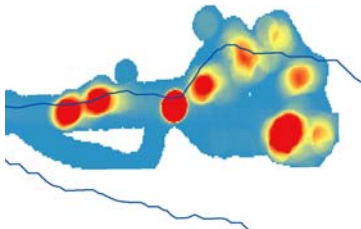


Final Report: A Profile of the Hook and Line Fishery for California Halibut in Monterey Bay, California

Learning from Fishermen through Collaborative Research



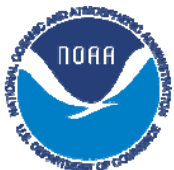
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Abstract

Many commercially-targeted fish species can be caught with different types of fishing gear, yet the choice of fishing gear can have major economic and ecological repercussions. California halibut (*Paralichthys californicus*) is a major commercial and recreational fish species in California and Mexico that can be commercially caught with bottom trawls, set gillnets, and various configurations of hook and line gear. Numerous studies have documented adverse impacts to seafloor habitats from the use of bottom trawls, including the 2002 National Research Council study which found that bottom trawling reduces the diversity, productivity, and complexity of marine habitats. To comply with Essential Fish Habitat provisions of the 1996 Sustainable Fisheries Act, the Pacific Fishery Management Council closed over 135,000 square miles of federal waters to bottom trawling off the U.S. west coast in the 2006 Pacific Coast Groundfish EFH Final Rule. Also in 2006, halibut trawl grounds in Monterey Bay, California became closed to trawling as the result of 2004 state legislation (SB 1459), and there has been ongoing debate about whether to reopen certain areas. Meanwhile, the California Fish and Game Commission is required to facilitate conversion of bottom trawling to more sustainable gears. However, while hook and line gear clearly has been shown in other studies to cause minimal impacts to seafloor habitats compared to trawling, little is known about the economic viability or the levels of incidental catch associated with hook and line fishing for California halibut.

The objective of this pilot study is to provide a preliminary snapshot characterization of the California halibut fishery currently taking place in northern Monterey Bay, California with hook and line gear, focusing on costs and revenues to participating fishermen, spatial patterns in fishing effort, and incidental catch. The intent is to contribute additional information to ongoing dialogue regarding the relative impacts of hook and line fishing gear and the potential to increase landings with this gear type in Monterey Bay. We identified three California halibut hook and line commercial fishermen to collect data while at-sea in the course of normal fishing operations and participate in extensive semi-structured interviews. While at sea, these fishermen continuously tracked their vessel location with GPS, and for each individual organism caught they recorded data: the GPS location where caught, the species identity, the total length, a still photograph, whether the organism was retained or discarded, and the condition of each discarded fish. We conducted semi-structured interviews with participating fishermen at the conclusion of the at-sea component of the study, which addressed perceptions and opinions, experience in the fishery, interpretations of data gathered in the at-sea components, personal economics associated with the fishery, and fishery trends. Fishermen were compensated for their participation in the study.

Data were collected during 14 trips from August to November 2011, representing the latter half of the 2011 halibut season for this fishery. Fishermen typically fished alone (i.e., without crew) on small vessels from 15-18 feet long by drifting live bait on 3-6 lines at a time. Fishing effort occurred within 5 miles of the Santa Cruz Harbor at less than a dozen discrete locations throughout the study. A total of 38 California halibut were caught, of which 36 were of legal size and 2 were sublegal. Ex-vessel prices ranged from \$4-6/lb for whole halibut, landed dead. Aside from halibut, other commonly retained species included lingcod, brown rockfish, gopher rockfish, copper rockfish, and sand sole. Overall, discard rates observed in this study were 19.5% of the total catch by weight. These discard rates are substantially lower than observed

discard rates in California halibut trawl fisheries, which range from 60-70% by weight. Discards were exclusively finfish. On an annual basis, the most significant costs included boat maintenance, tackle, licenses, and fuel. Based on a combination of recorded landings in the study and subsequent interviews to determine costs, estimates of annual profits per fisherman from halibut fishing ranged from \$11,295 to \$29,362 representing approximately 20-25% of each fisherman's total annual income. However, while the fishery is currently open access, there appear to be significant barriers to entry, particularly the technical difficulty associated with successfully using hook and line fishing gear to target this species.

This preliminary study indicates that the hook and line fishery for California halibut in Monterey Bay is an economically viable commercial fishery that is profitable with substantially less bycatch than what has been reported in other studies of bottom trawling for this species. This pilot study also indicates that collaborative research involving fishermen as participants and data gatherers provides significant opportunities to collect important, management-relevant data that may otherwise be cost-prohibitive.

Rationale

Passed in 2004, California legislation (SB 1459-Alpert) had an outcome of prohibiting bottom trawling in most ocean waters of the state. This statute became enforced within state waters of Monterey Bay in October 2006 (Appendix F). This legislation states that the Fish and Game Commission shall facilitate the conversion of bottom trawlers to gear that is more sustainable if the Commission determines that conversion will not contribute to overcapacity or overfishing (CA Fish and Game Code, 2011). Commercial landings data indicate that a range of 10-25% of total commercial landings of California halibut (*Paralichthys californicus*) statewide have historically been caught with hook and line fishing gear, suggesting that hook and line techniques are economically viable in some parts of the state as an alternative to trawling (Sweetnam, 2008).

In the Monterey Bay ports of Monterey, Moss Landing, and Santa Cruz, average annual landings of halibut by hook and line methods were at a level equivalent to 46.7% of average annual halibut landings by trawl from 2000-2007 (CDFG, 2011, Table 1). Over the past decade, halibut landings by hook and line have accounted for over 32% of total landings by all gear types in the three Monterey Bay ports. Hook and line fishing has at times landed more California halibut than trawling: in 2003 halibut landings by hook and line totaled 31,722 lbs, while landings by trawl totaled only 20,336 lbs (CDFG, 2011). However, since the closure of the trawl fishery in Monterey Bay, there has not been a significant increase in hook and line landings in Monterey Bay (Table 1; Figure 1). Commercial hook and line halibut landings have actually decreased slightly in recent years. This has led to the perception that an increase in commercial hook and line fishing may not be economically feasible in this area.

Table 1. California halibut landings in Monterey Bay ports (Monterey, Moss Landing, and Santa Cruz) by gear type, 2000-2010. Hook-and-line figures include gear codes 1 (H/L), 8 (groundfish-troll), and 9 (salmon-troll). These figures are based on data compiled from the CA Department of Fish and Game's Commercial Master Landings Database (CMaster) by Travis Tanaka (CDFG-SFMP), June 2011.

	Type of CA Halibut Landings	Landings (lbs)	% of Total
2000-2007	Total all gear types	476,807	-
	Total trawl	295,523	62.0
	Total hook and line	137,965	28.9
	Total gillnet	43,319	9.1
	Average annual all gear types	59,601	-
	Average annual trawl	36,940	-
	Average annual hook and line	17,246	-
2008-2010	Total all gear types	27,966	-
	Total trawl (2010 research cruise)	2,388	8.5
	Total hook and line	25,578	91.5
	Total gillnet	0	0
	Average annual all gear types	9,322	-
	Average annual hook and line	8,526	-

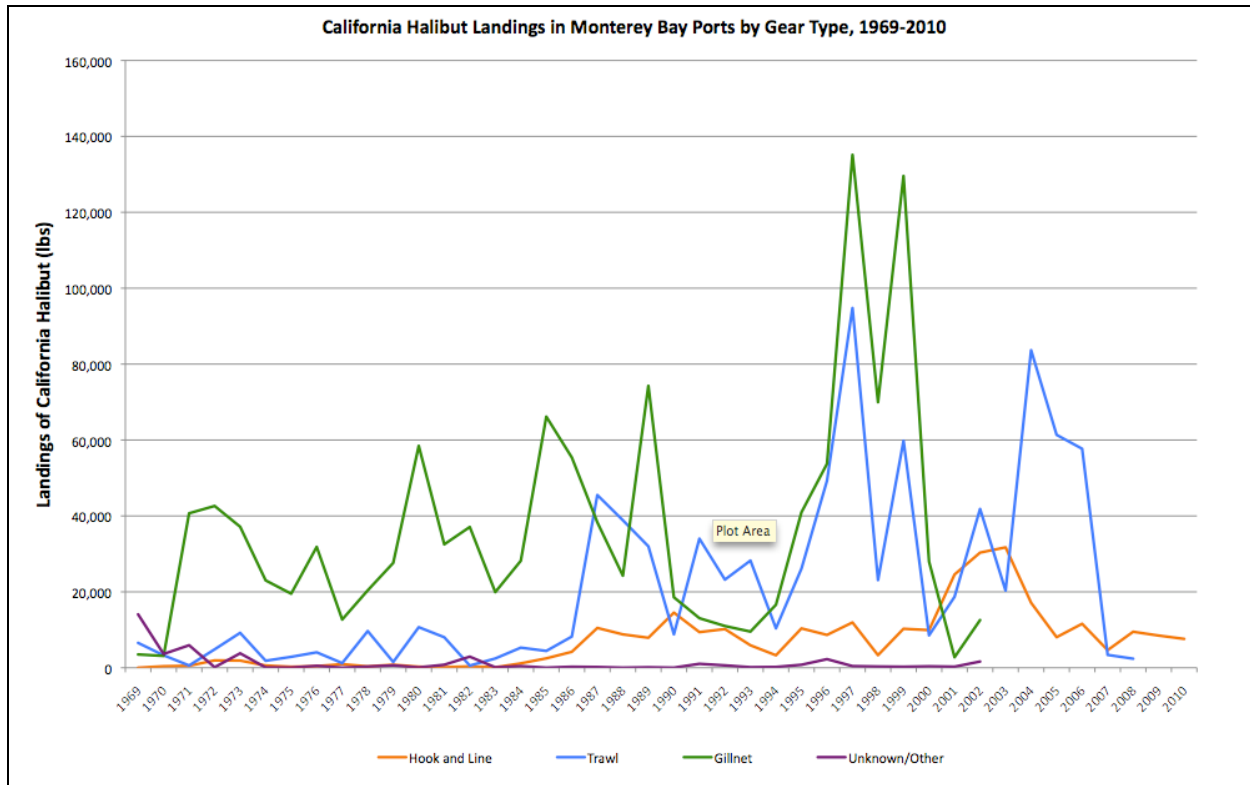


Figure 1. Landings of California halibut in Monterey Bay ports (Monterey, Moss Landing, Santa Cruz) by gear type (hook and line, trawl, gillnet, unknown/other), 1969-2010. Gillnetting historically brought in the highest landings of halibut. Both gillnet and trawl landings exhibit large fluctuations from year to year. Hook and line landings, though clearly at a lower average volume, have been comparably more stable over the past three decades. Data provided by Travis Tanaka (CDFG-SFMP), June 2011.

Studies in the late 1980s by the California Department of Fish and Game concluded that “otter trawls were the most effective gear for catching legal-size halibut.” Bottom longlining and trolling gears were evaluated in the Morro Bay area (Haseltine and Thornton, 1990). However, one of the two troll gear tests was done by a commercial fisherman who was not experienced with the gear. Additionally, the study stated that “a viable ‘wire line’ fishery exists for halibut off Central California,” but did not expand on the potential contributions of this fishery to overall halibut landings (Haseltine and Thornton, 1990). Also, while hook and line can be assumed to have negligible impacts on seafloor habitat, the bycatch levels in this area have not been assessed. Therefore, determining the extent to which a hook and line fishery for halibut is profitable in Monterey Bay and how the bycatch in such a fishery compares to trawling will help identify whether facilitating increased use of this gear is practical and more sustainable. Without information collected in a rigorous study, regulators and stakeholders will not be convinced on the extent to which hook and line fishing effort can increase, compensate, or replace landings caught in the trawl fishery.

Study Objectives

The approach of this component of a broader study is to determine the catch rates of California halibut (legal and sub-legal) and other species with hook and line gear, as used by some of the Monterey Bay fishermen who have demonstrated success in landing halibut. This study does not attempt to explain or represent all current participation in the Monterey Bay California halibut hook and line fishery. The objectives of this pilot study are to:

- Determine and document the methods and areas of Monterey Bay where catch rates are highest, relying on experienced fishermen to gather data.
- Determine whether there is potential for a profitable increase in effort using the techniques of more successful fishermen.
- Discover the most sustainable method for the harvest of California halibut (taking into consideration traditional methods of take, historic landings, multiple user groups, and socioeconomic viability).

Once these data are collected, they can be integrated with socioeconomic data on the current context of Monterey Bay fishery participants and permit holders to determine the extent to which effort might be expanded under current prices, as well as under alternative sets of prices and costs. For the purposes of this study, we are considering only pole-caught methods (including drifting, wire lining, trolling, and/or jig gear); not bottom longlining. This study serves as a starting point that will allow us to understand current trends in the fishery and establish a baseline for continued research.

Study Methods

Identifying Study Participants

To gain a preliminary understanding of the trends in the fishery, informal discussions were first held with regional fishermen who use hook and line methods to catch California halibut. To recruit fishermen participants, a flier was distributed throughout Monterey Bay ports (Appendix A), and the Department of Fish and Game mailed an announcement to the twenty individuals with the highest landings of California halibut in the Monterey Bay port area by hook and line methods in the past five years. The purpose of these conversations was to introduce fishery participants to study goals, to provide a rough outline of potential study methods, to share knowledge about catching halibut with hook and line methods in Monterey Bay, and to ask willing individuals to complete a brief questionnaire about their involvement in the fishery. This process was helpful in identifying fishermen involved in the fishery, including prospective study participants.

Three fishermen were selected to participate in the study. Participants were chosen because they: a) regularly target California halibut, b) fish in the State waters of Monterey Bay, c) employ hook and line techniques that they believe maximize their catch, and d) have a demonstrated record of landing significant quantities of California halibut and sustaining a profitable halibut fishing enterprise. One fisherman who took part in the study explained his

motivation for involvement: "I did this project not to affect anyone or shut down any fishery whatsoever, I did it to prove that the hook and line halibut fishery is a sustainable and successful fishery."

All three of the individuals selected to participate in the study were based out of the port of Santa Cruz. This is because the hook and line fishery for California halibut is significantly more active in Santa Cruz than in the other two Monterey Bay ports (Moss Landing and Monterey). Over 18,000 lbs of California halibut were landed commercially in Santa Cruz from 2008-2010, compared to less than 5,000 lbs in Monterey and Moss Landing (Table 2). The halibut fishery in Santa Cruz is also the highest value halibut fishery in Monterey Bay, with the average ex-vessel price, for the period 2008-2010, being over one dollar greater than the average ex-vessel price in the other two ports. In the future, it would be desirable to replicate this study with fishermen in both Monterey and Moss Landing to more fully understand the dynamics of the fishery throughout the entire bay.

