Temporal and Spatial Distribution of Catches of Tiger Sharks, *Galeocerdo cuvier*, in the Pelagic Longline Fishery Around the Hawaiian Islands

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Introduction

The tiger shark, *Galeocerdo cuvier*, has a circumglobal distribution in tropical and temperate oceans (Randall, 1992). While considered a nearshore shark, returns of tagged tiger sharks from the east coast of the United States show that they can move considerable distances. The Cooperative Shark Tagging Program of the NMFS Northeast Fisheries Center's Naragansett Laboratory tagged 2,257 tiger sharks during 1977-89 and have data from the recoveries of 135 tags (Randall, 1992). Fifty-seven tags were recovered at least 100 n.mi. away from the tagging sites. The greatest distance between the tag and recovery sites was 1,853 n.mi. (Randall, 1992). Generally, this movement is believed to be alongshore movement over the continental shelf.

Less is known about tiger shark movement in the oceanic Hawaiian Islands. In one tagging study only four tagged tiger sharks have been recovered, and only one showed any significant movement, 45 n.mi., from the north to the south of the Island of Oahu (Tester, 1969). Sonic tracking of a tiger shark in the Northwestern Hawaiian Islands over two 24-hour periods found the shark remained within 7 km of the reef (Tricas et al., 1981).

As a result of recent apparent increases in tiger shark attacks on humans in Hawaii (Balazs, In press), there is considerable interest in long-term movement patterns of tiger sharks around the Hawaiian Islands. Information on the movement of tiger sharks around the Archipelago would provide a useful biological background to assess the impact of management actions such as localized shark fishing.

Since November 1990, the Honolulu Laboratory of the NMFS Southwest Fisheries Science Center has collected logbooks from vessels fishing in the pelagic longline fishery around the Hawaiian Archipelago. Occasionally, catches of tiger sharks are recorded in the logbooks and these records provide unique information on the offshore occurrence of tiger sharks around the Hawaiian Islands. Here, we present a spatial and temporal analysis of catches of tiger sharks from the longline fishery logbooks.

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ABSTRACT—Thirty-five tiger sharks, Galeocerdo cuvier, *have been reported caught in pelagic longline gear from 25 to 265 n.mi. off the Hawaiian Archipelago during December 1990-May 1993. Fifteen sharks were caught farther than 50 n.mi. offshore, indicating that tiger sharks do occur well offshore and removed from benthic topography. About 89% of the sharks were caught during October-March, while only 56% of the fishing effort occurred during that period.*

Data

Fish are caught by longline gear with baited hooks on hundreds of branch lines attached to a single long main line often stretching 30 n.mi. The main line is buoyed at regular intervals by float lines connected to surface floats. The depth of the hooks alters the gear efficiency in catching different species. Each longline set requires most of a day or night to set, soak, and retrieve. Recently, because of the development of the swordfish fishery, the longline fleet has grown dramatically, and many vessels often make from 30- to 40-day trips, traveling 400-1,000 miles north of Hawaii. The longline fishery around the Hawaiian Archipelago typically targets swordfish and bigeye tuna but catches a wide range of fishes occasionally including tiger sharks. Longline sets targeting tunas are usually day sets; gear is deployed early in the morning and retrieved late in the afternoon. Sets targeting swordfish are night sets; gear is set late in the afternoon and retrieved early in the morning. Since November 1990, all longline vessels fishing around the Hawaiian Islands are required to report by set: Location of the set, number of hooks, and number of fish caught for the 15 most common species, including three species of oceanic sharks. Tiger sharks are not one of the species specifically identified in the logbooks; they are entered as "other" on the log sheets.

Logbooks from December 1990 to May 1993 were examined for reports of tiger shark catches. During this 30-month period, longlining within 50 n.mi. of the main Hawaiian Islands was prohibited for about 20 months (from mid-June to mid-December 1991 and from March 1992 to May 1993) to resolve gear conflicts.

Results

An examination of longline logbooks from December 1990 to May 1993 found 35 catches of tiger sharks recorded from 4,350 fishing trips (Table 1, Fig. 1).

Tiger sharks were caught both on day longline sets targeting tunas and night longline sets which target swordfish (Table 1). Fifteen of the catches occurred both south and north of the Archipelago beyond 50 n.mi. offshore, with the farthest at 365 n.mi. offshore (Table 1, Fig. 1). Eighteen occurred within 45 n.mi. of the north side of Maui between November 1992 and January 1993 (Table 1, Fig. 1). About 89% (31 of 35) of the sharks were caught during the 1st and 4th quarters (October-March), while only 56% of the fishing trips occurred during this period (Table 2). Based on a chi-squared test the catches of tiger sharks in the 1st and 4th quarters are greater than would be expected if catches were proportional to fishing trips ($P<0.0001$). When the catch is examined based on distance offshore we find that 60% of those caught beyond 50 n.mi. offshore are caught in the 1st quarter (Table 2).

Table 1.—Reports of catches of tiger sharks from pelagic longline logbooks[1]. The coordinate for each location is the mean between set location and haul location. Distance is from the nearest shore of the Hawaiian Archipelago.

