PACIFIC ISLANDS FISHERIES SCIENCE CENTER

Exploratory Study of Interactions Between Cetaceans and Small-boat Fishing Operations in the Main Hawaiian Islands (MHI)

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STUDY RATIONALE AND INTENT

NOAA Fisheries Pacific Island Fisheries Science Center (PIFSC) Cetacean Research Program (CRP) is currently working to assess human threats, particularly those associated with fishing activities, to cetaceans. Because cetaceans eat a number of species targeted and bait utilized by the recreational and commercial fishing sector, there is reason to believe that interactions may occur between fishing activities of the small vessel fleet and insular cetacean population. Ethnographic and survey research of small vessel-based fisheries in Hawaii have detailed that operators do occasionally interact with cetaceans while engaging in troll and handline fisheries (cf. Glazier 2007, 2009; Rhodes et al. 2007). Data from commercial catch reports (CML) reveal that fishermen lose catch to cetacean predation.

Of particular concern to NOAA Fisheries, has been fishing threats to False Killer Whale (FKW) populations in the Main Hawaiian Islands (MHI). In 2010, NOAA Fisheries established a Take Reduction Team to address the incidental mortality and serious injury of FKWoccurring as a result of the deep and shallow-set longline operations; a Take Reduction Plan was subsequently established in 2013. FKW in Hawaii are known to eat species targeted by the small vessel fleet - wahoo (*Acanthocybium solandri*), mahimahi (*Coryphaena hippurus*), yellowfin tuna (*Thunnus albacores*), albacore tuna (*Thunnus alalunga*), skipjack tuna (*Katsuwonus pelamis*), broadbill swordfish (*Xiphias gladius*), threadfin jack (*Alectis ciliaris*), and various Marlin species. The range of the insular population coincides with that of the small vessel fishery. Baird (2013) has suggested that small-scale fishing operations, which utilize a variety of non-longline fishing gear technologies, may cause injury or death of FKWs (c.f. Baird and Gorgone 2005; Baird 2009; Baird et al. 2014).

The intent of this exploratory research was to improve understanding of how, when, where, and why interactions between fisheries and cetaceans (generally) and FKWs (more specifically) tend to occur in the MHI. A focused study was applied to improving understanding of:

(1) The environmental conditions, fishing locations and gear types in which fishery-cetacean interactions tend to occur –as observed by fishermen,

(2) Methods small vessel operators employ to mitigate interactions with cetaceans in the MHI.

Efforts were also made during this research study to identify long-time and knowledgeable fishermen to participate in any future working groups devoted to cetacean and fisheries interactions.

This study was conducted February through June, 2015. It should be noted that the scope of this research is such that results cannot be used to estimate frequency or assess the distribution of cetacean-small vessel fishery interactions in the region or any parts of the region because of the small sample size and (non-random) sampling method.

BACKGROUND INFORMATION

In the Hawaiian context, "small vessel" is typically defined as less than 40 feet in length (cf. Glazier 2009, Hospital 2011). For the purpose of this research, we also included charter boats within the 40 feet range (c.f. Glazier 2009). Additionally, one respondent who operated a vessel of 55 feet was interviewed because of his knowledge of shortline fishing.[1]

Most small-vessel operators fish for a combination of reasons: for consumption and sharing with others, recreation, and they may also engage in commercial sale to cover operating costs and/or provide part-time income (cf. Glazier 2007; Hospital et al., 2011). Fishermen who sell fish are required to be licensed by the State of Hawaii and submit catch reports. Additionally, fishermen who fish recreationally for bottomfish in federal waters must comply with federal licensing and catch reporting requirements. There are currently, however, no other licensing or reporting requirements for non-commercial fishermen.

Small-vessel operators will typically use a variety of different gear types sequentially or simultaneously and target or catch a variety of different species[2]. Fishermen will target pelagic species through trolling and handline gear types/methods. Trolling occurs with lures, dead, or live bait. A variety of different configurations are utilized: outriggers and downriggers in conjunction with rod and reel, danglers, and greenstick. Danglers are used almost exclusively by commercial fishermen and in conjunction with private fishing aggregating devices (PFADs). Greenstick is reportedly used more by commercial fishermen than non-commercial fishermen or charter operators. The major forms of handline methods for pelagic species are *ika-shibi* and *palu ahi* (also called "bust bag," "drop stone," or "make dog"). *Palu ahi* and *ika-shibi* are used almost exclusively by commercial fishermen. Handline is also utilized for targeting bottomfish, mackerel scad (*opelu*), and bigeye scad (*akule*). Refer to Appendix 2 for further information regarding these fishing techniques and schematics of operations.

A 2007 intercept survey (cf. Hospital et al., 2011) of 343 small vessel fishermen revealed that commercial fishermen used, on average, 2.3 gear types per trip, and non-commercial fishermen used 2.1 gear types. Table 1 below provides information on gear preferences (measured in mean percentage of trips) for commercial and non-commercial fishermen.[3] The percentage of trip per gear type varies by port and island.[4]

[1] Shortline configurations and fishing technique resembles that of the longline fishery; operators of shortline gear, however, are not currently required to follow regulations for the longline fishery. Little has been documented about the characteristics of the shortline fleet. According to one respondent, operators of vessels less than 40 feet do utilize shortline fishing gear.

[2] The use of variety of gears during a single trip can make reporting and assessing catch data difficult.

[3] Figures do not necessarily equal 100% due to use of multiple gear types. Reef fishing is omitted for our purposes because it is not a fishery of interest for cetacean interactions.

[4] For example, percentage of fishing trips involving in *palu ahi* and *ika-shibi* are likely higher for small vessel operators fishing off the island of Hawaii.

Table 1.—Fishing gear use by fisherman type.

Trip Percentage by Gear Type	Commercial (%)	Non-commercial (%)
Trolling	65.9	76.9
Bottomfish	22.4	11.3
Akule/opelu	5.2	3.6
Palu ahi	5	.4
Ika-shibi	1.6	0

Source: Hospital et al. 2011

Another aspect of small-boat fishing is the use of Fish Aggregating Devices (FADs). FADs are comprised of a buoy or some other form of flotation that is moored to the ocean floor. The structure creates an identifiable small ecosystem in the ocean environment which is highly efficient in attracting pelagic species. The State of Hawaii maintains a network of FADs to support the viability of the small vessel fleet. As of May 2016, there are 35 State-maintained FADs in place. The inshore FADs are within 10 miles of the coast and set at depths of 3,000 to 5,500 feet[5]. As Itano and Holland (2000:215) write, "the inshore FAD network forms one of the most frequently visited inshore 'fishing grounds' for the diverse small boat fleet." Offshore weather monitoring buoys also act as FADs; utilization of these offshore weather monitoring buoys requires larger vessels, a minimum of 35 feet in length, and more typically 40 feet or longer (cf. Glazier et al. 2009). A small portion of the fishing fleet privately deploys their own FADs (commonly referred to as PFADs). Small-vessel operators, particularly in the Big Island, reportedly began using PFADs on the west side of the Big Island in the 1980s; the practice has since spread around the region (cf. Glazier et al. 2009)[6,7].

Typically, fishermen who are targeting pelagic species will center fishing activities along bathymetric features, such as a ledge, bank, pinnacle, or hole (*koa*), or at State-maintained or their own privately established FADs and where pelagic species are known to aggregate. Respondents report frequently exiting the harbor and heading directly to the closest FAD, often to pick up some live bait. However, fishermen may avoid FADs on crowded weekends or if word is out that fishermen are losing catch to cetacean predation near FADs. When travelling between FADs, fishermen will troll looking for birds, floating debris, and current lines as signs of where pelagic fish might be. Some small vessels are equipped with fish finders that indicate the presence of schools and GPS to locate important bathymetric features associated with high productivity. Many commercial fishermen use phone apps or computer services that provide

[5] The current location of FADs in the State program can be accessed at the State of Hawaii's Fish Aggregation Device Program online at: http://www.hawaii.edu/HIMB/FADS/

[6] The price of constructing a PFAD ranges from $6,000 - $15,000 depending on the materials, depth of deployment, and if any kind of instruments are involved. Due to the cost and effectiveness of the PFAD, locations are kept secret. The structures are often moored in the subsurface beyond the range of recreational and subsistence fishermen with smaller vessels. Respondents report that PFADs are placed by commercial fishermen, a *hui* (a collective/group) of fishermen, and charter operators.

[7] PFADs are considered a navigation hazard and are currently required to be registered with U.S. Guard. Operators placing PFADs in Federal waters are expected to consult with NOAA Fisheries and in State waters to be permitted with Army Corps of Engineers and Hawaii Department of Land and Natural Resources (c.f. Glazier et al. 2009). Reportedly the continued use of unregistered and unpermitted PFADs is common.

information that is also important to locating schools of pelagic species, such as temperature clines or chlorophyll concentrations.