Table 2. California halibut commercial landings and landings values by Monterey Bay port, 2008-2010. Data from California Department of Fish and Game Final Commercial Landings data, Table 18PUB, 2008-2010. Available online at <http://www.dfg.ca.gov/marine/landings08.asp>, <http://www.dfg.ca.gov/marine/landings09.asp>, <http://www.dfg.ca.gov/marine/landings10.asp>.

Monterey Bay Port	Year	Commercial Landings (lbs)	Value of Landings	Average Price Per Pound
Monterey	2008	824	\$3,021	\$3.66
	2009	71	\$286	\$4.03
	2010	3,813	\$10,872	\$2.85
	TOTAL	4,708	\$14,179	\$3.01
Moss Landing	2008	2,148	\$8,261	\$3.84
	2009	1,062	\$2,787	\$2.62
	2010	1,056	\$3,618	\$3.43
	TOTAL	4,266	\$14,666	\$3.44
Santa Cruz	2008	6,517	\$31,927	\$4.90
	2009	7,349	\$30,381	\$4.13
	2010	5,125	\$23,086	\$4.50
	TOTAL	18,991	\$85,394	\$4.50

Initially, we planned to employ observers trained by NMFS for the West Coast Groundfish Observer Program (WCGOP; part of the Pacific States Marine Fisheries Commission) to record data on all fishing trips over the course of the study. However, budget constraints made observer coverage prohibitively costly, and fishermen participants were instead trained to record data on their own trips. Due to the small vessel sizes of participants (16-18 ft), not having an additional person on board was viewed favorably by fishermen. No participant expressed that the responsibility of recording data presented too much of a burden nor compromised their ability to fish with their usual techniques.

Agreements with Fishermen

Fishermen signed agreements with Oceana that described the purpose of the research, explained the expected use of data, and provided the following key expectations:

- Fishermen were to undertake five full days of commercial fishing for California halibut within the state waters of Monterey Bay. For the purposes of this study, a full day was defined as at least four hours of fishing. Each day of fishing was to be separated by at least one week from the previous day of fishing, with study days self-selected based on fisherman experience, the weather, and other conditions.
- Fishermen were to target California halibut within the state waters of Monterey Bay with their preferred hook and line methods, with the goal of meeting reasonable economic expectations of a long-term profitable fishery for individual participants. Fishermen were to fish within Monterey Bay where they thought was best each day, rather than in some pre-determined location.
- All existing regulations, including landing requirements, were to be followed. Participating fishermen were to keep revenues from the sale of fish landed during the study trips.
- Following each study day, fishermen were required to fill out data sheets (Appendix B) in which they shared data related to fishing effort, catch composition, and ex-vessel values of landed fish. Fishermen were instructed to photograph every fish landed and to use an Oceana-provided GPS unit to track their vessel (Appendix C). Participation in an in-depth, semi-structured interview (Appendix E) about their perceptions and involvement in the fishery was also required.
- Fishermen were compensated for the costs incurred for study participation with a predetermined per-trip stipend independent of catch success.

Data Collection

At the conclusion of each week in which fishing occurred for the study, the Study Coordinator collected and compiled:

- Data sheets completed by the fishermen (Figure 2). Data fields recorded included trip start and end times, weather conditions, depth of each fishing location, times fishing started and ended at each location, number of lines and hooks used, type of bait, species caught, fish lengths, legality of fish, whether fish were kept or discarded, location of the hook, whether discarded fish were released dead, live or bleeding, fuel consumption, and amount and price of sold fish.
- GPS tracking data locating the vessel at 30-second intervals. GPS data was downloaded to computer after each trip.
- Photos taken by fishermen of every fish that was landed.



Figure 2. Fishermen who participated in the study recorded information about their fishing effort and catch composition on data sheets provided by researchers, and tracked their vessel's movement with a handheld GPS unit. Photo credit: halibut fishermen.

Regular data collection also served the purpose of providing fishermen participants with the opportunity to communicate to researchers any issues with data collection, as well as other concerns about study involvement. During the in-depth interviews, each fisherman provided information about their fishing methods and economic aspects of the fishery including their fixed costs of operations. Respondents also answered questions about spatial aspects of the fishery and shared their opinions about overall fishery trends.

Data analysis

Fishermen's data sheets and GPS data were compiled and organized by fisherman and by fishing day. Together with quantitative data obtained during in-depth interviews, this information was used to calculate (for each fisherman and as an average): the number of discrete fishing areas fished, the average total duration of a fishing trip, the average time spent fishing for bait, the average time spent fishing for target species, the average time spent motoring, average halibut sales in pounds, average halibut discards in pounds, average sales of other species in pounds, average discards of other species in pounds, the overall discard rate by percent of total fish caught, the overall discard rate by percent of total weight, legal halibut landings as a percent of total fish caught, average total revenue per trip, average variable costs (fuel) per trip, total fixed costs per year, and distance traveled per trip.

The analyses allow us to answer several questions:

- To what extent is the hook and line fishery for California halibut profitable (i.e., what are mean profits and for what proportion of trips do revenues exceed costs)?
- What are the financial requirements (in terms of fixed capital costs) for promoting the expansion of a hook and line based fishery in Monterey Bay?
- What levels of hook and line effort (and associated capital costs) would be required to meet socioeconomic landings volume objectives?

- What are bycatch levels from the hook and line fishery, and how do they compare to levels observed in the trawl fishery?

Participant Involvement in the Fishery

The fishermen involved in this study had each been fishing commercially for 9-10 years. Although one participant had once assisted with a trawl research project, all were experienced with using only hook and line techniques for their fishing enterprises. Fishing has been a part of their lives since they were children and they learned how to fish from both family and friends who were more experienced fishermen.

All three respondents prefer to fish almost exclusively out of Santa Cruz Harbor. Santa Cruz is favored as a home harbor by these individuals for several reasons: 1) familiarity with the area, 2) proximity to where they live, 3) access to good fishing on day trips both within Monterey Bay and ‘up the coast,’ 4) nearshore waters in Northern Monterey Bay are often warmer than those in Southern Monterey Bay (Graham, 1993), which is conducive to halibut fishing, and 5) there are easy opportunities to sell their catch in Santa Cruz Harbor to buyers who focus on marketing fresh local product.

Two respondents rated themselves average halibut fishermen in relation to other fishery participants in Santa Cruz, while a third described himself as above average. Those who declared themselves to be of average skill made this statement in relation to the other main fishermen in the fishery. Since there are a limited number of individuals who are regularly involved in the hook and line halibut fishery out of Santa Cruz, the bar is set fairly high: “those who do it regularly have it dialed.”

All three fishermen involved with this project primarily target halibut and white sea bass. The season for halibut typically runs from April (as early as late March and as late as May) to mid-November and occasionally into December. Halibut fishing is generally considered best in the months of July and August. Sea bass can also be targeted from April to November, although primarily from August to October. One fisherman also had a permit for salmon, and targets salmon from May to October depending on when the season is open and when conditions are favorable (halibut during periods of lower swell; salmon during periods of higher swell). Other main target fisheries include lingcod and vermilion rockfish (fished on the reef). However, these fishermen keep their focus on higher value fisheries. As the prices for lingcod and vermilion rockfish are only around \$2/lb, it is not always worthwhile to keep and sell them. One respondent had only sold a dozen lingcod all season, and no vermilion rockfish: “it’s not worth keeping it, it’s better to send it back to reproduce.” These participants do not fish regularly from December through March, and pursue alternative sources of income both during these months and during the halibut fishing season.

Fishermen's Knowledge about California Halibut

Fishermen participants had a range of ideas about the behavior of California halibut. All three fishermen named sardines, anchovies, and squid as the main species consumed by halibut. Tubesnout (*Aulorhynchus flavidus*), called “needlefish” by fishermen, are believed to be another key prey species. The fishermen mentioned that sand lance (*Ammodytes hexapturus*), sometimes referred to by fishermen as “candlefish,” also seems to be associated with halibut. It is usually possible to catch halibut when these fish are around, and halibut will sometimes “barf up 100 of them.”

The fishermen think that California halibut are residents year round. Movements of halibut are believed to depend largely on water temperature and swell. Fishing is best when the water is warmer and calmer; when the water gets colder in the fall months (*sic*) or when the swell comes up they move out to deeper water and “hibernate.” Thus, California halibut are optimally targeted on days when ocean conditions are flat calm. Swell over 7 feet and wind over 15-20 mph are not conducive to halibut fishing. One respondent also believes that currents associated with extreme tides make halibut bite more. Another interviewee expressed that halibut will also move in to water as shallow as two fathoms to spawn. There was wide agreement that bait availability is a key determinant of where halibut aggregate. Depending on where the bait are, it may be possible to catch halibut just in front of Santa Cruz Harbor (particularly during the earlier part of the season, from April to June), or it may be necessary to travel further up the coast. One participant did not claim to have a more extensive understanding of halibut movements over the course of the year, and suggested that a tagging project to track halibut movements would be interesting.

Two of the fishermen commented on the high intelligence of California halibut. Because it is difficult to get them to bite your line, they are considered the hardest fish in the bay to catch. One of the fishermen clarified that while halibut are abundant in the bay, they are unlikely to bite due to the abundance of forage fish in the bay. A fisherman needs to happen upon a group of halibut that are eating at that moment, or it is unlikely that they will bite. Moreover, while most other species will bite a fisherman's line again after being released, it is believed a released halibut will never do this. The larger the halibut, the smarter they are believed to be: “they don't reach such a large size by being stupid!”

A key factor in the decision to go halibut fishing, cited by all three participants, was informal news around the harbor. ‘Chatter’ within the fishing community about whether halibut are biting or not and where is an important form of social networking that can influence an individual's decision to fish or not. If the decision is made to target halibut and conditions become less favorable, these fishermen are sometimes able to transition their gear to target white sea bass instead. Most days, however, halibut is the only species targeted on a given day of fishing.

Hook and Line Fishing Methods

The sizes of participants' boats ranged from 16-18 feet, with live bait wells (around 30 gallons) and 4-6 rod holders positioned from bow to stern on the rails. The fishermen fished using 3-6

fishing poles at a time, depending on personal preference and conditions. All rods are generally configured the same way since all lines are targeting the same species at a given moment. Although these fishermen have experimented with trolling techniques, they primarily fish for halibut with hook and line only by drifting: live bait is thrown in while drifting with multiple rods. Trolling can be problematic as there is a lot of high-relief benthic “structure” surrounding the areas where halibut is usually fished, leading to frequent “hang-ups”.

The light tackle used by these fishermen features a triple swivel leader with a dropper loop, in which one swivel goes to the reel, the second is about 3-4 feet long and goes to the bait, and the third is about 6-8 inches long with a 6-12 ounce weight tied to it (Figure 3). Although a sliding weight is used to target white sea bass, it is not used to target halibut. Two treble hooks (4s or 6s) were used on each line.

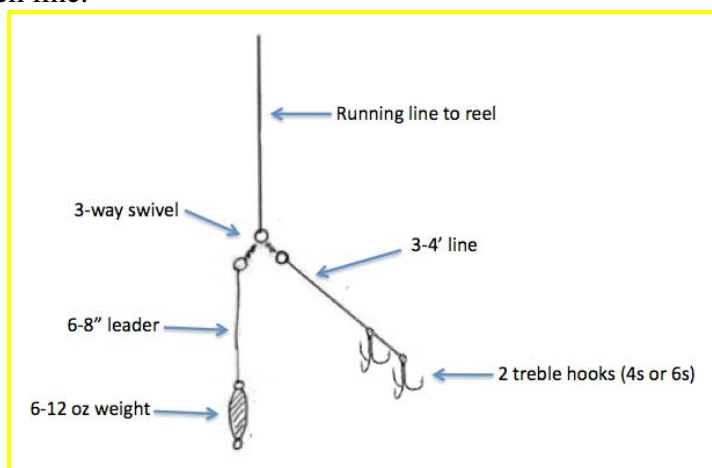


Figure 3. Tackle used by fishermen targeting California halibut by drifting live bait. A triple swivel leader is used with a 6-12 ounce weight, two treble hooks, and live bait.

Live bait is usually used. Live bait species include sardines (large ones are best), squid, anchovies, smelt, and mackerel. One respondent estimated that 75% of all the fish he catches are with live finfish bait. Dead squid is sometimes used instead, especially in the fall months. Another respondent opined that squid, sometimes considered more favorable for targeting white sea bass than California halibut, was more effective than sardines this year in getting halibut to bite. Unlike live sardines, live squid does not swim in circles nor pose the risk of twisted lines. Live bait can be purchased for \$20-40/day. The one vendor who used to sell live bait to commercial fishermen in Santa Cruz Harbor has not been in business since the tsunami impacted the harbor in March 2011, so it was necessary for study participants to catch their own bait for most of the 2011 fishing season. Although more is often used, at least 30 pieces of bait are needed to make a day’s fishing possible. The method typically used to catch bait is by jigging a sabiki rig (Figure 4). Bait is first marked on the fisherman’s fish finder, and then the sabiki rig is dropped and jigged.



Figure 4. Fishermen involved in the study routinely use a sabiki rig (left) to catch their own bait before fishing for halibut. The sabiki rig is dropped to the depth of the bait and then jigged up and down. Bait species are usually sardines (middle) and squid (right). Photo credits: halibut fishermen.

All respondents agreed that catching bait is very ‘hit or miss’; it can take as little as fifteen minutes or as long as four hours, but two hours is average. There were many days in the 2011 fishing season – including several study days – when Santa Cruz Harbor was thick with bait, making it possible to quickly catch a day’s worth of bait without even leaving the harbor. Generally, however, buying bait is preferred as it allows for more time spent fishing for targeted species and thus increases the odds of catching more halibut in a day’s trip.

These fishermen go fishing on day trips only. The maximum length of a fishing trip is from dawn to dusk (about 10 hours dock to dock), although one interviewee has been out for as long as 16 hours. The shortest amount of time participants will spend fishing in a day ranges from 2-6 hours. Estimates of the length of an average fishing trip ranged from 4-11 hours. For all three fishermen, every day is different. A day is most often called short due to poor weather, slow fishing, or running out of bait.

