Southwest Fisheries Science Center
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SUMMARY OF SWORDFISH LONGLINE OBSERVATIONS IN HAWAII, JULY-OCTOBER 1990

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INTRODUCTION

A longline fishery specifically targeting swordfish, *Xiphias gladius*, was begun by a few boats on an experimental basis in 1988. Until that time, swordfish had been a small incidental catch of the traditional tuna longline fishery, as well as the *ika shibi* fishery. By the end of 1989, the number of vessels that targeted swordfish at least part of the year had grown to 10, equaling about 10% of Hawaii's longline fleet. Swordfish landings in 1989 equaled an estimated 650,000 lb, compared with incidental landings of 50,000 lb in 1988. About 50 longline vessels were active in the swordfish fishery in 1990, and landings probably exceeded 2.5 million lb (valued at approximately $7.5 million). The vast majority of the swordfish are delivered fresh, headed, and gutted to Honolulu and then air-freighted to the U.S. mainland. Market reports indicate that swordfish from Hawaii have made major penetrations into the east coast wholesale markets. Total U.S. landings of swordfish in recent years equaled 11 million lb, but the future of these landings has been placed in doubt by recent regulatory changes on the east and west coasts. One effect of these regulations has been the migration of a substantial number of east coast swordfish vessels (as many as 20) to Hawaii.

The newly exploited swordfish are a part of an estimated Pacific-wide catch which has varied between 10,000 and 25,000 metric tons (20-50 million lb). Most of this catch is from temperate water fisheries [e.g., the Japanese longline fishery in the Northwest Pacific and north of Hawaii (25-40°N)]. The estimated sustainable catch of swordfish Pacific-wide is 40 million lb (Sakagawa 1989; Skillman 1989).

Scientific observers were placed aboard six swordfish longline vessels during July through October 1990 by the Honolulu Laboratory of the Southwest Fisheries Science Center, National Marine Fisheries Service (NMFS), NOAA. The observer placements were initiated for two reasons: Unconfirmed reports of interactions between swordfish vessels and protected species, such as Hawaiian monk seals, sea turtles, and seabirds, had been received, and no scientific information was available on swordfish-directed longlining.

Of the six vessels that carried observers, four were east coast swordfish longliners that had recently arrived in Hawaii, and two were Hawaii-based longliners--one having fished tuna in the main Hawaiian islands (MHI) and the other having fished primarily tuna outside the MHI. The placement of observers was on a voluntary basis through agreements with the individual vessel owners and captains with the understanding that all information about individual vessel operations would be kept confidential. Cooperation on the part of the vessel owners and captains was excellent.

The longliners fished three areas: the MHI, the Northwestern Hawaiian Islands (NWHI), and mid-Pacific waters north of Hawaii. Data on fishing operations cannot be broken down by area, because only one vessel fished in the MHI and one in the NWHI. The primary objective of the observer trips was to record any interactions between the longline gear and endangered and protected species and to collect detailed catch and effort information from the newly emerging swordfish fishery. Detailed biological data also were collected as called for by the sampling protocol (see Appendix A).

INTERACTIONS WITH ENDANGERED AND PROTECTED SPECIES

No interactions with protected species were observed in the MHI, but some occurred in the mid-Pacific and NWHI, although their impact appeared minimal. In the mid-Pacific, there was one sighting of a solitary killer whale. Almost every fish from a set made after the sighting had been damaged--only heads remaining on the hooks. Gear was retrieved and the vessel moved to a new location to avoid further interactions. No negative impact on the whale was observed. In the NWHI, two large leatherback turtles were entangled in the fishing gear. Both were released alive by the leader being cut as close to the hook as possible while the turtles were still in the water (both turtles were too large to bring on board). No other turtles were observed near the fishing gear during the other sets in the NWHI. In addition, eight porpoises (unidentified species) were sighted in the area of the gear during one NWHI set, but no interactions occurred. No other sightings were made while gear was in the water.

In both the mid-Pacific and NWHI, there were several incidents involving albatrosses. Observers mentioned the importance of sinking the bait and hooks rapidly as gear was deployed in order to avoid hooking birds. Typically, the birds followed the boat during deployment and retrieval of each set. An average of 12-15 black-footed albatrosses were seen each day. In the mid-Pacific, two black-footed albatrosses were hooked and killed during deployment of the fishing gear. The first dead albatross was found hooked when the gear was hauled, apparently having attacked the bait during deployment. Following this incident, precautionary measures were taken to scare the birds away. This was effective, except for one set when the "anti-albatross device" broke free and a second bird was hooked. Both birds were hooked early in the setting process when daylight was still sufficient for them to see the bait.