Fishermen can experience two kinds of predation: predation of bait and of catch. Fishing with lures or simple hooks (in the case of dangling) can lead to catch predation but not bait predation.

The average and maximum distance an operator will fish offshore varies by such factors as: size of boat, target species, category of fisherman (commercial and non-commercial), and oceanographic and bathymetric conditions associated with each access point. Table 2 below details distances fished offshore.

Table 2.--Distances fished offshore by trip and fisherman type.

	Pelagic trip		Non-pelagic trip	
Fisherman type	**Average**	**Maximum**	**Average**	**Maximum**
Commercial	12.9	18.9	8.4	12.6
Non-commercial	8.2	11.2	3.4	5.8

Source: Hospital et al. 2011

REVIEW OF SECONDARY DATA SOURCES

This section reviews secondary sources focusing on landings data from small vessel commercial operations and surveys with fishermen regarding marine mammal interactions. This information provides context for the research results presented below.

2007 Phone and Dockside Survey

In 2007, the University of Hawaii Sea Grant Program conducted telephone and dockside surveys with boat-based nearshore fishermen regarding marine mammal interactions (cf. Rhodes et al. 2007)[8]. Interactions were defined as an encounter directly related to fishing, such as bait or catch stealing, loss of or entanglement in gear, or accidental hooking. Respondents were queried regarding interactions with the following cetacean species: bottlenose dolphins (*Tursiops truncatus*), spinner dolphins (*Stenella longirostris*), rough-tooth dolphins (*Steno bredanensis*), pilot whales (*Globicephala melaena*), false killer whales (*Pseudorca crassidens*), melon-headed whales (*Peponocephala electra*), and monk seals (*Monachus schauinslandi*). Respondents also noted interactions with humpback whales (*Megaptera novaeangliae*) and turtles although they were not listed in the survey questionnaire. Respondent's ability to identify species was handled in different ways for each of the survey methods. In telephone interviews, respondents were provided the opportunity to answer "unknown species" of dolphin or whale. However, in dockside interviews, respondents were encouraged to provide size and color characteristics.

[8] Telephone interviews were conducted on a randomized, anonymous basis as part of NOAA's Fisheries Coastal Household Telephone Survey and included all six main Hawaiian Islands. In-person interviews were conducted opportunistically at select docksides on the island of Hawaii, Oahu, Molokai and Maui.

Respondents were asked to self-identify as recreational, commercial, or mixed/both. Additionally, respondents were queried on their primary gear type, type of interaction, and whether they view marine mammals as a benefit, burden, or neither to successful fishing. Dockside respondents were asked the economic impact of interactions, the type of fishing they were engaged in at the time of interaction, and their response to interaction.

Of the 379 fishermen included in the phone survey, 14 (3.7%) reported an interaction with a marine mammal during the past 12 months. All interactions were reported as dolphin species – 6 cases identified as bottlenose dolphin, 1 case as a spinner dolphin, and in 7 cases the respondent could not identify the species. Seven of 9 recreational fishermen surveyed who reported a dolphin interaction could not identify the species. Bait and catch stealing comprised the most common interaction at 43%.

Of the 292 individuals included in the dockside survey, 216 (74%) reported having an interaction with a marine mammal while fishing at some point in their lifetime. Of these, 43 (20%) reported that interactions were common; 175 (81%) as rare. 82% of fishermen reported they could positively identify the species, 15% guessed; 3% reported not being able to identify the species. 254 marine mammal interactions were reported by these respondents. Of these, 196 (77%) were with dolphins, and 44 (17%) were with whales. The most common kind of interaction with a marine mammal involved taking bait or catch at 79% of incidences. Taking of bait or catch was commonly associated with interactions with bottlenose dolphins and spinner dolphins. Ten incidences of accidental hooking were reported – 5 were reported as involving spinner dolphins and 2 were reported as involving pilot whales. Tables 3 and 4 below provide information on number of cetacean interactions by fisherman and gear types.

Table 3.--Number of cetacean interactions by fisherman type: Dockside Survey.

	Dolphins			**Whale**		
Fisherman Type and Number	**Spinner**	**Bottlenose**	**Rough-toothed**	**Pilot**	**False Killer**	**Humpback**
Recreational (232)	67	96	0	9	3	21
Commercial (37)	21	4	2	3	2	1
Both/mixed (23)	11	19	0	2	1	1

Source: Rhodes et al. 2007

Table 4.--Number of cetacean interactions by select gear type: Dockside Survey.

	Dolphins			Whale		
Gear Type	**Spinner**	**Bottlenose**	**Rough-toothed**	**Pilot**	**False Killer**	**Humpback**
Pole and Reel	64	100	1	9	5	20
Pole and Line	19	17	1	5	1	3
Handline	12	1	0	0	0	0

Source: Rhodes et al. 2007

Respondents were provided with six options to report responses to marine mammal interaction:

- cut the line to avoid gear loss
- cut the line and unhook the animal
- move to another area nearby (< 1 mile)
- move to another area far away (> 1 mile)
- stay in the area and ignore the animal, and
- stay in the area and try and get the animal(s) to leave.

Respondents provided additional responses, such as changing gears and changing depth. Response to marine mammal interactions varied by type of fishermen (recreational, commercial or both/mixed). Table 5 below indicates favored responses to marine mammal interactions by type of fisherman.

Table 5.--Response to marine mammal interactions by type of fisherman.

Response # of interactions	**Recreational**	**Commercial**	**Mixed/Both**
Cut the line to avoid gear loss	21	14	3
Cut the line and unhook the animal	18	5	5
Move to another area nearby	49	6	12
Move to another area far away	13	4	5
Stay in the area and ignore the animal	88	8	14
Stay and try to get animal to leave	29	3	2
Stay and wait	2	0	1
Change gears	17	1	1
Change depth	2	0	1

Source: Rhodes et al. 2007

The reporting of survey data does not include an analysis of how fishermen viewed or responded differently to different species of marine mammals or how fishermen's responses related to the particular kind of interaction or the particular type of fishing. Additionally, neither the survey protocol nor report provided information on how cutting line was operationalized to avoid the loss of gear, in particular, terminal tackle. Information of this nature would be useful to understand how to mitigate harm to marine mammals and economic loss to fishermen.

Commercial Fish Catch Reports (2003-2014)

Beginning in late 2002, commercial fishermen are required to include information regarding loss of catch due to predation – specifically the amount of fish, source of predation –on State of Hawaii commercial fish catch reports[9]. The commercial fish catch report data were used (Boggs et al. 2015) to summarize predation by fishing method, seasonality of interactions, and statistical area. Predation does not necessarily denote that hooking or entanglement or any other harm occurred to the marine mammal involved. Predation may be widely underreported on commercial fishing reports. There is no assurance that fishermen can accurately identify species, as shown by our own interviews. And the summarized data on loss due to predation do not take into account the amount of fishing effort by method, season, area, or year which may largely explain the observed patterns.

The most commonly reported marine mammal species involved in predation incidents were in descending order: porpoise, dolphin, monk seal, pilot whale, FKW, and pygmy killer whale[10]. In the case of dolphins and porpoises, it is not clear what particular species were being referred to or what distinction the respondent might make between the categories of "dolphin" and "porpoise"[11]. Table 6 provides information on the number of records and number of commercial marine license (CML) holders that reported dolphin and porpoise predation.[12]

Table 6.--CML data on Porpoise and Dolphin predation.

Year	Porpoise		Dolphin	
	# of records	# of CMLs	# of records	# of CMLs
2003	80	47	16	8
2004	70	39	6	4
2005	52	35	7	5
2006	58	36	5	4
2007	47	35	12	12
2008	63	51	13	7
2009	51	34	8	6
2010	52	40	16	12
2011	77	52	41	31
2012	75	49	59	45
2013	64	38	48	37
2014	61	35	73	47

Source: Boggs et al. 2015

[9] Boggs et al. (2015) identified 4 types of State of Hawaii reporting forms that had loss of catch to predators: "monthly", "BF", "DeepA", and "Tuna". All forms include three options for reporting predation: sharks, unknown, and other. See Boggs et al. (2015) for an example form.

[10] In accordance with standard confidentiality requirements, species named by three or fewer commercial license holders, for a queried time period or statistical area, were not included in data results and analysis.

[11] Strictly speaking, there are no porpoises in Hawaii but the term may have been developed so as to avoid confusion with "dolphin fish" mahimahi, which is commonly referred to as "dolphin" in many other parts of the U.S.

[12] Predation on multi-day and single day fishing trips appears as one record. The number of records may be an underestimation of the number of fishing days that fishermen encountered predation.