Targeted Areas

There was broad agreement about the types of sites that are most conducive to catching halibut. These halibut fishermen seek out locations with a large amount of sandy bottom that is surrounded by small reef barriers, rocks, or other types of benthic “structure”. These formations are often visible by using sonar and are usually higher than the sand, so the targeted sandy area resembles a lower-lying ‘draw’ formation. Halibut might be found on either side of broad sandy bottom area, waiting in ambush for prey species to come to them from the adjacent reef. Target depth is generally between 40-90’. This depth range is within 3 miles from shore and is not within the historic northern Monterey Bay trawl grounds.

Weather conditions affect decision making about how far from the harbor to travel. High winds in the spring and summer often make it difficult to travel further up or down the coast from the harbor, so on windy days sites are chosen that are within the sheltered northern areas of Monterey Bay. However, if word of mouth indicates that the fishing further afield is good, the fishermen may be compelled to travel further north or south despite high wind waves and swell. The advantage to traveling further from the harbor is that there is less fishing pressure, so the

odds of catching more improve with distance from port. One respondent commented that regardless of conditions, it is only possible to figure out where the halibut are by word of mouth or by going to different spots and trying the fishing out. All fishermen stated that the presence of halibut in a spot does not mean that they will be in the mood to bite.

The range that is usually fished by this study's fishermen extends from Moss Landing in the southeast to the perimeter of the Año Nuevo State Marine Conservation Area in the northwest. One participant dislikes traveling east of Santa Cruz to fish because it usually means returning against the wind. Although there are long stretches of sand of similar depth between Capitola and the Pajaro River, there is very little benthic relief in this area, so halibut fishing can be very slow. For these reasons, fishermen involved in this study usually target halibut at sites west of Santa Cruz Harbor, generally within five miles of the harbor mouth. GPS tracks were recorded at 30-second intervals on each fishing trip, and a point density analysis was used to show the relative amount of fishing effort (time spent) by participants in their preferred fishing spots (Figure 5). Each fisherman's tracks from their completed study days are shown in Appendix D. Specific locations are favored because they have proven their productivity over the past ten years. Study participants are aware of about a dozen familiar locations that seem to have a good concentration of halibut each year, and know the bottom topography well at these spots.

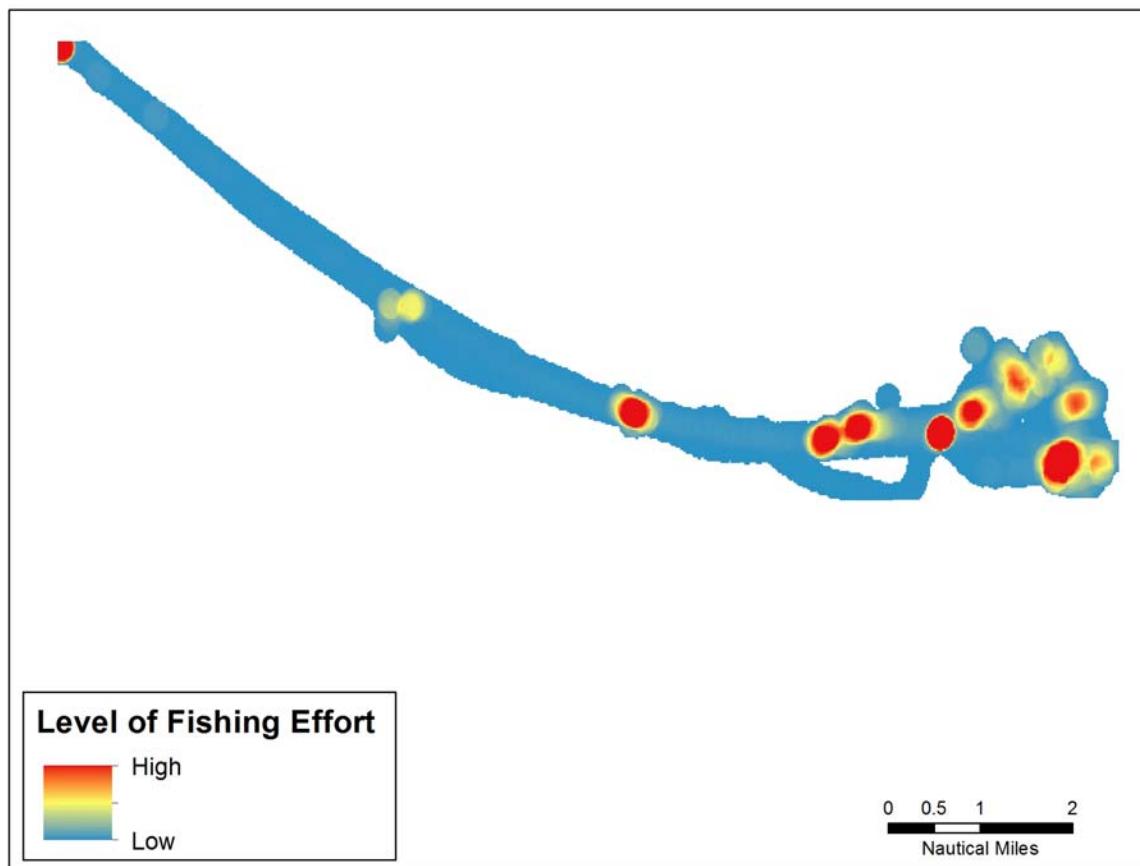


Figure 5. Point density analysis of GPS tracks of all three fishermen shows that fishing effort was concentrated in several preferred locations, most of which are within a five mile radius of the mouth of Santa Cruz Harbor. Map credit: Sophie DeBeukelaer, MBNMS.

New, less familiar locations are rarely visited. Occasionally, an unproven spot will be experimented with on the way back from fishing elsewhere, or if the fishing has not been productive. One fisherman explained that when fishing recreationally as a child, he learned that many spots should be avoided because they have a higher likelihood for bycatch. Without an intimate knowledge of bottom habitats and nearby landmarks, a fisherman runs the risk of both uncertain results and high levels of gear loss in areas with extensive high-relief reef “structure.” Repeated loss of gear can become expensive quickly, so such a scenario is not desirable.

Results from Observed Study Days

Days on which fishermen recorded data took place from August 3 to October 22, 2011 and provide a snapshot of the second half of the 2011 California halibut fishing season. Fishing conditions were not favorable for targeting halibut during most of September, so fishermen chose to record data on a series of days in August (8 days) and October (6 days). Figure 6 displays the patterns and results of a sample day of halibut fishing.

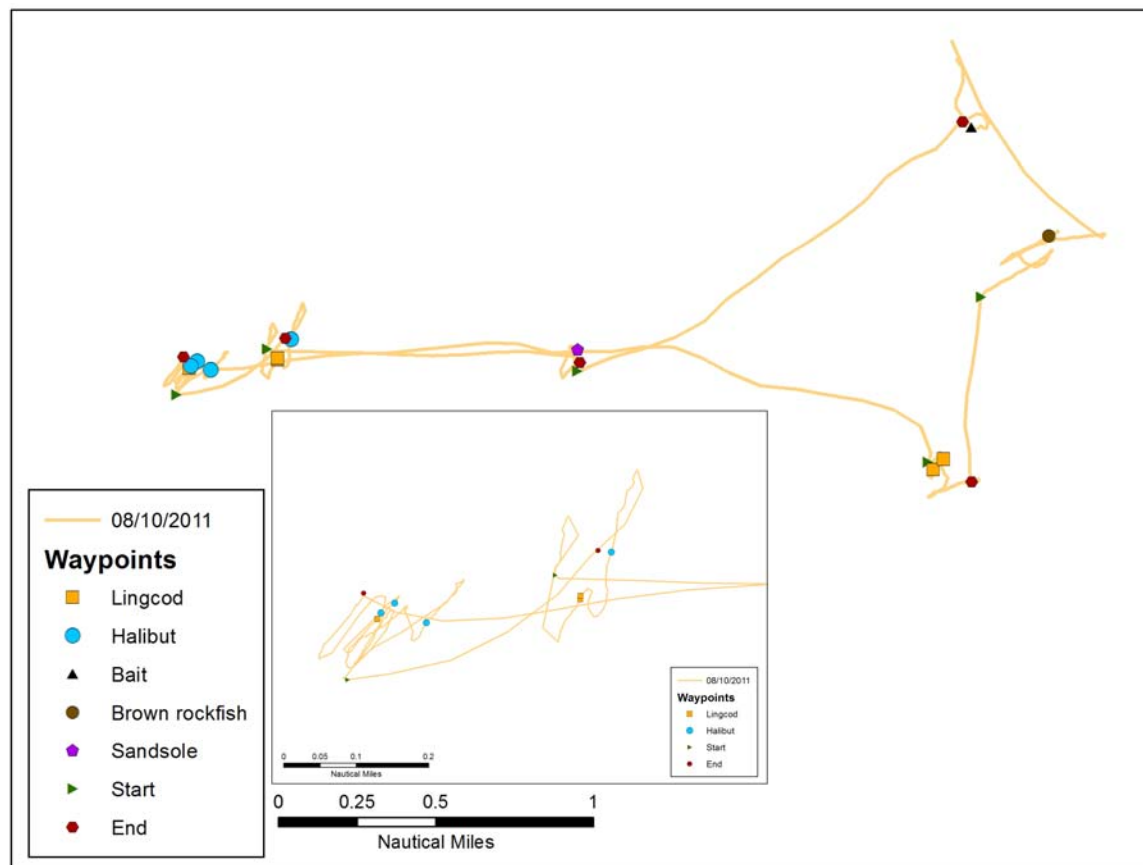


Figure 6. GPS track and waypoints recorded by Fisherman #1 on August 10, 2011. After leaving the harbor, he first “made bait,” then fished at five discrete locations. “Start” and “End” represent waypoints made when fishing at a location commenced and ended. Four halibut, one lingcod, and one sandsole were caught and retained, while four lingcod and one brown rockfish were discarded live. The inset shows the “zig zag” pattern used while drifting live bait. Map credit: Sophie DeBeukelaer, MBNMS.

To increase the odds of survival of discarded fish, no fish were weighed on vessels. Fishermen recorded the lengths of all fish caught, and retained fish were later weighed at the time of sale. Length-weight conversion formulas for each species caught (Bayer, 1985, Grosse, 1982, Haseltine and Thornton, 1990, Lauth, 1987, Love et al., 2002, Pearson and McNally, 2007, Torres, 1991, Wildermuth, 1983) were used to calculate weights for all fish caught. It was then possible to calculate discard and bycatch rates by weight in addition to other results (Table 3). Two fishermen completed five study days each, while one fisherman completed only four of the five days. On fishing trips that averaged 7.5 hours in length, an average of 2.57 legal halibut or 35.2 pounds of legal California halibut was landed and sold. Halibut of a range of weight classes were caught at a series of spatially well-defined locations (Figure 7). These results include data from 13 of 14 observed days (excludes Participant 3's 4th day, for which GPS data was not available).

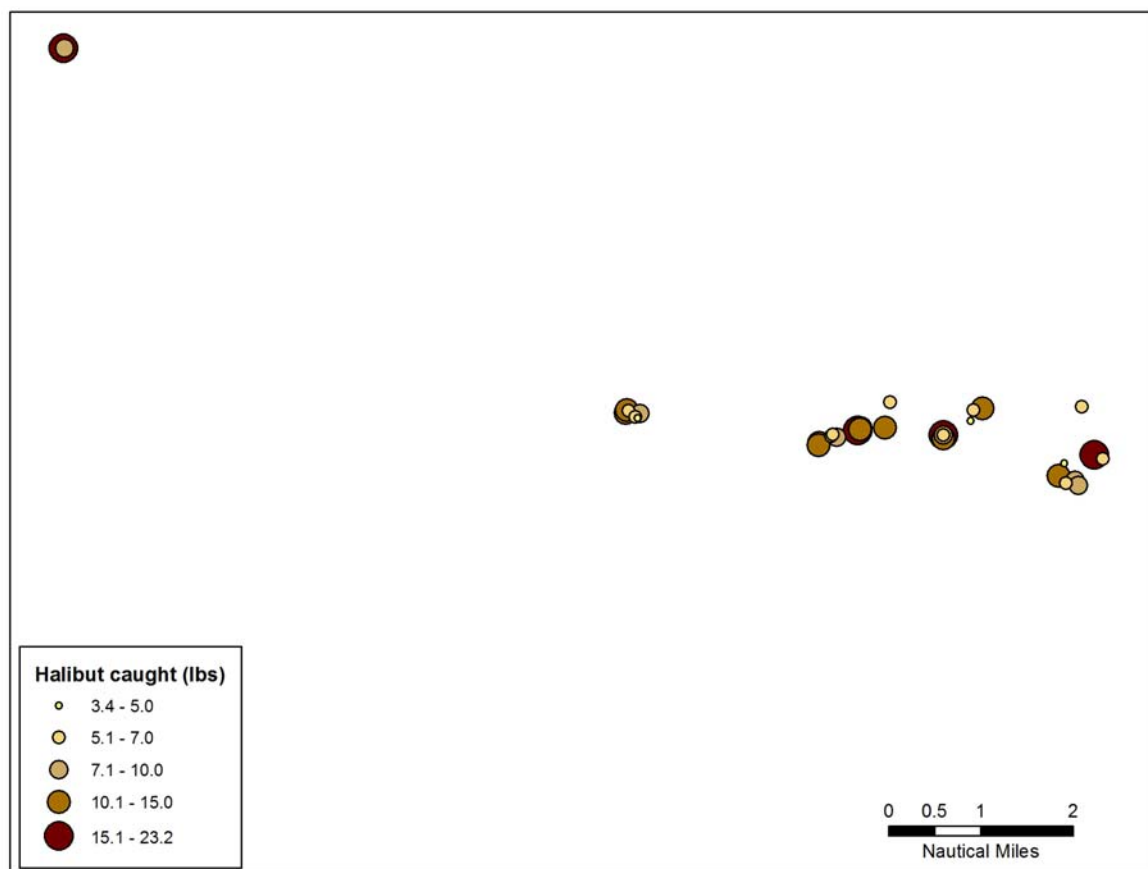


Figure 7. Study participants landed 38 California halibut in several discrete fishing areas. Circles of graduated size and colors represent halibut of different size classes. Larger, heavier halibut were caught in the same areas as smaller, lighter halibut. Average halibut weight was 9.6 pounds. Map credit: Sophie DeBeukelaer, MBNMS.

