False Killer Whale Take Reduction Team
Non-Longline Fisheries Work Group Teleconference
November 18, 2014
Summary

Participants

TRT members: Robin Baird, Hannah Bernard, Asuka Ishizaki (alternate for Paul Dalzell), Michael Jasny, David Laist, Kristy Long, Alton Miyasaka
Facilitators: Bennett Brooks, Scott McCreary
NMFS support staff: Bryan Dieter, Nancy Young
Invited experts: Phil Fernandez, Craig Severance

Background materials

The five documents listed below were provided to the work group ahead of the call. They are also included as Appendix 1 to this summary.

1. *Fisheries information from DAR*. This document was prepared by the Hawaii Department of Land and Natural Resources, Division of Aquatic Resources (DAR) for the April 2014 Pacific Scientific Review Group (PSRG) meeting. It provides an overview of the State's license and trip reporting requirements, fishing gear types, and data uses and limitations. The fishing report forms and commercial fisheries area grid charts are included as appendices.
2. *Excerpt from DAR presentation to PSRG on State Fisheries*. This is an excerpt of a presentation DAR gave to the PSRG at their April 2014 meeting. It provides similar information to document #1 above, but also includes gear descriptions and basic data summaries for fisheries that were identified as being of interest to the PSRG.
3. *Baird et al. 2014 – False killer whales and fisheries interactions in Hawaiian waters*. This is a paper recently published in Marine Mammal Science that assessed scarring patterns on false killer whales as evidence of fisheries interactions.
4. *Intro to FEAT*. This presentation from the Kona Integrated Ecosystems Assessment Symposium in September 2014 gives an overview of the Fishery Ecosystem Assessment Tool (FEAT), a geospatial tool for state fisheries data.
5. *Excerpt from DAR ESA Section 6 grant proposal*. This excerpt from DAR's recently-submitted proposal to NMFS under ESA Section 6 describes a proposed assessment of the degree of spatial overlap between MHI insular false killer whales and state fisheries.

Summary of key ideas and discussion, by agenda topic

- *Introductions.* The Work Group was joined by two invited fisheries experts, who provided self-introductions.
    - Phil Fernandez is a small-boat troll fishermen in Kona, characterizing himself as a recreational fisherman with a commercial license. He is a member of the Hawaiian Islands Humpback Whale National Marine Sanctuary's Advisory Council and NMFS's Hawaiian Monk Seal Recovery Team. He is also President of the Hawaii Fishermen's Alliance for Conservation and Tradition

(HFACT), one of two statewide fishermen's groups.

- Craig Severance is a troller and handliner, though says he is not as active as he used to be, and is a weighmaster for Hilo trollers. He is active in the Hawaii fishing community and in marine resource matters: he writes a column for Hawaii Fishing News and is a member of the Western Pacific Fishery Management Council's Science and Statistical Committee, the Hawaiian Monk Seal Recovery Team, and MAFAC (NOAA's Marine Fisheries Advisory Committee). He is also Chair of the Council's Social Science Planning Committee.

- *Background Review: TRT's history with this topic.* Nancy Young provided a brief overview of the TRT's history with the topic of non-longline fisheries (sometimes referred to as "state fisheries" or "other fisheries"), including NMFS and TRT discussions of the scope from as early as the pre-TRT meeting in 2009, and opportunities that have been provided for the TRT to consider fisheries not formally within the identified scope of the TRT. To date, the other fisheries have mainly been considered in the context of research recommendations.

- *Overview of State of Hawaii fisheries data collection.* Alton Miyasaka briefly summarized the information in the first two background materials, which describe the State's mechanisms for fisheries data collection. Alton noted that updated fisheries data are shared regularly with PIFSC, and suggested that any analysis requests should be submitted to PIFSC, since DAR has limited analysis capabilities.

  <u>Discussion (all answers are from Alton unless otherwise noted)</u>

  - How are data shared between DAR and PIFSC?
    - There is a Memorandum of Agreement between DAR and PIFSC which allows for the data to be shared while ensuring protection of data confidentiality.
  - What is a typical timeline for a response to a request for data analysis?
    - Data are provided to PIFSC almost daily, but analysis would be done on PIFSC's timeline, likely depending on what you're asking for and when you ask. The analysis step might take months, depending on work flow and the complexity of analysis.
  - Can spatial data on fishing effort, and not just catch, be made available to the TRT?
    - Yes; again, this would need to be requested through PIFSC.
  - Has preliminary information on marine mammal "interactions" (i.e., depredation as reported on the trip report form) been aggregated?
    - Yes, though the data are fairly sparse. The number of reported "interactions" is low, and the identification of the predator is mainly sharks and dolphins (not false killer whales or blackfish).

- *Review evidence of false killer whale fisheries interactions.* Robin provided a synopsis of his recently published *Marine Mammal Science* paper. The paper evaluates scarring patterns as an indirect approach to assess fisheries interactions. Dorsal fin photographs were scored based on consistency with fisheries interactions.

False killer whale populations showed significant differences in rates of scarring consistent with fisheries interactions (7.1% MHI insular, 1.3% pelagic, and 0% NWHI distinctive individuals), and of those with sex information, all (7) were females. One conclusion is that MHI insular false killer whales are interacting with fisheries at much higher rates than expected, at ~5 times the rate of the pelagic population where bycatch is known to exceed PBR. Caveats to the study and conclusions are described in the paper, such as the possibility of lower mortality in nearshore fisheries because gear is lighter than longlines, though population consequences of any mortalities may be greater because of the significant sex bias.

Discussion (all answers are from Robin unless otherwise noted)

- What proportion of dorsal fin injuries were due to fisheries interaction?
    - There are a number of potential sources of injuries; none of the whales' injuries were consistent with vessel strikes or killer whale attacks and only one animal in the population had evidence of a large shark bite wound. Some injuries are from conspecifics or possibly billfish, while the source of other injuries is unclear. However, the analysis shows that 7.1% of MHI insular false killer whales that have distinctive identifying features have injuries consistent with fisheries interactions.
    - Dorsal fin injuries are secondary, likely from a struggle during a mouth hooking. A more direct measurement of interactions would be from mouth-line injuries. A graduate student is looking at this now, but there is a small amount of data and it is difficult to get photos of whales' mouths.
- In the MHI insular population, do the injury rates vary by social cluster?
    - Yes, there are distinctions, though the differences are not statistically significant. Cluster 3 has a higher proportion than other clusters. The 2012 critical habitat paper showed that cluster 1 and 3 have different spatial use patterns, but we don't know where cluster 2 is spending its time (individuals have not been satellite tagged).
- How will you differentiate injuries from longline versus non-longline fisheries?
    - The main way of assessing the probability of interactions is where the animals spend time relative to where the fishery operates.

- *Introduction to Fishery Ecosystem Assessment Tool (FEAT).* Bryan Dieter, a GIS analyst at PIFSC, provided an overview of FEAT. FEAT was developed by PIFSC's socioeconomics group as a tool to help define fishing communities. It is a geoprocessing tool in the ArcGIS application that automates the workflow to query the fisheries database; merge the data with the fisheries reporting grids, zip codes, and ports of origin; cleanse the data to protect confidentiality; and output map layers. The three main outputs are pounds caught by grid square, Zip Code, and port of origin. The background PowerPoint presentation shows additional analyses beyond FEAT's outputs, such as gear usage patterns, pounds caught by gear type. FEAT uses a modified dataset from DAR, which does not include fishing effort or marine mammal (or other) depredation data.

Discussion (all answers are from Bryan unless otherwise noted)

- How long would it take to produce a map, such as the one on slide 10 of the background presentation?
    - A few hours, depending on how much data refinement is needed after the FEAT output (e.g., modifications and analysis from the query table, and then feeding it back into GIS).
- Can the output query table be used to calculate catch per unit area, rather than catch by grid cell, since cells vary in their areas?
    - Yes, anyone with intermediate GIS skills could take the FEAT output and do a follow-on analysis.
- Can effort data (e.g., # days on the water, # trips, # hooks) be incorporated into FEAT?
    - [Alton] Effort parameters are troublesome because the methods used to measure effort are inexact and leave room for a lot of interpretation. It is sometimes difficult to select a measure of effort appropriate for fishery management or any other purpose. Broader measures of a trip or day are okay for general trend analysis, but it is harder to tease out specific measures.
    - [Phil] Comparing effort measures within gear methods is okay, but it may not be useful to compare a particular measure of effort across gear methods because of differences in how gear is fished. For example, troll fishermen report the number of lines and number of hours fished. The same information from another gear method, such as shortline, where one line might have 1,000 hooks, does not capture the actual differences in effort.
    - [Craig] You also won't be able to tease apart differences in fishing styles from just the effort data. For example, while trolling with lures, you can cover a lot of ground since the vessel is moving at high speed, and it seems highly unlikely a cetacean would take a lure. But trolling with bait may be more visible to cetaceans, and it may leave an odor trail.
- Can we break down the gear characteristics by fishery?[1]
    - [Phil] We can, but we don't know the behavior of blackfish on bait versus artificial lures. We could assume they don't chase lures (which are meant to attract fish by flashes and lights), and that blackfish are more attracted to bait and its smell. I would guess that artificial lure trolling is the dominant method, and if blackfish are not attracted to lures, then it's a low-risk fishery. This could be the basis for a study.
    - [Phil] Trollers use lighter gear compared to ika shibi and handline. For trolling, the monofilament is "light" (30-50 lb) or "heavy" (80 lb), with the weights largely driven by the International Game Fish Association (for what can be used in tournaments), so that's how the gear is usually sold. Ika shibi and handline use much stronger mainline

[1] Following the call, Phil Fernandez and Craig Severance provided to the Work Group additional information on troll fishing, the use of bait versus lures, and depredation. This information is provided as Appendix 2 to this summary.

(~130 lb) with relatively lighter leaderline (~80 lb), since that fishery is interested in catching and landing quickly, not fighting the fish.

- Do some trollers seek dolphins?
    - [Phil] Some of the ahi tuna fishery is fished alongside spotted dolphins. The number of vessels anecdotally varies, and Robin has studied this, but this is the only fishery fishing close to marine mammals.
    - [Craig] This may be related to leeward current gyres, since it happens off leeward Oahu and Kona, but not Hilo.
- Do fishermen fish close to their homes (as indicated by zip codes)? Or do they move between islands?
    - [Phil] Small boat fishermen (generally 26-28' vessels) are very localized, as movement between islands is difficult, though larger boats (30+') can move between islands.
    - [Craig] There is occasional movement east/west. Larger boats (30-38') can move between the north shore of Maui and windward Big Island, some to weather buoys or their own buoys.
- We should examine whether the kaka line fishery is worth pursuing, given the very low effort, and because the gear has been misidentified in the literature.
- Have fish on lures been depredated?
    - [Robin] A paper by Shallenberger documents depredation in the troll fishery; it's likely that the depredating false killer whale is trying to take catch, not bait, unlike smaller dolphins like rough-toothed dolphins that take bait.
- If depredation by false killer whales is primarily on catch, would catch data in FEAT suffice as a proxy for effort?
    - [Craig] There needs to be some consideration of effort; catch data alone are not that useful.
    - [Robin] I am interested in the rate of interactions in different types of gear, so catch and effort are equally important.
- Can we fill in info on line weight, etc., in fisheries descriptions for the TRT?
    - [Craig] Yes, but be aware that there will be regional differences.

- *Proposed fisheries/false killer whale overlap analysis.* Robin provided a brief summary of a portion of the state's recently-submitted ESA Section 6 species recovery grant proposal. The proposal includes a field component and an analysis of the overlap between fisheries and false killer whales by fishing gear, area, and effort to identify the areas where the likelihood of interactions is the greatest. The expected output could be used to work with fishermen on cooperative methods to minimize interactions. Robin said notice should come in March/April whether the grant has been funded.

Next steps

- Nancy will send out a poll to assess availability for a follow-up Work Group call to be held in early December. Phil and Craig will be invited to participate in the follow-up call. [C*ompleted; teleconference date set for 12/8/14*]

- Call participants will send to Nancy any ideas for data analysis, to be compiled, distributed, and discussed on the next Work Group call
- NMFS will consider internally the issues related to TRT scope and membership, including the request to add a Hawaii troll fisherman and/or other non-longline fishermen to the TRT or Work Group, and provide an update to the Work Group and full TRT

Appendix 1 – Background Materials Provided to the Work Group

1. Fisheries information from DAR
2. Excerpt from DAR presentation to PSRG on State Fisheries
3. Baird et al. 2014 – False killer whales and fisheries interactions in Hawaiian waters
4. Intro to FEAT
5. Excerpt from DAR ESA Section 6 grant proposal

Appendix 1 – Document 1

The Department of Land and Natural Resource
Division of Aquatic Resources
Commercial Fisheries Information for the Pacific Scientific Review Group

I. INTRODUCTION

This document provides the Department of Land and Natural Resources (DLNR) Division of Aquatic Resources' (DAR) response to a request for information about Hawaii's state fisheries for the Pacific Scientific Review Group (PSRG). For specific fishery management rules please refer to http://hawaii.gov/dlnr/dar/admin_rules.html.

Since 1948, NOAA Fisheries has had access to the state's fisheries confidential commercial fisheries data under a Memorandum of Agreement with DLNR. In Hawaii, NOAA Fisheries include the Pacific Islands Regional Office and the Pacific Islands Fisheries Science Center (PIFSC). Dr. Kimberly Lowe, Program Manager, Western Pacific Fisheries Information Network (WPacFIN) & Dr. Chris Boggs, Division Chief, Fisheries Research and Monitoring at the PIFSC are able to extract and use the commercial fisheries data for analysis. Generally, this information is used for evaluating fisheries questions such as catch sustainability, but it can also be used to help evaluate the potential for marine mammal interactions with fisheries.

DAR issues commercial marine licenses (CMLs), as well as a range of other licenses and permits. CMLs are issued to individuals (not vessels) and allow an individual to take and land marine life for commercial purposes in the State of Hawaii. CMLs issued to fishers in Hawaii are not specific to a fishery, for example, there is no special category of "trolling" license holders, but the gear or method used on each fishing trip is recorded on the fishing report. Fishing reports are mandatory for commercial fishers and follow up for all licensees occurs when there are unusual reports or discrepancies between the dealer reports and fisher reports. Fishing reports include information on fishing effort and total catch (including bycatch). A description of all fishing report forms is included in Appendix A. Report form templates are in Appendix B. A sample report form (with sample values filled in) is included in Appendix C. The DAR fishing methods definitions are included in Appendix D. Fishers report their fishing locations using grid area charts. Commercial fisheries area grid chart maps are included in Appendix E. Selling even one fish from any gear type requires a CML, and all fishing activities and total catch are to be reported by license holders, regardless of whether anything was caught or the catch was actually sold. Therefore, in theory, this captures non-commercial activity by commercial license holders as well, yet it also means that some of the fishing reported on commercial catch forms is not actually commercial.

In addition to CMLs, DAR also issues commercial bait licenses, aquaculture facility licenses, and aquaculture dealer licenses. DAR is also in the process of developing more general dealer licenses. Permits are issued to allow the use of restricted gear (e.g., to allow the use of small mesh barrier nets when harvesting aquarium fish). The only permits currently issued by DAR are aquarium permits.

II. GEAR TYPES

It is important to note that the LOF and SARs fishery descriptions and definitions are not necessarily identical to state fisheries definitions on reporting forms, because the purposes of these lists are different. The State has defined fisheries with the purpose of conducting stock assessments for target species. In the case of SARs and LOF, NOAA lists and defines fisheries with the purpose of evaluating potential marine mammal interactions. Thus, in SARS and LOF, for example, gear type is more important than target species.

As noted above, DAR fishing methods definitions are included in Appendix C. Below, DAR has narrowed its discussion of gear type to the following: hybrid, kaka line, shortline, trolling and casting, and vessel charters.

Hybrid Gear: Hybrid gear is a menagerie of assorted tuna handline methods, troll, pole and line, casting, and danglers all deployed at different fishing stations on the vessel at the same time. This method specifically targets tuna near the Cross Seamount and around NOAA weather buoys and is fished year-round subject to weather and market conditions. This fishery is conducted from fairly large vessels to accommodate all the equipment necessary. The total hours per trip spent using this gear type can be extracted from the State's data. This fishery is conducted by fulltime highliner fishers with a specific target (tuna). Hybrid gear is not a gear type reported by most fishers who use multiple gears. Multiple or mixed gear 'trips' must be reported separately as individual types of gear (e.g. trolling & jigging). In cases where fishers do not breakdown their gear types on the report forms, DAR follows up with fishers to make sure each gear/method type is captured correctly.

Kaka Line Fishery: The kaka line fishery is primarily conducted with a branched line with multiple baited hooks near the bottom in shallow water; although sometimes it is set horizontally in mid-water for pelagics a little further offshore. Catch report data can be used to determine how much of the effort is in the nearshore grids (which are within two nautical miles of the islands). This effort is more likely near the bottom, and further offshore effort is more likely in mid-water. There is not much pelagic catch reported, so most effort appears to be on reefs near the bottom. As there are very few fishers reporting this gear type, DAR does not believe it to be a real concern for false killer whale interactions. However, this could be verified by extracting hours/kaka line and pelagic versus reef catch species for this fishery from the state data.

Shortline: Shortline fishing is generally conducted offshore. It consists of horizontal branch lines with baited hooks. The line is less than one nautical mile in length and fishers can set multiple lines at the same time. DAR collects data on the number of lines set, so effort associated with both hours and number of lines in the water can be evaluated. However, DAR does not collect data on number of hooks.The average number of hooks on a line could be used as a proxy for potential interaction. Generally, there are 10-20 active shortline fishers annually, but effort would likely be better calculated in the numbers of lines per hour.

Trolling and Casting: In some instances, troll and casting gear may be similar, but the methods differ. Trolling is a fishing method that is conducted from a vessel in motion while the gear is deployed. DAR collects data on three types of trolling methods (green stick, live bait, and lures).

Rod and reel is a gear that can be conducted from shore, such as in the fishing methods of casting/whipping/dunking, or on a stationary vessel, such as in the fishing method jigging. Whether using rod and reel from shore or from a stationary vessel, this fishing method is collectively recorded by DAR as "casting". With respect to potential marine mammal interactions, the distinction between trolling and casting is significant as trolling vessels will set over dolphins. These methods could be separated by analyzing state data by the species catch composition.

Vessel Charters: Through Hawaii Administrative Rules (HAR), vessel charter services are considered to be a commercial fishing operation and the operators (captain and crew) must obtain CMLs. These operators may use the CML to conduct charter and non-charter fishing trips. A fishing trip becomes a chartered vessel operation if it involves a paid fare (tourists). The licensee is required to submit fishing reports on all of their fishing activities and indicate which trips are chartered. Charters must report the gear type/method they use, just like all other CML holders. With respect to the potential to interact with marine mammals, it is double counting to consider "charter vessel" a fishery. When a charter fishes by trolling, the fishery report includes trolling, numbers of lines, and numbers of hours. However, not all of the chartered fishing trips are trolling trips as some operations include bottomfishing or other fishing methods. If charter is designated as a separate fishery for marine mammal management purposes (e.g., on the LOF), any charter fishing should be deducted from the other fishing methods when calculating effort for those methods.

III. DAR DATA USES AND LIMITATIONS

If state fisheries data are analyzed, the raw data can be used to determine effort and long-term averages. Long-term averages are important because fishing changes with markets, weather, season, and regulations, among other things. For more specific temporal or spatial-based efforts, analyses could evaluate when most fishing activity in different fisheries occurs, and where most effort is concentrated (within the available resolution of the grids), and follow up with fishers for more fine scale information.

The following is a list of possible uses of DAR data:

- **Effort:** #licenses, #days fished; #charter trips; #hours fished/method/area; #net sets or throws; #lines, traps, net length; dates (seasons or shifts over time); location by grid
- **Catch:** species, #landed, #lbs landed, #lost/released
- **Depredation:** #lost, predator if known
- **Demographics:** port of landing, fisher names & contact info, vessel name

However, there are limitations to using DAR data to evaluate effort. Limitations that should be kept in mind include the following:

- Not all licensed fishers fish fulltime
- Not all catch is sold commercially, so it is difficult to verify non-commercial catch
- Grid size is large and variable

- Depredation is not well categorized to evaluate marine mammal interactions;
    - Based on the reports, DAR cannot determine if marine mammal was actually "hooked" by the gear
- Although the database runs from 1948-present, depredation questions were only added in Oct 2002
- All gear and method definitions were standardized by DAR in October 2002.
- Online reporting only began recently - Monthly report form came online in Feb 2010 Deep 7 bottomfish trip report form came online in September 2011
- The gear/method definitions used by the State are not directly comparable to NOAA's on the LOF or in the SARs.

DAR is available to provide clarifying information on fishing methods, gear types, and how DAR fishing definitions align with NOAA fishing definitions; however, without an increase in staff and resources, DAR does not currently have the capacity to conduct additional statistical analyses in-house.

IV. CONTACT

For further information, please contact Adi Nycz, the DAR Protected Species and Marine Mitigation Law Fellow at adi.nycz@hawaii.gov; Alton Miyasaka, Acting Program Manager, Commercial Fisheries at alton.k.miyasaka@hawaii.gov; Reginald Kokobun, Research Statistician, at Reginald.m.kokubun@hawaii.gov; and Elia Herman, State Co-Manager, Hawaiian Islands Humpback Whale National Marine Sanctuary at elia.y.herman@hawaii.gov.

V. APPENDICES

Appendix A
Fishing Report Forms - Descriptions

At the time a fisherman is licensed DAR inquires about his/her intended fishing activities. This determines the fish report type that is distributed for reporting purposes. Below is a description of each of the seven possible report forms.

Fishing Report (general form) - this is a versatile report form that is designed to collect catch and effort information except for Bait fishing and Aquarium collecting activities. Depending on circumstances of a fishery, a specific report form will have to be completed (see below). Otherwise, all information is reported on the Fishing Report.

- Of the gear types discussed above, **kaka**, **shortline**, and **trolling** may be reported on this form. In addition, **charter** trips are marked on this form.

MHI "Deep 7" Bottomfish Fishing Trip Report - this report form must be used if any of the Deep 7 bottomfish species was caught, released or lost due to predation on a fishing trip, regardless of fishing methods deployed or if it was a single or multi-day trip. The report is designed to report all of the gears/methods used in the general Fish Report. And, this trip report is due within 5 days after the end of the trip. Note: Deep 7 bottomfish are primarily caught by deep bottom handline. If a bottom handline trip did not result in landing any Deep 7 bottomfish, then this trip should be reported on the Fishing Report.

- Of the gear types discussed above, **trolling** may be reported on this form.