Table 7 below provides information on the number of records and number of commercial marine license (CML) holders that reported whale predation. Due to less frequent reporting of interactions with whale species, information is reported in three year periods in accordance with confidentiality requirements. Reports of whale interactions show a seasonality with peak reportage occurring in July through August for Pilot Whales and May through June for FKWs.

Table 7.-- CML data on Pilot Whale and FKW predation.

Three-year Period	Pilot Whale		False Killer Whale	
	# of records	# of CMLs	# of records	# of CMLs
2003-2005	ND	ND	ND	ND
2006-2008	7	6	ND	ND
2009-2011	10	10	14	11
2012-2014	15	14	13	11

ND - not disclosed due to confidentiality requirements
Source: Boggs et al. 2015

The most common fishing method reported involved in depredation by cetacean species, was trolling with lures. However, this does not necessarily imply that trolling was inherently more likely to be involved in loss of catch due to mammal predators than another fishing method. It could simply be that trolling was used more than other methods. Boggs et al. (2015) did not analyze the amount of fishing by each method, season, area, or year, as would be required to draw such conclusions.

Table 8.--CML data: Predation by species and gear type.

Gear Type	Porpoise		Dolphin		Pilot Whale		FKW	
	# or records	# of CMLs	# or records	# of CMLs	# or records	# of CMLs	# or records	# of CMLs
Trolling -Lure	230	146	119	78	27	27	15	15
Deep-Sea/ Bottom Handline	206	62	41	22	27	27	ND	ND
Palu Ahi	96	66	55	26	ND	ND	6	6
Inshore Handline	57	20	21	11	ND	ND	ND	ND
Casting	24	19	16	10	ND	ND	ND	ND
Trolling- Bait	20	14	9	9	ND	ND	ND	ND
Ika-Shibi	8	8	9	4	ND	ND	ND	ND
Trolling – Misc.[13]	3	3	ND	ND	ND	ND	ND	ND

ND not disclosed due to confidentiality requirements
Source: Boggs et al. 2015

[13] For State of Hawaii commercial fishing reporting purposes, trolling is divided into four methods: trolling with bait; trolling with lures; trolling with green stick; and miscellaneous, which includes all other trolling gear configurations.

The most records of predation by porpoise and dolphin were associated with statistical areas on the west and northwest of the Big Island. In the case of FKW, most reports of predation were associated with three offshore statistical areas on the west side of the Big Island and three offshore statistical areas on the west/southwest of Oahu. The highest numbers of reported predation by pilot whales was associated with statistical areas on the west/southwest of Oahu. This does not necessarily imply that fishing in the above areas is more likely to result in cetacean predation as it could mean simply that more fishing is conducted in those areas.

Other Documentation

In 1993 Nitta and Henderson provided a review of fisheries – protected species interactions in Hawaii based on interviews conducted with fishermen, observer reports, and fish catch reports from fishermen. Table 9 below details kinds of cetacean predation in small vessel fisheries. Interactions with dolphins were reported to have increased with the use of FADs.

Table 9.--Type of predation by fishery and cetacean species.

Fishery/Species	Bottlenose dolphin	Rough-toothed dolphin	False Killer Whale
Bottomfish	bait/catch		
Palu ahi	bait/catch	bait/catch	
Ika-shibi	bait/catch		
Handline (*opelu)*	catch		
Trolling	bait	bait	catch

Source: Nitta and Henderson 1993

METHODOLOGY OF THIS RESEARCH PROJECT

This project's research utilized the following methods:

- Discussions with protected species and cetacean specialists regarding identifying characteristics of various species of cetaceans and geography for FKW populations of interest;
- Discussion with persons within the State of Hawaii - Division of Aquatic Resources, NOAA Fisheries, Western Pacific Fishery Management Council, and the fishing community who are knowledgeable of small boat fishing operations and operators to: (1) develop a research protocol and (2) identify experienced fishermen with likely knowledge of operational and biophysical conditions under which an interaction might occur;
- Interviews with small vessel fishermen who operate out of harbors and/or boat ramps on windward and leeward sides of Oahu and the Big Island.

Fishermen interviews were focused on Oahu and the Big Island due to small vessel fishing effort, measured by landings data, and presence of FKWs, a cetacean species of particular interest to PIFSC's Cetacean Research Program. Major ports were chosen on windward and leeward sides

of each island to capture different small vessel fishing patterns and to acknowledge the range of FKWs, as suggested through tagging data[14,15]. The interview protocol for this research was developed to elicit respondents' direct observations of, interactions with, and responses to cetaceans. The protocol can be found in Appendix A.

Table 10 below details the number of interviews by type and location.

Table 10.--Number of interviews by type and location.

	Oahu		**Big Island**	
Agency staff	4		1	
Other fisheries specialists	2			
Other cetacean specialist	1			
Fishermen	**Waianae**	**Hale'iwa**	**Kailua-Kona**	**Hilo/Pohoiki**
Scheduled	1	0	4	6
Intercept	12	8	7	2

RESEARCH FINDINGS

The discussion of research findings addresses: 1) cetacean identification and 2) reported cetacean interaction and mitigation strategies. The discussion also divides the general category of cetaceans into: 1) FKW and other "blackfish" species and 2) dolphin species to reflect the particular interest of the research program in FKW and common categorical distinctions made by fishermen.

Cetacean Identification

FKW and other whale species in the "blackfish" category[16]

Respondent comments were analyzed for their confidence in their ability to identify four distinct species in the "blackfish" category and the likeliness that their use of terms corresponds with those of the scientific community.[17]

[14] A study of 27 tagged FKWs (insular population) showed individuals spending slightly less time on leeside of island than windward sides but ranging more broadly. Tagging efforts were not, however, able to capture movements from March through June and as such there is a seasonal bias in the research findings. Additionally, tagging data was from only two of the three social clusters of insular FKW. (cf. Baird et al. 2012).

[15] Although both Waianae (Oahu) and Kona (Big Island) are exposed to large swells on a seasonal basis, ocean surface conditions are generally smoother than those in Hale'iwa (Oahu) and Hilo (Big Island).

[16] "Blackfish" is a term not widely used amongst fishermen interviewed for this research. During interviews, respondents referred to species within the category, by a distinct species names, as a small whale, or as "not a humpback whale."

[17] The Risso's dolphin (*Grampus griseus)* was not included in the list of blackfish common in Hawaiian waters. The species is widely distributed throughout the world and from a distance may be confused with FKW and bottlenose dolphins (c.f. Jefferson et al. 1993). None of the fishermen-respondents in this study used the term.

After respondents indicated observations or interactions with any one of the blackfish species, they were shown photos and illustrations to allow them to clarify or change their identifications and/or were asked to characterize the appearance and behavior of the species. The difficulty members of the fishing community had recognizing FKWs became apparent during this exercise. It may be that some communities have adopted a distinct species name to stand for the categorical grouping of blackfish. Some names may also be counter-intuitive. For example, pilot whales were, on occasion, confused with melon heads perhaps because of the bulbous shape of the former's head.

Nine fishermen showed confidence in their ability to identify blackfish species and their description of physical and behavioral attributes of blackfish species suggested their ability to accurately ID species.[18] Respondents were longtime charter operators and commercial fisherman. Seven respondents spoke of observing or interacting with FKWs but their description of physical and behavioral attributes were somewhat questionable – either the frequency of observations, size of group, or shape of head suggests another species. In some cases, respondents began discussing blackfish species with confidence but upon seeing IDs began questioning their identifications. Six respondents reported at the outset that they could not accurately distinguish species. In five cases, the respondent did not give enough information in the course of the intercept interview to judge whether species identification was accurate or not. Table 11 below provides information on respondent confidence and ability to identify FKWs.

Table 11.--Respondent confidence and ability to identify FKWs.

Location	Confident/ Positive ID	Confident/ Questionable or Questions ID	Recognizes Can't ID	Not Enough Information	Total
Oahu					
Waianae	2	5	2	1	10
Hale'iwa	1	1		2	4
Big Island					
Kona	4	1	1	2	8
Hilo/Pohoiki	2		3		5
Total	**9 (33%)**	**7 (26%)**	**6 (22%)**	**5 (19%)**	**27**

Dolphin Species

Respondents referred to dolphins in various ways: a) the categorical terms of dolphin or porpoise, b) species specific terms, such as rough-toothed (also referred to as *stenos),* bottlenose, spotted dolphins, c) descriptive terms, "bad" or "good" or white-nosed, and 4) Hawaiian terms *puka* and *kikos.* There was no clear geographical preference for use of either dolphin or porpoise. Twenty-three respondents (62 %) who discussed dolphins/porpoises used specific terms. For those respondents who did use species-specific terms, there was high agreement on which

[18] According to agency staff/cetacean specialists, identification based on shape of head is more accurate than that based on fin shape/size or behavioral attribute. Reportedly, fin shape varies within species and perception of size varies depending on amount of whale body that is visible.

species were responsible for predation and what they predated – rough toothed dolphin predation on live bait and catch - and which species were used for locating target pelagic species – spotted dolphin. In the case of dolphin species, some fishermen simply broke them down into categories of good and bad, the former being known to be useful indicators for locating target pelagic fish species while the latter is known to steal bait or catch and/or scare target fish species away.