The three fishermen who took part in the study had differing opinions about how their catch on study days compared to “normal.” Respondent #1 believed his average daily landing of 47.5 pounds over the course of five study days was representative of his average landings. Respondent #2, with an average daily landing of only 16 pounds, stated that he usually had much better results than this: “I felt like the pressure of the project jinxed me.” Possible reasons given to explain lower catch rates on this individual’s fishing days include high wind, red tide, or “the

bite just not being on.” What participants did agree on was that in the hook and line halibut fishery, every day is different and unpredictable. “Some days you'll catch ten [halibut], other days you'll get skunked,” explained one fisherman. Landings vary like the extremes of a rollercoaster; it's hard to define a "normal" day. But what does a “good” day of halibut fishing look like?

Table 3. Summary table of fishing effort, landings, and economic data obtained over the course of fourteen days on which halibut fishermen recorded information about their fishing trips. Drifting live bait with rod and reel was the primary gear/method for all three participants.

	Participant 1	Participant 2	Participant 3	Average
Number of trips completed	5	5	4	4.7
Size of boat (ft)	18	16	16	16.7
# of discrete fishing areas fished	10	13	7	10.0
Avg total duration of trip	7:19	8:24	6:42	7:32
Avg time spent fishing for bait	0:32	0:55	Not provided	0:43
Avg time fishing for target species per trip	6:18	5:39	6:14	6:03
Avg time spent motoring	0:29	1:50	0:28	0:55
Avg number of halibut caught /day	3.8	2	2.25	2.68
Avg halibut sales /day (lbs)	47.5	16.0	42.1	35.2
Avg discards halibut (lbs)	0	1.42	0	0.47
Avg sales other species (lbs)	13.2	0.8	0	4.67
Avg bycatch (lbs)	26.7	3.9	1.5	10.7
Avg discards (lbs)	16.9	3.2	1.5	7.2
Overall discard rate (% of total fish caught)	57.4	35.7	18.2	37.1
Overall discard rate (% of weight)	23.7	16.3	6.7	15.6
Legal halibut landings as a % by weight of total fish caught	60	77.2	96.6	77.9
Avg total revenue per trip (dollars)	281	85.8	199	189
Avg distance traveled per trip (nm)	9.57	14.62	10.09	11.43
Avg variable costs per trip (i.e., fuel) (dollars)	6.8	6.8	9.6	7.7
Total fixed costs per year (dollars)	11,900	4,105	5,370	7,125

One fisherman expressed that a day in which six halibut of legal size are landed would be on the higher end of average; between three and five halibut could be considered an average daily catch. If each fish weighs 10-15 lbs, this would equate to an average landing of 40-70 lbs. A fantastic day might be one in which a fisherman was able to sell 100-150 lbs of halibut. All three individuals stated that their personal record for the most halibut caught in a single day was either 21 or 22 fish. In 2011, the most one participant caught in a day was 12 halibut. But the fishery is still considered worthwhile when landings are lower. Another respondent commented that selling 45 pounds of halibut would be an excellent day if the ex-vessel price were in the \$5/pound range. When a single day's expenses are considered without factoring in fixed costs, it does not take very much to break even. A roundtrip from Santa Cruz Harbor to favored spots at the northern extent of these fishermen's range would only require about \$20 in fuel. Most days far less fuel is consumed. All three fishermen agreed that landing a single halibut of 10-20 pounds would be more than adequate to cover the day's costs.

Very few undersized halibut, referred to as 'shakers' by fishermen, were landed. Two fishermen landed no sub-legal halibut, and the average between all three fishermen was only 0.47 pounds

of discarded halibut per trip. Participant 1 stated that he might only catch five shakers per year. They live mostly in shallow, very nearshore waters, and he avoids the areas he knows are more likely to have undersized fish. One fisherman voiced the opinion that shakers are most common when the water is at its warmest, generally between June and August, while another believes that earlier in the season there is a greater likelihood of catching smaller halibut. Participant 2 opined that catching two shakers out of a total of ten halibut he landed during the study was a higher than usual rate: “The only time I caught shakers was for this project.” Participant 3 thinks that it depends on the year. Two years ago he caught more ‘shakers,’ which he offered as an explanation for why mostly keeper size fish are being caught now.

Analysis of Bycatch

An average of 13.0 pounds of bycatch¹ of other species were caught per trip, and an average of 7.6 pounds of other species and sublegal halibut were discarded per trip. The most commonly caught bycatch species included lingcod, brown rockfish, gopher rockfish, copper rockfish, and sand sole (Figure 8). Other non-targeted species caught included black rockfish, staghorn sculpin, cabezon, and soupfin shark. At times non-target bycatch species were kept and sold if they were of legal size and marketable. Species sold other than California halibut during the study period included lingcod, sand sole, and one 52-pound soupfin shark. Participant 1, who landed the soupfin shark, explained that sharks are more commonly caught at the tail end of the fishing season. He does his best to avoid catching sharks at all costs because “they’re a nightmare – they’re dangerous, they’ll bite you, break your rod, and live for hours.” All non-halibut species caught over the course of the study are indicated by GPS waypoints in Figure 9. Other species that are sometimes caught and sold while targeting halibut include starry flounder, sand dabs, rock sole and vermillion rockfish.

While many of the bycatch species caught are also targeted as sport retention species, these fishermen do not possess the permits required to keep many species, so they are “avoided at all costs.” One fisherman explained that if he experiences a high bycatch rate at a location due to a concentration of forage species there, he would leave that area and not return until the bycatch rate had receded – even if halibut were present and being landed at that time.

¹ The California Fish and Game Code defines bycatch as “any fish or other marine life that are taken in a fishery but which are not the target of the fishery (FGC §90.5). This includes discards (alive and dead) and incidentally caught marketable species that are kept and sold.” (CDFG, 2008[b]).

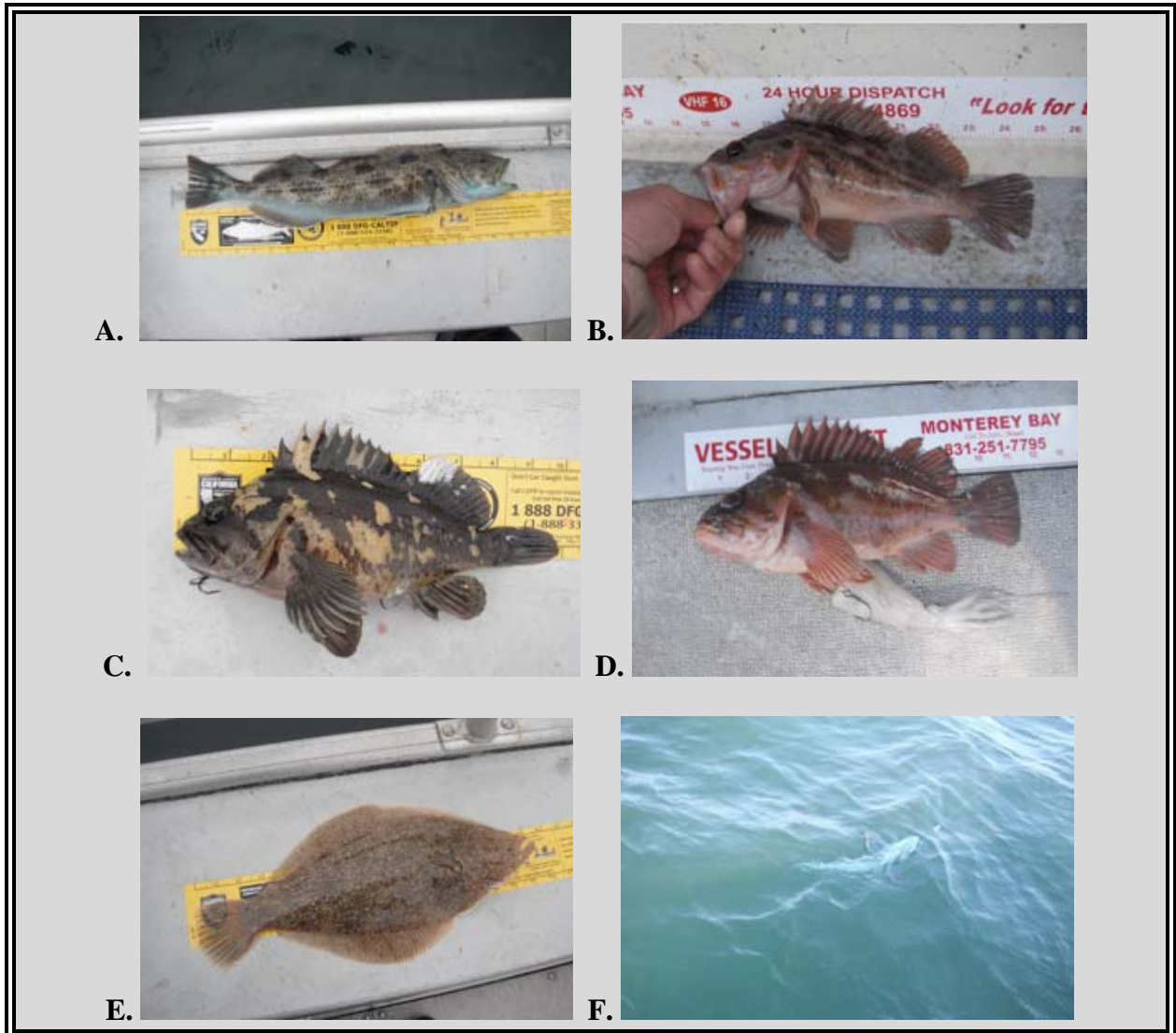


Figure 8. The five most common bycatch species over the course of the study were: a) lingcod (*Ophiodon elongates*), b) brown rockfish (*Sebastes auriculatus*), c) gopher rockfish (*Sebastes carnatus*), d) copper rockfish (*Sebastes caurinus*), and e) sand sole (*Psettichthys melanostictus*). All fish that were not kept were discarded live, and none were bleeding. Outside of this study, these fishermen often release fish that will not be retained without removing them from the water (f).

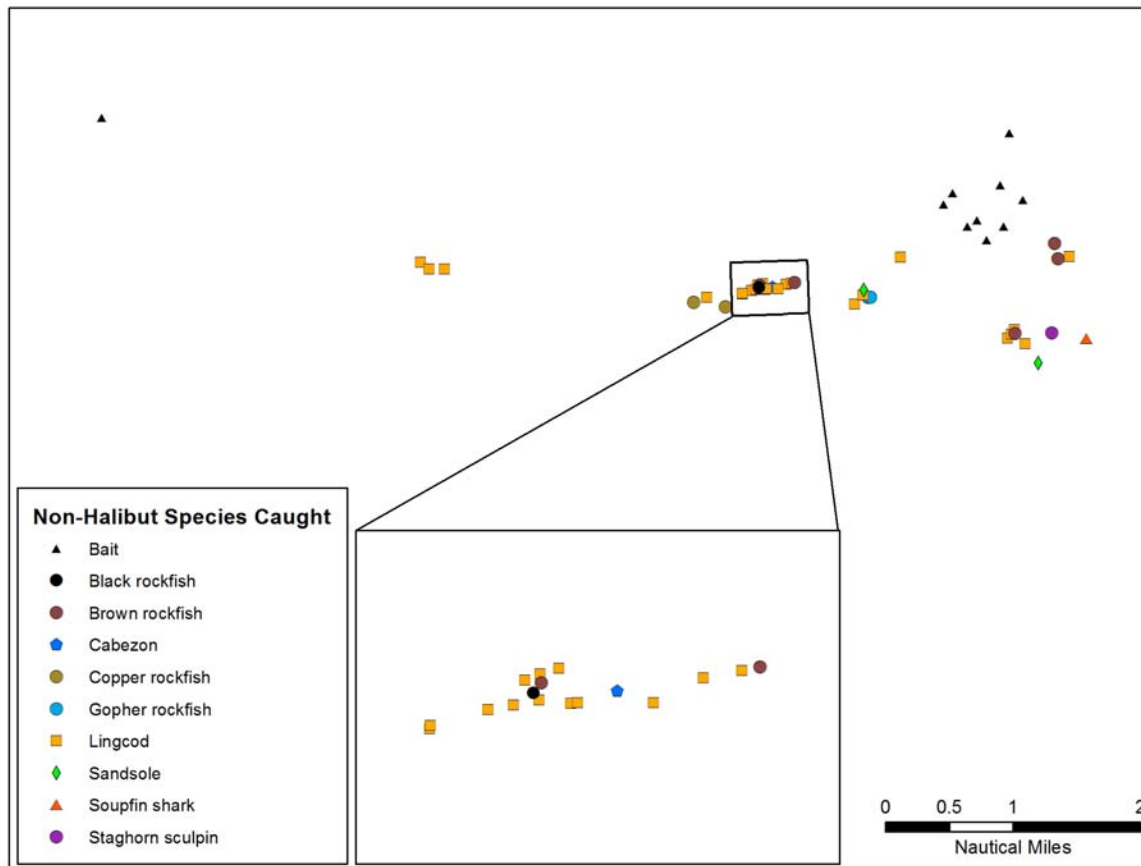


Figure 9. All non-halibut fish caught over the course of the study, including bait (mostly sardines) which participants spent an average of 43 min/day targeting. Excluding bait, 41 fish other than halibut were caught, of which five were retained and the remainder were discarded live. Map credit: Sophie DeBeukelaer, MBNMS.

The average discard rate² including both undersized halibut and non-retained other species was 48.1% when calculated as a percentage of the total number of fish caught. When this discard rate is calculated as a percentage by weight, it is substantially lower at only 19.5%. Discard rates by weight varied substantially among study participants, with Participant 1 averaging 23.7% and Participant 3 averaging only 6.7%. Legal halibut landings comprised a great majority of the total weight of all fish caught, with the three fishermen's results averaging 77.9%.

Participants 2 and 3 opined that the bycatch rates on their study days were representative of their normal levels. Participant 3 commented that fishermen like himself who fish for halibut every year have learned the spots halibut go to. Since he knows exactly where to go to find them, he can minimize his bycatch. Participant 1, who had the highest bycatch rate, emphasized that this was a higher rate than usual and that his bycatch on these days is likely a reflection of fishing in areas that had temporarily high levels of forage species that caused non-targeted species to “wander out of their normal habitat.” Two of the fishermen commented that they wish they could have provided a demonstration of how they normally release fish that are not ‘keepers.’ Although asked to measure the length of discarded fish for the purpose of this study, they commonly will unhook unwanted fish alongside their vessels (Fig. 7f) to minimize damage to the

² Discards are defined as marine life caught in a fishery and not retained for sale or personal use. Discard rate is a calculation of discards as a percentage of total catch.

fish. One fisherman related that discarded species such as lingcod are often in such good condition that they will bite his hooks again following release. All discarded fish but one were hooked in the mouth, all were released live, and none were bleeding.