Tuna Handline Trip Report - the report form is completed by offshore fishers who fish at the Cross Seamount and NOAA Weather buoys targeting tuna and are out on a multi-day trip of at least 3-days. They commonly deploy troll, tuna handline, shortline, vertical line and hybrid methods.

- Of the gear types discussed above, **hybrid**, **shortline**, and **trolling** may be reported on this form.

Aku Boat Fishing Report - this report form must be completed by the vessel captain of the fulltime live-bait tuna boat that is allowed to use regulated live baitfish species to catch aku (skip jack tuna). This is a very unique fishery that targets only aku using barb-less hook and line and must use live bait primarily nehu. All of the aku boat fishers are fulltime. In addition to the Commercial Marine License, the vessel captain must obtain the Commercial Bait License to use a large mesh net and to collect unlimited quantities of any regulated baitfish species. The Aku Boat report is designed to report the baitfish effort and catch, and fishing effort and catch for aku.

Bait Fishing Report - this report form is to be completed by licensed fishers (non-aku boat fisher) collecting regulated baitfish species for the commercial fishing operation. Only the bait fishing effort and regulated baitfish species catch should be reported on the Bait Report. In addition to the Commercial Marine License, the fishers must obtain the Commercial Bait License, which allows the use of small mesh net (non-casting configuration), and to collect unlimited quantities of regulated baitfish species except nehu and iao.

Aquarium Fish Report - this report form must be completed if live marine life is collected from the reef for aquarium purposes. In addition to the Commercial Marine License, the collector must obtain the Aquarium Permit, which allows the use of small mesh net.

Net, Trap, and Dive Activity (NTD) report - this report form is completed by fishers who use various net and trap types, and either spear or dive regardless of re-breathers such as SCUBA gear. Since this is an activity report, they must report each separate activity using a specific gear for each area fished. This form is best used if the catch includes many different species. We recommend fishers report this activity on the Fishing Report if they catch only single species.

Appendix B

Fishing Report Forms - Templates

(Please Print)

Fishing Report

FOR OFFICE USE
L/S ________
K/D ________

Licensee Name ______________________________ Commercial Marine License No. [ ][ ][ ][ ][ ]

Vessel Name ______________________________ HA No. [ ][ ][ ][ ] – [ ][ ] USCG No. [ ][ ][ ][ ][ ][ ][ ]

Month & Year Fished ______________________ (Month) [2][0][ ][ ] (Year)

FISHING EFFORT									SPECIES	CATCH		L/R	
Day Fished	Charter Trips "X"	Buoy or Area Fished	Specific Fishing Method (See Methods List)	Hours Fished Per Method/ Area	Number of Net Sets or Throws	Number of Fishing Lines, Traps or Net Length in Feet	No Catch "X"	Port of Landing	Specific Species Name (See Species List)	Number Landed	Pounds Landed	Number of Lost and Released Fish L = Lost to Predator R = Released	
												L	R

Number Lost to Predators: SHARKS ________ (Number) UNKNOWN ________ (Number) OTHER ____________________ (Predator Name) / ________ (Number)

Comments to DAR: ____

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

FR 09/2005

Page ______ of ______

SEND THIS COPY

(Please Print)

MHI "Deep 7" Bottomfish Fishing Trip Report

FOR OFFICE USE
R/L _____
K/D _____

Licensee Name _____ Commercial Marine License No. ☐☐☐☐☐☐

Vessel Name _____ HA No. ☐☐☐☐-☐☐ USCG No. ☐☐☐☐☐☐☐

Trip Start Date: ☐☐ Month ☐☐ Day 2 0 ☐☐ Year Trip End Date: ☐☐ Month ☐☐ Day 2 0 ☐☐ Year Wind Speed (Kt.): check one only ☐ 0-10 ☐ 11-15 ☐ 16-20 ☐ 21+

FISHING EFFORT							SPECIES	CATCH		LOST & RELEASED	
Day Fished	Buoy or Area Fished	Fishing Method (See Methods List)	Hours Fished per Method/Area	Number of Lines or Loop Nets	No Catch "X"	Port of Landing	Species Name (See Species List)	Number Landed	Lbs. Landed (est.)	Number Lost to Predation	Number Released

Number Lost to Predators: Sharks _____ (Number) Unknown _____ (Number) Other _____ / _____ (Number) Crew: CML NO: ☐☐☐☐☐☐ CML NO: ☐☐☐☐☐☐

To Whom Sold: Dealer _____ Dealer _____ Cash or Retail Sale: ☐ √ & file Personal Cash Sales Report

Comments to DAR: _____

Bottomfish Trip Report must be submitted to DLNR-DAR within 5 days after end of trip (§13-74-20(d) & §13-74-2(6), Hawaii Administrative Rules.)

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

MHI D7 BF TR 02/10/2011

(Please Print)

Tuna Handline Fishing Trip Report

Office Use
R/L _____
K/D _____

Licensee Name _____ Commercial Marine License No. ☐☐☐☐☐ HA No. ☐☐☐☐ - ☐☐ USCG No. ☐☐☐☐☐☐☐

Vessel Name _____ Trip Start Date ☐☐ ☐☐ 2 0 ☐☐ (Month Day Year) Port of _____ (Departure) Trip End Date ☐☐ ☐☐ 2 0 ☐☐ (Month Day Year) Port of _____ (Landing)

FISHING EFFORT						CATCH																
Day Fished	Buoy or Area Fished or Transit	Fishing Method HY=Hybrid IS=Ika-Shibi PA=Palu-Ahi TL=Trolling Lures (See Methods List)	Hours Fished Per Method /Area	No. of Fishing Lines (Not for Hybrid)	No Catch "X"	Bigeye tuna (Mebachi) (6) Weight (1-40 Lbs.)		Bigeye tuna (Mebachi) (6) Weight (40+ Lbs.)		Yellowfin tuna (Ahi) (3) Weight (1-40 Lbs.)		Yellowfin tuna (Ahi) (3) Weight (40+ Lbs.)		Print Species Name (See Species List)		Print Species Name (See Species List)		Other Species Landed and Lost and Released (See Species List)			Number of Lost & Released Fish L = Lost R = Released	
						No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	Species Name	No. Landed	Lbs. Landed	L	R

Number Lost to Predators: SHARKS _____ (Number) UNKNOWN _____ (Number) OTHER _____ (Predator Name) / _____ (Number) Comments to DAR: _____

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii
THFTR 8/2002

PAGE_____of_____

SEND THIS COPY

(Please Print)

Aku Boat Fishing Report

FOR OFFICE USE	
R/L	
K/D	

Licensee Name _____ Commercial Marine License No. ☐☐☐☐☐ Month and Year Fished _____ (Month) 2 0 ☐☐ (Year)

Vessel Name _____ HA No. ☐☐☐☐ – ☐☐ USCG No. ☐☐☐☐☐☐☐

FISHING EFFORT						CATCH							BAIT USED				
Day Fished	Buoy Fished	Area Fished	No. of Men	No Catch "X"	Port of Landing	Aku (Skipjack) (2)		Yellowfin tuna (Ahi) (3)		Other Species Landed Examples: Bigeye tuna, Kawakawa, Mahimahi, etc. (See Species List)			Nehu (41)	Sardine (46)	Iao (42)	Other Bait Species Examples: Piha, Tabai, etc.	
						No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	Species Name	No. Landed	Lbs. Landed	Buckets Used	Buckets Used	Buckets Used	Species Name (See Species List)	Buckets Used

BAIT FISHING SECTION

Day Fished	Location Fished	Number of Net Sets	No Catch "X"	Nehu (41)	Sardine (46)	Iao (42)	Other Bait Species Examples: Piha, Tabai, etc.	
				Buckets Taken	Buckets Taken	Buckets Taken	Species Name (See Species List)	Buckets Taken

Day Fished	Location Fished	Number of Net Sets	No Catch "X"	Nehu (41)	Sardine (46)	Iao (42)	Other Bait Species Examples: Piha, Tabai, etc.	
				Buckets Taken	Buckets Taken	Buckets Taken	Species Name (See Species List)	Buckets Taken

Division of Aquatic Resources, Department of Land and Natural Resources
ABFR 8/2002

Page_____of_____

SEND THIS COPY

(Please Print)

Bait Fishing Report

FOR OFFICE USE
R/L _____
X/D _____

Licensee Name_____ Commercial Marine License No. [ ][ ][ ][ ][ ]

Vessel Name_____ HA No. [ ][ ][ ][ ] - [ ][ ] USCG No. [ ][ ][ ][ ][ ][ ][ ]

Month and Year Fished _____ (Month) 2 0 [ ][ ] (Year)

Day Fished	Location Fished	Number of Net Sets	No Catch "X"	Nehu (41) Gallons Taken	Sardine (46) Gallons Taken	Iao (42) Gallons Taken	Tabai (43) Gallons Taken	Piha (44) Gallons Taken	Other Bait Species Species Name	Other Bait Species Gallons Taken

BFR Rev 8/2002 Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

PAGE_____of_____

SEND THIS COPY

Please Print

Net, Trap, & Dive Activity Report

FOR OFFICE USE	
R/L	
K/D	

HEADER

Licensee Name _____ Commercial Marine License No. ☐☐☐☐☐

Vessel Name _____ HA No. ☐☐☐☐ – ☐☐ USCG No. ☐☐☐☐☐☐☐

Port of Landing _____

FISHING EFFORT

Date Fished ☐☐ (Month) ☐☐ (Day) 2 0 ☐☐ (Year)

Fishing Method Used _____ (One method per form)

Net Dimensions in Feet _____ (Length) X _____ (Height)

No. of Net Sets or Throws _____ (Number of times)

No. of Traps, Crab Nets _____ (Traps or Crab Nets harvested)

No. of Divers _____ (Methods SS or DV)

Area Fished _____ (One area per form)

Hours Fished _____ (Soak Time)

No catch "X" ☐ (Enter an X if you did not catch anything)

INVERTEBRATE CATCH

Species Name	No. Landed	Lbs. Landed	No. Released		No. Lost
			Berried	Minimum Size	
Red Spiny Lobster (716)					
Green Spiny Lobster (717)					
Haani (719) (Humpbacked slipper lobster)					
Squammosus (Scaly slipper lobster) (718)					
Kona Crab (Frog crab) (701)					
White Crab (Kuahonu) (702)					
Laevigatus (Shrimp, ama ebi) (708)					
Ensifer (Shrimp) (709)					
He e (Day tako) (726)					
OTHER SPECIES (See Species List)					

FISH CATCH

Species Name		No. Landed	Lbs. Landed	Number Lost	Number Released
Scad					
Akule (Bigeye)	(28)				
Opelu (Mackerel)	(81)				
Goat Fish					
Kumu (Whitesaddle)	(52)				
Moana (Manybar, moano)	(68)				
Moana kali (Blue, moana kea)	(206)				
Red weke (Yellowfin)	(127)				
Weke nono (Pflueger's, moe lua = weke ula)	(24)				
White weke (Yellowstripe, weke a)	(128)				
Unicorn & Surgeon Fish					
Kala (All unicornfish with horns)	(47)				
Umaumalei (Orangespine)	(125)				
Kole (Goldring)	(51)				
Maiko (Blueline)	(60)				
Manini (Convict)	(64)				
Naenae (Olive tang)	(72)				
Palani (Eyestripe)	(86)				
Pualu (Yellowfin)	(92)				
Other Species					
Aawa (Hawaiian hogfish)	(25)				
Aholehole (Flagtail)	(27)				
Aweoweo (Glasseye)	(34)				
Menpachi (Soldierfish, u u)	(100)				
Mu (Bigeye emperor)	(71)				
Nenue (Gray chub)	(74)				
Taape (Bluestriped snapper)	(114)				
Toau (Blacktail snapper)	(115)				
Uhu (Bullet parrotfish)	(96)				
OTHER SPECIES (See Species List)					

Number Lost to Predators: SHARKS _____ (Number) UNKNOWN _____ (Number) OTHER _____ (Predator Name) / _____ (Number)

Comments to DAR: _____

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

NTDAR 5/2004

Page ____ of ____

SEND THIS COPY

Appendix C
Fishing Report Forms - Sample

(Please Print)

FOR OFFICE USE
L/S _____
K/D _____

Fishing Report

Licensee Name *John Doe* Commercial Marine License No. 0 1 0 0 0

Vessel Name *Doe's Boat* HA No. 0 1 0 0 - C F USCG No. 0 0 0 0 0 0 0

Month & Year Fished *October* (Month) 2 0 0 2 (Year)

FISHING EFFORT									SPECIES	CATCH		L/R	
Day Fished	Charter Trips "X"	Buoy or Area Fished	Specific Fishing Method (See Methods List)	Hours Fished Per Method/ Area	Number of Net Sets or Throws	Number of Fishing Lines, Traps or Net Length in Feet	No Catch "X"	Port of Landing	Specific Species Name (See Species List)	Number Landed	Pounds Landed	Number of Lost and Released Fish L = Lost to Predator R = Released L	R
Example #1: Trolling Fishing Trip													
2		404	IH	2		3		Haleiwa	Opelu	18	12		
		424	TL	1.5		4	X						
		II		.5		6			Aku	3	9	1	
		↓	↓	↓		↓			YF Tuna	1	6		
		424	TB	2		1			Stripe Marlin	1	89		
		425	TL	1.5		4	X						
		J	TB	2		6			Mahimahi	9	210		
↓		424	TL	2		4	X	↓					
Example #2: Charter Trolling Multiple Fishing Trips (half-day)													
4	X	422	TL	3.5		6	X	Kewalo					
	X	BO	TL	1		6			Blue marlin				1
									Shortbill spearfish	1	35		
↓	↓	↓	↓	↓		↓		↓	YF Tuna	3	105		
4	X	422	TL	2		6	X	Kewalo					
	X	BO	TL	1.5		6			Mahimahi	5	115		
		↓		↓		↓			YF Tuna	6	175		
↓	↓	HH	↓	1		5		↓	Ono	1	16		
Example #3: Tuna Handline Fishing Trips													
6		121	TL	2.5		4		Honokohau	Mahimahi	2	20		
		↓	↓	↓		↓			Aku	11	90		
		121	IS	8		4			BE Tuna	28	900		
		C	CS	1.5		2			YF Tuna				2
↓		↓	↓	↓		↓		↓	Aku	3	25		
8		120	PA	5.5		3		Honokohau	YF Tuna	15	400		3
		120	TB	3		4			Blue marlin	1	160		
		120	IS	6.5		4			BE Tuna	18	550		
		↓	↓	↓		↓			YF Tuna	3	45		1
↓		100	TL	2.5		2	X	↓					

Number Lost to Predators: SHARKS _____ (Number) UNKNOWN *1* (Number) OTHER _____ (Predator Name) / _____ (Number)

Comments to DAR: _____

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii
FR 09/2005

Page *1* of *3*

SAMPLE

Appendix D

DAR Fishing Gear Definitions (https://dlnr.ehawaii.gov/cmls-fr/pdf/FishingMethodList.pdf)

Line

1. **Casting (CS)**: Fishing from shore or a vessel using a pole and casting reel. Includes techniques such as whipping, jigging, dunking, slide baiting, fly-fishing or any technique using a pole and line.
2. **Deep-sea handline (BF)**: Fishing from a vessel using a vertical mainline with single/multiple baited hooks and weight, lowered near the bottom.
3. **Inshore handline (IH)**: Same as Deep-sea handline to include artificial lures (damashi). With the exception of fishing tackle usually consisting of lighter gear than deep-sea handline.
4. **Kaka line (KL)** (set line): Fishing with a mainline less than one nautical mile in length from which branch lines of baited hooks are attached. Line is set horizontally, on or near the bottom, or in shallow mid water.
5. **Shortline (SL)**: Fishing using a horizontal mainline, less than or equal to one nautical mile in length and suspended from the ocean surface with floats, from which leaders with baited hooks are suspended.
6. **Verticalline (VL)**: Fishing using a vertical mainline, suspended from the surface with float, from which leaders with baited hooks are attached and ending with a terminal weight.
7. **Ika-Shibi (IS)**: Fishing (mainly at night) using a vertical mainline with high-test monofilament leader, from which is suspended a baited hook. Muhe'e ("true squid") or opelu, typically used as bait.
8. **Palu Ahi (PA)**: Similar to "ika-shibi". Fishing (usually daytime) with a baited hook and cut pieces of bait ("chum"). This method also includes jigging for tunas while drifting, and the use of "danglers" for reporting purposes.
9. **Trolling:** Fishing by towing or dragging line(s) with artificial lure(s) or dead or live bait using a sail, surf or motor-powered vessel.
    a) **Trolling with Bait (TB)**: Trolling with bait (dead or alive.)
    b) **Trolling with Lures (TL)**: Trolling with artificial lures.
    c) **Trolling with Green Stick (TS)**: Trolling with the bird, green stick and danglers.

Net

1. **Crab net (CN)**: Fishing with a small lift net that is used to catch crabs.
2. **Gill net (GN)** (fence net, cross net, surround net, lay net, and pai pai net, etc.): Fishing with a net that usually captures fish by entangling the fish's head in the strands of mesh behind the gill covers.
3. **Kona crab net (KN)**: Fishing with a fine stranded netting stretched over a metal frame to form a flat net. Multiple baited nets are set on sandy bottoms trapping crabs when they get entangled in the mesh.
4. **Lift net (LN)**: Fishing with a net that captures fish by raising the net from beneath a school of fish. Normally fish are encouraged over and into the net with chum.
5. **Lobster net (LB)**: Fishing with a net with large eye mesh used to entangle lobsters.
6. **Purse seine net (PN)**: Fishing with a net that is used to surround a school of fish and is closed by drawing the bottom of the net together to form a bag.
7. **Seine net (SN)** (hukilau, beach seine, seine, dragnet, pen, etc.): Fishing with a net by moving it through the water to surround fish by corralling and trapping them within the walls of the net.
8. **Throw net (TN)**: Fishing with a round shaped weighted outer perimeter net that is thrown over fish.
9. **Shrimp trawl net (TR)**: Fishing with a net that is dragged through the water by the vessel.

Trap

1. **Bullpen trap (BT)**: Fishing with net(s) fixed in position to form a large stationary enclosure.
2. **Trap/Trap fishing:** Fishing with any of the various fishing devices made into the shape of a box, or enclosure, with one or more openings that allow marine life to enter but keep them from leaving.
    a) **Crab Trap (CT):** Fishing with traps primarily targeting crabs.
    b) **Fish Trap (FT):** Fishing with traps primarily targeting fish.
    c) **Lobster Trap (LT):** Fishing with traps primarily targeting lobsters.
    d) **Shrimp Trap (ST):** Fishing with traps primarily targeting shrimp.

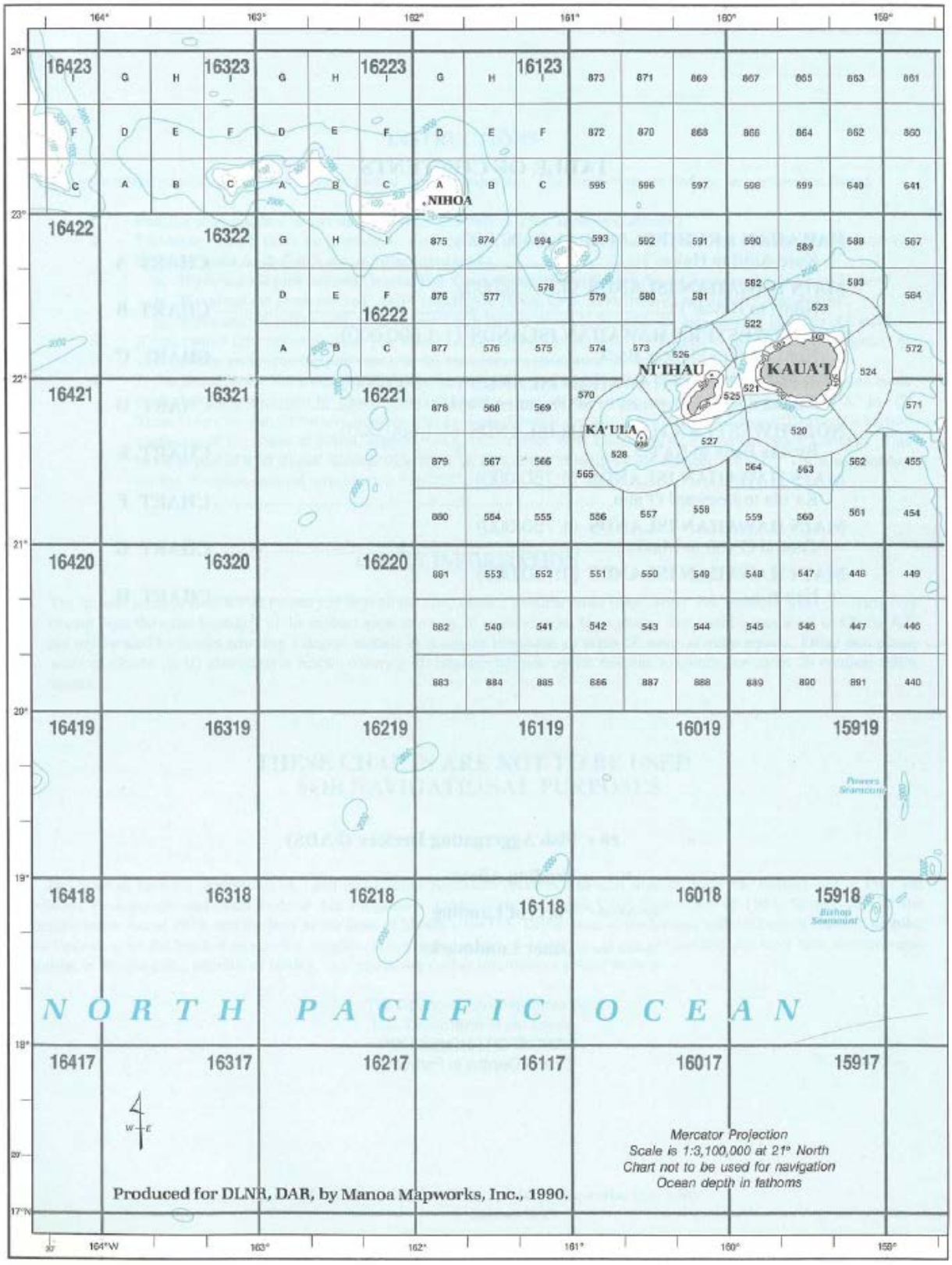
Dive

1. **Black coral dive (CD)**: Divers harvesting black coral using SCUBA or re-breathers.
2. **Diving (DV)**: Fishing while swimming free dive (skin diving) or swimming with the assistance of compressed gases (SCUBA, re-breathers, etc.). Examples are lobster or namako diving. Does not include diving with a spear (see spearfishing), a net (see various nets), or for limu or opihi (see handpicking).
3. **Spear/Spearfishing (SS)**: Fishing with a shaft with one or more sharpened points at one end usually associated with diving. Includes bow and torch fishing.