During NWHI sets, Laysan albatrosses approached the boat as gear was being deployed and retrieved. Gear on this vessel had been modified to sink the light sticks and bait before the birds could attack them. Noisemaking pyrotechnics also were used to the scare birds away. No interactions were observed.

FISHING VESSEL OPERATIONS

All vessels targeted swordfish initially. However, during the last three observer trips, catches of marketable-sized swordfish were low, so bigeye tuna were targeted instead. No modifications were made on the longline configurations, and the gear and fishing techniques used for swordfish were just as effective for the tunas.

Five of the vessels were steel hulled; one was fiberglass over wood. Vessel lengths ranged from 63 to 88 ft (average, 75 ft). Each vessel used monofilament gear (3.0-4.0 mm) and Cyalume,[1] World Plastics frozen light sticks, or both. Trip lengths varied from 11 to 23 days. The six vessels accumulated a total of 111 days at sea; 61 of those days were spent fishing.

Depending on the vessel, location, and particular ocean conditions prior to setting, gear consisted of a main line of 20-50 miles of monofilament with a distance of 250-450 m between floats. The number of hooks deployed varied (450-1,800 per set). Light sticks of various colors were attached with rubber bands to branch or dropper lines about 6 ft above the hook (branch lines were approximately 36 ft long and consisted of 2.1 mm monofilment). Bait consisted of large (300-400 g) whole squid, saury, and mackerel. At times, squid were experimentally dyed with red or green food coloring to attract more fish. All hooks were baited, but not all branch lines contained light sticks.

The number of sets made individually by the 6 vessels ranged from 10 to 14. Forty-six sets were made in the mid-Pacific, 10 in the MHI, and 5 in the NWHI. The mid-Pacific sets were at approximately 28-35°N and 160-165°W, the MHI sets were 30-60 miles offshore (although because of drift, some gear retrieval occurred as close as 21 miles from land), and the NWHI sets were made in the northwestern end of the archipelago. Gear deployment was usually begun late in the day just before sunset and completed just before midnight. Hauling commenced just after sunrise the following morning. Soak time lasted 8-16 hours, depending on which end of the gear was hauled first.

On four trips, data for the depth of the fishing gear were collected by a time depth recorder (TDR) during each set. The TDR was usually attached with a 10-fathom ball drop to the main line midway between the two floats. The TDR information was submitted to the Pelagic Ecosystem Program of the Honolulu Laboratory, and a profile was given to each vessel owner or captain.

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[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Plastic debris, including expended light sticks and monofilament gear discarded from each set, was collected and saved for on-land disposal on three of six trips.

CATCHES

Catches were divided into four categories: pelagic management unit species (PMUS), shark (which are also PMUS), tunas, and incidentally caught fish. Scientific names are listed in Table 1; Figure 1 shows species composition of the catch (by number). Catch was also summarized by the total and average number of fish caught and by catch per unit effort (CPUE; catch per 100 hooks; Table 2). A total of 527 swordfish were hooked during these 6 trips, representing 21.7% of the fish caught (N = 2,425). The number of swordfish caught equaled 13-36% of the total catch by individual trips. The mean size of measured swordfish (N = 339) was 130.54 cm eye orbit to fork length.

Swordfish under 23 kg are commonly called "rats" by the fishing industry, 23-45 kg swordfish are called "pups," and those over 45 kg are known as "markers." During the last three trips, the majority of all swordfish caught were rats. The rats were usually discarded regardless of whether they were dead or alive. Most of the rats were dead by the time they were brought on board; however, two recovered alive were each tagged with a dart tag and released. Swordfish destined for sale were headed, finned, gilled, and gutted on board and landed in Honolulu.

Swordfish less than 23 kg were weighed on a portable scale; however, those larger than 23 kg (maximum scale capacity) were not because of restrictions in time and space and the lack of a larger capacity scale. Therefore, to obtain accurate dressed-to-whole weight ratios, >23 kg swordfish were weighed for discarded parts (i.e., head, fins, tail, and guts), tagged with red surveyor's tape, and numbered for later identification and recovery of the actual dressed weight. Dressed swordfish (N = 376) equaled 71% of the total swordfish catch and weighed a total of 18,550 kg. Weight loss during transit is unaccounted for and represents a bias in the data. The dressed weight of all fish was recorded during off-loading operations in Honolulu.