Bycatch and discard rates have also been analyzed in studies of the trawl fishery for California halibut. Although not directly comparable with the bycatch and discard rates calculated by this study due to different areas, depths, habitats, and months of observation, these data provide a context upon which to consider the results of this study. The West Coast Groundfish Observer Program (WCGOP) observed 104 tows within or adjacent to Monterey Bay made by 15 vessels in the limited entry trawl fleet using traditional roller gear from 2002 - April 2009. WCGOP data show an 84.3% bycatch rate by weight and a 70.6% (57.8% excluding jellyfish) discard rate by weight for the Monterey Bay halibut trawl fishery (WCGOP, 2010). These data are similar to those generated by a recent study of the California halibut trawl fishery in Southern California. From June to September 2007, the California Halibut Trawl Grounds Study conducted 32 experimental tows using Paranzella trawl gear in state waters off the Ventura and Santa Barbara coast. The Department of Fish and Game released a report of this study that shows a bycatch rate by weight of 73.3% and a discard rate by weight of 61.1% (CDFG, 2008[a]). Data generated by this study show that bycatch from the hook and line halibut fishery in Monterey Bay is at a relatively low level (Figure 10). Discarded species in the Monterey Bay trawl, Southern California trawl, and Monterey Bay hook and line fisheries for halibut also appear to differ greatly in composition (Figure 11). While the hook and line fishermen in this study discarded only finfish, the trawl fisheries caught and discarded many sharks, skates, and rays, which generally have “high” or “very high” ecological vulnerability scores (Cheung et al., 2005).

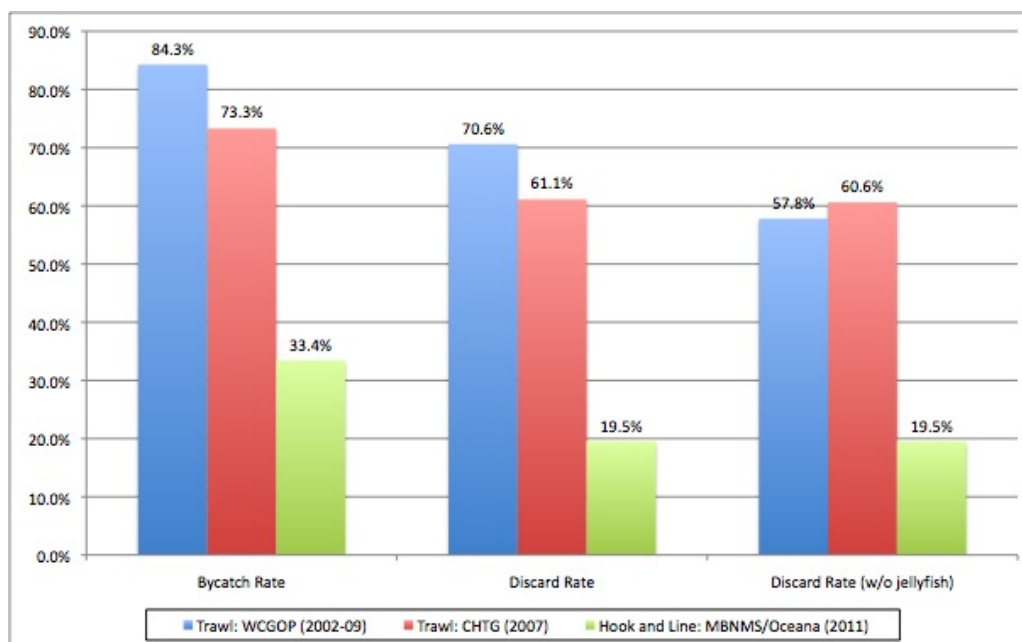


Figure 10. Comparison of bycatch and discard rates in the Monterey Bay halibut trawl fishery as observed by the WCGOP, the Southern California halibut trawl fishery, and the Monterey Bay halibut hook and line fishery.

Additionally, the Department of Fish and Game conducted a California halibut trawl survey of North Monterey Bay (the area formerly open to halibut trawling) in August 2010. Twelve tows

were conducted using a standard 4.5-inch commercial otter trawl net. Although weights of many non-halibut species were taken in aggregate, some animals were not weighted because they were over or under the scale's capacity (T. Tanaka, pers. comm.). Therefore, it is not possible to calculate bycatch or discard rates by weight. Of 1424 total fish caught, 138 were legal halibut, indicating a bycatch rate by number of individuals of 90.3%. Included in the bycatch were 76 sublegal halibut (CDFG, 2010). Although statistical significance has not been demonstrated, qualitatively there seems to be a substantial difference in bycatch between the trawl and hook and line fisheries for California halibut.

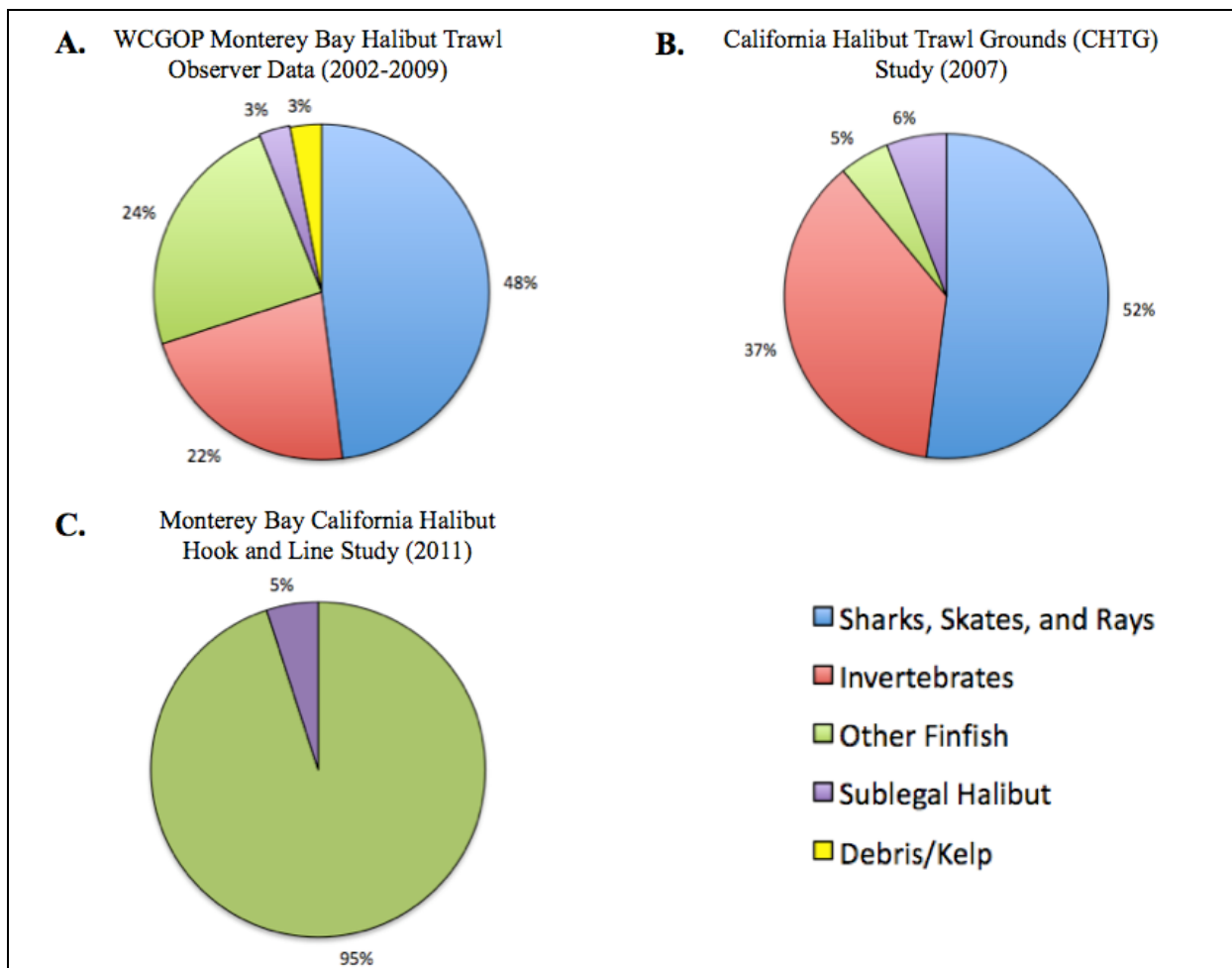


Figure 11. Comparison of discarded species in a) the Monterey Bay halibut trawl fishery (excludes jellyfish), b) the Southern California halibut trawl fishery, and c) the Monterey Bay hook and line halibut fishery. The trawl fisheries catch and discard many sharks, skates and rays. The hook and line fishery did not catch or discard invertebrates, and all discarded fish were reported to be released live in good condition.

Selling Landed Halibut

Fishermen involved in the study generally sell all the marketable fish that they land. One participant occasionally keeps fish for himself to eat, while the other two never keep fish for themselves or for friends. Halibut and other species that are kept are sold whole and dead

(Figure 12). Fish are placed on ice in a cooler in the boat, and are usually sold within the Santa Cruz Harbor area promptly upon return to port. None of the study participants have sold to the live fish market. One fisherman has flirted with this idea, but doing so would involve finding a buyer from San Francisco with ties to the larger live market there.



Figure 12. All legal California halibut landed during the study were sold whole and dead. Fish are kept on ice until they are purchased by buyers in Santa Cruz Harbor. Photo credits: halibut fishermen and Oren Frey.

Over the course of this study, ex-vessel prices for halibut hovered in the \$4-6/lb range, although they were generally \$5/lb or above and thought to average \$5.50/lb. At the beginning of the 2011 season when supply was low, \$6/lb was considered a standard price. A flooded market can bring the price down to \$4 or \$4.50/lb. One fisherman observed prices that reached as low as \$3.75 during the study period, which is well below average and signifies that fishing was good with many halibut being landed. As supply begins to diminish, the ex-vessel price will usually rebound again toward the end of the halibut fishing season – market price was \$6/lb during observed study days in October. Price has risen steadily over the 10-year period that respondents have been involved in the fishery. In 2001, they report prices being in the \$2.50-2.75/lb range. One fisherman stated that the biggest jump in price occurred after the ban on trawling in Monterey Bay began to be enforced. During the trawling years, the market price for halibut was sometimes “as low as \$1.75/lb if you could sell them at all.” One fisherman expressed that prices have remained more stable in recent years since trawling stopped. With the top price in 2010 not surpassing \$5/lb, the current average price of \$5.50/lb is considered quite good. All

interviewees pointed out that other key determinants of the price they receive are whom they sell to and the condition of their fish.

Maintaining good relationships with buyers is seen as very important by all three fishermen in the study. Buyers include restaurants and individuals who sell fish at retail venues such as farmer's markets. Fishermen choose buyers who offer a combination of high price, convenience and familiarity. Two study participants sell almost exclusively to one buyer who pays "top dollar" and is considered a friend. This buyer is also popular because he is located right in the harbor and provides fishermen with as much ice as they require at no charge. One fisherman explained that: "[this buyer] pays a bit above market since he's selling locally and I'm a local fisherman who does everything clean and has the best quality product." One problem is that some buyers only have so much capacity before they cannot buy any more and are "plugged." One popular buyer can take only about 300-500 pounds a week; after that it's necessary to look elsewhere. At this point the market may begin to be flooded and prices may begin to fall.

Fishery Economics

During semi-structured interviews, fishermen were asked a series of questions about the fixed and variable costs of participation in the hook and line fishery for California halibut. Their responses varied considerably, particularly for the categories of boat maintenance, tackle, and fuel – this is to be expected in a small sample. A summary of estimated annual expenses incurred by fishermen, as well as projected annual revenues and profits based on data from observed days was compiled (Table 4). These calculations indicate that the fishery is profitable for all three participants, with estimated profits ranging from \$11,295 to \$29,362 per year and the average profit between the three fishermen estimated to be \$17,900. When this average profit is divided by the average number of days targeting halibut per year (143), we find that that average daily net earnings in the fishery are about \$125. Calculated individually, average daily net earnings ranged from \$64 for Fisherman 2 to \$195 for Fisherman 3. Average daily net earnings can then be divided by the average duration of a fishing trip (from Table 3), indicating an estimated hourly wage of \$16.70 for fishermen in the hook and line halibut fishery. Again, Fisherman 2 was on the low end at \$7.62/hr, while Fisherman 3 was on the high end at \$29.10/hr. By comparison, the PSMFC and NMFS' Fishery Economics Data Program reports that average annual earnings for those working in finfish fisheries in California was \$3,736 in 2010 (Fisheries Economics Data Program, 2012).

Table 4. Estimated annual expenses and projected annual revenues of participation in the Monterey Bay hook and line halibut fishery.

	Respondent 1	Respondent 2	Respondent 3	Average
Annual Expenses (\$)				
Paid crew	0	0	0	0
Slip fees	600	630	1800	1010
Insurance	0	0	0	0
Loan payments on boat	0	0	0	0
Boat maintenance	4000	500	1000	1833
Tackle	4000	500	1000	1833
Licenses	1100	875	420	798
Fuel	1800	1400	750	1317
Ice	0	0	0	0
Supplies	400	200	0	200
Other	0	0	400	133
<i>Estimated total annual expenses</i>	<i>11,900</i>	<i>4,105</i>	<i>5,370</i>	<i>7,124</i>
Annual Revenue				
Avg. landings on study days (lbs)	47.5	16.0	42.1	35.2
Number days targeting halibut/yr	105	175	150	143
Projected annual landings (lbs)	4,988	2,800	6,315	4,701
Avg. ex-vessel price per pound (\$)	5.00	5.50	5.50	5.33
<i>Projected total annual revenue from halibut (\$)</i>	<i>24,940</i>	<i>15,400</i>	<i>34,732</i>	<i>25,024</i>
Projected Annual Profit (\$)	13,040	11,295	29,362	17,900

Income generated from halibut fishing makes a moderate to substantial contribution to our participants' overall portfolios of income generating activities. Respondent 1 estimated that 25% of his income comes from halibut fishing, while another 25% comes from fishing for other species. Respondents 2 and 3 both stated that about 20-25% of their total income comes from fishing, with the vast majority of that coming from sales of California halibut.