Cetacean Interactions and Mitigation Strategies

FKW and other whale species in the "blackfish category"

Two respondents reported that they have located fish by using FKW. They reported that they keep their distance to avoid losing catch or gear entanglement. (Both of these respondents were categorized as questionable in regards to their ability to identify FKW which suggests that instead of FKW they could have been other blackfish.) Three respondents reported having lost catch to a FKW/pilot whale while engaging in troll (unspecified type), longline [19], and greenstick. Of the three respondents, one was able to positively identify FKW, one had a questionable identification, and one did not provide enough information to assess reliability of identification. Three respondents reported seeing or interacting with FKWs/pilot whales at FADs or buoys. (All of these respondents were categorized as confident and able to identify FKWs.)

The majority of respondents report that they avoid (or would avoid) interactions with blackfish by leaving the area as soon as possible or traveling in the opposite direction because of the perception that blackfish scare away target fish and/or steal catch. There is also the common perception amongst fishermen that blackfish are smart enough to only take catch, leaving the hook. The perception of blackfish and resulting avoidance strategy may reduce the risk of fisheries and FKW interactions. Charter operators generally point out various whale and dolphin species to guests who reportedly are very happy to see cetaceans and will give a larger tip. As one charter operator explained "you go from zero to hero when people see them."

In addition to the four "blackfish" species, twelve respondents discussed observing or interacting with humpbacks. Three inshore handline operators referred to dangers of humpback whales "popping" up and crossing fishing lines. One respondent reported having had to cut lines and lose gear on one occasion. Four inshore trollers reported having to "zig-zag" to avoid humpbacks. Due to the size of humpbacks and their habit of sudden surfacing, respondents spoke of them as "scary" and "terrifying." Charter operators, in contrast, saw the appearance of humpback whales as an opportunity to please guests. Additionally, two respondents reported recently seeing killer whale(s) (easily distinguishable by black and white) - a particularly rare sighting.

[19] The respondent was not operating a small vessel when utilizing longline fishing technology. The utilization of longline gear typically requires a larger vessel. According to a 2000 study, the smallest vessels in the Hawaiian longline fleet, which target tuna, were on average 48 feet length (O'Malley and Pooley 2000.)

Dolphin Species

Fourteen respondents reported using dolphins for locating fish and by trolling in front of, behind, or around pods. No respondents reported incidences of fouled hooks. One respondent in Kona reported that cutting through schools of dolphin (or target species) was considered a "no-no" and something only an inexperienced, non-local troller might do. Hilo respondents reported that they did not have a schooling variety of dolphins that could be used for locating target species.

Eighteen respondents reported dolphin predation. Dolphin predations are low frequency but consistent events and occur while live bait fishing/trolling and engaging in night handline fisheries. According to interviews conducted as part of this research, predation is widely underreported on commercial fishing reports. Respondents indicated that fishermen do not report predation on catch that is intended to be used as bait to target other species. As one fisherman put it, "it is not catch unless it is for the poke bowl." Additionally, respondents report that fishermen do not generally consider predation as a "loss" unless a substantial amount of catch is involved.

Respondents who had lost catch to dolphins noted that they usually take the bait/catch and leave the head on the hook. Three respondents had reported hooking dolphins in five instances (three were identified as bottlenose, one as rough-toothed, and one unnamed). One respondent reported being able to bring the bottlenose dolphin close to the boat, grab the animal by the snout, and dehook the animal. Reportedly, the dolphin was docile. Nine respondents associated predatory dolphins, such as rough-toothed dolphins, and sharks with FADs/buoys, and three respondents felt that dolphins were becoming habituated to fishing at FADs.

In response to dolphin predations, respondents report shortening fishing time, leaving for another (distant) fishing area, and/or moving one's vessel in such a way to encourage the dolphin(s) to focus attention on another vessel. The latter response/technique is variously referred to as "switch out," "leap frog," "drop off a porpoise," and "bait and switch." In the night handline fisheries, this is generally acknowledged to leave one with a bad reputation. Handline fishermen also reported that they commonly turned off lights if dolphins approached at night. (Lights are used to attract target species, which in turn, reportedly attract dolphins. By turning off lights, both the target species and predating dolphins disperse.) One respondent commonly also turned off his depth finder. Respondents also noted that certain members of the fishing community had tried "dolphin bombs," acoustic deterrents, but found them ineffective.

Four trollers reported that attaching metal to live bait is effective in deterring predation by dolphins. Fishermen variously used wires, pop can tops, or hooks attached to the tail[20]. Three respondents reported having heard about the use of metal to mitigate dolphin predation but had not found it effective. One fisherman reported that metal deters their target fish (marlin) so they

[20] According to Nitta and Henderson (1993), research conducted by the National Marine Fisheries Service (NMFS) found that attaching metal to bait, injecting bait with noxious substances, and using noise devices were not successful in deterring dolphins in their desire to predate. However, other more recent studies on cetacean depredation mitigation efforts suggest that wrapping bait in metal wire; entangling catch with metal streamers, which are deployed upon strike; and using dissuasive acoustic pingers do significantly deter predation by cetaceans (c.f. McPherson and Nishida 2010). Recent efforts are also being made to develop acoustic buoys to detect FKW whistles that communicate food sharing during predation events.

will not attach metal to their live bait. Respondents noted that in their experience "dolphins" do not steal dead bait nor are they attracted to lures.

The ability to avoid predation is facilitated by the fact that pelagic fishermen typically, and to some degree, share knowledge and interact with each other. Although fishermen may be guarded about favorite fishing spots, many respondents reported that sharing information regarding predation is very common. These days, fishermen will typically communicate by cell-phone and will enquire of others in their network if dolphins/porpoises are at FADs (cf. Glazier et al. 2013).

Research results suggest:

1) respondents may refer to the same cetacean species with a different term and/or ascribe those characteristics to any number of cetacean species that look similar;
2) respondents' general perception of blackfish as aggressive predators has led to a general avoidance strategy;
   the ability to correctly identify FKWs seems to correlate with outreach and education programs,[21] long term fishing experience as charter operator or fulltime/avid commercial fisherman in areas of known high FKW presence, and close observation and/or interaction.

[21] An outreach program in Kailua-Kona Harbor distributes plastic whale ID cards to fishermen.

REFERENCES

Baird, R.W., and A.M. Gorgone.
2005. False Killer Whale Dorsal Fin Disfigurements as a Possible Indicator of Long-Line Fishery Interactions in Hawaiian Waters. Pacific Science (2005), vol. 59, no. 4:593–601.[22]

Baird, R.
2009. A Review of False Killer Whales in Hawaiian Waters: Biology, Status, and Risk Factors. Prepared for the U.S. Marine Mammal Commission under Order No. E40475499 by the Cascadia Research Collective. Olympia.

Baird, R.
2013. Letter to NOAA PIRO regarding Notice of Intent to prepare a Recovery Plan for the MHI insular false killer whale Distinct Population Segment. Cascadia Research Collective. November 1. Olympia.

Baird, R.W., M.B. Hanson, G.S. Schorr, D. L. Webster, D. J. McSweeney, A. M. Gorgone, S. D. Mahaffy, D. M. Holzer, E. M. Oleson, and R. D. Andrews.
2012. Range and primary habitats of Hawaiian insular false killer whales: informing determination of critical habitat. Endangered Species Research. Vol. 18:47-61.

Baird, R. W., S. D. Mahaffy, A. M. Gorgone, T. Cullins, D. J. McSweeney, E. M. Oleson, A. L. Bradford, J. Barlow, and D. L. Webster.
2015. False killer whales and fisheries interactions in Hawaiian waters: Evidence for sex bias and variation among populations and social groups. Marine Mammal Science Vol. 31: 579-590.