As time and conditions allowed, supplementary biological measurements and samples were taken: morphometrics (a set of 6 morphometric measurements was taken from 110 swordfish), stomach contents, otoliths, and whole specimens. These data are being analyzed by Honolulu Laboratory scientists and will be reported elsewhere.

On most trips, sharks (by number) constituted the largest individual component of the catch, representing 32% (range, 25-55%) of the total number of fish caught. Blue sharks (N = 593) were more predominate than any other species. Most of the sharks

(90%) were released rather than landed. However, all dead sharks were usually finned, and the fins were dried to be sold commercially. Mako, thresher, and pelagic white tip sharks were usually landed and sold with the rest of the catch. These species (N = 74) represented only about 3% of the total catch.

A total of 260 bigeye and 148 yellowfin tunas were caught during 6 trips. The mean size of measured bigeye (N = 199) and yellowfin tunas (N = 35) was 132.23 and 154.37 cm, respectively. During the last three trips, bigeye tuna (22%) and mahimahi (26%) dominated the catch. Figure 2 shows size distributions and relative frequency (percent) for swordfish, bigeye tuna, mahimahi, and yellowfin tuna.

The remainder of the catch consisted of various PMUS, such as blue and striped marlins and a few miscellaneous pelagic species, such as stingrays, lancetfish, and oilfish.

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CITATIONS

Sakagawa, G. T.
1989. Trends in fisheries for swordfish in the Pacific Ocean. *In:* Stroud, R. H. (editor), Planning the future of billfishes: research and management in the 90s and beyond, p. 61-79. Proceedings of the Second International Billfish Symposium, Kailua-Kona, Hawaii, August 1-5, 1988, Part 1. National Coalition for Marine Conservation, Inc., Savannah.

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Table 1.--List of common and scientific names of fishes and protected species.

Common name	Scientific name
Pelagic Management Unit Species	
Swordfish	*Xiphias gladius*
Blue marlin	*Makaira mazara*
Striped marlin	*Tetrapturus audax*
Shortbill spearfish	*T. angustirostris*
Sailfish	*Istiophorus platypterus*
Mahimahi	*Coryphaena hippurus*
Wahoo	*Acanthocybium solandri*
Blue shark	*Prionace glauca*
Thresher (big eye)	*Alopias superciliosus*
Mako (short fin)	*Isurus oxyrinchus*
White tip (pelagic)	*Carcharhinus longimanus*
Tiger shark	*Galeocerdo cuvieri*
Miscellaneous sharks	*Carcharhinidae*
Tunas	
Bigeye tuna	*Thunnus obesus*
Yellowfin tuna	*T. albacares*
Albacore	*T. alalunga*
Kawakawa	*Euthynnus affinis*
Miscellaneous	
Lancetfish	*Alepisaurus* spp.
Oilfish	*Lepidocybium flavobrunneum*
Barracuda	*Sphyraena barracuda*
Stingray (pelagic)	*Dasyatis violacea*
Protected Species	
Hawaiian monk seal	*Monachus schauinslandi*
Killer whale	*Orcinus orca*
Green sea turtle	*Chelonia mydas*
Loggerhead turtle	*Caretta caretta*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coricea*
Laysan albatross	*Diomadea immutabilis*
Black-footed albatross	*D. nigripes*

Table 2.--Number of total fish caught and catch per unit effort (CPUE; number of fish per 100 hooks).

Species	Number caught	Average caught/day	CPUE
Pelagic Management Unit Species			
Swordfish	527	8.6	1.2
Blue marlin	38	0.6	0.09
Striped marlin	59	1.0	0.13
Other billfish	4	0.07	0.009
Mahimahi	312	5.1	0.7
Ono	15	0.2	0.03
Sharks			
Blue sharks	593	9.7	1.3
Mako sharks	19	0.3	0.04
Thresher sharks	24	0.4	0.05
White tip (pelagic)	31	0.5	0.06
Miscellaneous sharks	107	1.8	0.2
Tunas			
Bigeye tuna	260	4.3	0.6
Yellowfin tuna	148	2.4	0.3
Albacore	11	0.2	0.02
Other tunas	2	0.03	0.005
Miscellaneous			
Miscellaneous	275	4.5	0.6