Were the price of halibut to rise by \$1/lb, all three fishermen said they would probably fish more, although they would not alter their methods in any way. Were the ex-vessel price to increase by \$5/lb, these individuals would be compelled to fish full time rather than engaging in other income generating activities. One respondent stated he would sleep on his boat and fish 24-hour days, while another would consider starting a charter company, as he's heard that it's possible to make \$800/day in the fishing charter business.

Interactions within the Fishery

The halibut fishery is a small and somewhat insular community that is not well understood by outsiders. Within Santa Cruz, study participants estimate that there are a total of approximately 8-15 fishermen with commercial licenses who are seriously engaged in the hook and line fishery for California halibut. While a greater number likely hold licenses, many only target halibut occasionally or fish recreationally most of the time. Participant knowledge about fishermen engaged in the fishery elsewhere in Monterey Bay is hazy. One interviewee estimated that there may be 40-50 hook and line halibut fishermen in all of Monterey Bay, but noted that this was just a guess and that making such an estimate was difficult. Other sources suggested the number of halibut fishermen was likely half as many.

Small groups or ‘cliques’ of halibut fishermen typically work together to help each other by sharing information about where and when halibut are biting, the locations of ‘secret’ spots, and proven techniques. Although some individuals are always more open and others are usually more secretive, within such a group there is an expectation that all such information will be openly shared. One study participant believes that it is important to maintain good relationships with others in the fishery: “If I’m catching fish somewhere, I want to tell my friends and help them out too. I want others to make money and have fun, so that they’ll help me out down the road. I try to befriend everyone but I see a lot of drama!”

Fishermen are routinely asked questions when they return to port about how many they caught and where they fished. The decision to share or withhold information beyond such a group is largely dependent on how the fishing has been; when lots of halibut are being caught, there’s more talking and when less fish are being caught, fishermen tend to keep information to themselves.

Interactions with Other Fisheries

Study participants were asked several questions about how the hook and line halibut fishery has interacted with both the halibut trawl fishery and with fisheries for other species. They were also asked to compare the ecological impacts of their gear to the impacts of other methods used to catch halibut. None of the respondents believe that fisheries for other species interact directly or indirectly with the halibut fishery. The crab and salmon fisheries do not affect the halibut fishery, one respondent noted, adding that there are very few licenses for nearshore species other than California halibut and white sea bass. Although there was some sentiment that wetfish fisheries could affect their bait availability at times when there is a lot being caught, there was no certainty about this relationship. All participants agreed that there seems to be plenty of bait around, and wetfish fisheries were not perceived as a problem.

It is important to note that the trawl and hook and line fisheries for California halibut largely do not overlap spatially; the traditional trawl grounds in northern Monterey Bay are in deeper water than these hook and line fishermen usually fish. The spots favored by hook and line fishermen are too close to shore and have too much benthic relief for trawling; if trawlers were to fish in these rugged areas, they would lose their gear to the reef. One respondent commented that when

the trawl fishery was active in Monterey Bay ten years ago, hook and line halibut fishermen were sometimes catching more fish – perhaps because the trawlers ‘chased’ the halibut into more accessible shallower waters. Another respondent also noted how halibut move between the areas targeted by the trawl and hook and line fisheries: when storms and rough weather would come, halibut would move from spots targeted by hook and line fishermen to deeper waters where the trawlers would catch them. Two of the fishermen recall that there were more small halibut 3-4 years after the trawling in Monterey Bay stopped. The other fisherman explained that since trawling hasn’t happened within the bay for so many years now, he cannot recall any impacts during the time period that it did occur. This respondent did express that it is possible that the halibut fishing season now runs longer than it did when there was trawling in the bay.

Participants agreed unanimously that their hook and line fishing techniques were the most sustainable, lowest impact way to catch halibut. One hook and line fisherman commented: “What I do is the lowest impact – I use a gas efficient 4-stroke motor, I recycle everything, and all my bycatch lives. I try to be as clean as possible. I love this ocean and would never do anything to pollute it.”

Another expressed that in terms of impacts on the halibut population and the environment, there is “not even a comparison” between the hook and line and trawling methods: “We are minimum impact to environment and halibut population. Trawlers have higher bycatch and higher impact to seafloor. All of the commercial fishermen in Monterey Bay don't even have equivalent landings to one trawl boat.” Yet there is hesitation to criticize other types of fishermen. One respondent explained that tolerance is important: “In fishing, everyone has to make a living.” When asked directly whether they believe any parts of Monterey Bay should be re-opened to bottom trawling for halibut, two participants responded “no” while the third said he had “no opinion” because it is not his decision to make.

Trends in the Fishery

In the ten years that the fishermen who took part in this study have been fishing for halibut commercially, they have not made any significant changes to their gear or fishing methods. Drifting live bait has proven to be the most productive method, and they have stuck with it. One fisherman observed that there seem to be fewer people fishing for halibut commercially now than there were ten years ago. Although there are more sport fishermen targeting halibut these days, the individuals who are fishing commercially for 100% of their income are becoming increasingly few and far between. The only full-time fishermen who are still around now are the ones who have been fishing commercially for 30 years or more and have stuck it out “through thick and thin.”

Over the past decade, fishermen believe that the number of halibut in the bay has decreased, but that in more recent years abundance has rebounded. One explanation put forth is that a decade ago, fishing pressure was more spread out since Monterey Bay’s fisheries were more diversified. The result was less pressure on the population of California halibut, and thus greater abundance. The shortening of seasons for rockfish species, coupled with non-existent salmon seasons and the implementation of other new regulations focused more pressure on the halibut fishery. As more

people started to turn to halibut for income, the fishermen perceived a decline in the abundance of halibut. But according to one study participant, the number of halibut in the bay has since rebounded in the past three years, possibly due to natural cycles or because trawling within the bay has ended. Halibut used to be easier to find because they were concentrated in areas inshore from where the trawlers were. Now the stock appears to be healthier but the halibut are less predictable and more difficult to locate. There have also been larger halibut landed in the past five years. “We used to get more shakers, but now shakers are pretty rare,” commented one fisherman.

The other main change that has affected the fishermen involved in the study has been the increase in the ex-vessel price they receive for halibut. Since the value of halibut has more than doubled since they began in the fishery, they are able to earn substantially more than before. Other observations made by fishermen relate to the spatial distribution of halibut. For example, one respondent noted that in 2011 there were no halibut in 30ft or less of water, whereas in the past two years there were. Some of the explanations put forth by fishermen to explain such changes include movements in populations of forage species, shifting currents, water temperature, swell conditions, pollution, the presence of sharks (halibut may be eaten by soupfin sharks), and red tides, which create low-oxygen condition ill-suited to catching halibut.

Overall, study participants believe that the halibut stock is doing well and seems to be as healthy as it has ever been. Two study participants believe that the current management of the halibut fishery seems to be working well as it is, and that no changes in fishery management should be made. One commented, “I don't want to see more fisheries go to limited entry, because I want to make sure the next generation can get a permit to do what I do without facing any discrimination.” A stipulation made by one of these individuals is that marine protected areas (MPAs) should be opened to halibut fishing: “Some of my spots are too close to MPAs so I avoid them, but I see people in there fishing anyway.” The third respondent thinks there should be some additional management introduced to the halibut fishery to reduce fishing pressure and ensure sustained high landings for current fishery participants. His suggestions were to a) introduce a halibut fishing season so that it is not open all year and to b) regulate the number of licenses that are issued.

Assessing the Capacity for Fishery Expansion

A notable characteristic of the California halibut fishery at this time is that it remains an open access fishery, unlimited by the permits or seasonal closures placed on other fisheries. In the words of one study participant, “If they wanted to, 10,000 people could go get licenses next year and start fishing halibut just like we do.” However, this fisherman is only aware of about a dozen individuals who have gotten new commercial fishing licenses over the course of the past ten years – and most of them are sport fishermen for most of the year, only selling their catch if they do extremely well. Although the question of why more people have not gotten involved in the hook and line fishery for halibut in Monterey Bay – especially in the wake of the trawling closure – is an interesting one, it is beyond the scope of this study to answer.

We can begin to consider, though, what the startup costs and barriers to entry for someone interested in becoming a new participant in this fishery would be. The short answer is that startup costs are relatively minimal. One fisherman summed it up: “all you need is \$420 [for a fishing license] and a boat.” One of the fishermen who took part in the study paid \$17,000 for his boat, while another paid \$5500 for a boat and an additional \$3000 for a replacement motor. When other costs such as renting a slip and buying gear are taken into account, a figure within the \$5-10K range emerges as the minimum someone can invest upfront in order to become a serious commercial halibut fisherman. Perhaps a larger challenge for a new entrant is acquiring the knowledge required to be successful in this fishery. In addition to learning the most productive fishing spots, how to run the gear, and how to run different types of bait differently, one needs to develop an understanding of the relevant laws and regulations affecting the fishery. All of this would take at least one full fishing season to figure out.

The fishermen involved in this research do not think there is a need to change the amount of hook and line effort in their fishery at this time. All three individuals think that the current level of effort is fine as it is. No one is eager to see new competition. “The less pressure, the better for me,” was the sentiment expressed by one fisherman. The fishermen are fearful that additional fishery participants would crowd the established fishing spots that have taken them years to discover and potentially prevent them from getting in to fish them. Fishermen also believe that an expansion of effort could a) make halibut less abundant and harder to catch and/or b) cause too much halibut to reach the market, threatening to bring prices down from the all-time high they are currently at. Fishermen think that the biggest limiting factor could be individuals willing to expend the effort: “I can't see there being more participants in the halibut fishery. It takes a specific person to want to do it. A lot of people try to catch them but it's too much work and they don't usually bother. I can see there being more sport fishermen, but they get discouraged easily. Halibut is tricky to catch. You have to love it.”

One fisherman suggested that due to the difficult nature of what they do, there should be increased incentives for people to engage in sustainable fishing. “[The government should] offer a tax write-off for hook and line fishing because it's hard and costs money and takes a lot of time,” one individual offered. The estimated potential for profit of \$125/day calculated in this study may help some individuals decide whether the investment of time and money required to participate in the fishery would be worthwhile or not. It is clear that earnings at this level require a commitment to the fishery of over 100 days of effort per year, which may severely limit the number of potential new entrants.

Future Research Needs

The results of this preliminary study may have been skewed somewhat by a small sample size and by a focus on the latter half of the halibut fishing season. Fishermen expressed that they wished it had been possible to get underway with field research earlier in the season. Ideally, participants would have liked to have one study day per week per fishermen to capture periods of high landings in late June and July. Doing so would provide us with a more complete picture of catch rates and the income generating capacity of the fishery.

The fishermen who took part in this study were unsure as to why commercial halibut landings in Moss Landing and Monterey have not been higher in recent years. Study participants offered several theories to explain this phenomenon:

- The halibut fishery is more oriented towards smaller boats. Monterey and Moss Landing are generally home to bigger vessels and fishing activities are at a larger scale (offshore salmon, white sea bass and albacore fishing) with less day boats. There are less fishermen in the southern part of the bay and a different fishing culture.
- There are not individuals in those ports who are interested in or have time for the hook and line halibut fishery. It is a lot of work and it is not possible to make a huge amount of money because the fishery is not year round like it is in Southern California.
- Halibut is more likely to be caught in southern Monterey Bay by trolling rather than drifting, which would make effort less concentrated.
- Santa Cruz offers the ideal location to target halibut with hook and line gear.

This research could be further developed by expanding the study to include fishermen in the ports of Moss Landing of Monterey. Santa Cruz was selected as a focus port because of the relative vitality of the California halibut fishery there. Participants in this study have not been successful in fishing for halibut south of Moss Landing, but have only attempted to do so on very rare occasions and are largely unfamiliar with specific hotspots. Whether the same techniques are being used by fishermen in southern Monterey Bay, and if so, whether catch rates and bycatch levels are similar, remains unknown. In addition, it is not understood why the price fishermen receive for halibut is higher in Santa Cruz than in Monterey and Moss Landing.

A little known fishing method that is currently used outside of San Francisco Bay and has been used in the past in Monterey Bay is called wire lining. Wire lining involves the use of a solid or multi-strand wire line in place of traditional monofilament line. The wire line terminates at a three-way swivel to which are attached a 2-3 pound lead weight and a long, heavy monofilament leader with up to 30 plastic squid lures on 12" droppers (E. Tavasieff, pers. comm.). None of the three fishermen involved in this study have ever experimented with this technique, as it would require an investment in different gear. There is a fisherman in Santa Cruz who reports using this method extensively with a partner in the 1980s with excellent results. One study participant expressed interest in learning the method from this individual and has begun making preparations to do so. Wire lining is reportedly best suited to areas with wide expanses of sand or mud bottom, as is common in the central and southern parts of Monterey Bay. The fishing locations near Santa Cruz favored by fishermen during this study are thought to be too small and confined for wire lining; there is the risk that the gear would get hung up on reefs and other high-relief benthic formations surrounding favorite fishing spots. If additional research at other locations around Monterey Bay is possible in the future, it would be desirable to document the experience of a fisherman who is using this method.

One unknown in this study was the relative abundance of California halibut during the study period. Halibut abundance may be cyclical (Moser and Watson, 1990), and the halibut catch rates calculated by this study could be deceptively low or high depending on whether the halibut population is at a relatively low or high level. Extending the study over subsequent years would capture other stages in the halibut population cycle and could provide more reliable baseline data on which to assess whether or not there is the potential for a profitable increase in effort in the

fishery. Finally, although not viable using current technology and size of vessels, a live California halibut fishery could be more valuable to the participants and its potential should be investigated.

Conclusions

The fishermen who participated in this study were enthusiastic to share data that would showcase the hook and line halibut fishery and demonstrate its sustainability. Their language indicates that they are unequivocally proud of their ‘clean’ techniques: “I’ve proven that our bycatch lives. I’ve had lingcod bite my line again after I let them go. I wish there was a way to mount a video camera on the side of the boat to show our release tactics.” These fishermen have a deep appreciation for the richness of Monterey Bay, and they believe that the fish they bring to market is the best of the best: “There is an abundance out there – the fisheries aren’t as depleted as they think. In fact I think they’re actually flourishing. Monterey Bay has some of the best water in the world. Combine that with us taking really good care of the fish we catch... nothing else comes close to our quality.”