Boggs, C. H., D. P. Gonzales, and R. M. Kokubun.
2015. Marine Mammals Reported under Catch Lost to Predators on Fishermen's Commercial Catch Reports to the State of Hawaii, 2003-2014.[23]
Cascadia Research Collective.
2013. Identifying "Blackfish" in Hawaiian Waters.[24]

Cortez, W.
2016. State of Hawaii's Fish Aggregation Device Program. Last updated May 27, 2016.[25]

Finn, F. K., and P. Dalzell.
2009. Hawaiian Shortline Fishery. Presentation to the False Killer Whale Take Reduction Team Pre-Meeting. November 19-20.[26]

[22] http://scholarspace.manoa.hawaii.edu/bitstream/handle/10125/24202/PacSci_593-602.pdf?sequence=1
[23] http://www.pifsc.noaa.gov/library/pubs/DR-15-006.pdf
[24] http://www.cascadiaresearch.org/Hawaii/CRCHawaiiBlackfishComparison.pdf
[25] http://www.hawaii.edu/HIMB/FADS/
[26] http://www.nmfs.noaa.gov/pr/interactions/fkwtrt/pre_trt_meeting/presentations/day2/hi_shortline_dalzell.pdf

Glazier, E. W.
2007. *Hawaiian Fishermen*. Wadsworth-Cengage Publishers. Belmont, California.

Glazier, E. W., J. Shackeroff, and C. Carothers.
2009. A Report on Historic and Contemporary Patterns of Change in Hawaiʻi-Based Pelagic Handline Fishing Operations. University of Hawaii Pelagic Fishery Research Program. SOEST Publication 09-01. Honolulu.

Hospital, J., S. S. Bruce, and M. Pan.
2011. Economic and social characteristics of the Hawaii small boat pelagic fishery. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-11-01, 50 p. + Appendices.

International Game Fish Association.
2015. International Angling Rules.[27]

Itano, D.
2004. Hawaiian-style small-scale deep setting longline technique used on seamounts. SPC Fisheries Newsletter #111. October/December.

Itano, D. G., and K. N. Holland.
2000. Movement and vulnerability of bigeye (*Thunnus obesus*) and yellowfin tuna (*T. albacares*) in relation to FADs and natural aggregation points. *Aquatic Living Res*., 13 (4): 213-223.[28] .

Jefferson, T. A., S. Leatherwood, and M.A. Webber.
1993. FAO Species Identification Guide. Marine Mammals of the World. Rome, FAO.[29]

Kawamoto, K.
2009. Field Guide for the Main Hawaiian Islands Bottomfishing Vessels and Gear. Presentation at Western Pacific Fishery Management Council Meeting. Oct 7.

McPherson, G. and T. Nishida.
2010. Overview of toothed whale depredation mitigation efforts in the Indo-Pacific region. Secretariat of the Pacific Community Fisheries Newsletter 132: 31-36.[30]

Miyasaka. A.
2013. Shortline Fishery in Hawaii. Presentation False Killer Whale Take Reduction Team Meeting. May.[31]

[27] https://www.igfa.org/images/uploads/files/Updated%20Rules%202014_English_Feb2015.pdf

[28] http://journals.cambridge.org/download.php?file=%2FALR%2FALR13_04%2FS0990744000010627a.pdf&code=1872a595763fb16a6dc05fe2f918880a

[29] ftp://ftp.fao.org/docrep/fao/009/t0725e/t0725e23.pdf

[30] http://www.iotc.org/sites/default/files/documents/proceedings/2010/wpeb/IOTC-2010-WPEB-Inf17.pdf

[31] http://www.nmfs.noaa.gov/pr/interactions/fkwtrt/meeting6/presentation6.pdf

Nitta, E. T., and J. R. Henderson.
1993. A Review of Interactions between Hawaii's Fisheries and Protected Species. Marine Fisheries Review 55(2): 83-92.[32]

O'Malley, J. M., and S. G. Pooley.
2000. Economic and Operational Characteristics of the Hawaiian-Based Longline Fleet in 2000. SOEST Publication 03-01, JIMAR Contribution 03-348.[33]

POP Fishing and Marine.
ND. The Hamaguchi Greenstick Fishing System.[34]

Preston, G. L, L. B. Chapman, and P. G. Watt.
1998. Vertical Longlining and other Methods of Fishing around Fish Aggregating Device (FADs): A Manual for Fishermen.[35]

Rhodes, K. L., D. T. Kornfeind, and M. J. Donohue.
2007. Boat-based Fishery and Marine Mammal Interactions in Hawaii's Nearshore Waters. Report to the Pacific Islands Regional Office, National Marine Fisheries Service, Honolulu, Hawai'i.[36]

Rizutto, J.
1987. Hawaii Fishing Style, Volume 2: A Guide to Saltwater Angling. Honolulu, Hawaii: Hawaii Fishing News.

Wescott, W.
1996. The Wanchese green-stick tuna rig. North Carolina Sea Grant. UNC-SG-96-04.

[32] http://spo.nmfs.noaa.gov/mfr552/mfr55210.pdf
[33] https://pifsc-www.irc.noaa.gov/library/pubs/OMalley_Pooley_SOEST_03-01.pdf
[34] http://pop-hawaii.com/fileadmin/pdf/GREENSTICK_GUIDE2.pdf
[35] http://www.spc.int/DigitalLibrary/Doc/FAME/Manuals/Preston_98_VLL.pdf
[36] Available from Pacific Islands Regional Office, 1601 Kapi'olani Boulevard, Suite 1110, Honolulu, Hawai'i 96814.

APPENDICES

APPENDIX A—INTERVIEW PROTOCOL

Fishermen identified through social networking were contacted by telephone and interviewed in their homes or work places, or at coffee shops and restaurants. Interviews were generally scheduled for an hour and ranged from 45 minutes to three hours. One fisherman was interviewed on more than one occasion to provide follow up information. Intercept interviews were conducted at boat harbors generally, at loading ramps, cleaning stations, and docks. Interviews typically lasted ten minutes but on one occasion lasted thirty minutes. Two fishermen were interviewed on more than one occasion to provide follow-up information.

All respondents were asked if they could provide names of other knowledgeable fishermen. Five fishermen interviewed by intercept were later identified through social networking method as knowledgeable by other fishermen.

Scheduled interviews were semi-structured allowing the respondent to engage in free-flowing talk story. Intercept interviews were structured. In both cases, interviews enquiries included the following topics:

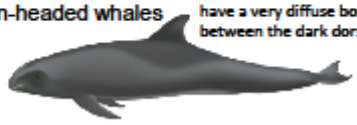
- History of boat-based fishing
- Identification as recreational, subsistence, subsistence/commercial, or fulltime commercial
- Frequency of fishing
- Preferred gear type and target species
- Vessel length
- General fishing area and fishing range
- Observations of cetaceans and ability to identify cetacean species and FKW, in particular
- Experience with cetacean predation, outcomes, and mitigation efforts
- Patterns of predation

Long hand notes were taken during the interview. Additional ethnographic observations were recorded into small hand-held tape recorder after the interview. Field notes and recordings were later typed for analysis. Photo illustrations and behavior characteristics used to clarify respondent identification of blackfish species and/or assess accuracy of species identification are provided on the following page.

IDENTIFYING "BLACKFISH" IN HAWAIIAN WATERS

There are four species of "blackfish" resident in Hawaiian waters, two relatively large (short-finned pilot whales, false killer whales) and two relatively small (melon-headed whales, pygmy killer whales). The four species look fairly similar but can be discriminated based on relative dorsal fin size and position as well as other characteristics (summarized in table below).

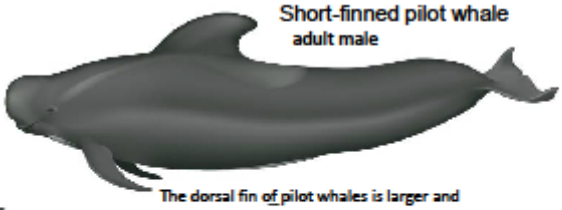
Melon-headed whales have a very diffuse boundary between the dark dorsal cape and the lighter side of the body



Pygmy killer whales have more white linear scars than melon-headed whales

False killer whale

Short-finned pilot whale adult male



The dorsal fin of pilot whales is larger and further forward on the back than other species. Adult males are ~3' larger than adult females and have a much larger dorsal fin

Species	Group size typical & range	Behavior towards boats	Behavior during day	Body size range	Typical depths fathoms	Frequency seen?	Group spread
Pilot whale	18 (1-195)	Usually indifferent	Usually resting at surface or travel	4.6' - 17.2'	270-1640	Common	Typically one or two subgroups
False killer	18 (1-41)	Often bowrides	Actively foraging, leaping regularly	4.9' – 18'	25-2700	Rare	Often over many miles
Pygmy killer	11 (1-33)	Usually avoids	Usually resting at surface	2.6' - 8.5'	270-1640	Rare	Typically one group
Melon-headed	245 (1-800)	Often bowrides	Usually resting at surface or travel	3.2' – 9'	110-2700	Uncommon but very large groups	Usually very clustered

Prepared by Cascadia Research Collective, a 501(c)3 non-profit research and educational organization based in Olympia, WA. For more information or to send photos contact Robin Baird rwbaird@cascadiaresearch.org or 425-879-0360. Illustrations by Uko Gorter. Rev 2 Jul 13.