Other

1. **Handpicked (HP)**: Hand harvesting marine life by various methods.
2. **Submersible (SU)**: (for precious coral): Using a vessel (manned or unmanned) capable of diving and/or remaining underwater for selectively harvesting deepwater precious corals.

Appendix E
Commercial fisheries area grid charts



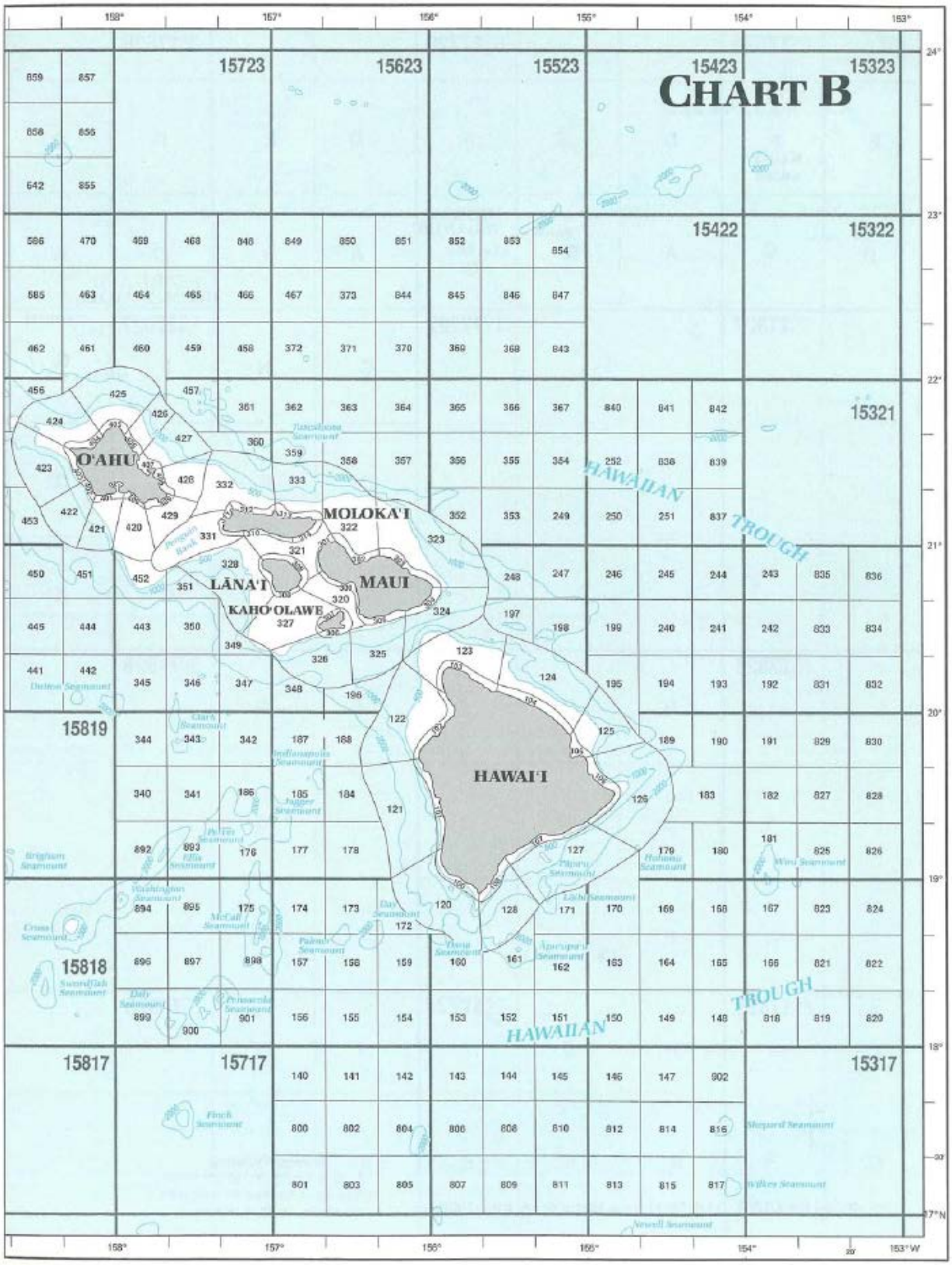


CHART B
O'AHU
MOLOKA'I
LĀNA'I
MAUI
KAHO'OLAWE
HAWAI'I
HAWAIIAN TROUGH
15723
15623
15523
15423
15323
15422
15322
15321
15819
15818
15817
15717
15317

Appendix 1 – Document 2

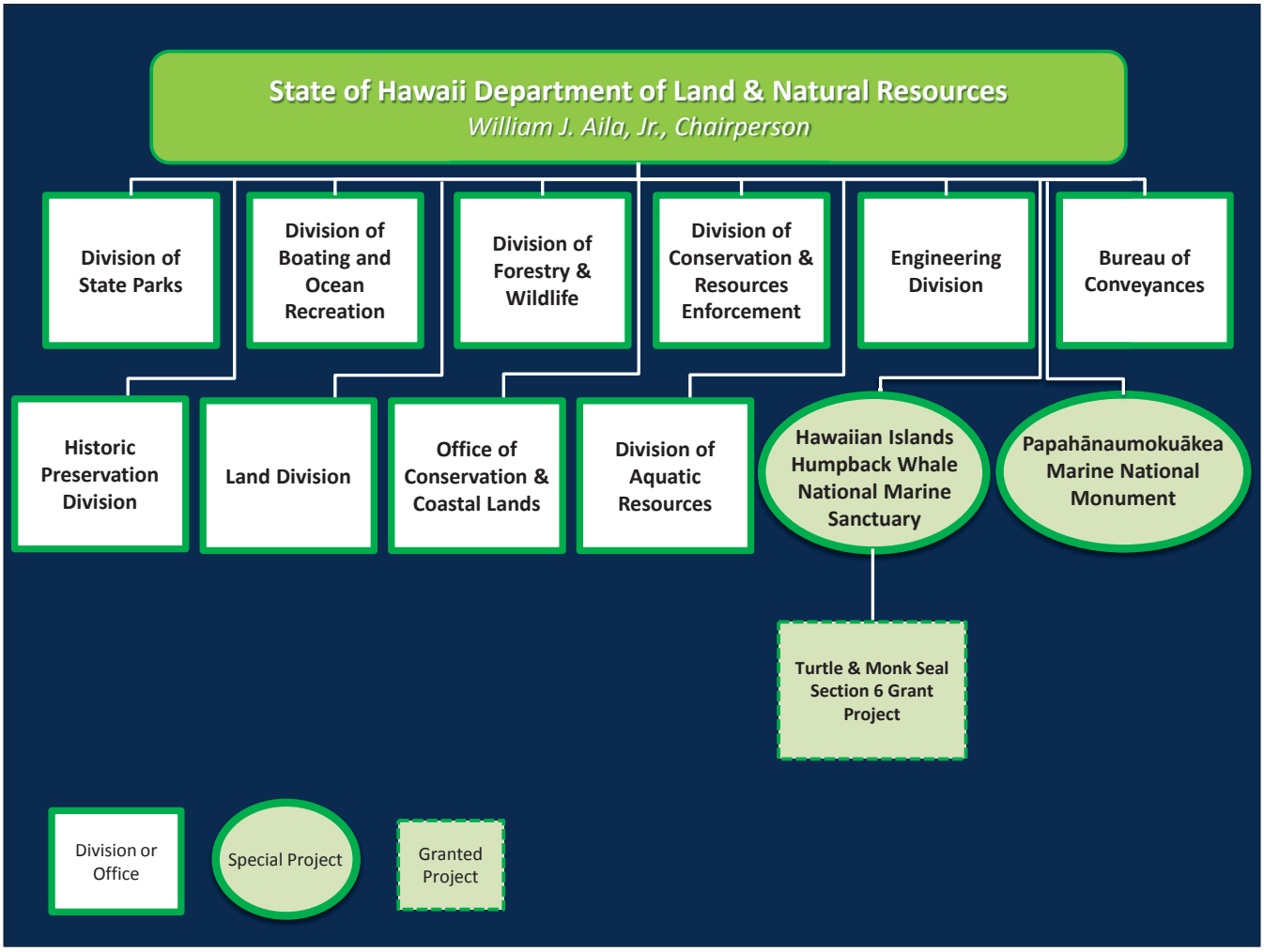
State of Hawaii PSRG Presentation 2014

Division of Aquatic Resources
Department of Land and Natural Resources
State of Hawai'i

"Fish for the Future"

Outline

- DLNR and DAR organizational overview
- State Commercial Fisheries
  - Commercial Marine License
  - Fishing methods/gear of interest to PSRG
  - Data availability and reporting limitations
  - Fishing Report Forms
- Other State Activities of interest to PSRG
  - ESA Section 6 – Monk Seals
  - ESA Section 6 – False Killer Whales
  - Hawaiian Islands Humpback Whale Sanctuary Management Plan Review



Division of Aquatic Resources

- Department of Land and Natural Resources
  - Responsible for managing Hawaii's unique and limited natural, cultural and historic resources

- Division of Aquatic Resources (DAR)
  - Responsible for managing the State's aquatic resources (all life that lives in salt, fresh, or brackish water)

DAR issued (Marine) Fishing Licenses, Permits, and Registrations

- Commercial Marine License
- Bait License
- Kona Crab/Lobster Closed Season Sales Licenses
- Bottomfish Fishing Vessel Registration
- Lay Gill Net Registration
- Aquarium Permit and West Hawaii Aquarium Permit
- Special Marine Product License
- Aquaculture Facility License
- Aquaculture Dealer License
- Special Activity Permit
- Kaunakakai fishing Permit
- Papahānaumokuākea Access Permit

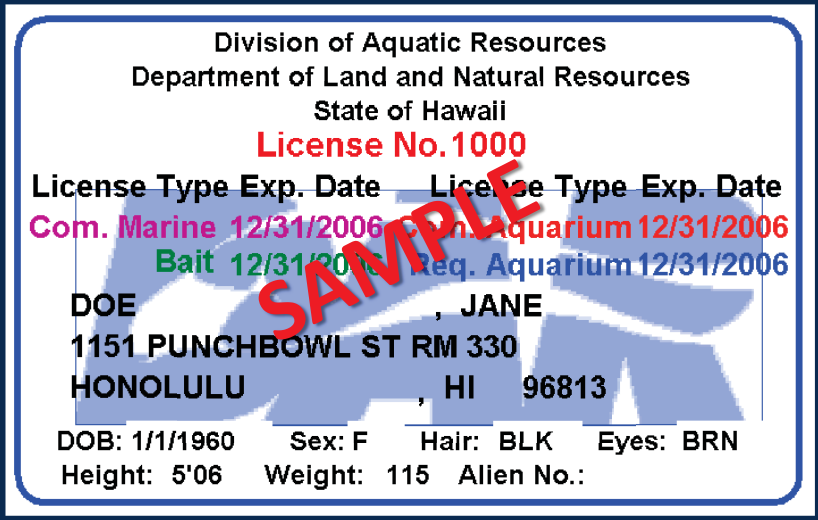
→ *DAR in process of establishing a several new licenses*

Commercial Marine License (CML)

- Issued to fishers to take and land marine life for commercial purposes
- Issued to individuals (captain and crew), not vessels
- Not specific to a fishery (e.g., there is no "trolling" license or "shortline" license, etc.)
- Specific fishery information is captured on specialized reporting forms

Commercial Marine License

(189-2, HRS & Section 13-74-20, HAR)


Division of Aquatic Resources
Department of Land and Natural Resources
State of Hawaii
License No. 1000

License Type	Exp. Date	License Type	Exp. Date
Com. Marine	12/31/2006	Com. Aquarium	12/31/2006
Bait	12/31/2006	Req. Aquarium	12/31/2006

SAMPLE

DOE , JANE
1151 PUNCHBOWL ST RM 330
HONOLULU , HI 96813

DOB: 1/1/1960 Sex: F Hair: BLK Eyes: BRN
Height: 5'06 Weight: 115 Alien No.:

Fishing methods/gear of interest to PSRG

- Hybrid
- Kaka Line
- Shortline
- Vertical Line
- Trolling
- Casting

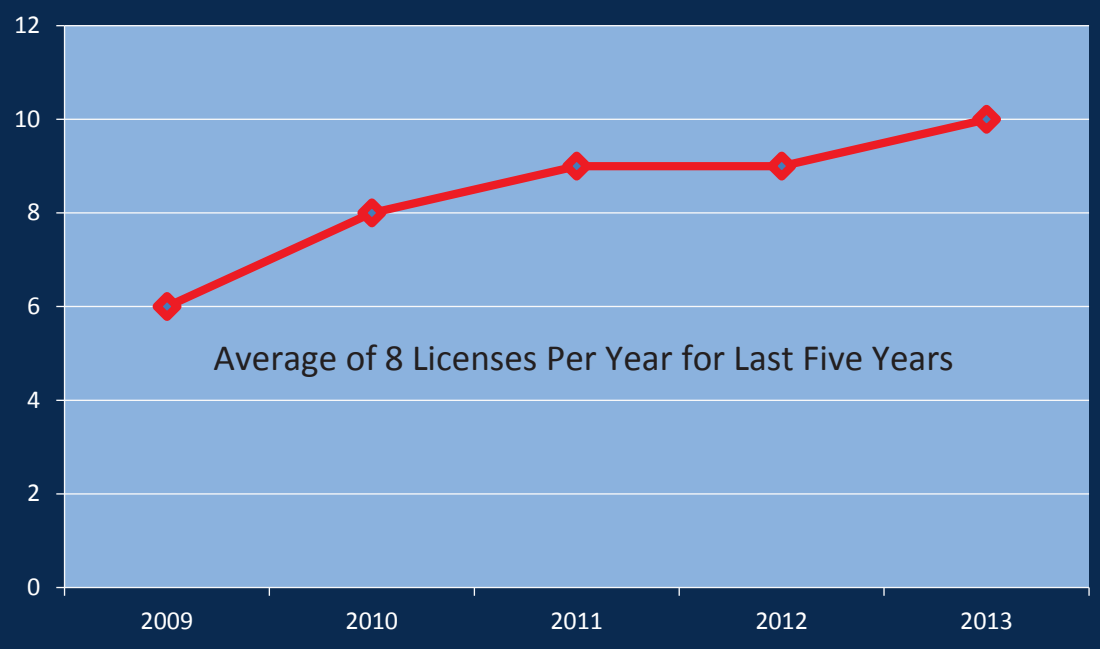
Fishing methods/gear of interest: Hybrid

- Mix of assorted tuna handline methods (palu-ahi, ika-shibi, pole and line, casting, and danglers)
- All methods deployed from different fishing stations on the same vessel at the same time
- Target species: Tuna near Cross Seamount and around NOAA weather buoys; fished year-round
- Conducted from large vessels
- Average of 8 licensees reported using this gear per year
  (5 year average, 2009-2013)

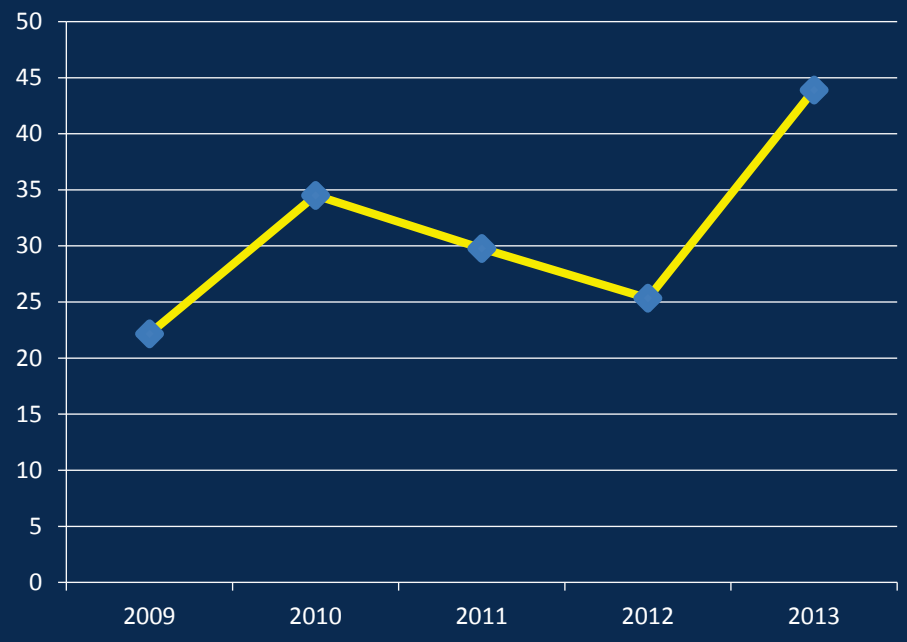
→ *Hybrid is NOT the same as using multiple gear types in one trip*

- Hybrid = multiple gears fished off different parts of the boat at the same time
- Multiple gear types = fisher uses different gear types during one trip (e.g., trolls on the way out; bottomfishes; trolls on the way back)

Hybrid Gear
Number of Licenses Per Year



Hybrid Gear
Average Annual Fishing Days Per Licensee



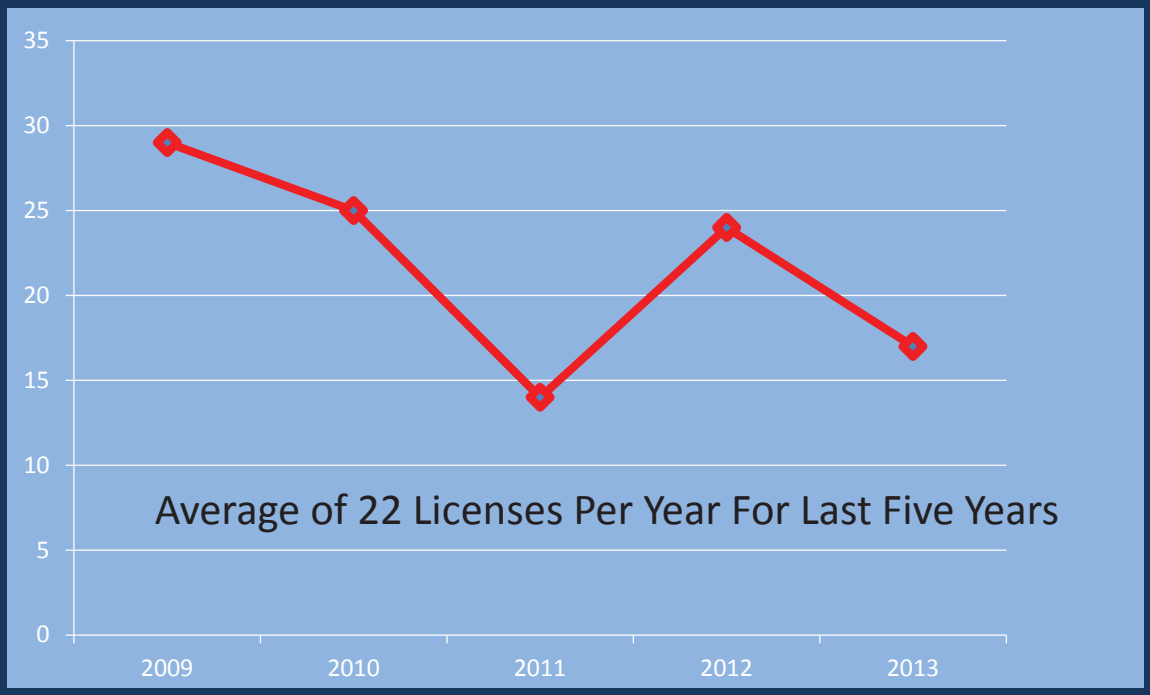
Average 32 Fishing Days Per Year
Per License Over Last Five Years

Fishing methods/gear of interest: Kaka Line

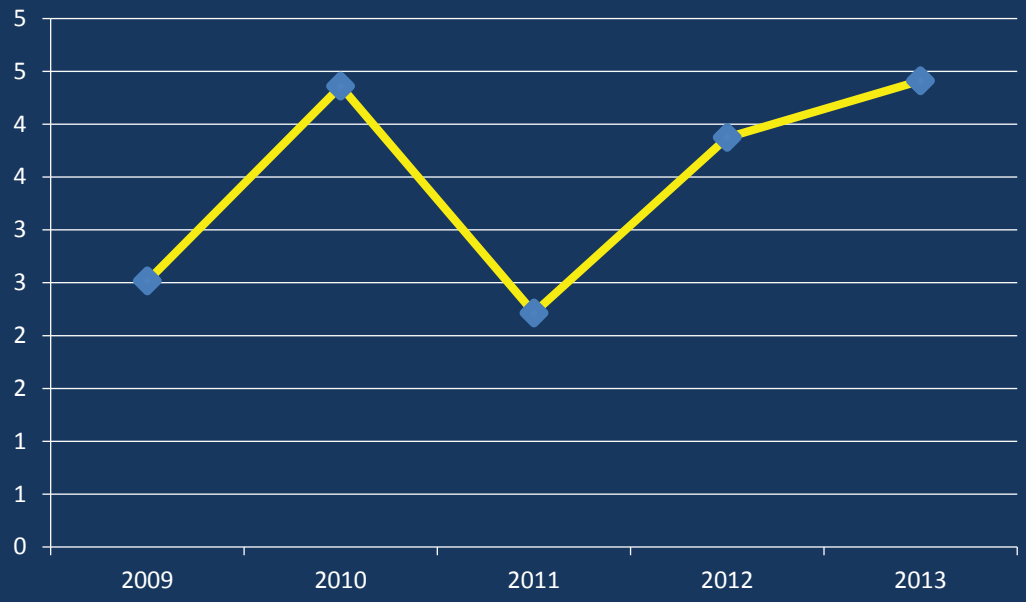
- Horizontal branched lines
- Multiple hooks near the <u>bottom or in shallow mid-water</u>
- Conducted <u>nearshore</u>
- Target species: reef fishes (papio, oio, goatfishes)
- Average 22 licensees reported using this gear per year (5 year average)

→*Because target is reef fish gear is small, therefore serious injury or mortality is less likely*