Although halibut landed in Santa Cruz already fetches higher prices than halibut landed in other Monterey Bay ports, there is a strong belief that local line-caught fish should be worth more. Another participant commented: “This fish is caught as cleanly as humanly possible, treated with care, the freshest you can buy. The frozen [Pacific] halibut from Alaska could be six months old by the time people eat it. Halibut is selling in markets for \$18.95 – if I could get \$7 or \$8 it would be insane.”

He added that people in Santa Cruz harbor are targeting whatever species is perceived to be the ‘moneyfish,’ the fish with the highest price at that moment. Another respondent echoed similar sentiments, and explained that the line-caught halibut fishery can only expand if local demand expands: “Average consumers don’t realize how crappy farmed fish can be compared to a native hook and line caught fish. I’m catching a high quality product compared to a frozen, farmed species like tilapia that many people buy. A lot of people don’t like fish because there are a lot of restaurants selling bad fish. The problem is that there is not a big enough market for local fresh fish.”

As individuals whose fishing livelihoods are entirely tied to the health of the ocean, halibut fishermen in Santa Cruz recognize the importance of being careful marine stewards. There is strong sentiment that the needs of the next generation of fishermen need to be provided for, as reflected in comments volunteered by one fisherman, “I want the ocean to be pristine and clean for the next generation, like it was when I first saw it. I pick up plastic bags out of respect for the ocean. I set barely legal halibut free so the next generation can enjoy a fifty pounder instead of a three pounder.” Not everyone has a mindset similarly oriented toward marine conservation. One study participant expressed that he wishes there was more education to the general fishing public about the time it takes for a fish to mature and other basic ecological concepts. Many sport fishermen “aren’t careful enough and are not aware of their impacts” he offered.

Ultimately, this study has documented the practices and perspectives of a small group of Monterey Bay fishermen who take steps to minimize their bycatch, release discarded fish in optimal condition, and properly care for the halibut they sell so that they can maintain the highest-value fishery possible. Our hope is to make the general public aware of the commitment to sustainability exhibited by these fishermen so that demand for their products continues to grow. With recognition and support, the landings and income generating potential of the line-caught halibut fishery can be sustained and gradually increased in the future as an attractive food source throughout the Monterey Bay ports and associated communities.

Acknowledgments

The authors thank the three fishermen who participated in this study for their willingness to share information and shed light on an otherwise poorly understood fishery. We also thank participants in the Halibut Research Design Project (HRDP) for their guidance in designing this research; the Department of Fish and Game and the harbormasters of the three Monterey Bay ports for their assistance in identifying study participants; Sophie DeBeukelaer at the Monterey Bay National Marine Sanctuary for her assistance with GIS; and Dr. Jason Scorse, Dr. Gregor Cailliet, Dr. Peter Nelson, Paul Reilly and Travis Tanaka of the Department of Fish and Game, and Oceana staff Dr. Mike Hirshfield, Ben Enticknap, Jon Warrenchuk, and Susan Murray for reviewing earlier drafts of this report. Institutional support for this study came from the CA Sea Grant State Fellowship Program, Oceana, and the Monterey Bay National Marine Sanctuary.

Literature Cited

Bayer, R.D. 1985. Shiner perch and Pacific staghorn sculpins in Yaquina Estuary, Oregon. *Northwest Science* 59(3): 230-240.

California Fish and Game Code. Section 8841(j). Available at: <http://www.leginfo.ca.gov/cgi-bin/displaycode?section=fgc&group=08001-09000&file=8830-8843>

California Department of Fish and Game, Marine Region (CDFG). 2008 [a]. Review of California Halibut Trawl Fishery in the California Halibut Trawl Grounds: Report to the California Fish and Game Commission. State Fisheries Evaluation Project. Available at: www.dfg.ca.gov/marine/pdfs/chtg-report.pdf

California Department of Fish and Game (CDFG). 2008 [b]. DFG Information concerning the California Halibut Trawl Fishery off Southern California. Draft Report to the California Fish and Game Commission, 15 January 2008. p.18.

California Department of Fish and Game, Marine Region (CDFG). 2010. Cruise Report, California halibut (*Paralichthys californicus*) trawl survey of north Monterey Bay. Prepared by Travis Tanaka, 15 September 2010.

California Department of Fish and Game (CDFG). 2011. Monterey Bay Pounds by Gear. Data extracted from the Department's Commercial Master Landings Database (CMaster) by Travis Tanaka (CDFG-SFMP).

Cheung, W.W.L., Pitcher, T.J., and D. Pauly. 2005. A fuzzy logic expert system to estimate intrinsic extinction vulnerabilities of marine fishes to fishing. *Biol. Conserv.* 124: 97-111.

Fisheries Economics Data Program. 2012. Average Wages for Fishers, All Industries: California. Pacific States Marine Fisheries Commission in cooperation with the National Marine Fisheries Service. http://www.psmfc.org/efin/data/ser_desc.html#WAGE_CA

Graham, W. M. 1993. Spatio-Temporal Scale Assessment of an "Upwelling Shadow" in Northern Monterey Bay, California. *Estuaries*. 16(1): 83-91.

Grosse, D.J. 1982. An experiment in the artificial rearing of lingcod (*Ophiodon elongatus*) for purposes of enhancement. Washington Department of Fisheries Technical Report No. 70, 92 p.

Haseltine, A. and Thornton, S. 1990. Alternative Gear Development off Central California in Haugen, C.W. (ed): The California Halibut, *Paralichthys californicus*, Resource and Fisheries. California Department of Fish and Game *Fish Bulletin* 174: 341-358.

Lauth, R.R. 1987. Spawning ecology and nesting behavior of the cabezon, *Scorpaenichthys marmoratus* (Ayres), in Puget Sound, Washington. M.S. Thesis, University of Washington. 104p.

Love, M. S., Yoklavich, M. and L. Thorsteinson. 2002. The Rockfishes of the Northeast Pacific. Berkeley: University of California Press, 416 pp.

Moser, H. G., and W. Watson. 1990. Distribution and abundance of early life history stages of the California halibut, *Paralichthys californicus*, and comparison with the fantail sole, *Xystridura liolepis*. In C. W. Haugen, ed. The California halibut, *Paralichthys californicus*, Resource and Fisheries. California Department of Fish and Game, Fish Bulletin 174: 31-84.

Pearson, D.E. and McNally, S.V.G. 2007. Age, growth, life history, and fisheries of the sand sole, *Psettichthys melanostictus*. *Marine Fisheries Review* 67(4): 9-18.

Sweetnam, D. 2008. Review of Some California Fisheries for 2007: Coastal Pelagic Finfish, Market Squid, Dungeness Crab, California Spiny Lobster, Highly Migratory Species, Ocean Salmon, Groundfish, California Halibut, Hagfish, Pacific Herring, and Recreational. *Fisheries Review*. CalCOFI Rep., Vol. 49. Available at:
www.calcofi.org/newhome/publications/CalCOFI_Reports/v49/Fisheries_web.pdf

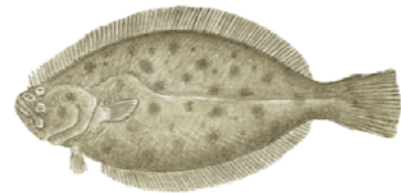
Torres, F.S.B. Jr. 1991. Tabular data on marine fishes from Southern Africa, Part I. Length-weight relationships. *Fishbyte* 9(1): 50-53.

West Coast Groundfish Observer Program (WCGOP). 2010. Observations of the trawl fleet targeting California halibut in Monterey Bay, CA, 2002 - April 2009.

Wildermuth, D.A. 1983. Length-weight regression analysis for thirty-eight species of sport caught marine fishes. Progress Report 198. Washington State Department of Fisheries, Olympia. 7 p.

Attention Fishermen, WE NEED YOUR HELP!

The Halibut Research Design Project (HRDP) is a group convened by Assemblyman Bill Monning in 2010. Participants have included commercial and recreational fishermen, scientists and representatives from local government, fisheries management and non-governmental organizations. The goal of the HRDP is to:



Evaluate the potential socio-economic and marine ecosystem impacts of trawling and hook-and-line based fishing for halibut in Monterey Bay to inform stakeholder group discussions and decision makers

The strategy of the HRDP is to organize studies that evaluate the economic and ecological sustainability of these different gear types.

Targeting Halibut with Hook and Line Gear

The first HRDP study aims to assess hook and line fishing for halibut. Our objective is to learn more about the potential for increased landings of halibut using hook and line methods in Monterey Bay. We hope to conduct a small experimental fishing project this summer to look at catch rates and by-catch in the hook and line fishery at various times throughout the season. Data will be collected by observers.



Chronicle / Craig Lee



We Want to Learn from Your Experience

To properly design our hook and line study, we need to understand the nature of the halibut hook and line fishery in Monterey Bay at this time. We need your help in filling out a quick questionnaire that will provide this baseline information. Your assistance will enable us to learn more about how we can increase landings in this fishery. If you have questions or would like additional copies of the questionnaire, please contact Oren Frey, California Sea Grant State Fellow, at 831-647-4228.

Appendix B: Participant Data Collection Form

Study of the Hook and Line Fishery for CA Halibut in Monterey Bay

Fisherman name _____

Vessel name _____

Date _____

Study trip # _____

General Trip Information

Trip start time (exit harbor) _____

Trip end time (enter harbor) _____

Weather conditions (circle) SUNNY PARTLYCLOUDY MOSTLYCLOUDY OVERCAST FOG RAIN

Swell size (ft) _____

Wave height (ft) _____

Avg windspeed (mph) _____

Wind direction _____

Why was trip ended? (circle) WEATHER NOTBITING CAUGHTENOUGH OUTOFBAIT OTHER _____

Trip fuel consumption (gallons) _____

Total sales: **CA halibut**

Other Species _____

Pounds sold _____ Price _____

Pounds sold _____ Price _____

Dealer name _____

Landing receipt number _____

Fishing Period #1

Location name _____

Fishing method (ex troll/jig/drift) _____

Starting Waypoint # _____

Number of lines out _____

Starting Waypoint time _____

Number of hooks out _____

Ending Waypoint # _____

Type of bait used _____

Ending Waypoint time _____

Depth fished (range) _____

Dead, Alive,

	WP #	Species	L (in)	Legal (Y/N/NA)	Photo file #	Keep (Y/N)	Hook Loc?	or Bleeding
Fish 1								
Fish 2								
Fish 3								
Fish 4								
Fish 5								
Fish 6								
Fish 7								
Fish 8								
Fish 9								
Fish 10								

Fishing Period #2

Location name _____
 Starting Waypoint # _____
 Starting Waypoint time _____
 Ending Waypoint # _____
 Ending Waypoint time _____

Fishing method (ex troll/jig/drift) _____
 Number of lines out _____
 Number of hooks out _____
 Type of bait used _____
 Depth fished (range) _____

	WP #	Species	L (in)	Legal (Y/N/NA)	Photo file #	Keep (Y/N)	Hook Loc?	Dead, Alive, or Bleeding
Fish 1								
Fish 2								
Fish 3								
Fish 4								
Fish 5								
Fish 6								
Fish 7								
Fish 8								
Fish 9								
Fish 10								

Fishing Period #3

Location name _____
 Starting Waypoint # _____
 Starting Waypoint time _____
 Ending Waypoint # _____
 Ending Waypoint time _____

Fishing method (ex troll/jig/drift) _____
 Number of lines out _____
 Number of hooks out _____
 Type of bait used _____
 Depth fished (range) _____

	WP #	Species	L (in)	Legal (Y/N/NA)	Photo file #	Keep (Y/N)	Hook Loc?	Dead, Alive, or Bleeding
Fish 1								
Fish 2								
Fish 3								
Fish 4								
Fish 5								
Fish 6								
Fish 7								
Fish 8								
Fish 9								
Fish 10								

Fishing Period #4

Location name _____

Starting Waypoint # _____

Starting Waypoint time _____

Ending Waypoint # _____

Ending Waypoint time _____

Fishing method (ex troll/jig/drift) _____

Number of lines out _____

Number of hooks out _____

Type of bait used _____

Depth fished (range) _____

	WP #	Species	L (in)	Legal (Y/N/NA)	Photo file #	Keep (Y/N)	Hook Loc?	Dead, Alive, or Bleeding
Fish 1								
Fish 2								
Fish 3								
Fish 4								
Fish 5								
Fish 6								
Fish 7								
Fish 8								
Fish 9								
Fish 10								

Fishing Period #5

Location name _____

Starting Waypoint # _____

Starting Waypoint time _____

Ending Waypoint # _____

Ending Waypoint time _____

Fishing method (ex troll/jig/drift) _____

Number of lines out _____

Number of hooks out _____

Type of bait used _____

Depth fished (range) _____

	WP #	Species	L (in)	Legal (Y/N/NA)	Photo file #	Keep (Y/N)	Hook Loc?	Dead, Alive, or Bleeding
Fish 1								
Fish 2								
Fish 3								
Fish 4								
Fish 5								
Fish 6								
Fish 7								
Fish 8								
Fish 9								
Fish 10								

Appendix C: Instructions for Fishermen

Study of the Hook and Line Fishery for CA Halibut in Monterey Bay

Data Collection Instructions for Fishermen

Please record all of the below data on one of the data sheets provided by Oceana.

Before Fishing

1. Record your name, vessel name, the date, and study trip number (i.e., 1st, 2nd, 3rd, etc.).
2. Turn on the Oceana GPS unit and make sure it begins to track your route.
3. Record “trip start time.” This should be the time that you exit the harbor.

While Fishing

1. When you arrive at your first fishing location, begin to fill out the section for ‘Fishing Period #1.’
 - a. Describe the location name.
 - b. Enter a GPS waypoint when you begin to put lines out at that location.
 - c. Record ‘starting waypoint’ time and waypoint number assigned by the GPS.
 - d. Record fishing effort: fishing method, # lines out, # hooks out, type of bait, and depth range fished.
2. Complete a row in the chart for each fish caught:
 - a. Enter a GPS waypoint at the time the fish is landed. Record waypoint number assigned by the GPS.
 - b. Record species name.
 - c. Record total length of fish in centimeters. Please attempt a measurement for all fish.
 - d. Record whether fish is of legal size (Y for yes; N for no; N/A for not applicable).
 - e. Please take a photo of each fish on the Oceana camera. Record the file number of the photo assigned by the camera on the data sheet.
 - f. Record whether the fish was kept or not (Y for yes/kept, N for not kept/discarded).
 - g. Record the location of the hook in the landed fish (i.e., mouth, gut, etc.)
 - h. If discarded, record whether fish appeared to be dead, bleeding, or alive upon release.
3. When you finish fishing at a spot, enter a GPS ‘ending waypoint’. Record the waypoint number assigned by the GPS and ‘ending waypoint’ time on the corresponding lines.
4. For every additional location fished on that date, repeat steps #1-3 above, completing sections for Fishing Period 2, Fishing Period 3, etc. as needed.