Source: Cascadia Research Collective nd.

APPENDIX B—OVERVIEW OF FISHING METHODS

In this appendix, we provide an introduction to various fishing methods utilized by the small vessel fleet. Basic information covered includes: numbers, configuration, and strength of fishing lines per method; times and places where fishing typically takes place; and other important characteristics of the fishery. Fishermen may use a combination of methods during any given fishing trip. The ability to engage in certain or multiple methods depends on the size of vessel and its ability to accommodate equipment. As mentioned previously, not all methods are used with equal frequency by the small vessel fleet.

Trolling Methods

To attract fish to the surface, fishermen use a number of techniques: plastic lures, live or dead bait applied to hooks, bait chummed at the surface or within the water column, and water sprayed on the surface. Live bait trolling occurs most often in the vicinity of FADs where the bait is caught, bridled to a hook, and then slowed trolled, at a speed of 2-3 knots. Fishermen who have live wells or tuna tubes that can keep bait alive, will also live bait troll in areas away from FADs. Dead bait is typically trolled at a speed of 6-9 knots. Fishermen may also have bait on hand for use to chum if they encounter a school of fish, such as mahimahi. Artificial lures, which come in a wide variety of shapes, sizes, and colors, are trolled at higher speeds; respondents reported lure trolling from 5.5 to 14 knots.

Outriggers/rod and reels

An operator will typical set up 4-7 lines with different lengths, lures, and hooks to entice a variety of different pelagic species or sizes by creating the illusion of a school of bait. Outriggers are commonly utilized to increase the spread of lures or bait. When sport trolling for big game fish with lures, fishermen will typically troll with a main line ranging from 30 to 130 pound test weight and leaders of 300 to 500 pound test weight [41]. When trolling for commercial purposes, fishermen will use main lines of up to 200 pound test weight. The time from hooking a fish to landing in the vessel (catch retrieval time) is highly variable. Figure 1 depicts a typical trolling configuration with outriggers.

[41] According to rules of the International Game Fish Association, maximum strength of line is 130 lbs. Prizes are awarded per weight of line and typically the lighter the line, the more finesse and skill is required of the fisherman to land a fish.

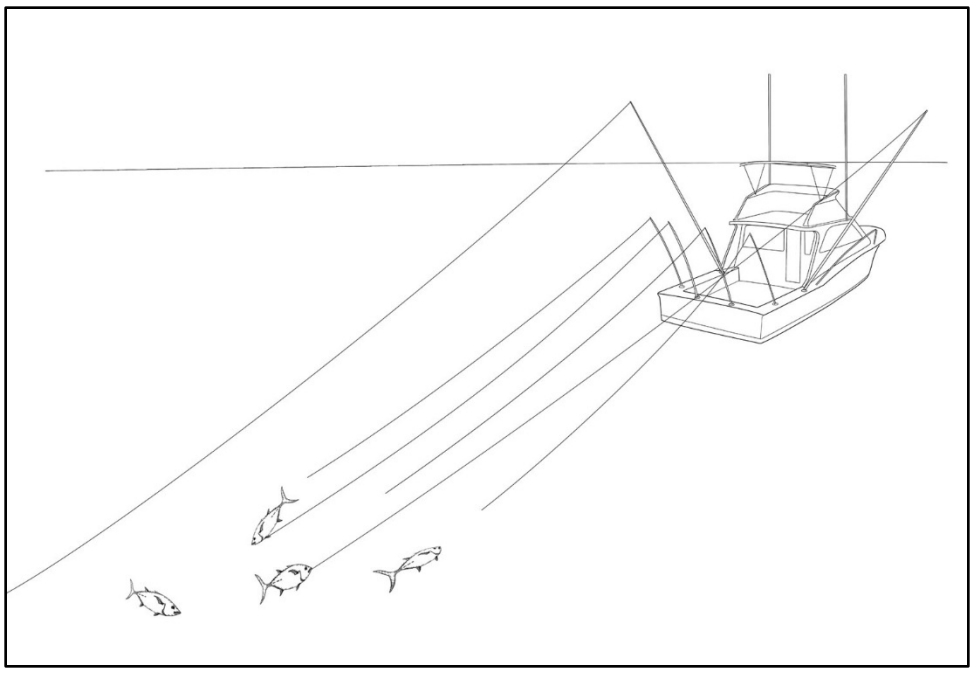


Figure 1.—Troll.

Danglers

When deployed, danglers bars are set perpendicular to the vessel, extending out four to six feet at various points of the vessel. Each bar is fixed with short lengths of monofilament or rope, large barbless hooks, and plastic squid lures. The line is typically 500 pound test weight. Depending on the size of the vessel and number of crew, two-six poles will be worked while the vessel moves slowly through the water. Danglers are usually deployed when tuna have rushed to the surface. According to respondents, danglers are a favored gear type for PFAD fishermen. The catch retrieval time is almost immediate. (When pelagic fish appear at the surface in a feeding frenzy, fishermen will also often use stick poles of 5-9 feet in length with a single barbless hook.) Figure Two below depicts the gear configuration for the dangler.

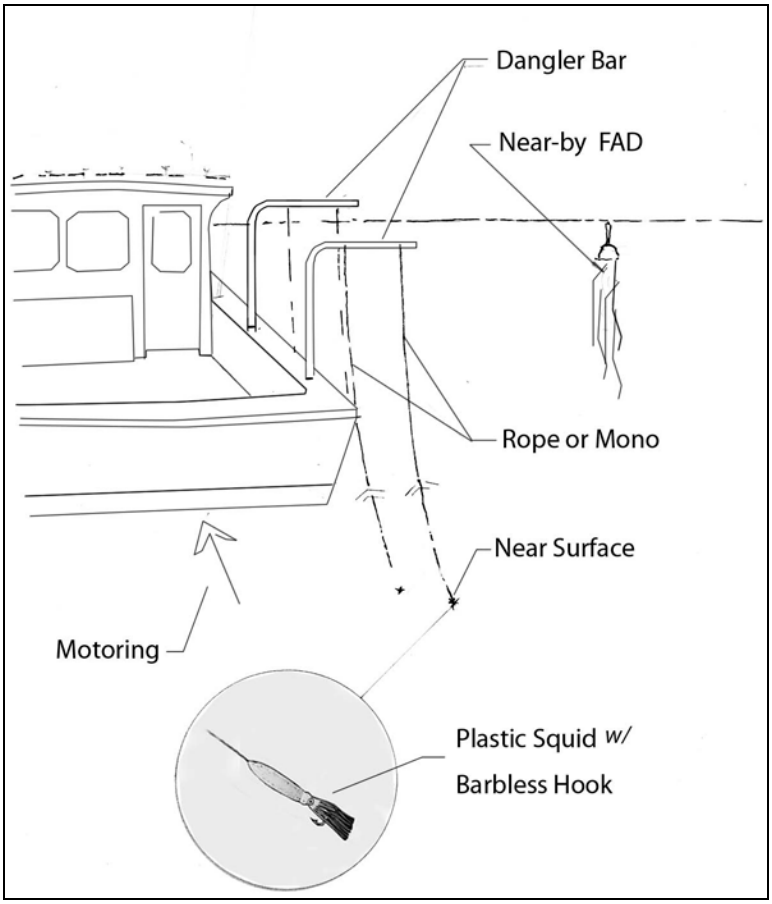
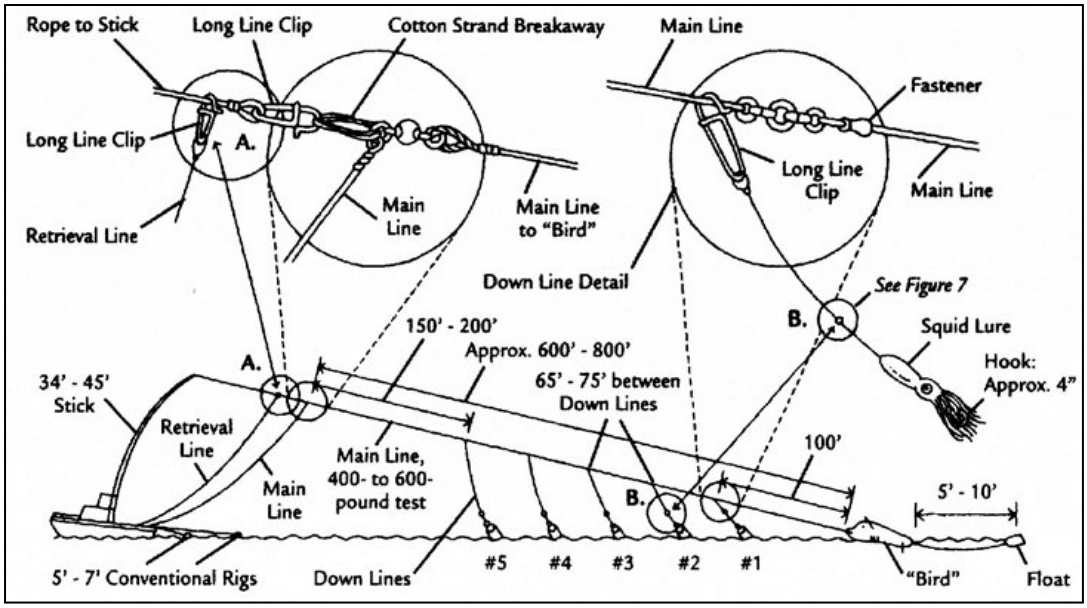


Figure 2.—Dangler.