Kaka Line
Number of Licenses Per Year



Kaka Line
Average Annual Fishing Days Per Licensee



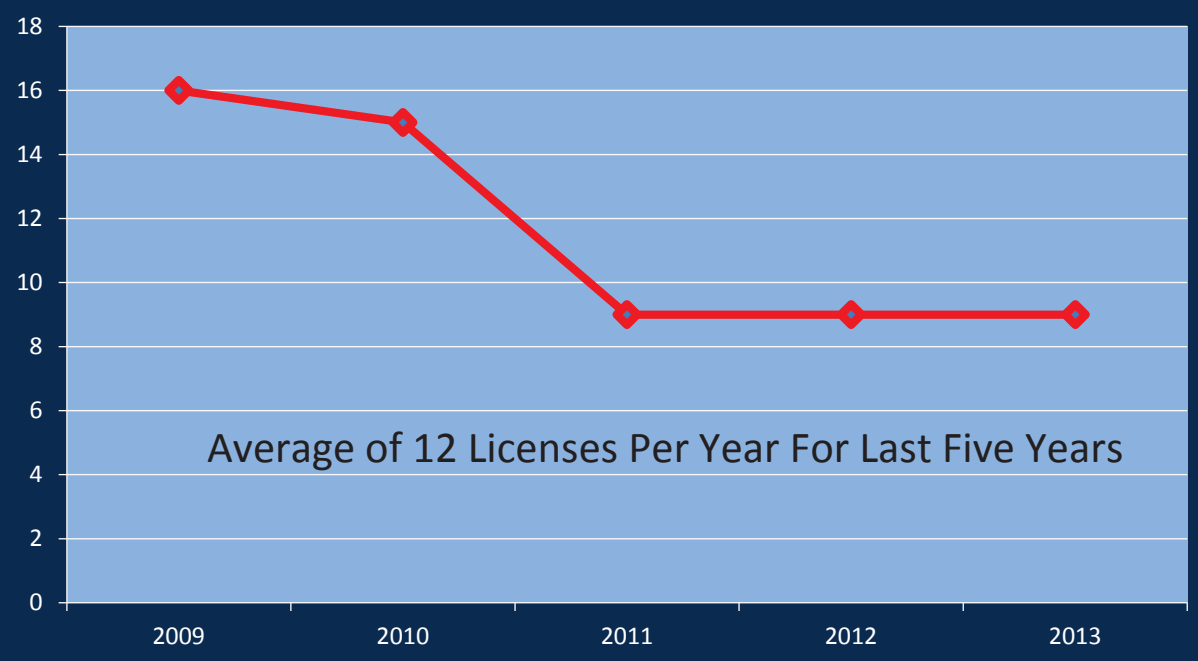
Average of 3 Fishing Days Per Year
Per License For Last Five Years

Fishing methods/gear of interest: Shortline

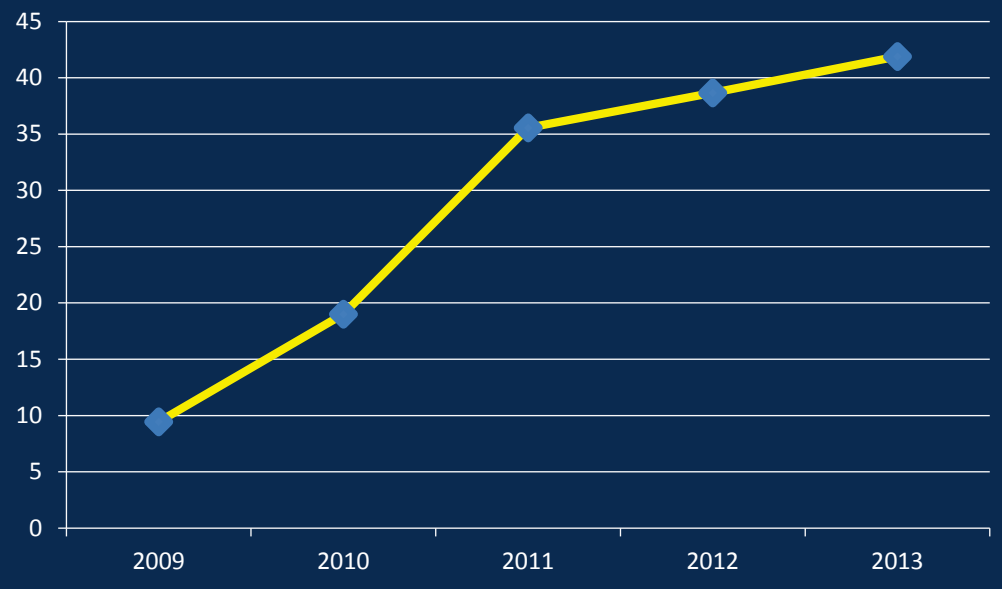
- Horizontal branched lines
- Lines are supported by floats at the surface
- Primarily conducted offshore (seamounts)
- Target species: bigeye and yellowfin tuna, mahimahi
- Average 12 licensees reported using this gear per year (5 year average)

→ *NOT included in longline regulations because main line is less than 1 nm in length*

Shortline
Number of Licenses Per Year



Shortline
Average Annual Fishing Days Per Licensee



Average of 26 Fishing Days Per Year
Per License For Last Five Years

Fishing methods/gear of interest: Vertical Line

- Vertical mainline, suspended from the surface with a float, from which leaders with baited hooks are attached and end with a terminal weight
- Primarily conducted offshore
- Target species: bigeye and yellowfin tuna, monchong
- Nine licenses with 35 active fishing days (5 year average, 2009-2013)

Fishing methods/gear of interest: Trolling and Casting

- Trolling
  - Conducted from a vessel in motion
  - Uses a rod & reel to tow or drag lines
  - Conducted nearshore and offshore
  - Target species: bigeye and yellowfin tuna, mahimahi, ono, aku, striped and blue marlin
  - 1,680 licensees with 35,018 active fishing days (5 year average)
- Casting
  - Conducted from shore or from a stationary vessel
  - Uses a rod & reel
  - Target species: varies – nearshore and small offshore species
  - 215 licensees with 1,565 active fishing days (5 year average)

→ *With respect to potential cetacean interactions, the distinction between trolling and casting is significant as boats that are trolling may set over dolphins*

Clarification of Charter Fishing

- Currently Hawaii views charter fishing differently than NOAA
- In Hawaii, charters must report the gear type/method they use, just like all other CML holders.
- CML holder submits fishing reports on all of their fishing activities and indicates which trips are chartered.
- App. 200 vessels statewide offer charted trips for hire

→ *"Charter fishing" is a subset of commercial fishing activities.*

Fishing Reports

- Commercial Marine Licenses require reporting monthly or by trip
- Fishing reports are mandatory and include information on fishing gear, fishing effort, total catch, fishing location, and depredation
- Late reports are considered delinquent and subject to penalties

New penalty system led to increase in compliance from 33% to 95%

Data

- All state commercial fisheries dependent data since 1948 have been provided to NOAA
- Data Uses
  - Gear
  - Effort
  - Catch
  - Demographics
  - Depredation (since October 2002)

Number Lost to Predators: SHARKS _____ (Number) UNKNOWN _____ (Number) OTHER _____ (Predator Name) / _____ (Number)

Comments to DAR: _____

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

FR 09/2005

Page _____ of _____

SEND THIS COPY

Reporting Limitations

- Not all licensed commercial fishers are fulltime fishers
- Under-reporting of total catch
- Area fished grid size is large and variable
- Fishing gear definitions standardized in 2002
- Online reporting began Feb 2010
- Differences in gear/method definitions exist between State and NOAA
- Reported catch and effort information is not validated by observers on the vessel
- Depredation not well categorized to evaluate marine mammal interactions
- Depredation questions only added in Oct 2002

Fishing Methods/Gear (most relevant to PSRG)

7 fishing report forms

→ 3 of potential interest to PSRG

- **Fishing Report** (general form)
- **MHI "Deep 7" Bottomfish Fishing Trip Report**
- **Tuna Handline Trip Report**

Fishing Report (general form)

(may include kaka, shortline, trolling + identification of charter trips)

(Please Print)

Fishing Report

FOR OFFICE USE
L/S _____
K/D _____

Licensee Name _____ Commercial Marine License No. ☐☐☐☐☐

Vessel Name _____ HA No. ☐☐☐☐ - ☐☐ USCG No. ☐☐☐☐☐☐☐

Month & Year Fished _____ (Month) 2 0 ☐☐ (Year)

FISHING EFFORT									SPECIES	CATCH		L/R	
Day Fished	Charter Trips "X"	Buoy or Area Fished	Specific Fishing Method (See Methods List)	Hours Fished Per Method/ Area	Number of Net Sets or Throws	Number of Fishing Lines, Traps or Net Length in Feet	No Catch "X"	Port of Landing	Specific Species Name (See Species List)	Number Landed	Pounds Landed	Number of Lost and Released Fish L = Lost to Predator R = Released	
												L	R

Number Lost to Predators: SHARKS _____ (Number) UNKNOWN _____ (Number) OTHER _____ (Predator Name) / _____ (Number)

Comments to DAR: _____

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii
FR 09/2005

Page _____ of _____

SEND THIS COPY

MHI "Deep7" Bottomfishing Trip Report

(may include trolling)

(Please Print)

MHI "Deep 7" Bottomfish Fishing Trip Report

FOR OFFICE USE
R/L _____
K/D _____

Licensee Name _____ Commercial Marine License No. ☐☐☐☐☐☐

Vessel Name _____ HA No. ☐☐☐☐-☐☐ USCG No. ☐☐☐☐☐☐☐

Trip Start Date: ☐☐ (Month) ☐☐ (Day) 2 0 ☐☐ (Year) Trip End Date: ☐☐ (Month) ☐☐ (Day) 2 0 ☐☐ (Year) Wind Speed (Kt.): check one only ☐ 0-10 ☐ 11-15 ☐ 16-20 ☐ 21+

FISHING EFFORT							SPECIES	CATCH		LOST & RELEASED	
Day Fished	Buoy or Area Fished	Fishing Method (See Methods List)	Hours Fished per Method/Area	Number of Lines or Loop Nets	No Catch "X"	Port of Landing	Species Name (See Species List)	Number Landed	Lbs. Landed (est.)	Number Lost to Predation	Number Released

Number Lost to Predators: Sharks _____ (Number) Unknown _____ (Number) Other _____ (Number) / _____ (Number)

Crew: CML NO: ☐☐☐☐☐☐ CML NO: ☐☐☐☐☐☐

To Whom Sold: Dealer _____ Dealer _____ Cash or Retail Sale: ☐ √ & file Personal Cash Sales Report

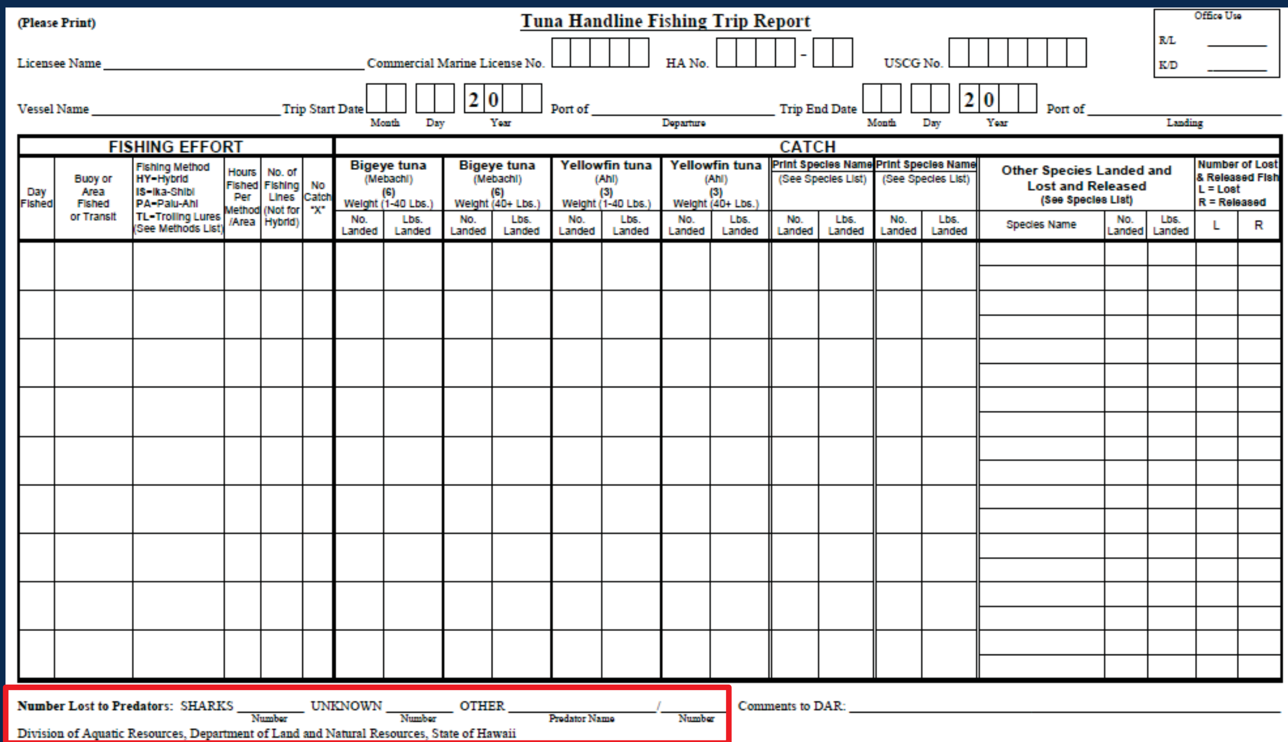
Comments to DAR: _____

Bottomfish Trip Report must be submitted to DLNR-DAR within 5 days after end of trip (§13-74-20(d) & §13-74-2(6), Hawaii Administrative Rules.)
Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii
MHI D7 BF TR 02/10/2011

Page ____ of _____

Tuna Handline Fishing Trip Report

(May include hybrid, shortline, and trolling)



(Please Print)

Tuna Handline Fishing Trip Report

Office Use
R/L ______
K/D ______

Licensee Name ______ Commercial Marine License No. [ ][ ][ ][ ][ ] HA No. [ ][ ][ ][ ]-[ ][ ] USCG No. [ ][ ][ ][ ][ ][ ][ ]

Vessel Name ______ Trip Start Date [ ][ ] Month [ ][ ] Day [2][0][ ][ ] Year Port of ______ Departure Trip End Date [ ][ ] Month [ ][ ] Day [2][0][ ][ ] Year Port of ______ Landing

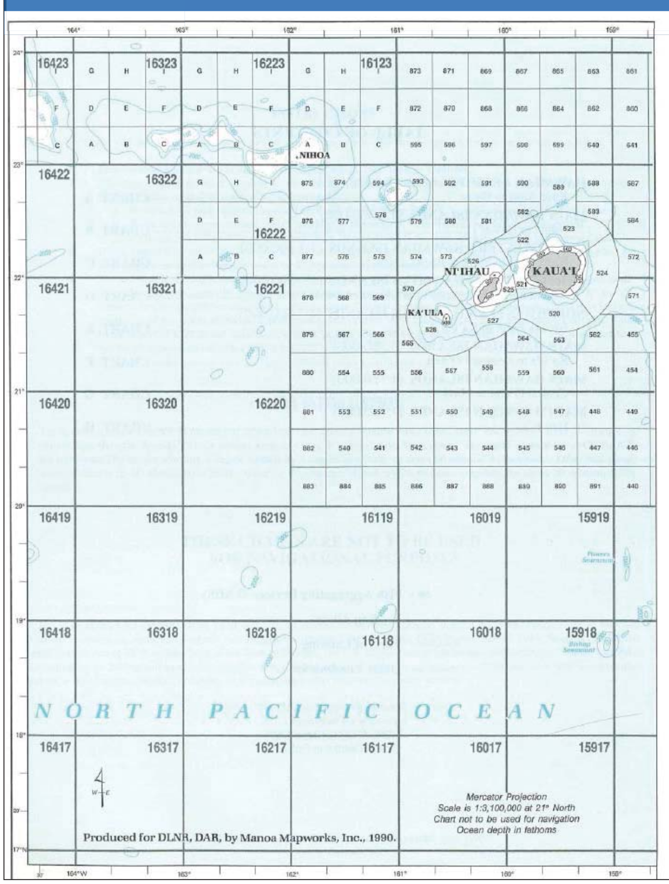
FISHING EFFORT						CATCH																		
Day Fished	Buoy or Area Fished or Transit	Fishing Method HY=Hybrid IS=Ika-Shibi PA=Palu-Ahi TL=Trolling Lures (See Methods List)	Hours Fished Per Method /Area	No. of Fishing Lines (Not for Hybrid)	No Catch "X"	Bigeye tuna (Mebachi) (6) Weight (1-40 Lbs.)		Bigeye tuna (Mebachi) (6) Weight (40+ Lbs.)		Yellowfin tuna (Ahi) (3) Weight (1-40 Lbs.)		Yellowfin tuna (Ahi) (3) Weight (40+ Lbs.)		Print Species Name (See Species List)		Print Species Name (See Species List)		Other Species Landed and Lost and Released (See Species List)			Number of Lost & Released Fish L = Lost R = Released	
						No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	No. Landed	Lbs. Landed	Species Name	No. Landed	Lbs. Landed	L	R

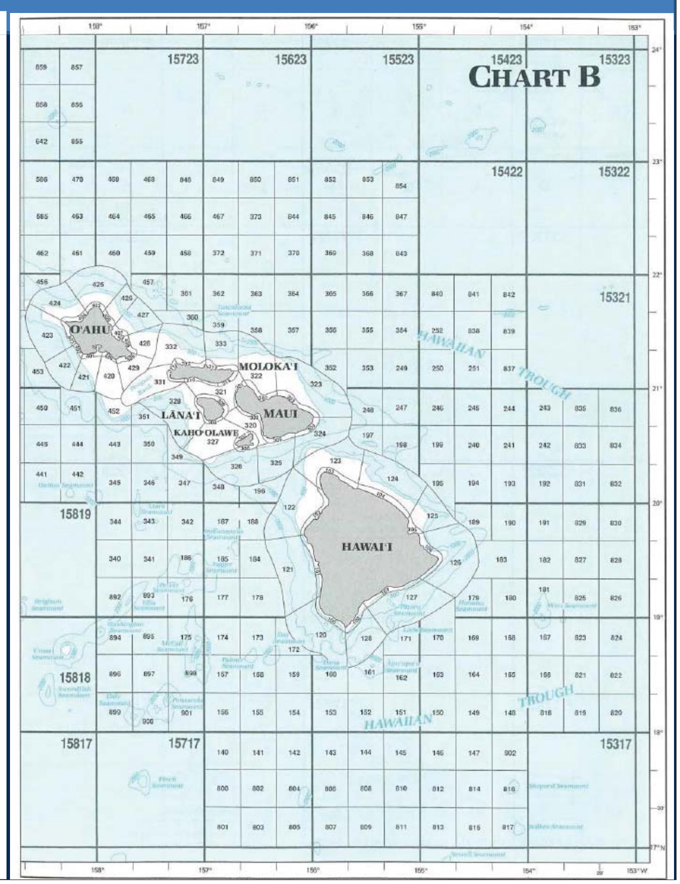
Number Lost to Predators: SHARKS ______ Number UNKNOWN ______ Number OTHER ______ Predator Name / ______ Number

Comments to DAR: ______

Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii

Commercial Fisheries Area Grid Chart





Summary: State Commercial Fisheries

- DAR (and NOAA) have a lot of data
- These data may be used to look at a range of questions (e.g., potential overlap between state fisheries and marine mammals)
- Additional data analyses will require increases in staff and support

Appendix 1 – Document 3

Marine Mammal Science

MARINE MAMMAL SCIENCE, **(*): ***–*** (*** 2014)
Published 2014. This article is a U.S. Government work and is in the public domain in the USA.
DOI: 10.1111/mms.12177

False killer whales and fisheries interactions in Hawaiian waters: Evidence for sex bias and variation among populations and social groups

Robin W. Baird,[1] **Sabre D. Mahaffy** and **Antoinette M. Gorgone**, Cascadia Research Collective, 218½ W. 4th Avenue, Olympia, Washington 98501, U.S.A.; **Tori Cullins**, Wild Dolphin Foundation, 87-1286 Farrington Highway, Waianae, Hawai'i 96792, U.S.A.; **Dan J. McSweeney**, Wild Whale Research Foundation, Box 139, Holualoa, Hawai'i 96724, U.S.A.; **Erin M. Oleson** and **Amanda L. Bradford**, Pacific Islands Fisheries Science Center, NOAA Fisheries, 1845 Wasp Boulevard, Building 176, Honolulu, Hawai'i 96818, U.S.A.; **Jay Barlow**, Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, California 92037, U.S.A.; **Daniel L. Webster**, Cascadia Research Collective, 218½ W. 4th Avenue, Olympia, Washington 98501, U.S.A.

Abstract

We assessed scarring patterns as evidence of fisheries interactions for three populations of false killer whales in Hawai'i. Bycatch of the pelagic population in the tuna longline fishery exceeds their Potential Biological Removal level. Scarring was assessed by seven evaluators as consistent, possibly consistent, or not consistent with fisheries interactions, and average scores computed. Scores were highest for scarred main Hawaiian Island (MHI) false killer whales, followed by pelagic and Northwestern Hawaiian Island (NWHI) individuals. Considering only whales for which the majority of evaluators scored scarring as consistent revealed significant differences among populations in the percentage of individuals scarred; MHI: 7.5%, pelagic: 0%, NWHI: 0%. Assessment by social cluster for the MHI population showed that 4.2% of Cluster 1, 7.1% of Cluster 2, and 12.8% of Cluster 3 individuals had such scarring, although differences between clusters were not statistically significant. There was a significant sex bias; all sexed individuals ($n = 7$) with injuries consistent with fisheries interactions were female. The higher proportion of MHI individuals with fisheries-related scarring suggests that fisheries interactions are occurring at a higher rate in this population. The bias towards females suggests that fisheries-related mortality has a disproportionate impact on population dynamics.

Key words: bycatch, injuries, fisheries interactions, fisheries, sex bias, false killer whales, Hawai'i.

Three discrete populations of false killer whales (*Pseudorca crassidens*) have been designated in Hawaiian waters, a main Hawaiian Islands (MHI) insular population, a Northwestern Hawaiian Islands (NWHI) insular population, and a pelagic population (Chivers *et al*. 2007, 2010; Baird *et al*. 2008, 2010, 2013; Martien *et al*. 2014). For the pelagic population, estimates of mortality and serious injury from interac-

[1]Corresponding author (e-mail: rwbaird@cascadiaresearch.org).

tions with the Hawai'i-based tuna longline fishery exceed the population's Potential Biological Removal (PBR) level (Carretta *et al*. 2014), defined under the U.S. Marine Mammal Protection Act (MMPA) as the maximum number of animals that can be removed from a population while allowing that population to reach or maintain its optimum sustainable population size (Taylor *et al*. 2000). Because of the high levels of bycatch relative to PBR, under the MMPA a Take Reduction Team[2] was established in 2010, and a Take Reduction Plan (TRP), to try to reduce bycatch, was put into place in 2013. The scope of the TRP includes the tuna and swordfish longline fisheries and all three recognized populations of false killer whales in Hawaiian waters.