Longline Summary Report

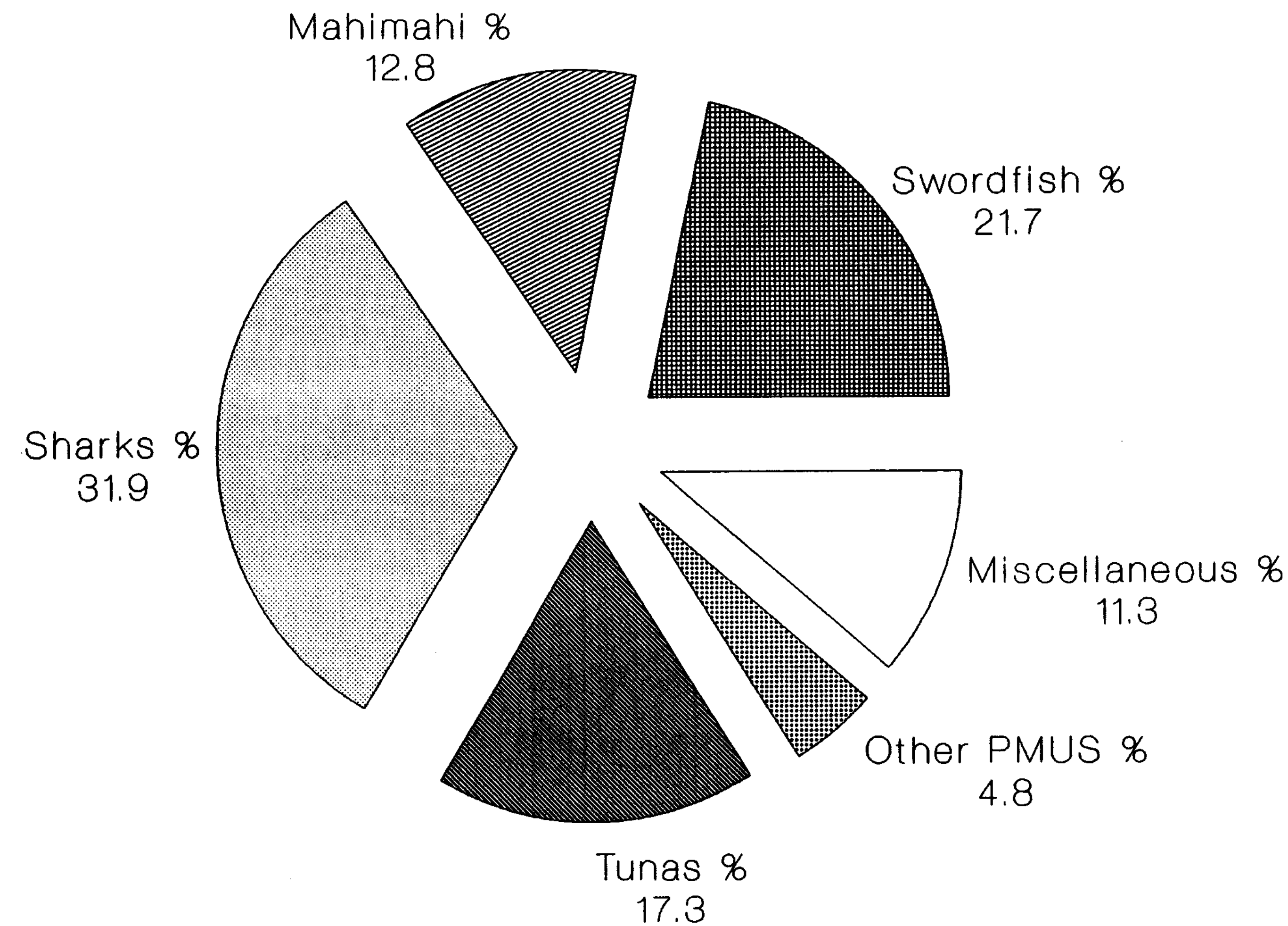

Figure 1.--Percent species composition.