Greenstick

The Greenstick is comprised of 24-48 foot pole affixed vertically midship. A mainline runs from the top extending 300-900 feet in length. The mainline can range from 250 to 1200 pound test in strength, although 400-600 pound is most typical. A series of branch lines run from the mainline, each having a lure attached. Typically, fishermen will have 4-8 lures of different colors. The lures jump in and out of the water as the boat trolls at speeds of typically 5-7 knots. Attached at the end of the mainline is a wooden "bird" which keeps the line taught and creates the illusion of a large predator fish chasing a school of prey fish. Respondents report that the greenstick can be effective in getting fish to bite when conventional methods do not work. Multiple hook-ups can occur.

Greenstick (also called "the rig") can be used for commercial or charter purposes. In the case of the former, the catch is retrieved with a mechanic reel. In the case of the latter, the catch is retrieved on a rod (cf. POP Fishing and Marine). Retrieval time varies depending on method. Commercial fishermen typically use electric or hydraulic reels for fast retrieval. If trolling for sport, a fisherman will typically use a rod and reel for retrieval. Figure 3 depicts in detail the greenstick configuration.



Source: Wescott 1996

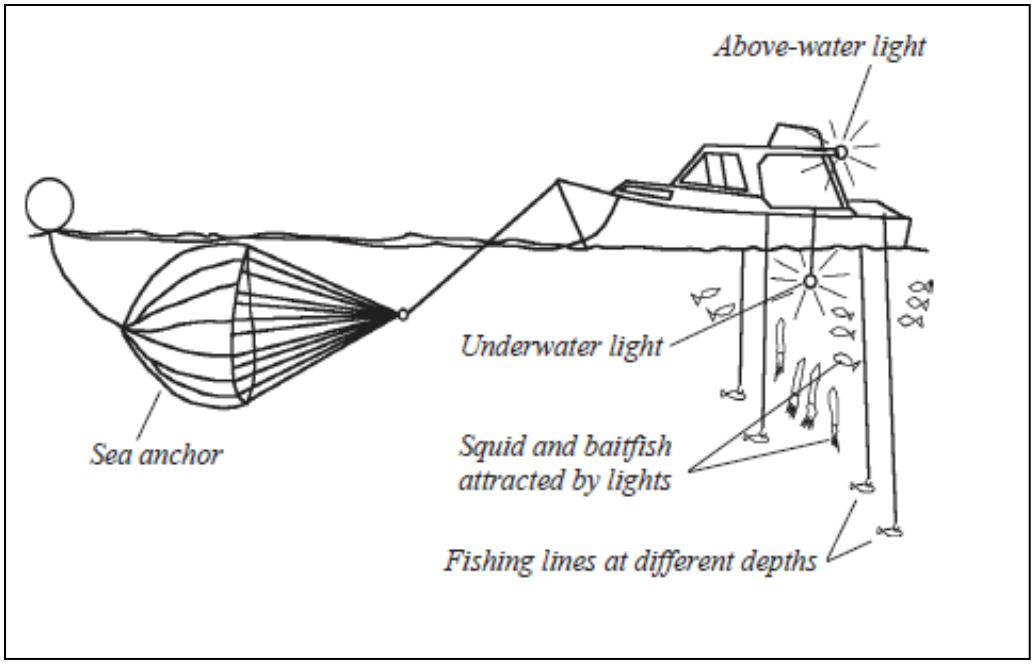
Figure 3.—Greenstick.

Handline

Pelagic Species

Ika-Shibi is a handline fishery used for targeting bigeye and yellowfin tuna. The fishery is conducted at night. Operators typically use 20 -30 watt bulbs underwater or over the surface to attract squid, which are subsequently used as bait. (Mackerel scad (*opelu*) and bigeye scad (*akule*) are also frequently used as bait.) Fishermen will typically deploy multiple lines with different hooks and lure, floaters, and chum arrangements so they can target fish at different levels. A short baited, unweighted line is sometimes kept ready to toss to a larger fish that may rise in the chum line. *Ika-shibi* fishermen fish shelves (near a 6,000 foot contour) and FADs, and utilize sea anchors to guide their movement. The line strength for *ika-shibi* is typically 300-500 pound test. Figure 4 below depicts *ika-shibi* fishing.

Palu ahi is the daylight, handline cousin fishery of *ika-shibi*, used for targeting skipjack and yellowfin tuna. Fishermen typically deploy one line per person, each with a single hook, baited with mackerel, mackerel scad, or squid, and a chum (*palu)* bag. The fishery is conducted at depths of up to 450 feet (cf. Nitta and Henderson 1993). The line strength for *palu ahi* is typically 150-200 pound test.



Source: Preston et al. 1998

Figure 4.-- *Ika-Shibi.*

Bottomfish

Fishermen also use handlines to target bottomfish. Operators frequently use anchors to ensure they can maintain their position over bathymetric features associated with target species. Depending on the size of the vessel the anchors will be deployed and retrieved by hand or hydraulic mechanism. Bottomfish species target range from depths of 60 to 1200 feet. Fishermen typically use 2-8 lines weighted with lead at the bottom; each line has a series of branch lines spaced 6-10 feet apart, with small baited circle style hooks. Branch lines are generally 40-100 pounds and of hard monofilament. A chum bag, containing chopped squid or fish, is usually suspended above the highest of these hooks. Typically the gear is retreived with a mechanical or hydraulic reel after several fish are hooked. Fishing occurs during day and night hours, depending on target species. Small vessel operators will typically take one day or overnight trips (cf. Nitta and Henderson 1993; Kawamoto 2009). Figure Five depicts the gear configuration for deepsea handline.

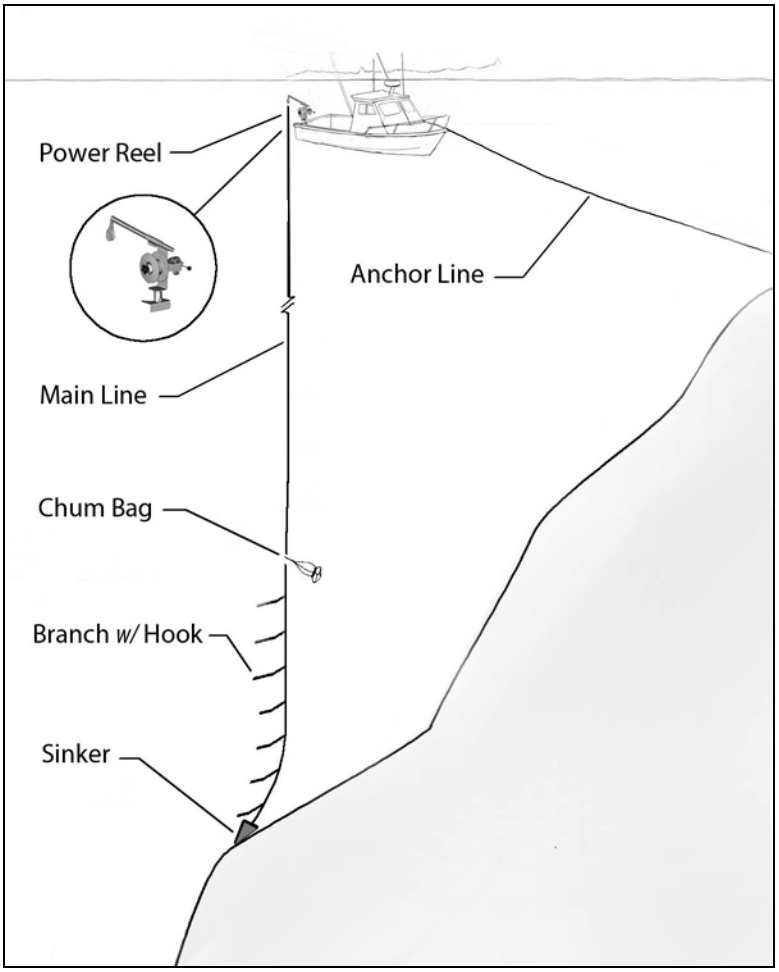


Figure 5.--Deepsea handline.