Presumably bycatch occurs as false killer whales attempt to take the catch or bait off lines, occasionally getting hooked as a result. Observer coverage in the Hawai'i-based tuna (~20%) and swordfish (100%) longline fisheries has provided the only information on false killer whale bycatch rates in fisheries in Hawaiian waters (Forney and Kobayashi 2007, Bradford and Forney 2014). These longline fisheries are excluded from operating in near-shore waters around the Hawaiian Islands, and the number of longline vessel licenses is limited. Individuals from the NWHI false killer whale population likely have relatively limited interactions with fisheries. The majority of the range of that population is within waters of the Papahānoumokuākea Marine National Monument (Baird *et al*. 2013), an area where commercial and most recreational fishing activity has been banned since 2009, and prior to that was limited, at least in comparison to the main Hawaiian Islands.[3]

False killer whales also take fish from other commercial and recreational fisheries in Hawai'i (Shallenberger 1981, Nitta and Henderson 1993, Oleson *et al*. 2010), most of which operate closer to the main Hawaiian Islands in areas where longline fishing is prohibited. However, there is currently no observer coverage in other fisheries in Hawaiian waters, and historical observer coverage has been limited to some bottomfish fisheries in the Northwestern Hawaiian Islands. Information on movements of satellite tagged individuals from the MHI insular population suggests that, at least for two of the three social groups identified, movements into areas where these individuals could interact with the longline fisheries are infrequent (Baird *et al*. 2010, 2012). However, the range of this population does overlap with waters used by other commercial and recreational fisheries around the main Hawaiian Islands (Oleson *et al*. 2010). The MHI insular population of false killer whale was listed as endangered under the U.S. Endangered Species Act (ESA) in 2012. In the ESA status review for this population, interactions with fisheries was ranked as one of the most important current and future threats for this population, while recognizing that the level of certainty regarding these threats was low (Oleson *et al*. 2010). Fisheries operating around the MHI include troll and handline fisheries, as well as short-line and kaka-line fisheries. These latter two fisheries use similar gear to longlines, but are restricted to mainlines less than one nautical mile in length, with kaka-lines set on or near the bottom or in midwater, while short-lines are set near the surface (Carretta *et al*. 2014).

In Hawai'i a State Commercial Marine License (CML), also known as a commercial fishing license,[4] is required for selling catch from fisheries. From 2010 through 2013, the number of CMLs issued each year ranged from 3,711 to 3,916 for participation in

[2]http://www.nmfs.noaa.gov/pr/interactions/trt/falsekillerwhale.htm.

[3]http://coralreef.noaa.gov/education/educators/resourcecd/brochures/resources/nwhi_fisheries_b.pdf.

[4]http://state.hi.us/dlnr/dar/licenses_permits.html.

fisheries in Hawaiian waters.[5] Some of these CMLs are for longline fishing, with 129 vessels actively fishing in the longline fleet in 2012.[6] Assuming that the captain and four crew members all hold CMLs, less than 20% of the total CMLs are issued for longline fishing. Thus, no fewer than 3,000–3,200 CMLs are issued each year for other fisheries in Hawai'i, including the troll, handline, short-line, and kaka-line fisheries. With no observer coverage in these other fisheries, there is a limited basis for assessing their interactions with false killer whales around the main Hawaiian Islands.

In the absence of observer data, the number of live false killer whales with scarring that can be attributed to fisheries interactions may be used as an indicator of the relative frequency of nonfatal fishery interactions for particular species or populations. This approach has been used with a number of species of cetaceans to assess the relative frequency and outcome of fisheries interactions (*e.g.*, Philo *et al.* 1992, Robbins and Mattila 2004, Kiszka *et al.* 2008, Bradford *et al.* 2009). False killer whales hooked on longlines have been observed struggling against the taut line, and Baird and Gorgone (2005) suggested that injuries to the dorsal fin or other appendages may occur as the animals struggle. Such injuries were documented on a dwarf or pygmy sperm whale (*Kogia* sp.) recently hooked in the longline fishery (National Marine Fisheries Service [NMFS] Pacific Islands Regional Office, unpublished data). Baird and Gorgone (2005) assessed photographs taken of false killer whales from the MHI population from 2000 through 2004 for evidence of line injuries on the dorsal fin likely originating from fisheries interactions. These authors found that four individual false killer whales out of a catalog of 80 individuals had scarring consistent with fisheries interactions, and the rate of major dorsal fin disfigurements was more than four times higher than for any of the 13 other populations (of eight different species) evaluated.

Two recent events prompted a reexamination of dorsal fin injuries on false killer whales as an indicator of fisheries interactions in Hawaiian waters. First, under the ESA, NMFS is tasked with developing and implementing recovery plans for threatened or endangered species, and on 2 October 2013, NMFS announced their intent to prepare a recovery plan for the MHI false killer whale population (U.S. Federal Register 2013). An assessment of dorsal fin injuries as an indicator of fisheries interactions may have relevance for recovery planning. Second, on 6 October 2013, a necropsy was undertaken on a false killer whale from the MHI population that had stranded and died at Ka Lae, Hawai'i Island. Although there was no external evidence of interactions with fisheries, upon examination of the stomach contents five fish hooks were recovered, including three J-hooks (two different sizes), a circle hook, and a hook resembling a Japanese tuna hook.[7] Varying states of degradation of the hooks indicate they were likely ingested over a number of months, and hook types and sizes suggest that at least three of the five hooks did not originate from the longline fishery.[7] While histopathology results did not implicate hook ingestion as a cause of death,[7] the number and type of hooks indicate the animal repeatedly interacted with more than one type of fishery, and injury or death during future fishery interactions was plausible given that ingested gear typically leads to mortality (Wells *et al.* 2008).

[5]Personal communication from R. M. Kokubun, Department of Land and Natural Resources, 1151 Punchbowl Street, Honolulu, HI, 7 March 2014.

[6]http://www.pifsc.noaa.gov/library/pubs/DR-13-004.pdf (accessed 9 June 2014).

[7]Personal communication from K. L. West, College of Natural and Computational Sciences, Hawai'i Pacific University, 45-045 Kamehameha Hwy, Kaneohe, HI, 5 March 2014.

Since the Baird and Gorgone (2005) study, the photo-identification catalog of false killer whales from Hawaiian waters has grown to include individuals from all three different populations found in Hawaiian waters (Baird *et al*. 2008, 2013). The availability of photographs from each of these populations allowed us to compare dorsal fin injury rates and thus a measure of fisheries interactions among populations. In addition to comparisons among the three different populations, we assessed differences in evidence for fishery interactions among three distinct social units, termed "clusters," within the MHI insular population (Baird *et al*. 2012). These clusters represent individuals that preferentially associate over long periods of time (Baird *et al*. 2008), and based on genetic analyses represent extended groups of related individuals (Martien *et al*. 2014). Satellite tagging data from two of the three social clusters (Clusters 1 and 3) indicate that, while their ranges largely overlap, each cluster has different high density areas (Baird *et al*. 2012), thus they likely overlap with fisheries to different degrees. In addition, foraging behavior of many species of whales and dolphins is a learned behavior, passed on from mothers to offspring and/or learned within social groups (Sargeant and Mann 2009, Allen *et al*. 2013), thus it is likely that different social clusters may interact with fisheries to varying degrees. Lastly, assuming that the evidence of fisheries interactions from scarring of live animals reflects underlying rates of fisheries interactions for the social groups and populations, we examined evidence for sex-bias in fisheries interactions. A sex bias in fisheries interaction rate may have important implications for the impacts of fisheries-related mortality on population dynamics.

Methods

Photo-identification Catalogs and Association Analyses

Photographs of false killer whales were obtained throughout Hawaiian waters from a variety of sources (Baird *et al*. 2008, 2013). Although photos of individually recognizable false killer whales in Hawai'i are available starting in the mid-1980s, directed photo-identification where efforts were made to photograph all individuals in each encountered group began in 2000 (Baird *et al*. 2008). Photos obtained from 2000 through the end of 2013 were used in our analyses. Photos within encounters were sorted by individual, and each individual was assigned a distinctiveness rating: (1) not distinctive, (2) slightly distinctive, (3) distinctive, (4) very distinctive. Assessment of potential origin of scarring was restricted to distinctive and very distinctive individuals (hereafter referred to as distinctive). The best photo for each individual from each encounter was also graded for quality (see Baird *et al*. 2008). Analyses were undertaken both using photos of all qualities and restricted to those individuals with good or excellent quality photos (hereafter referred to as good quality). Individuals were compared between encounters to generate sighting histories. Population identity (*i.e*., MHI insular, NWHI insular, pelagic) was assessed on a per group basis, using a variety of types of information. These include sighting history of individuals, mitochondrial haplotypes from genetic samples obtained from some groups (Martien *et al*. 2014), the location where photographs were obtained, the proportion of individuals within an encounter that were already in the catalog, and satellite tag data (Baird *et al*. 2012, 2013). For the MHI insular population, individuals were assigned to a social cluster following the methods outlined in Baird *et al*. (2012). Individuals not assigned to one of the three main social clusters were categorized into one of the three clusters based on proximity within the social network, as network distance between individuals indicates relative association strength.

Assessment of Scarring Patterns

The two primary catalog curators (AMG, SDM) independently chose photos from the catalog for further evaluation if individuals had linear cuts on the dorsal fin or other major disfigurements of the dorsal fin (*e.g.*, missing the fin, bent fin) or the area(s) immediately behind or in front of the fin. For each individual whale chosen by either reviewer, the best left and/or right side photos available were identified for evaluation. If available, photos taken from in front or behind the animal that would allow for assessment of injuries were also included. To account for the uncertainty associated with evaluating the original source of injuries on animals long after the injuries have occurred, seven different individuals independently evaluated the set of photographs. Individual evaluators had particular expertise or experience related to false killer whales, bycatch, and/or fisheries interaction assessments and injury assessments of live and/or dead cetaceans. Evaluators were asked to classify dorsal fin injuries as consistent, possibly consistent, or not consistent with line injuries from fisheries interactions. Individuals undertaking evaluations were: RWB, AMG, and SDM (Cascadia Research Collective), ALB and EMO (Pacific Islands Fisheries Science Center), E. Lyman (Hawaiian Islands Humpback Whale National Marine Sanctuary), and A. J. Read (Duke University). Each of the ratings was converted to a numerical score: 3 (consistent), 2 (possibly consistent), 1 (not consistent). The average score for each individual whale was calculated using all seven numerical scores. The average score of selected individuals by population was compared using a Kruskal-Wallis one-way ANOVA. To assess differences in the proportion of individuals with scarring consistent with fisheries interactions among populations, we considered individual whales with an average score >2.5 to have injuries consistent with fisheries interactions. Individual whales could pass the 2.5 threshold either by having four scores of consistent and three scores of possibly consistent (mean = 2.57), or by having five scores of consistent, one score of possibly consistent, and one score of not consistent (mean = 2.57). Individual whales with scores >2.5 are hereafter referred to as having injuries consistent with fisheries interactions. To evaluate the influence of our choice of >2.5 as a cutoff on our conclusions, we also assessed a cut off of >2.7, equivalent to five of the seven scores of consistent and two scores of possibly consistent. We used the Freeman-Halton extension of the Fisher's exact test (two-tailed) to compare proportions of individuals with fisheries-related scarring among populations, and among social clusters in the MHI population. When possible, we identified the sex of individuals with such scarring through genetic analysis of biopsy samples (Chivers *et al*. 2010) or based on the presence of neonates or small calves in close attendance. Evidence for a sex bias in individuals with scarring consistent with fisheries interactions was assessed with a two-tailed Sign test. Significance levels for all analyses were set at 0.05.

Results

Assessment of Fisheries Related Scarring

The numbers of distinctive individuals in the catalog from 2000 to 2013 by population were: pelagic, 76; NWHI insular, 51; MHI insular, 168. Restricted to only those with good quality photos, the numbers were: pelagic, 53; NWHI insular, 39; MHI insular, 160. For the MHI insular population, the numbers of distinctive

individuals by social clusters were: Cluster 1, 76; Cluster 2, 43; Cluster 3, 49, using all photo qualities, or: Cluster 1, 71; Cluster 2, 42; Cluster 3, 47, using only good quality photos. From the total of 295 distinctive individual false killer whales, 19 (6.4%) individuals were chosen by one or both reviewers for evaluation, four from the pelagic population, two from the NWHI insular population, and 13 from the MHI insular population. Good quality photos were only available for one of the four individuals from the pelagic population, neither of the two from the NWHI population, and all 13 from the MHI population. For the 19 individuals chosen, average scores varied by population (Kruskal-Wallis one-way ANOVA, $P = 0.007$), with highest scores for MHI individuals (median = 2.71), followed by pelagic (median = 2.29) and NWHI individuals (median = 2.21). As there was only a single pelagic individual with good quality photos it was not possible to test for differences by population, although the score for the pelagic individual was 2.14, while the lowest score for an individual from the MHI population was 2.43. Of the 19 individuals selected for evaluation, 13 individuals (4.4% of the 295 individuals) had scores >2.5 (mean scores of these 13 ranged from 2.57 to 3.0). The 13 individuals with scores >2.5 included the four individuals noted by Baird and Gorgone (2005), one missing the dorsal fin entirely, two with linear cuts at the leading edge base of the fins with the fins bent completely over, and one with evidence of a leading edge cut on the fin and the fin partially bent over. Of the additional nine individuals, one was missing approximately the top two-thirds of the dorsal fin, and the remaining eight all had leading edge cuts on the dorsal fin, four of which were partially bent over. Examples of individuals with injuries consistent with fisheries interactions are shown in Figure 1.

Using those with an average score of >2.5, the number of individuals with injuries consistent with fisheries interactions by population were: pelagic, 1 (1.3% of the distinctive pelagic individuals); MHI, 12 (7.1% of the distinctive MHI individuals); NWHI, 0 (0% of the distinctive NWHI individuals). Good quality photos were available for 12 of the 13 individuals with average scores >2.5; all 12 were from the MHI population. Considering only individuals with good quality photos, 7.5% (12 of 160) of the distinctive MHI individuals had scores >2.5. The proportion of individuals with injuries consistent with fisheries interactions varied significantly by population, whether considering all distinctive individuals (Fisher's exact test, $P = 0.032$) or restricted only to those with good and excellent quality photos (Fisher's exact test, $P = 0.023$). Eight individuals passed a cut-off of 2.7; all were from the MHI population. Using the 2.7 cut-off, the difference by population was not significant when considering all distinctive individuals (Fisher's exact test, $P = 0.161$) or restricted to those with good and excellent quality photos (Fisher's exact test, $P = 0.053$). Using those with an average score of >2.5 and restricted to individuals with good quality photos, the breakdown by MHI social cluster was: Cluster 1, 3 (4.2%); Cluster 2, 3 (7.1%); Cluster 3, 6 (12.8%). Proportions of individuals with injuries consistent with fisheries interactions did not differ significantly between clusters either using all distinctive individuals (Fisher's exact test, $P = 0.215$) or restricted to those with good and excellent quality photos (Fisher's exact test, $P = 0.236$). Sex was known (based on genetics) for 6 of the 12 MHI insular individuals, and inferred (based on presence of a small calf next to one individual) for a seventh individual. All seven individuals were females and this sex bias was significant, whether considering all seven individuals (Sign test, $P = 0.016$) or only the six where sex was confirmed based on genetics (Sign test, $P = 0.031$). One female from Cluster 2 acquired injuries in two different events. When first documented in 2006, this individual had a linear cut on the leading edge of the fin at the base of the fin. When next documented in

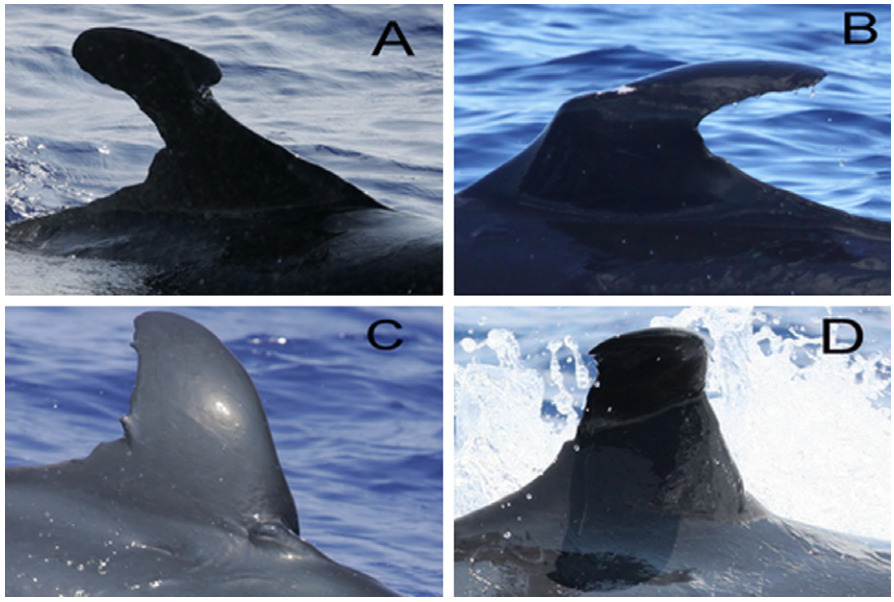


Figure 1. Example photographs of four false killer whales from the main Hawaiian Islands population categorized with fisheries-related injuries. A. HIPc230, an adult female from Cluster 2. B. HIPc299, of unknown sex from Cluster 3. This individual is the same as that shown in figure 7 of Baird (2009). C. HIPc316, an adult female from Cluster 1. D. HIPc398, an adult female from Cluster 2. This individual has two independently-acquired injuries, a cut on the leading edge base of the fin present when the individual was first documented in 2006, and a cut part way through the fin about mid-way up the fin on the leading edge, resulting in partial fin collapse. This injury was present when the individual was next documented in 2010.

2010, this individual had an additional leading edge cut approximately half way up the fin, with the fin partially bent over (Fig. 1). Of the remaining 11 MHI individuals categorized with injuries consistent with fisheries interactions, the first year individuals were documented (in all cases already with scarring) were: pre-2000 (two individuals), 2000 (one individual), 2003 (three individuals), 2004 (two individuals), 2005 (one individual), and 2008 (two individuals).

Discussion

Individual whales can acquire injuries to the dorsal fin from a variety of sources, including inter- and intraspecific interactions, as well as encounters with humans or human activities in contexts other than fisheries, such as vessel strikes. Each source of injury tends to leave specific types of scars, and the scarring patterns observed in our study consistent with injuries from fisheries interactions, *i.e.*, typically single linear injuries on the leading edge of the dorsal fin, often at the base of the fin and parallel to the body axis, are very different than the types of injuries that are well-known to occur from vessel strikes, shark bites, or intraspecific interactions (*e.g.*, McSweeney *et al*. 2007, Kiszka *et al*. 2008, Wells *et al*. 2008, Luksenburg 2014). Our results,

combined with the evidence from the stranded false killer whale with five hooks in the stomach,[7] suggest that false killer whales from the MHI insular population are regularly interacting with fisheries. While two of the individuals with scarring consistent with fisheries interactions were first documented prior to 2000, and four others were first documented in the early years of our photo-identification efforts (2000–2003), individuals with such scarring continue to be documented. It should be noted that the false killer whale with five hooks in the stomach had no external evidence of fisheries interactions, thus the scarring documented here should be taken as an indicator of such interactions, rather than representing the absolute proportion of individuals within the population (or social cluster) that survive interactions with fisheries. Our results also indicate the individual rate of interactions, as evident by the proportion of individuals in the population with such injuries, may be greater for individuals from the MHI population (7.1% of distinctive individuals or 7.5% with good quality photos) than for individuals from the pelagic (1.3% of distinctive individuals or 0% with good quality photos) or NWHI (0%) populations. As noted previously, the estimated number of individuals from the pelagic population that are seriously injured or killed exceeds the Potential Biological Removal level for that population (Carretta *et al*. 2014). If the likelihood of serious injury or mortality were similar for different gear types for each interaction when false killer whales depredate catch or bait, the more than five-fold difference in proportion of individuals with such scarring is cause for concern for the MHI insular population. It is possible that the rate of mortality or serious injury is higher from hooking on longline gear than on other gear types, perhaps a reflection of the relatively heavier longline gear. A higher per interaction rate of mortality and serious injury may therefore apply to the pelagic false killer whale population, given the majority of their range overlaps with the offshore longline fishing grounds. Of those false killer whales known to be hooked or entangled in the tuna longline fishery between 2007 and 2011, 83% (20 of 24) were either killed or considered to have serious injuries (Bradford and Forney 2014). The per interaction rate of mortality or serious injury may be less for MHI false killer whales primarily interacting with other fishery types.

The fishery or fisheries likely responsible for the observed scarring is unknown. However, given the relatively infrequent overlap between individuals from the MHI population and longline fishing areas, at least for Clusters 1 and 3 (Baird *et al*. 2010, 2012), it is likely that other sources, such as interactions with nearshore fisheries, account for some proportion of scarring in this population. This is further supported by the hook types found in the stomach of the false killer whale that stranded in October 2013 (identified as a member of Cluster 3), at least three of which were not longline hooks. Although not significant, the three-fold difference in the proportion of individuals with injuries consistent with fisheries interactions between Cluster 1 (4.2%) and Cluster 3 (12.8%) suggests that different social groups interact with fisheries at different rates. This could reflect differences in where the different social groups spend their time and/or that depredation behavior may be culturally acquired within social groups, as are other types of foraging behaviors (Sargeant and Mann 2009, Krützen *et al*. 2014). Satellite tag data are available from 18 different groups of Cluster 1 individuals, but only six different groups of Cluster 3 individuals and no Cluster 2 individuals (Baird *et al*. 2012; RWB, unpublished data). From tag data available through early 2011, Clusters 1 and 3 appear to differ in their high density areas (Baird *et al*. 2012), suggesting they likely differ in terms of their spatial and temporal overlap with nearshore fisheries. Although the sample size for tagged Cluster 3 individuals is much smaller, one of the tagged Cluster 3 individuals did venture

outside the longline exclusion boundary around the main Hawaiian Islands (RWB, unpublished data), suggesting that Cluster 3 individuals might overlap with longline fisheries more frequently than Cluster 1 individuals.