After Fishing

1. Fill in the rest of the General Trip Information section. Data that must be recorded includes:
 - a. Trip end time (time that you entered the harbor)
 - b. Weather information [circle weather condition(s)], average swell size, average height of wind waves, average wind speed and wind direction.
 - c. Reason why the trip was ended when it was.
 - d. Approximate gallons of fuel consumed during trip.
 - e. Total pounds of each species sold and price received for each species.
 - f. Name of dealer to whom fish was sold and landing receipt number.
2. If anything seemed notable, unusual, or particularly interesting about the trip, please make notes on the data sheet (supplement with photos if appropriate, and describe photos on data sheet).
3. You are responsible for passing the Oceana GPS and camera to the next person who will complete a study day.
4. Study Coordinator will collect data sheets and GPS/camera data as needed.

Thank you for helping us to better understand the hook and line fishery for California halibut in Monterey Bay!
Please contact Oren Frey (831-647-4228, oren.frey@noaa.gov) with questions.

Appendix D: Fishermen's Tracks from Completed Study Days

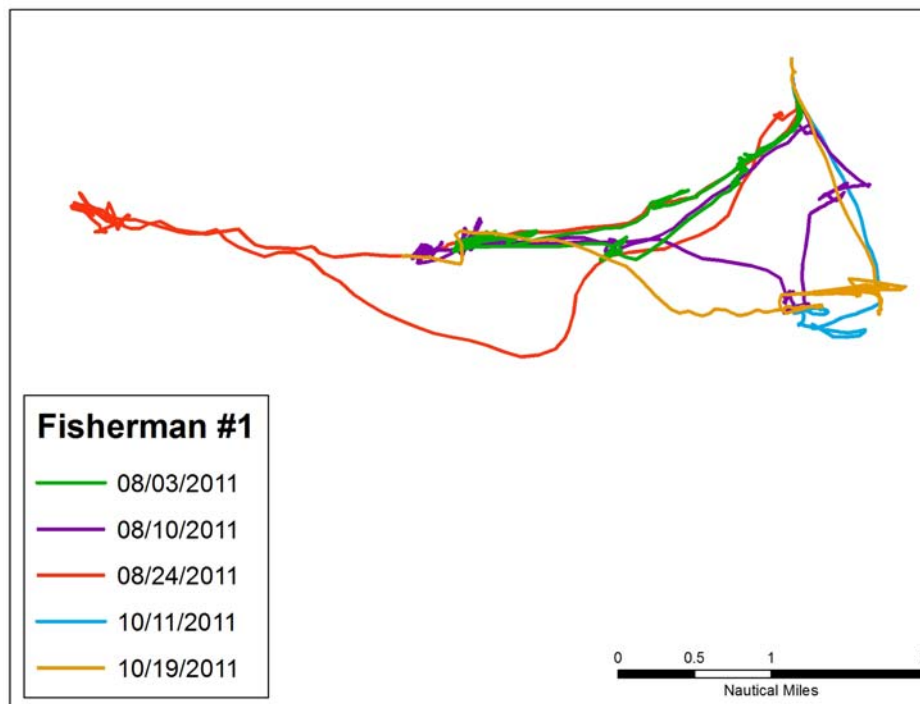


Figure D1. Fisherman #1 completed five study trips, and carried a GPS unit that recorded the vessel's position at 30-second intervals. Average distance traveled per trip was 9.57 nautical miles. Map credit: Sophie DeBeukelaer, MBNMS.

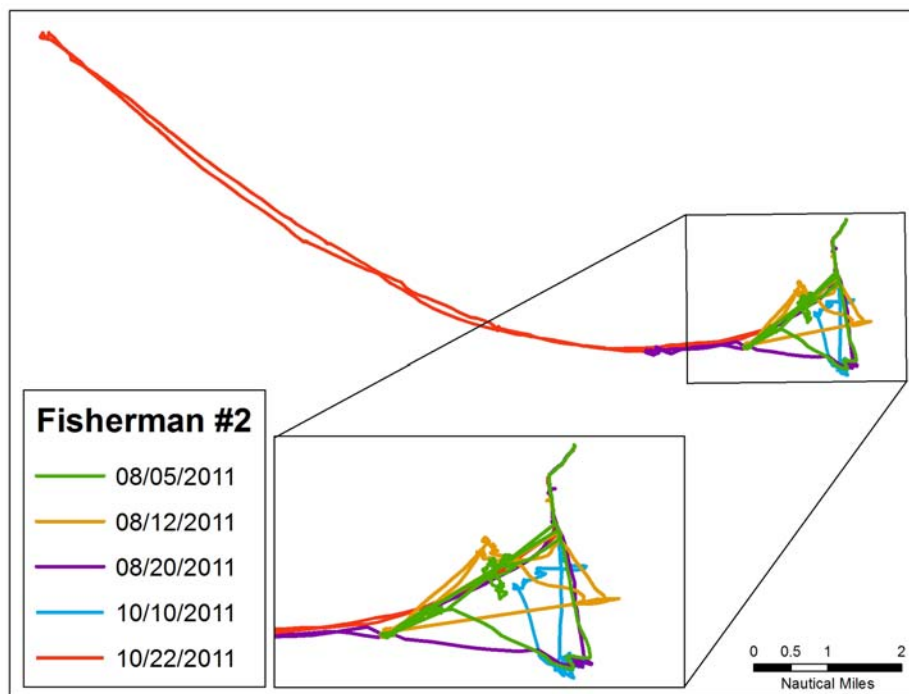


Figure D2. Fisherman #2 completed five study trips, and carried a GPS unit that recorded the vessel's position at 30-second intervals. Average distance traveled per trip was 14.62 nautical miles. Map credit: Sophie DeBeukelaer, MBNMS.

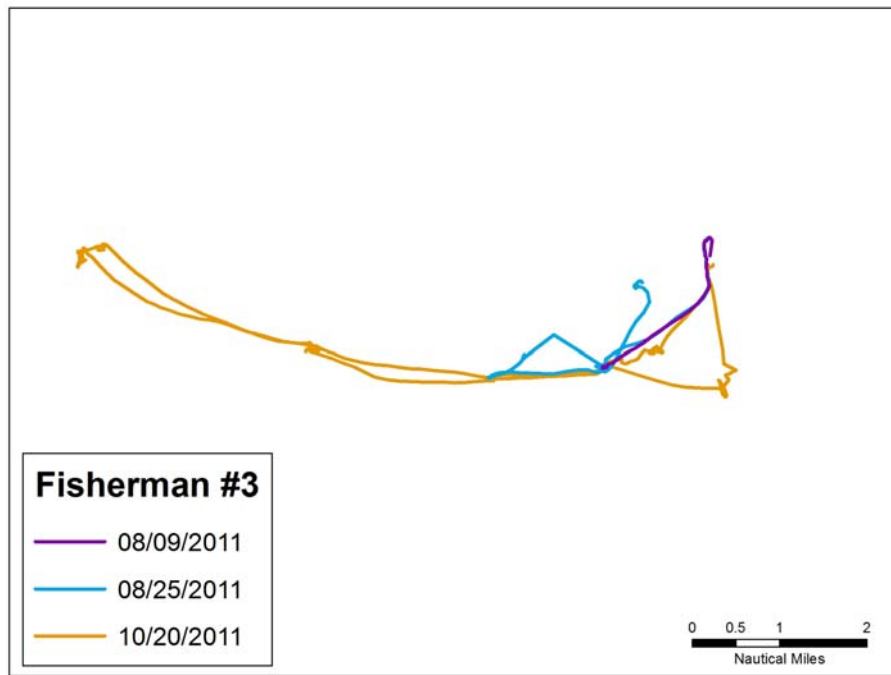


Figure D3. Fisherman #3 completed four study trips, and carried a GPS unit that recorded the vessel's position at 30-second intervals. The GPS unit did not function properly on the fourth trip, and tracks are only displayed for the first three days. Average distance traveled per trip was 10.09 nautical miles. Map credit: Sophie DeBeukelaer, MBNMS.

Appendix E: Participant Interview Questions

At the time of interviews, areas highlighted in yellow were completed with the appropriate data for each participant.

Introduction: The purpose of this interview is to better understand the dynamics of the California halibut fishery in Monterey Bay taking place with hook and line and understand the various social, biological, and economic aspects of the fishery from the perspective of fishery participants. Oceana and the Monterey Bay National Marine Sanctuary are interested in this information to help determine the potential for promoting sustainable fishing activities in and around Monterey Bay.

This is an anonymous interview. Your responses to the interview and any personal information you share will not be linked to your name in any public communications or publications. Your responses will be collected and stored in a manner so that your name is not connected to the responses. You are not required to answer any question, as this is a voluntary interview and refusal to answer questions will not affect your compensation.

GENERAL QUESTIONS

1. How long have you been fishing commercially?
2. How many years of experience do you have targeting halibut with H&L? Have you in the past or do you still also target halibut with non- H&L gear?
3. How did you get started in the halibut fishery? How did you learn?
4. What other species do you target throughout the year ?

MONTH	MAIN TARGET FISHERY	OTHER SPECIES	GEAR
JANUARY			
FEBRUARY			
MARCH			
APRIL			
MAY			
JUNE			
JULY			
AUGUST			
SEPTEMBER			
OCTOBER			
NOVEMBER			
DECEMBER			

5. How do you decide to target halibut on a given day vs. not fishing or fishing for other species?
6. How would you rate yourself as a halibut fisherman relative to others that fish with hook and line in the area?
7. Which harbor do you fish out of and what makes your harbor conducive to your fishing boat/method and selling your catch?

FISHING METHODS

8. What is your boat size and configuration that you use when fishing halibut? Please describe multiple configurations.
9. Please describe in detail **each fishing method** that you use when targeting halibut. Are there methods you have not tried?
10. Are you familiar with “wire lining” and have you tried it?
11. What type(s) of bait do you use? How do you get your bait? How many hours do you spend fishing for bait on a typical day? How much money do you spend on bait? What kind of bait works best? What type of hooks?

ECONOMIC ASPECTS OF THE FISHERY

12. Your average daily landing was **XXX** lbs earning revenues at the dock of \$**XXX** over the study days you submitted as part of this project.
 - a. How do your landing results from this series of days compare to “normal”? What factors might explain any differences?
 - b. What is a typical length of a fishing trip from dock to dock? What’s the longest you’d go out? Shortest?
 - c. What is the highest halibut catch you’ve had in a fishing day?
13. What catch level is your break-even point?
14. When you go out for halibut, do you ever target other species on the same trip?
15. What other species do you keep if you catch them on a halibut trip? Do you sell them? Do you ever keep any fish for personal use/gifts?
16. How do the prices that you received over the course of the study compare to “normal”?
17. In addition to halibut, you caught the following species **XXXXXX** and had an overall bycatch rate of XX% Do by-catch levels from your study days seem representative?

18. **XX** % of all the halibut you caught were above legal size. Is this typical? Are there certain times or places where you get more sub-legals?
19. What percent of your income comes from fishing? How much of this is comes from the halibut fishery?
20. Do you pay others to fish with you or help you with fishing activities?
21. What are your annual fishing-related costs:
- a. Slip fees?
 - b. Insurance?
 - c. Loan payments for boat/gear?
 - d. Maintenance on boat?
 - e. Replacing fishing poles, line, hooks?
 - f. Fishing license?
 - g. Fuel?
 - h. Ice?
 - i. Supplies?
 - j. Other?
22. How long is the season; please estimate the # of days/yr targeting halibut?
23. What has your average off-the-boat price been this year? How much does it vary (what's the range) within seasons? Among seasons? Do you ever sell to the live market? Why or why not? Do you sell filets or whole fish?
24. How would you fish differently if the price of halibut went up by \$1/pound? \$5/pound?
25. How do you choose your buyers? Do you change buyers, and why?

MAPS AND SPATIAL QUESTIONS

26. Please describe the attributes of the fishing spots where you've had the most success fishing for halibut. How do you decide where to fish? What do you do on good weather days? What do you do on bad days?
27. Let's review some of the spots fished during this study (**map**). Why did you choose each spot at that time? What are differences in catch between spots?
28. What are the names of each spot? What other spots did you go to? Where do you catch bait. Do you go to some of these places to catch species other than halibut?
29. What's the farthest you go from the harbor?
30. How much/often do you explore new places you haven't fished before?

31. Have you ever fished in the South part of Monterey Bay (south of Moss Landing)?

TRENDS IN THE FISHERY

32. What trends in the halibut fishery have you experienced over the time you've been involved?

33. What changes in gear types have occurred over time? Are there methods not being used that have been in the past? Have new methods emerged?

34. What are the barriers to entry for new participants?

35. What are the dynamics between other halibut fishermen like? How many others are there – in Santa Cruz? In Monterey Bay?

36. Do you talk to other fishermen about where the halibut are?

37. How does the hook and line halibut fishery interact with other fisheries? To what extent do you feel impacted by wetfish (sardine/squid) and trawl fisheries?

38. Why aren't there more hook and line landings in Moss Landing? Monterey? Why not more in Santa Cruz?

PERCEPTIONS/OPINIONS

39. How does your fishing gear compare to bottom trawl fishing for halibut in terms of ecological impacts (i.e., bycatch, habitat damage, halibut)?

40. Should any parts of Monterey Bay be re-opened to bottom trawling for halibut?

41. Do you think there should be any changes in the management of the halibut fishery?

42. What are the main species that California halibut eat?

43. How is the stock of halibut doing? How has it changed over the years since you started fishing?

44. Aside from fishing, what factors influence the abundance of halibut?

45. How much do halibut move on a daily basis? Over the year?

46. Do other fisheries interact directly or indirectly with the halibut fishery?

47. Are there other fishermen you'd recommend we talk to? Contact info? May we tell them you recommended we talk with them?
48. Do you think the current level of fishing effort in Monterey Bay for halibut is too much, not enough, or OK as is? Why?
49. How would you be affected if hook and line effort expanded in your area?
50. Do you have any other thoughts or suggestions for how we could promote sustainable fisheries in Monterey Bay?

Appendix F. Trawl closures in the Monterey Bay National Marine Sanctuary, including their date of implementation. Note that all state waters of Monterey Bay are closed to trawling.