Mackerel and Bigeye Scad (*Opelu* and *Akule*)

Handline for mackerel scad (*opelu*) and bigeye scad (*akule*) is a night fishery conducted inshore. Fishermen deploy lights to illuminate an area around the boat. Fishermen typically use a light line and leader with several hooks, spaced up to a yard apart, either baited or with feathered jigs. Branch lines are generally 8-12 pound test and of hard monofilament. This gear is used to target fish at depths of 50 -80 feet (cf. Nitta and Henderson 1993). Figure Six depicts the gear configuration for inshore handline.

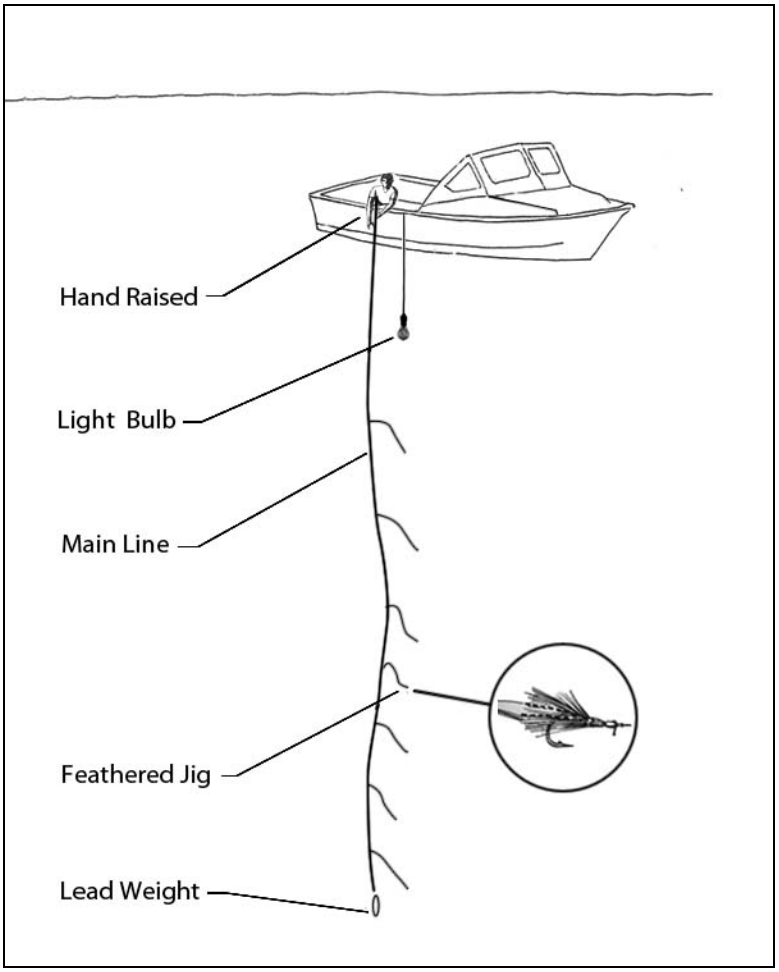


Figure 6.--Inshore handline.

Shortline

Shortline gear is utilized around seamounts and PFADs. Shortline configurations and fishing technique resembles that of the longline fishery. Baited hooks are suspended from a long mainline with floats attached intermittently to keep the baits and hooks at an appropriate range of depths, typically 15-20 feet. Hooks are typically baited with large bait (approximately one foot in length) and remain in the water for 2- 12 hours as the line drifts (cf. Itano 2004; Finn and Dalzell 2009; Miyasaka 2013). By definition measuring less than one nautical mile in length, shortlines are not currently required to follow regulations for the longline fishery. There is no legal limitation on the number of sets one can lay, but for practical purposes it is typically three. Figure Seven depicts the gear configuration for shortline.

An additional set of longline configurations is vertical, allowing fish species that live at different depths to be targeted. The configuration has been promoted in the South Pacific but no respondents reported doing vertical longline or knowing of any other fishermen that utilize this technique within MHI.

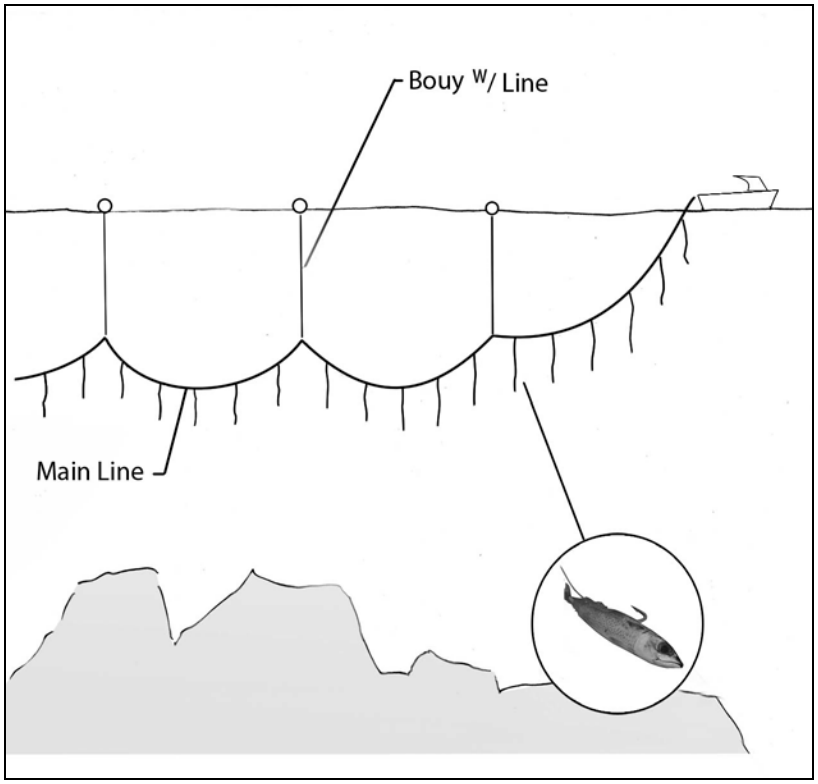
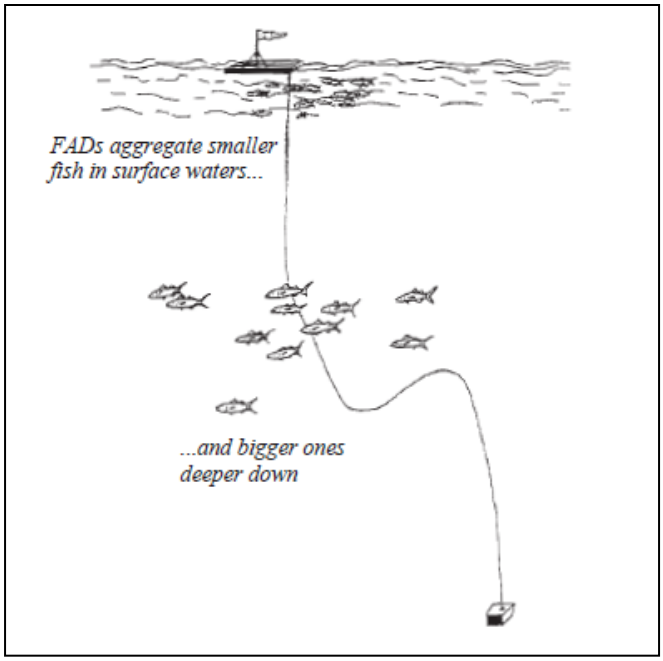


Figure 7.—Shortline.

Fish Aggregating Device (FAD) and Private FADs (PFADs)

To increase the aggregative potential, FADs are typically deployed to take advantage of some ocean features, such as a ledge. Typically fishermen troll out to and between FADs and *ika-shibi*, *palu ahi*, fishery often occur in areas of FADs (Nitta and Henderson 1993.)

In the case of privately deployed FADs (PFADs), some fishermen will place more than one structure. Typically, fishermen will troll one or two circles around the structure, retrieve troll lines, and then chum, to create a surface rush. The surface rush is then targeted with handlines, straight poles, and/or danglers. The use of danglers and pole fishing is particularly associated with PFADs. Charter operators will chose locations for emplacing PFADs that enable day charters. Respondents on the Big Island report that the use of PFADs is common for fishermen who operate out of both Hilo and Kona. Figure Eight depicts a FAD structure.



Source: Preston et al. 1998

Figure 8.--FAD