While the catalog sizes for NWHI insular (51 distinctive individuals) and pelagic populations (76 individuals) are relatively small, only a single individual from these combined populations (0.8% of the combined NWHI and pelagic cataloged individuals) was categorized as having a dorsal fin injury consistent with fishery interactions using average scores >2.5, in comparison to 7.1% of the MHI individuals. When restricted to good and excellent quality photos, the difference among populations increases, with 7.5% of MHI individuals having scores >2.5%, compared to 0% of pelagic individuals. The same pattern holds when increasing the threshold to >2.7. Using that threshold none of the pelagic individuals, and eight (4.8%) of the MHI individuals had scarring consistent with fisheries interactions, although this difference was not statistically significant. However, photographic sampling of both the NWHI population and the pelagic population is limited in relation to the estimated abundance of these populations. Thus, the sample of photo-identified individuals in the pelagic and NWHI populations may not be large enough to accurately or representatively reflect the proportion of individuals with injuries consistent with fisheries interactions. Bradford *et al*. (2014) provided abundance estimates for the Hawai'i pelagic population and NWHI insular populations as 1,552 (CV = 0.66) and 552 (CV = 1.09) individuals, respectively, so our existing catalog for these populations, including only good quality photos, represents only approximately 3.4% of the pelagic individuals and 7.1% of the NWHI individuals. Two recent abundance estimates for the MHI insular population, both for the 2006 to 2009 period, were 151 (CV = 0.20) and 170 (CV = 0.21) individuals (Oleson *et al*. 2010). During that period 102 distinctive individuals were documented, all with good quality photos, thus the catalog likely represents from approximately 59% to 67% of the MHI individuals.

While we did not find significant differences among MHI social clusters in the proportions of individuals with dorsal fin injuries consistent with fisheries interactions, the proportion of Cluster 3 individuals with such scarring was more than three times higher than for Cluster 1 individuals. We postulate that these types of dorsal fin injuries occur as a secondary process reflecting an individual being hooked in the mouth and struggling against a line. Thus, analysis of injuries visible externally on the mouth line (gape) of individuals may be more powerful for detecting differences among social clusters, since individuals that ingest hooks or are hooked in the mouth or in the lip may be more likely to show evidence of such hooking by injuries on the gape than on the dorsal fin. Such analyses are currently underway, although existing sample sizes of head photographs is limited, and additional field efforts will be needed to increase the sample size of head photographs of all three social clusters. Regardless, the potential for fishery interaction rates to vary among social clusters in the MHI insular population suggests that interaction rates may vary by social group within the pelagic and NWHI populations. However, the current representation of social groups within the pelagic and NWHI populations is insufficient to evaluate this variation.

Powell and Wells (2011) noted that, for common bottlenose dolphins (*Tursiops truncatus*) in Florida, it was primarily adult males that were interacting with recreational fisheries, although for stranded dolphins which were known to have ingested fishing gear, there were similar numbers of males and females (Wells *et al*. 2008). For fish-eating killer whales (*Orcinus orca*) in Alaska involved in longline depredation, Matkin *et al*. (2008) noted that of the 13 individuals of known sex with bullet wounds, 10 of the 13 were females. Our results indicate a significant bias towards

females with injuries consistent with fisheries interactions. There are several possible explanations for this bias. Females may be involved in depredation at higher rates than males, reflecting either the higher energy needs of females during lactation and/or the importance of prey sharing among females (see *e.g.*, Ford and Ellis 2006). Conversely, it is possible that male false killer whale interactions with fisheries are more likely to be lethal. Males are, on average, larger and heavier than females (Ferreira *et al*. 2014), and thus might have a greater likelihood of breaking lines when hooked, and trailing gear may impede feeding or locomotion. However, if females are interacting with fisheries at a higher rate, then fisheries-related mortality may have a disproportionate influence on population dynamics, influencing the rate of growth, and thus potential recovery, of the population to a greater extent than if fisheries-related mortality rates were equal for both sexes or were biased towards males. A female-bias in fisheries interactions may influence population dynamics in two ways. If fisheries-related mortality of females is higher than males, this will reduce the potential population growth rate to a greater extent than if fisheries-related mortality was unbiased in relation to sex or biased towards males. In addition, if a female involved in a fatal fisheries interaction has a dependent calf, it is probable the calf will not survive, thus effectively resulting in two deaths.

Combined these results suggest that recovery planning for the MHI population under the U.S. Endangered Species Act should account for the social structure of the population and the potential for impacts from human activities acting disproportionately on certain social groups. Such an approach has been taken with one other population listed under the ESA, southern resident killer whales (National Marine Fisheries Service 2008). Our results also suggest that examining overlap with fisheries as well as estimating abundance and monitoring trends should be undertaken on a cluster-specific basis. Given the relatively high proportion of Cluster 2 individuals with fisheries-related scarring (7.1%), obtaining movement data from satellite tag deployments on individuals from this social cluster is needed to assess whether this group regularly moves far enough offshore to interact with the longline fishery, and determine with what nearshore fisheries it is most likely to interact. Similarly, additional satellite data are needed on groups of Cluster 3 individuals, given the relatively small sample size available for that social group and the high proportion of individuals with injuries consistent with fisheries interactions. Furthermore, our results, combined with the evidence from the stranded individual with a variety of hooks in the stomach, suggest there is a need to broaden the scope of the Take Reduction Plan, which currently focuses only on the longline fisheries, to include nearshore fisheries.

Acknowledgments

We would like to thank Ed Lyman and Andy Read for evaluating photos, Reginald Kokubun from the State of Hawai'i for providing information on the number of Commercial Marine Licenses issued, Kristi West for providing information on the ingested hooks in the stranded false killer whale, and Karen Martien of the Southwest Fisheries Science Center for providing sex determinations from genetic samples. We would also like to acknowledge Dan Salden, Mark Deakos, Chuck Babbitt, Rachel Cartwright, Phillip Colla, Adam Frankel, Ed Lyman, Kim New, Doug Perrine, Peggy Stapp, Alison Stimpert, Deron Verbeck, Kristi West, and Danielle Woodward for providing photographs used in the analyses, Jessica Aschettino and Greg Schorr for assistance in the field, John Calambokidis, John Hall, John La Grange, Jeff

Moore and Katherine Ralls for helpful discussions, and Annie Douglas, Sam Pooley, Jerry Wetherall and two anonymous reviewers for reviews of the manuscript.

Literature Cited

Allen, J., M. Weinrich, W. Hoppitt and L. Rendell. 2013. Network-based diffusion analysis reveals cultural transmission of lobtail feeding in humpback whales. Science 340:485–488.

Baird, R. W. 2009. A review of false killer whales in Hawaiian waters: Biology, status, and risk factors. Report prepared for the U.S. Marine Mammal Commission under order No. E40475499. Available at http://www.cascadiaresearch.org/hawaii/publications.htm.

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 59:593–601.

Baird, R. W., A. M. Gorgone, D. J. McSweeney, *et al*. 2008. False killer whales (*Pseudorca crassidens*) around the main Hawaiian Islands: Long-term site fidelity, inter-island movements, and association patterns. Marine Mammal Science 24:591–612.

Baird, R. W., G. S. Schorr, D. L. Webster, D. J. McSweeney, M. B. Hanson and R. D. Andrews. 2010. Movements and habitat use of satellite-tagged false killer whales around the main Hawaiian Islands. Endangered Species Research 10:107–121.

Baird, R. W., M. B. Hanson, G. S. Schorr, *et al*. 2012. Range and primary habitats of Hawaiian insular false killer whales: Informing determination of critical habitat. Endangered Species Research 18:47–61.

Baird, R. W., E. M. Oleson, J. Barlow, A. D. Ligon, A. M. Gorgone and S. D. Mahaffy. 2013. Evidence of an island-associated population of false killer whales (*Pseudorca crassidens*) in the Northwestern Hawaiian Islands. Pacific Science 67:513–521.

Bradford, A. L., and K. A. Forney. 2014. Injury determinations for cetaceans observed interacting with Hawaii and American Samoa longline fisheries during 2007–2011. NOAA Technical Memorandum NMFS-PIFSC-39. 22 pp.

Bradford, A. L., D. W. Weller, Y. V. Ivaschchenko, A. M. Burdin and R. L. Jr. Brownell. 2009. Anthropogenic scarring of western gray whales (*Eschrichtius robustus*). Marine Mammal Science 25:161–175.

Bradford, A. L., K. A. Forney, E. M. Oleson and J. Barlow. 2014. Accounting for subgroup structure in line-transect abundance estimates of false killer whales (*Pseudorca crassidens*) in Hawaiian waters. PLOS ONE 9:e90464.

Carretta, J. V., E. M. Oleson and D. W. Weller, *et al*. 2014. U.S. Pacific marine mammal stock assessments, 2013. NOAA Technical Memorandum NMFS-SWFSC-532. 406 pp.

Chivers, S. J., R. W. Baird, D. J. McSweeney, D. L. Webster, N. M. Hedrick and J. C. Salinas. 2007. Genetic variation and evidence for population structure in eastern North Pacific false killer whales (*Pseudorca crassidens*). Canadian Journal of Zoology 85:783–794.

Chivers, S. J., R. W. Baird and K. K. Martien, *et al*. 2010. Evidence of genetic differentiation for Hawai'i insular false killer whales (*Pseudorca crassidens*). NOAA Technical Memorandum NMFS-SWFSC-458. 46 pp.

Ferreira, I. M., T. Kasuya, H. Marsh and P. B. Best. 2014. False killer whales (*Pseudorca crassidens*) from Japan and South Africa: Differences in growth and reproduction. Marine Mammal Science 30:64–84.

Ford, J. K. B., and G. M. Ellis. 2006. Selective foraging by fish-eating killer whales *Orcinus orca* in British Columbia. Marine Ecology Progress Series 316:185–199.

Forney, K. A., and D. Kobayashi. 2007. Updated estimates of mortality and injury of cetaceans in the Hawaii-based longline fishery, 1994–2005. NOAA Technical Memorandum NMFS-SWFSC-412. 30 pp.

Kiszka, J., D. Pelourdeau and V. Ridoux. 2008. Body scars and dorsal fin disfigurements as indicators of interaction between small cetaceans and fisheries around the Mozambique Channel island of Mayotte. Western Indian Ocean Journal of Marine Science 7:185–193.

Krützen, M., S. Kreicker, C. D. MacLeod, J. Learmonth, A. M. Kopps, P. Walsham and S. J. Allen. 2014. Cultural transmission of tool use by Indo-Pacific bottlenose dolphins (*Tursiops* sp.) provides access to a novel foraging niche. Proceedings of the Royal Society B. doi: 10.1098/rspb.2014.0374.

Luksenburg, J. A. 2014. Prevalence of external injuries in small cetaceans in Aruban waters, southern Caribbean. PLOS ONE 9:e88988.

Martien, K. K., S. J. Chivers, R. W. Baird, *et al*. 2014. Nuclear and mitochondrial patterns of population structure in North Pacific false killer whales (*Pseudorca crassidens*). Journal of Heredity 105:611–626.

Matkin, C. O., E. L. Saulitis, G. M. Ellis, P. Olesiuk and S. D. Rice. 2008. Ongoing population-level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Marine Ecology Progress Series 356:269–281.

McSweeney, D. J., R. W. Baird and S. D. Mahaffy. 2007. Site fidelity, associations, and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales off the island of Hawai'i. Marine Mammal Science 23:666–687.

National Marine Fisheries, Service. 2008. Recovery plan for Southern Resident killer whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, WA. Available at http://www.nmfs.noaa.gov/pr/recovery/plans.htm (downloaded 26 August 2014).

Nitta, E. T., and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Marine Fisheries Review 55:83–92.

Oleson, E. M., C. H. Boggs, K. A. Forney, *et al*. 2010. Status review of Hawaiian insular false killer whales (*Pseudorca crassidens*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-PIFSC-22. 140 pp.

Philo, L. M., J. C. George and T. F. Albert. 1992. Rope entanglement of bowhead whales (*Balaena mysticetus*). Marine Mammal Science 8:306–311.

Powell, J. R., and R. S. Wells. 2011. Recreational fishing depredation and associated behaviors involving common bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. Marine Mammal Science 27:111–129.

Robbins, J., and D. Mattila. 2004. Estimating humpback whale (*Megaptera novaeangliae*) entanglement rates on the basis of scar evidence. Report to the National Marine Fisheries Service under Order Number 43EANF030121, Woods Hole, MA. Available at http://www.coastalstudies.org/pdf/Robbins_and_Mattila_2004.pdf.

Sargeant, B. L. and J. Mann. 2009. Developmental evidence for foraging traditions in wild bottlenose dolphins. Animal Behaviour 78:715–721.

Shallenberger, E. W. 1981. The status of Hawaiian cetaceans. Report No. MMC-77/23 of the U.S. Marine Mammal Commission. 79 pp.

Taylor, B. L., P. R. Wade, D. P. De Master and J. Barlow. 2000. Incorporating uncertainty into management models for marine mammals. Conservation Biology 14:1243–1252.

U. S. Federal Register. 2013. Endangered and threatened species; notice of intent to prepare a recovery plan for main Hawaiian Islands insular false killer whale distinct population segment. FR 78(191):60850–60851 (2 October 2013). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce, Washington, DC.

Wells, R. S., J. B. Allen, S. Hofmann, *et al*. 2008. Consequences of injuries on survival and reproduction of common bottlenose dolphins (*Tursiops truncatus*) along the west coast of Florida. Marine Mammal Science 24:774–794.

Received: 9 July 2014
Accepted: 30 August 2014

Appendix 1 – Document 4

The PIFSC Fishery Ecosystem Assessment Tool and Potential Contributions to the Kona IEA

Prepared for the

Kona IEA Symposium 2014

by

Bryan Dieter (PIFSC JIMAR)

Edward Glazier (PIFSC SPG)

Background

- FEAT is a Geographic Information System (GIS) that integrates many types of data to enable spatiotemporal analysis and visual representation of fishing activity and socio-demographic attributes of fishery participants

- Originally developed with FME software (high interoperability); ESRI has now attained similar interoperability

- PIFSC is now reconfiguring FEAT as an ARC-GIS desktop application

- [In-Progress]

Conceptual origins / rationale

- MSFCMA NS-8; Identify and define “fishing communities” and assess/monitor effects of prospective regulatory changes on fleets & support sectors
- Ecosystem-based fisheries management – humans as an part of the system – consider fishing activity as crucial aspect of trophic interaction
- Also useful for assessing socioeconomic and demographic effects of oil spills, oceanic regime shifts, other sources of change

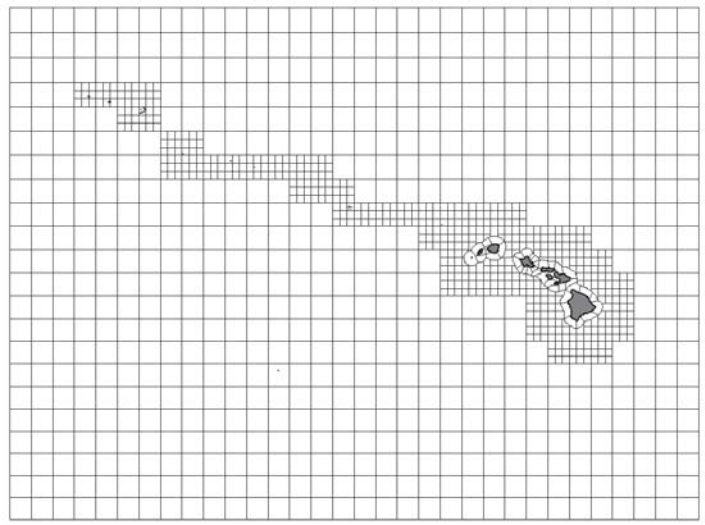
Present Utility for Kona IEA

- Indicate commercial fishing activity in pelagic zone along the Kona Coast (based on reporting from 1996-2014)
- Have not yet incorporated recreational data (MRIP)
- Indicate spatial and temporal distribution of catch by gear
- Indicate distribution of fishery participants (here using traditional handline methods as an example)
- Briefly consider macro-economic factors in relation to fishing activity

HDAR Commercial Fisheries Data

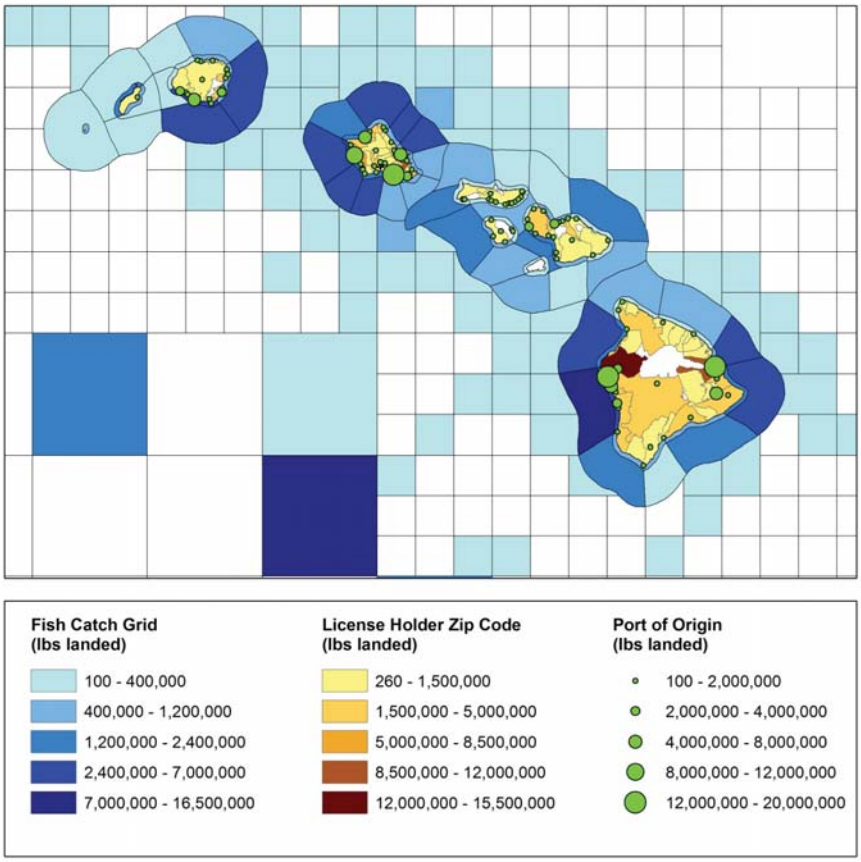
Commercial Fisheries Reporting

- 1.5 million reports since 1996
- Extent non-reporting unknown
- Reports contain:
  - -Grid ID block number
  - - Type of gear
  - - Species landed
  - - Date of capture
  - - Port of origin
  - - Zip code of license holder
  - - Confidential data!
- State and federal waters
- Scale of grid blocks precludes detailed site-specific analysis
- Three or more reports needed



Output Example:

- All MHI
- All gear & species
- 1996-2014
- Volume of landings:
  - o Kona Coast & Cross Seamount;
  - o Windward/Leeward Oahu
  - o Kona side of Kauai
  - o Hilo side



Hawaii Island

- All gear/species
- 18 grids (9 near- 9 off-)
- 47,000,000 pounds
- Highest volume catch: Offshore Central Kona (16.5 M lbs.)

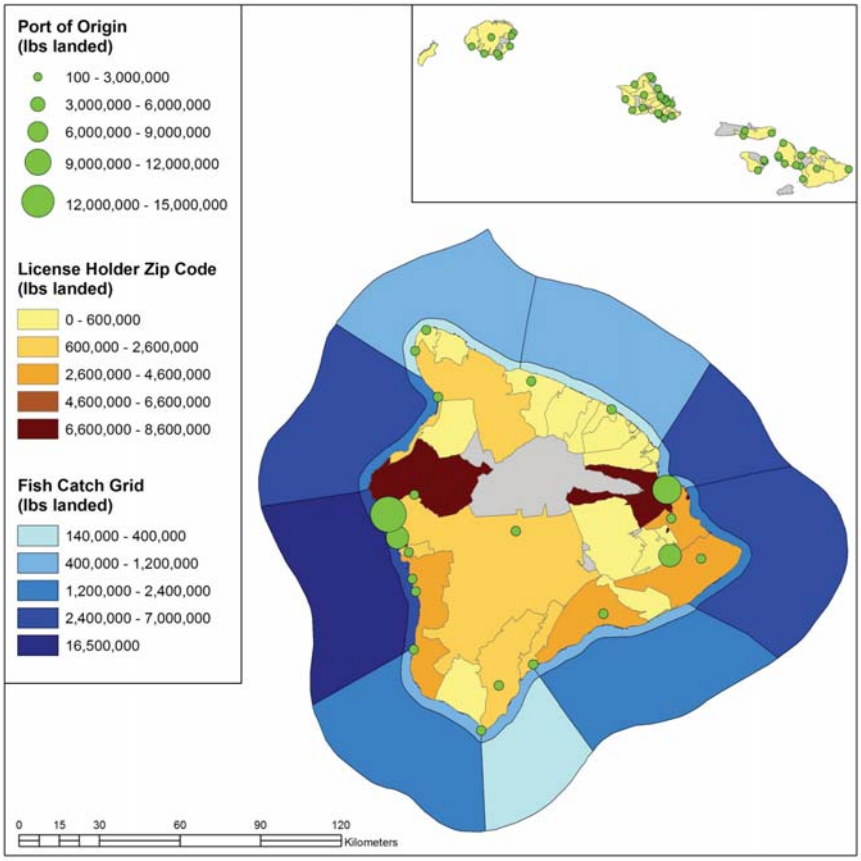
Port-level:

Hilo (10 M lbs)

- Distribution x Residence:

Kona (8.5 M lbs.)

Hilo (10.2 M lbs.)



