
Shark		

IN THIS SECTION WE WOULD LIKE TO ASK YOU SOME QUESTIONS ABOUT YOUR BACKGROUND WHICH WILL HELP US COMPARE YOUR ANSWERS TO THOSE OF OTHER PEOPLE. WE WOULD LIKE TO STRESS THAT ALL OF YOUR ANSWERS ARE STRICTLY CONFIDENTIAL.

1 How old are you? _______ years old

2 Are you _______ Male _______ Female?

3 How many years of school have you completed?

____1____2____3____4____5____6____7____8____9____10____11____12

____Some college _____B.A. or equivalent _____Advanced Degree

4 What is your primary occupation? Please be specific as possible. If you are a homemaker or student, please indicate the occupation of your spouse or parent. If retired, give your former occupation.

____

5 With reference to your primary occupation, are you currently:

_____ Fully retired

_____ Semi-retired, working part-time

_____ Retired, working at a different job part-time

_____ None of the above

6 Please check the response that comes closes to your total household income before taxes.

_____ $0 to $3,999

_____ $4,000 to $7,999

_____ $8,000 to $11,999

_____ $12,000 to $15,999

_____ $16,000 to $19,999

_____ $20,000 to $23,999

_____ $24,000 to $27,999

_____ $28,000 to $31,999

_____ $32,000 to $35,999

_____ $36,000 to $39,999

_____ $40,000 to $43,999

_____ $44,000 to $47,999

_____ more than $48,000

IF YOU HAVE ANY COMMENTS CONCERNING THE FISHING BUOYS, OR THIS RESEARCH PROJECT, FEEL FREE TO WRITE SOMETHING ON THIS PAGE.

THANK YOU FOR YOUR ASSISTANCE. WE HOPE THAT YOU FOUND THIS QUESTIONNAIRE AN INTERESTING AND ENJOYABLE EXPERIENCE!

PLEASE RETURN THE QUESTIONNAIRE AT YOUR EARLIEST CONVENIENCE IN THE SELF-ADDRESSED, STAMPED ENVELOPE PROVIDED TO YOU.