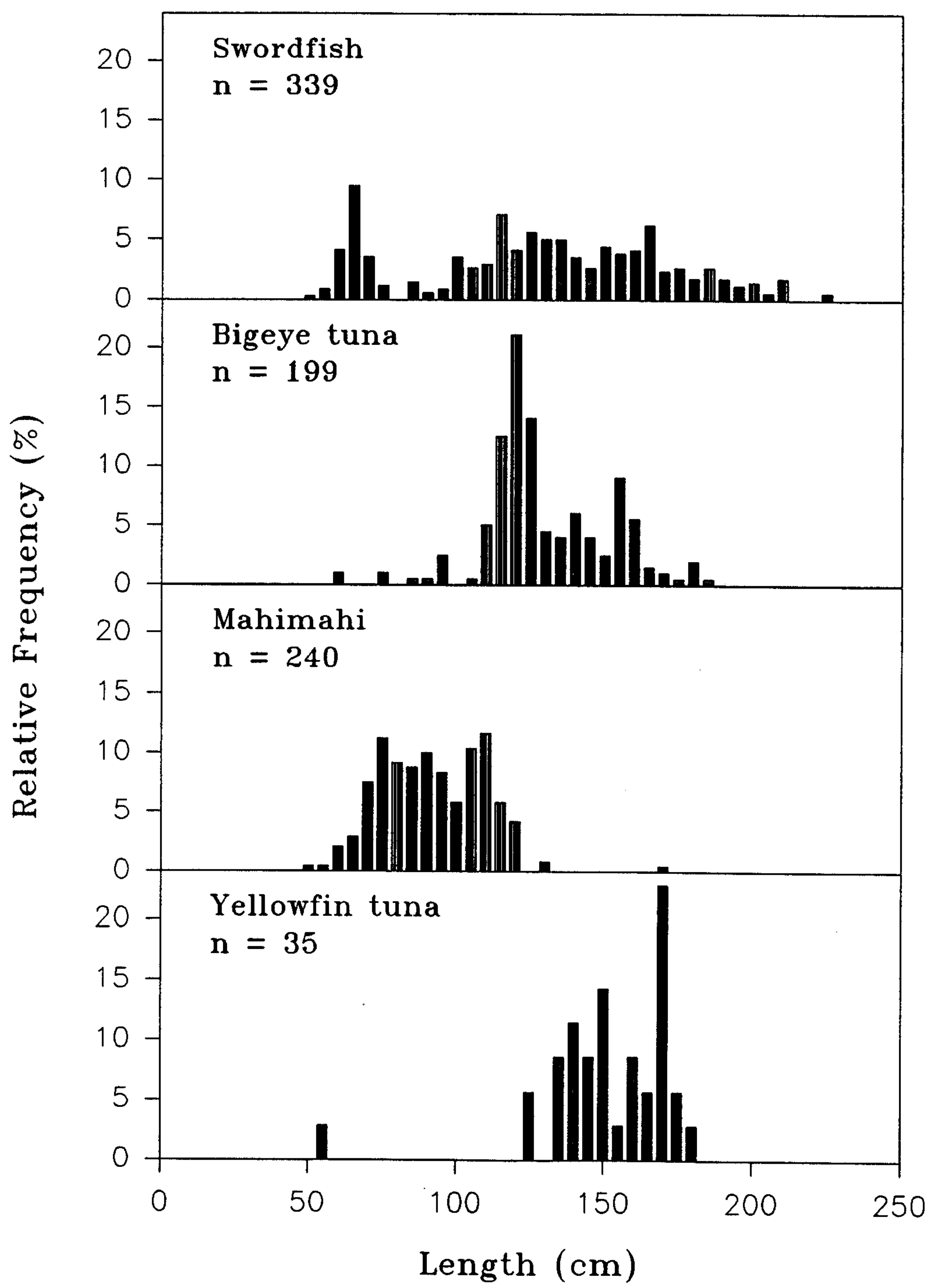

Figure 2.--Length-frequency histograms for swordfish, bigeye tuna, mahimahi, and yellowfin tuna.

Appendix A.--Swordfish observer protocol.

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Swordfish Observer Protocol

Fishery Management Research Program observers aboard longline fishing vessel targeting swordfish, especially in the Northwestern Hawaiian Islands, have the following priorities:

1. Fishing effort data:
   a. Type of gear deployed
   b. Time-depth recording

2. Catch sampling log:
   a. Location of set
   b. Catch (individual fish) (species, sex, length)
   c. Oceanographic conditions

3. Endangered and protected species interaction summary log:
   a. Interaction observed during setting and hauling gear
   b. Photos of animals in water
   c. Photos and measurements of dead animals on deck (animals will be released upon measurement)

4. Supplementary biological measurements and samples:
   a. Recovery rates
   b. Morphometrics
   c. Other biological samples (e.g., otoliths)

Supplemental observations include fishing gear and techniques and neighboring vessel activity.