Hawaii Island

Pelagic Zone

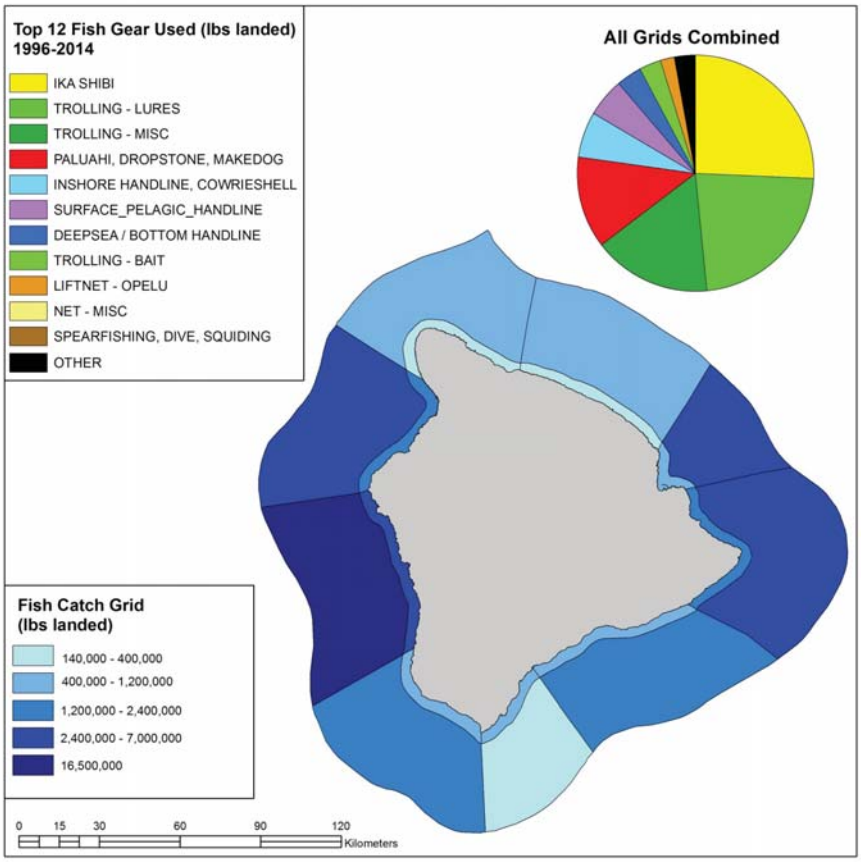
Principal Gear Types

~75% of all landings involve:

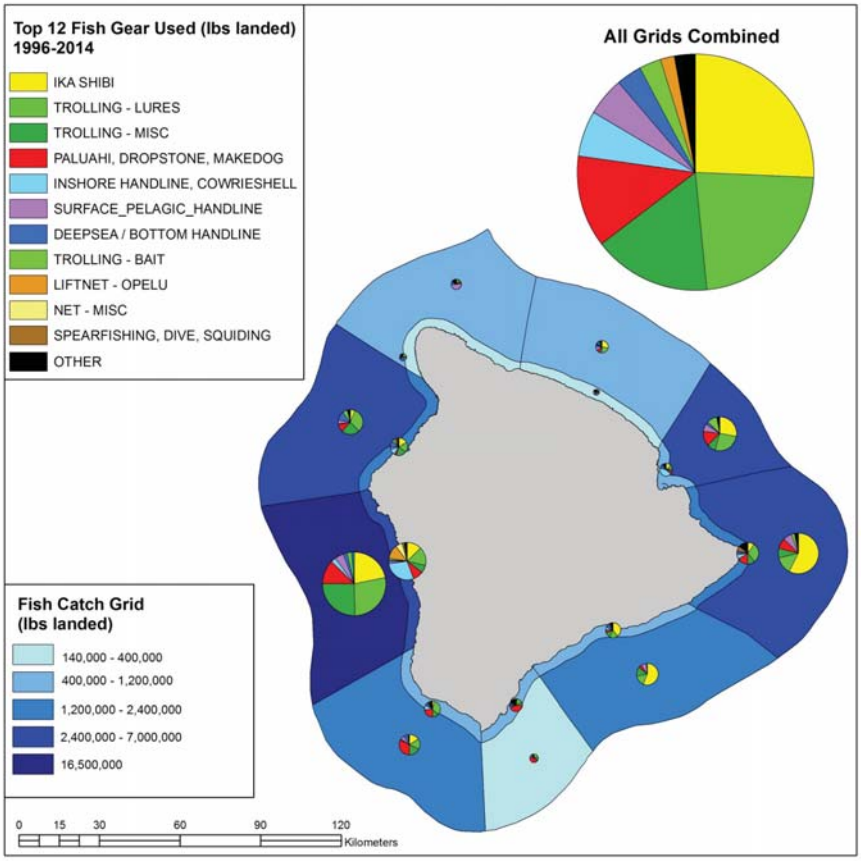
-Troll gear (lures/bait)

-Ika shibi (squid/palu)

-Palu ahi and variants (bust bag, make dog, etc.)



Hawaii Island
Relative Extent of Landings
by Gear Type



Hawaii Island
Gear Use Patterns by District

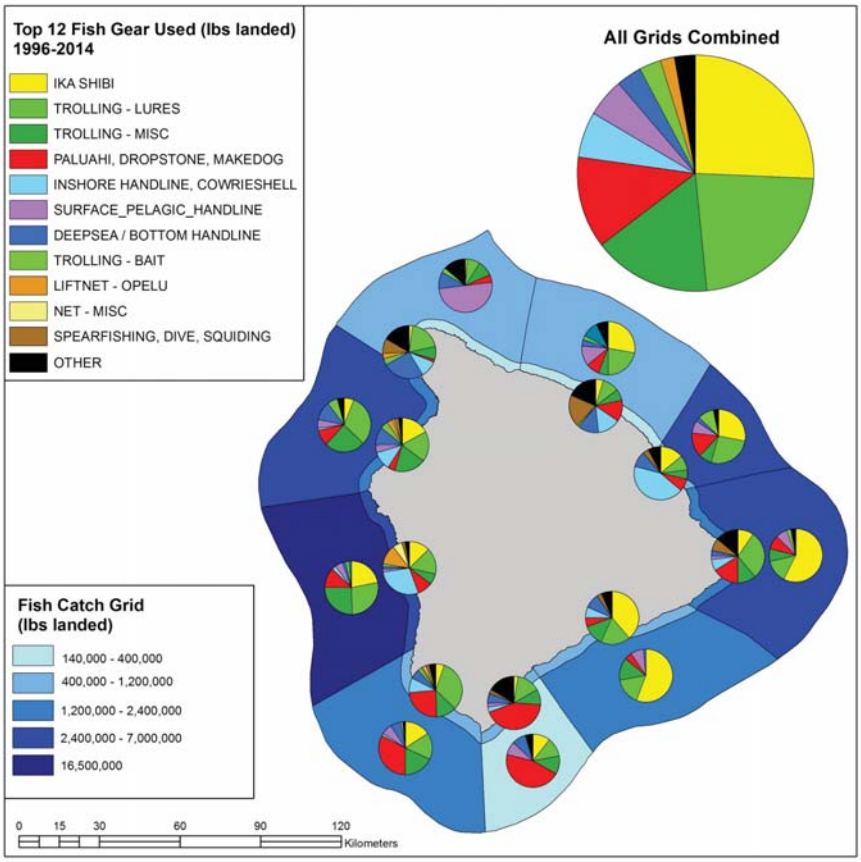
- Palu Ahi ~ South Point

-Ika-Shibi windward

-Surface Handline Hamaku

- Troll leeward

-



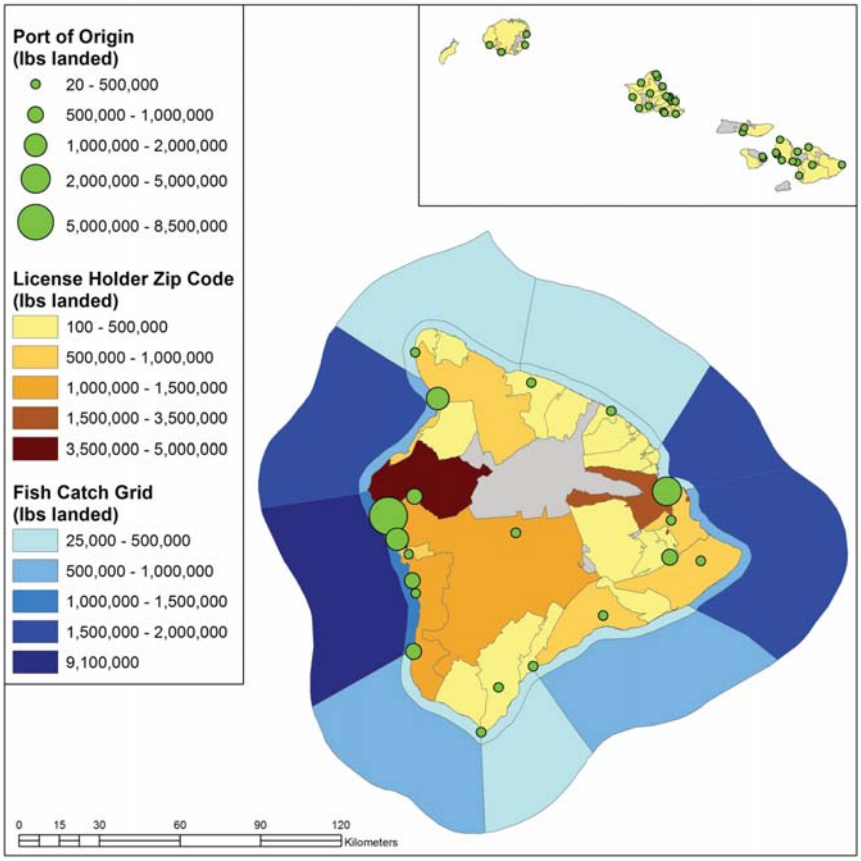
Gear-Specific Harvest:
Troll

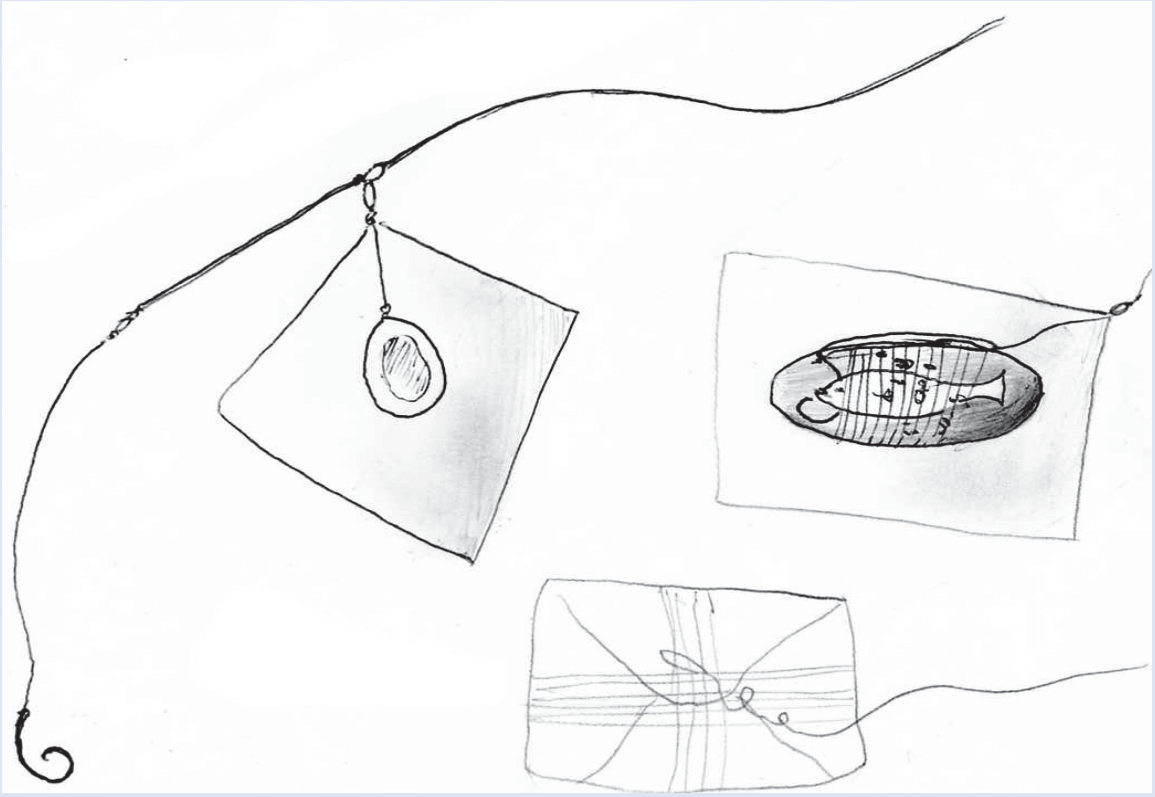
- Most troll harvest occurs along Kona Coast

- Fishermen living Kona side report greatest volume of catch

- Kona also the most productive port

-Some troll along the Kona Coast but reside (or maintain P.O. boxes elsewhere)





Gear-Specific Harvest:

Traditional Handline

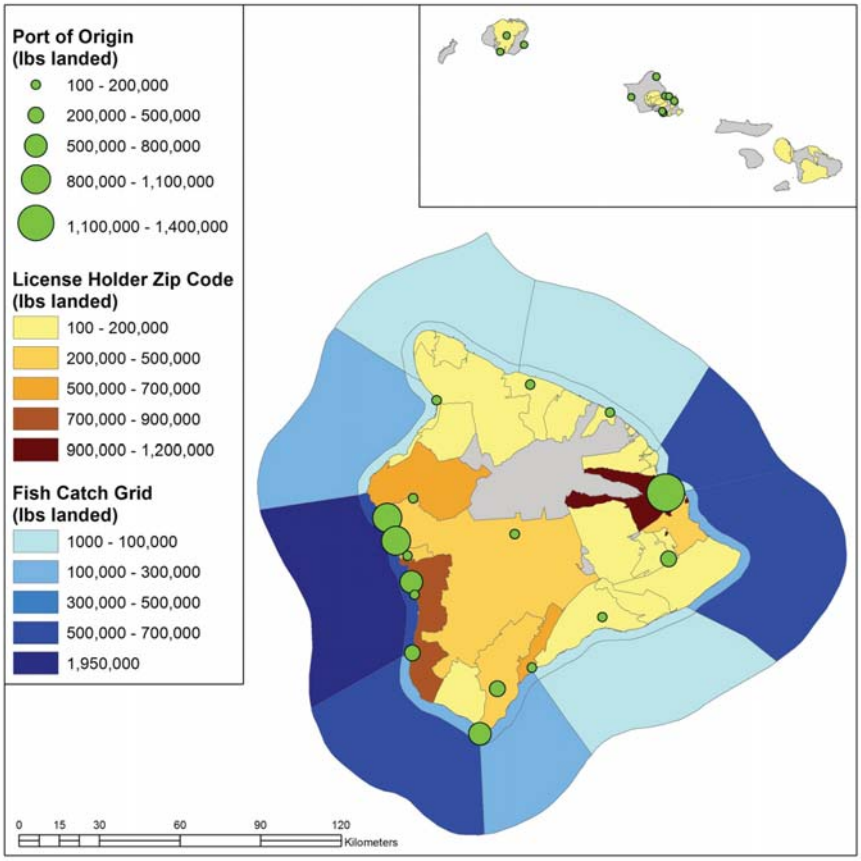
(Palu Ahi, Drop Stone)

- Order of magnitude less volume of harvest w/ traditional handline gear

- Kona Coast most productive overall

- Fishermen from Hilo & South Kona harvest majority of catch using palu ahi gear

- Hilo – port with greatest volume of handline caught fish

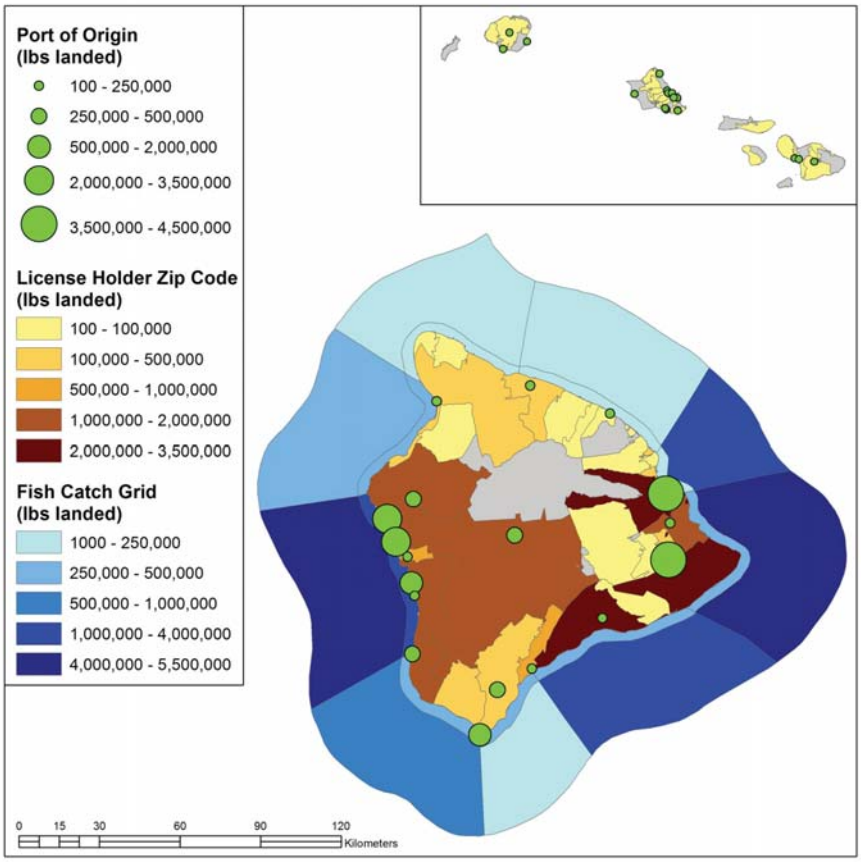


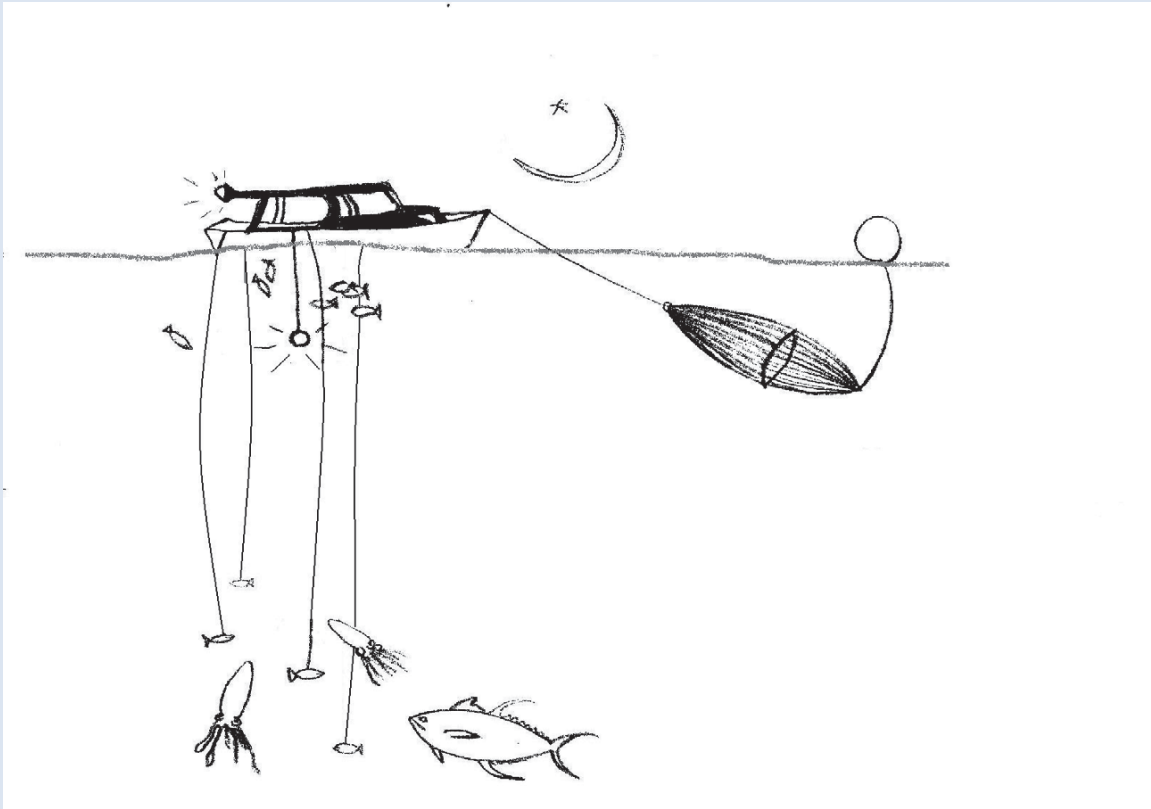
Traditional Handline Gear

(here including ika-shibi)

- Extensive use of ika-shibi technique by windward-based fishermen

- But extensive harvest both windward and leeward



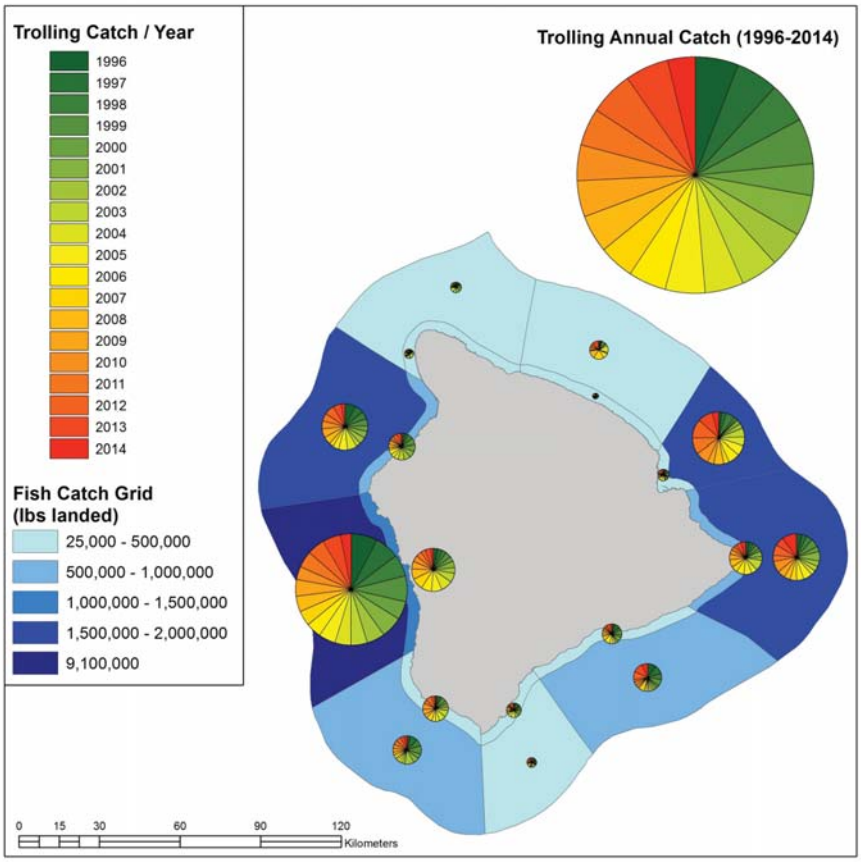


Temporal Variability:

Annual Catch Rate w/ Troll Gear

- Troll catch has remained fairly constant over time series

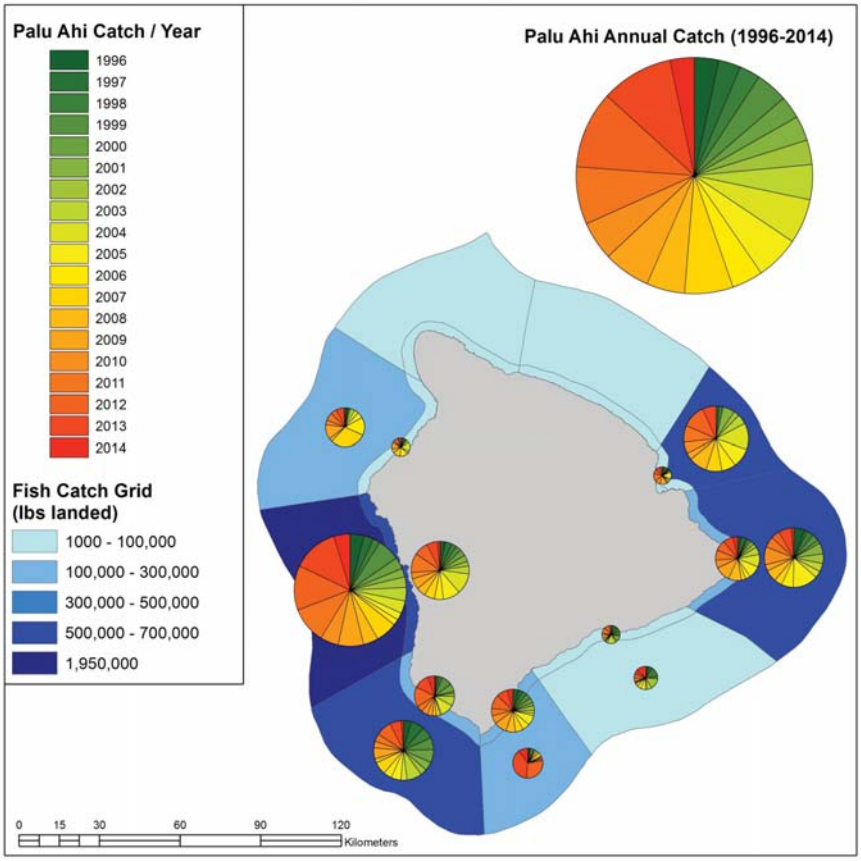
- Limited variability between regions



Temporal Variability:

Annual catch rate w/ traditional handline methods

-Harvest has increased over last ~20 years, particularly over last few years

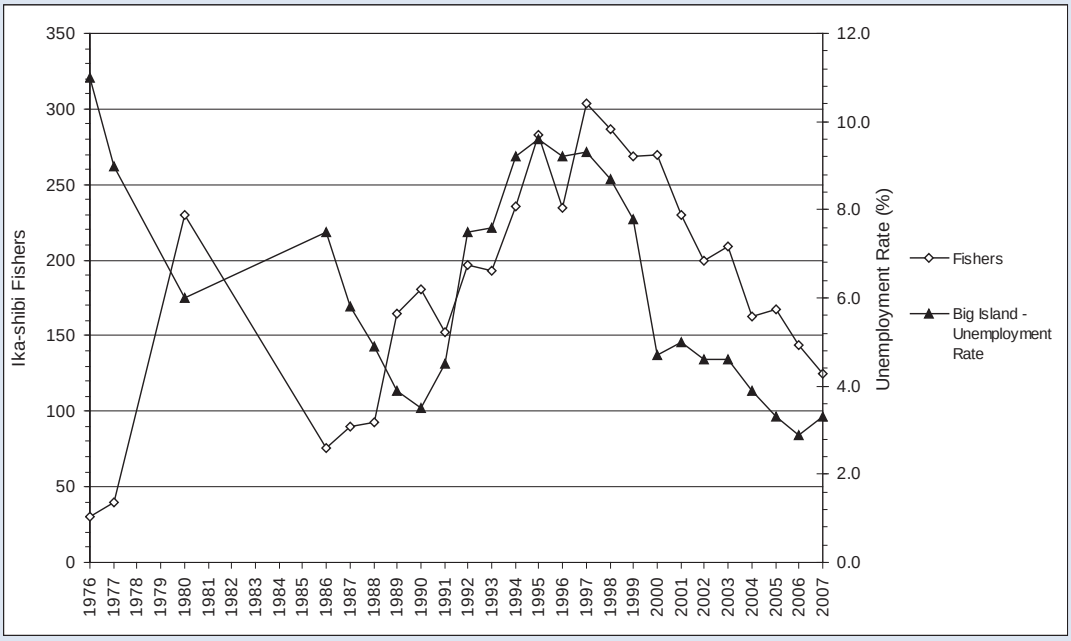


Conclusions

- FEAT rapidly assesses regional variability in fishing activity / distribution of catch and effort over time: Kona 1
- Can further understanding of connections between people geography, and fishing / enable baseline for SIA
- Readily incorporates variety of data indicative of nature & extent of human interaction with marine environment (protected species interactions, MPA effects analysis, etc.)
- FEAT is (highly) effective tool for assessing the human–ocean interface - Great care needed in its application

Also some predictive potential: e.g.,

Big Island fishing and unemployment



- The scope and distribution of fishing activity under such conditions can to some extent be anticipated, with much potential for refinement and testing of the tool moving forward.

- Pau -

Acknowledgements

- Stewart Allen (now at Dept. Interior, BLM)
- Reggie Kokubun, et al. (Hawaii Div. Aq. Res.)
- Kimberley Lowe, et al. (PIFSC WPacFIN)
- Michael Parke, PIFSC
- Evan Howell, et al., PIFSC

Appendix 1 – Document 5

Cooperative Conservation and Long-Term Management of False Killer Whales and Other Endangered Cetaceans in Hawaii

1. Projects by Objective
   i. Objective 1

Objectives 1 and 2 aim to assess the degree of spatial overlap between MHI false killer whales and state fisheries effort. There is considerable information available on false killer whale movements and habitat use based on satellite tag deployments (Baird et al. 2010, 2012) that could be used for a preliminary assessment of overlap with fisheries. As of October 2014, data are available from 33 deployments of satellite tags on individuals from this population, covering a span of 2.1 to 199 days (mean = 49 days)[1]. There are, however, a number of limitations to the existing data set that we will address with additional field work involving satellite tagging (Objective 1). Most importantly, three large social units, termed social clusters (Baird et al. 2012), have been identified within the MHI insular population. Tag data are available from only two of the three social clusters (Cluster 1 and 3). These social clusters are similar to killer whale "pods" (see e.g., Bigg et al. 1990), that is, long-term stable groups of related individuals (Martien et al. 2014). Like killer whale pods, the social clusters differ in their high-use areas (Baird et al. 2012). Although no tag data are available from Cluster 2 individuals, evidence from distribution of sightings data indicates that Cluster 2 individuals use areas differently than either Cluster 1 or Cluster 3 individuals (Baird et al. 2012). In addition, based on the timing of previously funded field work through CRC, there is a large seasonal gap in information from tagged individuals, with little location data available from February through May (Figure 1). Lastly, we do not know whether there are inter-annual differences in spatial use. Field work planned under this study will attempt to address all of these limitations, with tagging selectively targeted in areas and/or times of year to address data gaps. In addition to obtaining data to accomplish this goal, other information obtained during field projects will be used to help estimate abundance and to evaluate fisheries interactions.

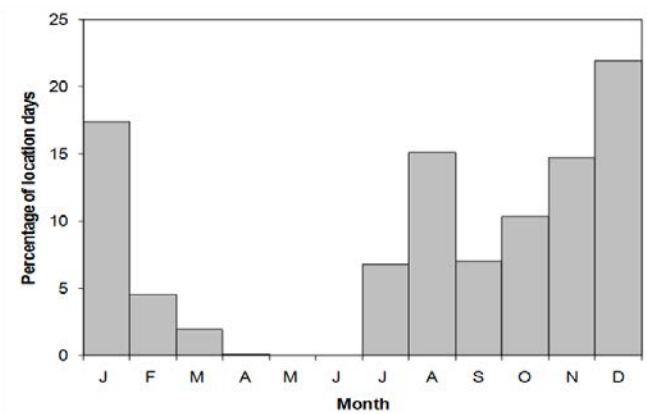


Figure 1. Seasonal distribution of tag data from MHI insular false killer whales, from Baird et al. (2012).

Field operations will be conducted on small boats, using vessels ranging from approximately 21-35' (see Baird et al. 2013b). Field work will generally be focused in leeward waters, to increase the likelihood of both finding false killer whales and successfully deploying satellite tags (both of which require relatively calm working conditions). However, for work off Maui we will explore options for working on the windward side, in particular launching the research vessel from Kahului Harbor during

[1] Two tags deployed on MHI false killer whales off Kauai in October 2014 are still transmitting.

periods when conditions allow for working off the north side of Maui. Off Hawaii Island, recent analyses examining false killer whale sighting rates by area (north and south of Honokohau Harbor) have revealed that overall sighting rates north of the harbor are 2.4 times greater than south of the harbor, and sighting rates for Cluster 2 false killer whales are four times higher north of the harbor than to the south. In addition, sighting rates of Clusters 2 and 3 are higher in deep waters (Baird unpublished). In the past, the majority (66.5%) of our field effort off Hawaii Island has been to the south of the harbor and much of the effort to the north has been in shallow areas. During this study, effort will be concentrated north of the harbor and in deeper waters as much as possible to maximize sighting rates of Clusters 2 and 3. We will also assess the feasibility of basing operations out of Kawaihae, rather than Honokohau Harbor, to allow survey effort to be concentrated off the north end of island and possibly extending to the windward side of the island if conditions allow. This work will be undertaken in the first two grant years, specifically targeting times and areas to address tag data limitations.

Year 1: The timing and location of field effort in Year 1 is meant to address two data limitations: the seasonal gap in data from Mar-Jun (Figure 1), and the geographic bias in tag deployment locations, as tags deployed to date have been off either Kauai (n=2), Oahu (n=10) or Hawaii Island (n=21). Field work in Year 1 will be undertaken off Maui and Lanai during February-March 2016, a period when large numbers of whale watching boats can assist with finding false killer whale groups. If conditions allow, some effort will be on the windward side of the island by launching from Kahului Harbor.

Year 2: The timing and location of field work in Year 2 will depend in part on the success of Year 1 field efforts. We will undertake at least two field efforts to address seasonal, spatial, and social cluster limitations of the data. For the purposes of budgeting and initial planning, we are anticipating projects off Oahu and Hawaii Island. We will also explore options for working off the windward sides of Maui, Oahu, and Hawaii Island by basing operations out of Kahului, Kaneohe, or possibly Hilo. We anticipate a field project off Oahu in October 2016, a month when false killer whale sightings are relatively common in that area, or during the winter to address the seasonal limitation in data availability. In addition, tagging individuals from Cluster 2 is a high priority, and so to maximize the likelihood of tag deployments on Cluster 2 we anticipate a field effort off Hawaii Island. Previous field efforts have indicated that Cluster 2 individuals are seen primarily off Hawaii Island (Baird et al. 2012), in particular during the month of August, so one field effort will target that island at that time of the year (August 2017). As noted above, field efforts will concentrate in areas and depths where sighting rates of Cluster 2 will be maximized.

The satellite tags we will deploy are location-only Wildlife Computers SPOT5 transmitters in the LIMPET configuration, attached with two 6.5-cm titanium attachment darts. These are the same tags used previously with false killer whales (see Baird et al. 2010, 2012, 2013a). The tag is secured to an arrow with a urethane holder and deployed with a Dan-Inject JM Special 25 pneumatic projector. Tags will be programmed to transmit daily for 9-12 hours per day during hours with the best satellite coverage, with data obtained during both the day and night. Tag attachment durations for 21 location-only LIMPET tags deployed on MHI insular false killer whales since 2008 have ranged from 6.3 to 199 days (median = 50 days). Tags are duty cycled to transmit daily for the first 60 days, to obtain high resolution location data over the period of typical tag attachment, and then at multi-day intervals afterwards, to obtain a longer time-series for those tags that stay attached longer than average. False killer whales encountered in the field will be photographed for individual identification, and two to three satellite tags will be deployed on individuals in each group, depending on the group size and social cluster encountered. A catalog of MHI insular false killer whales will be taken in the field and used in real-time to determine the social cluster(s) present, to minimize the likelihood of tagging an individual that has been previously tagged, and to selectively target individuals from Cluster 2 if more than one cluster is present.

Skin and blubber biopsy samples will be obtained using standard methods (Chivers et al. 2010). If individuals have not been previously biopsied, samples will be used to determine sex and will be contributed to population genetics studies at the Southwest Fisheries Science Center. Samples

will also be used for studies of persistent organic pollutants at the Northwest Fisheries Science Center (Ylitalo et al. 2009; Foltz et al. 2014), and for analysis of stress and reproductive hormone levels at HPU. Mouth-line photos will be obtained from bow-riding individuals using a GoPro HD camera on a pole, and above-water mouth-line photos will also be obtained when behavior of the animals allows for it. Photos of false killer whale mouth-lines will be matched to dorsal fin photos (when photo series allow for such matching) to estimate the percent of false killer whales that are likely interacting with fisheries, and how this varies with sex and social cluster. All photos will be compared with the long-term photo-identification catalog (Baird et al. 2008) to determine individual identity and sighting history. Photo-identification data will be used in a mark-recapture framework to estimate abundance of this population following methods in Baird et al. (2013c).

Information will also be obtained from other species of odontocetes encountered and used for population assessments. When ESA-listed sperm whales are encountered, we will also attempt to deploy satellite tags on this species to obtain information on movement patterns and habitat use to better understand this species in Hawaiian waters. CRC has previously tagged 10 sperm whales in Hawaii, with tag data obtained from periods of 1 to 14 days; any sperm whale tag data obtained during this project will be combined with the existing data set to evaluate movements. Sperm whale photo-identification photos will also be sent to the Southwest Fisheries Science Center for contribution to their photo-ID catalog of this species.

After location data are downloaded from the Argos system, they will be assessed for plausibility using the Douglas Argos-Filter Ver. 7.08 following the same criteria as for previous satellite tags deployed on this species (Baird et al. 2010, 2012), with location classes (LC) 3 and 2 retained, using a maximum sustainable rate of movement of 20 km h^{-1} and the default rate coefficient for marine mammals of 25. Error associated with locations varied by location class (Argos User's Manual): LC3 < 250 m; LC2 < 500 m; LC1 between 500 and 1500 m; no estimation of accuracy for other classes. When data from multiple tags are temporally overlapping, the degree of independence of tagged individuals will be assessed following the protocols outlined in Baird et al. (2012). The straight-line distance between locations of pairs of individuals will be calculated when locations are obtained during a single satellite overpass, and both the average and maximum distances among the pairs will be assessed to determine if the individuals were acting independently. For individuals that were acting in concert, only one individual from each pair (or trio) will be used for analyses of false killer whales spatial use (the longest duration track). Assessments of overlap with areas of fishing (see Objective 2) will be undertaken using all locations that pass the Douglas filter (e.g., Figure 2) from one of each pair or trio of individuals.

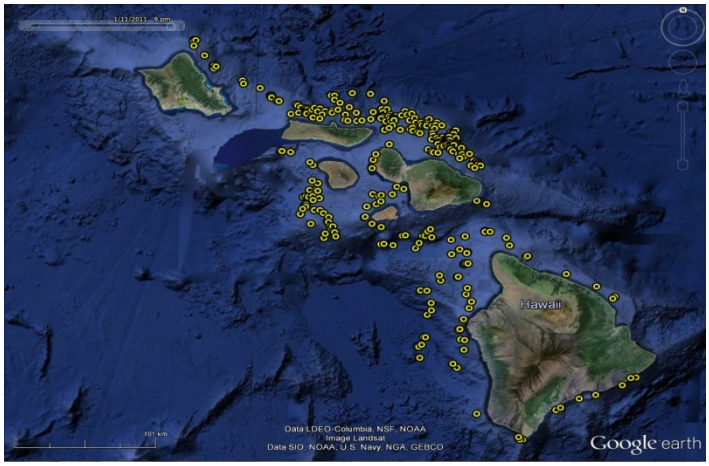


Figure 2. Map of locations of satellite-tagged false killer whale HIPc169, tagged off Hawaii Island on December 11, 2010 and tracked over a span of 31 days.

ii. Objective 2

Objective 2 investigates overlap of effort in state fisheries with the spatial use patterns of the MHI false killer whales. CRC will conduct a GIS analysis, in coordination with DLNR-DAR and the

NMFS Pacific Islands Fisheries Science Center (PIFSC), using ArcGIS 10.2. False killer whale location data from satellite tags (see Objective 1)[2] will be mapped onto a vector grid of the mandatory state commercial landing report grid areas around the MHI (Figure 3), to assess use of each grid area by social cluster, season and year. Methods to assess grid area use will follow the protocols outlined by Baird et al. (2012) for analyzing false killer whale spatial use around the MHI. A spatial join will be used to associate false killer whale locations within grid cells for all filtered locations of all individuals. False killer whale tracklines will be developed by connecting locations in a temporal sequence and intersecting the resulting features by the overlay grid. A number of different approaches will be taken to assess false killer whale usage of grid areas (see Baird et al. 2012 for more details), including the number of location records within each grid area, the total visit duration, the total visit duration with a late start, and the number of unique individuals using each grid area, with results compared to assess the best approach.

DLNR-DAR issues commercial marine licenses to individuals to take and land marine life for commercial purposes in the State of Hawaii. Fishing reports are mandatory for commercial fishers and include information on fishing locations using grid area charts (Figure 3), fishing effort, and total catch (including bycatch). State fisheries data is provided to PIFSC, and data outputs by fishery area are available through the Fishery Ecosystem Assessment Tool (FEAT) developed by PIFSC (Dieter and Glazier 2014). Summaries of the fishery data by grid area will be used to examine spatial and temporal trends (annual, seasonal, monthly) for each of the primary MHI insular fisheries (e.g., tuna handline, troll, short line, vertical line, kaka line, and bottom handline) that could have interactions with false killer whales. A variety of effort metrics will be considered, including total number of vessels fishing within grid cells, total number of days of fishing effort within each grid cell, as well as total catch, from which CPUE can be calculated.

Analyses will compare measures of fishing effort by fishery to indices of false killer whale usage of grid cells to identify areas of highest overlap between fishing effort and false killer whale spatial use, and how overlap varies by season, social group, and year. Analyses will be coordinated between CRC, DLNR-DAR Aquatic Biologists and Statisticians, and PIFSC staff. In Year 1, preliminary analyses will use existing satellite tag data and fisheries data. In Year 3 final analyses will be undertaken to include all new satellite tag data obtained in Year 1 and Year 2 (Objective 1). Environmental and other factors (e.g., false killer whale social cluster, locations of known Fish Aggregating Devices "FADs") that may influence false killer whale area use will also be examined on a finer scale than the state grid areas. Environmental factors to be examined include depth, slope, distance to shore, and chlorophyll a, following methods outlined in Baird et al. (2012).

As with all the research results, these analyses will be made available to the DLNR-DAR Outreach and Program Coordinator established through this grant (see Objective 4). These findings will inform outreach efforts with fishers in order to reduce misconceptions about false killer whales and to work collaboratively to potentially develop mitigation measures. Additionally, outreach efforts could be targeted to fishermen by location (harbors) or fishing gear types, based on the results of these analyses. The results will also be presented to NMFS in relation to the recovery plan process, the FKWTRT, and the NMFS Pacific Scientific Review Group.

[2] Data obtained through efforts funded by other sources (e.g., U.S. Navy, NOAA PIFSC, NOAA Bycatch Reduction Engineering Program) will also be utilized in these analyses.

Appendix 2

Appendix 2 - Additional Information on Trolling, Use of Bait versus Lures, and Depredation

Craig Severance and Phil Fernandez provided first-hand anecdotal information to the Work Group by email subsequent to the Work Group call. The information from their emails has been reproduced below, with slight editing for clarity and formatting.

Craig Severance

For clarification on bait as an attractor: on Hilo side, bait will be primarily used in the handline fisheries (both palu ahi and ika shibi, and both may use chum), and the vessel may be anchored (on an ahi Koa sometimes 70-100° F) or drifting with a chute near a FAD (the latter more frequent).

Trollers may drag bait in three ways:

1. Cut bait (i.e. aku belly strip), which is the least frequent and is used primarily for targeting mahi;
2. Whole opelu, which is somewhat more frequent, and is rigged with smaller J hooks targeting mahi and Ono; and
3. "Live bait," which is more frequent, especially at FADs. Live baiters use light-gear-caught aku or ahi in the 3-5 lb range, bridled with J hook in front of the nose. Live baiters target marlin and larger ahi (i.e. 80-100 and up).

Porpoises (species unknown) sometimes (rare events I think!) take a live bait leaving the head, bridle, and hook. Predation on live bait by sharks does occur, and can sometimes be recognized if the bridle is cut. Predation on smaller aku and ahi that have been hooked on light gear (i.e. spinning gear 30 lb and aku lures.) may also occur. I have never seen or heard of predation on larger hooked fish like marlin or ahi 50 lbs and up, and I've only seen blackfish once. Like most everyone else I know, we just left the scene. We might consider some educational outreach on recognition and avoidance practices.

Phil Fernandez

Bait use by trollers are relatively rare - I would probably say about 10% or less of the effort is trolling with bait. Unless you are pretty certain there is fish in an area, doing a slow troll with bait is pretty much a waste of time since you troll with bait at a very low speed (~2 - 3 knots). With artificial lures, the speed range is 8 to 10+ knots so you can cover a much larger area. Predation of bait will likely be either rough-toothed dolphins or sharks. After the first bait is lost to a dolphin or a shark, you quit baiting and go to artificial lure because it is a waste of time and fuel to drag a bait just to feed a dolphin or a shark. They will follow a boat until you run out of bait. Troll fishermen also may carry bait (but not for trolling) to have in case they come across a school of mahimahi. They will stop the boat and try to drift with the mahimahi school and cast baited hooks toward the school. Fishermen may also throw cut bait to the school of mahimahi to create a feeding frenzy (but at this point they are no longer trolling, just drifting, but fish caught in this manner will likely be reported under trolling).

Predation of catch occurs, mostly shark. Sharks will follow a hooked fish on the end of the fishing line right up to the boat, and just as you prepare to gaff the fish, the shark will take a big chunk out of the fish. Sometimes they succeed in taking the whole fish, but mostly it will rip off the back end of the fish (this is true with either tuna or marlin). The shark seem to wait until the fish is close to the boat since when the fish is far away from the boat, it can swim in a larger arc, but as the line is pulled in the fish can only swim in a short arc and it makes it easier for the shark to bite the fish.

There is predation of caught-but-escaped fish. These are fish, including "bait size" (i.e. 2 - 4 lb tuna) to medium (10 to 25 lb mahi, ono, tuna, etc.) to even large fish, that break off while the fisherman is fighting or landing a fish. These fish become easy prey as they may be injured, tired, or are dragging a hook and broken fishing line. In the Northwest and in Alaska, injured salmon or salmon with hook and broken line are often seen swimming at the surface and become easy prey to eagles and other birds of prey. It is not unusual to find fishing hooks in eagles' nests or osprey nests from this type of predation. It's likely that in Hawaii, larger swimming predators find these injured or compromised hooked fish.