Record	Haul date	Set time	Haul time	Location Lat.	Location Long.	No. of tiger sharks	Distance from nearest shore (n.mi).	Quarter
1	930307	0700h	1800h	21° 56'	164° 41'	1	95	1
2	930304	0700	1800	21 46	164 37	1	105	1
3	930303	0730	1700	21 57	164 43	2	201	1
4	930119	0930	1730	18 54	160 20	1	165	1
5	930117	0900	1730	18 54	159 52	2	170	1
6	930117	0700	1730	21 12	155 47	1	30	1
7	921223	0750	1500	19 07	159 46	1	150	4
8	921222	0735	1430	19 27	160 41	1	104	4
9	921201	0800	1600	21 38	156 08	1	45	4
10	921126	0700	1600	21 32	156 01	1	35	4
11	921117	0800	1600	21 16	155 45	5	30	4
12	921116	0830	1600	21 17	156 00	4	25	4
13	921114	0800	1600	21 18	155 58	3	25	4
14	921113	0800	1600	21 22	155 51	3	35	4
15	920829	0630	1450	19 40	158 52	1	105	3
16	920811	1800	600	27 06	157 28	1	315	3
17	920209	830	1630	21 28	160 38	1	30	1
18	920117	610	1610	20 30	150 45	1	240	1
19	910626	1800	730	27 24	163 31	1	250	2
20	910617	1830	730	26 45	166 02	1	180	2
21	910329	1845	1030	28 19	159 05	1	365	1
22	910129	1400	0800	23 05	162 54	1	45	1

[1] Data provided by the Pelagics Fishery Management Plan of the Western Pacific Regional Fishery Management Council and compiled by the Fishery Management Research Program, SWFSC Honolulu Laboratory.

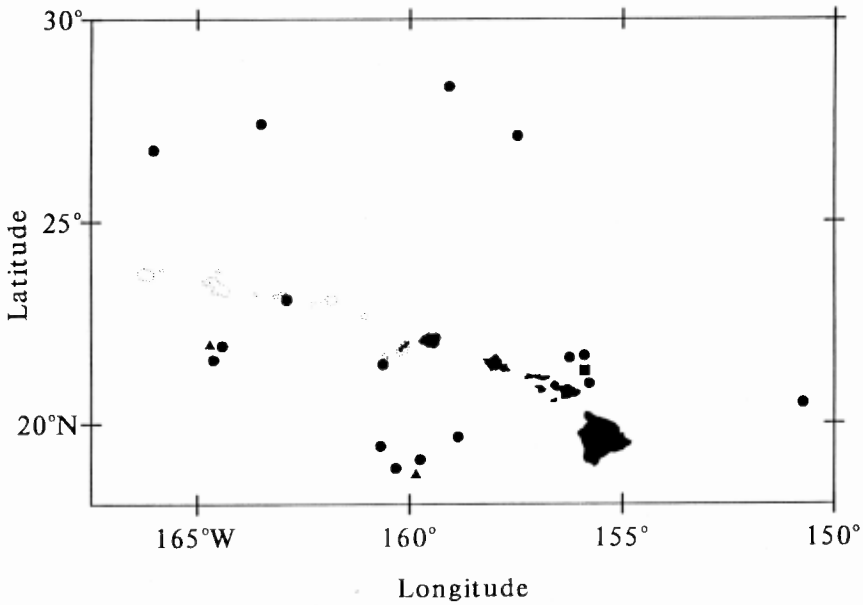

Figure 1.—Locations of tiger sharks caught by the longline fishery based on longline logbooks during December 1990-May 1993. Dots represent catches of a single tiger shark per longline set, triangles represent catches of more than one tiger shark per longline set, and the square represents four sets each with a catch of more than one tiger shark.

Discussion

Since tiger sharks are rarely caught on longline gear and since reporting requires that the incident be entered on the log sheet, it is likely that the reported catches underestimate actual catches. In fact, discussions with captains of vessels not reporting tiger shark catches in the logbooks confirm that other vessels have caught tiger sharks, but they have not specifically reported the catch. We cannot confirm that all tiger sharks reported were actually tiger sharks, but since tiger sharks are easily identified, it is likely that anyone interested enough to take the time to note the catch of a tiger shark would be able to correctly identify the species.

The reported catches show that tiger sharks can be found far offshore and well away from topographic features. Bottom depths even just 25 n.mi. off most of the islands exceed 4,000 m. Certainly, movement along the entire length of the Hawaiian Archipelago would be possible given these offshore movements. The higher catches of tiger sharks during the 1st and 4th quarters and, specifically, the higher catches of tiger sharks beyond 50 n.mi. during the 1st quarter suggest some seasonal offshore movement pattern. However, a more rigorous experimental design is needed to evaluate this hypothesis. The catches of 18 tiger sharks within 45

Table 2.—Tiger shark catches and fishing trips by quarter from the pelagic longline logbooks, December 1990–May 1993.

	Quarter of the Year 1	2	3	4
Fishing Trips	1,569	1,207	689	885
Tiger Sharks				
less than n.mi. offshore	3	0	0	17
more than 50 n.mi. offshore	9	2	2	2
Total Tiger Sharks	12	2	2	19

Data provided by the Pelagics Fishery Management Plan of the Western Pacific Regional Fishery Management Council and compiled by the Fishery Management Research Program, Honolulu Laboratory.

n.mi. of the north side of Maui between November 1992 and January 1993 and, particularly, the catches of 15 tiger sharks during 13-17 November 1992 indicate that incidental tiger shark catches by the longline fishery can have significant local impact on the tiger shark population.

While information of the size of the tiger sharks caught is not reported, discussions with vessel captains reporting catches indicate the sizes of tiger sharks caught on the longline gear range from 5 to 17 feet.

The reported catches of 35 tiger sharks by the longline fishery over the past 2 years indicate that tiger sharks may be attracted to longlines either because of the bait, or to prey on fish caught by the longline. Thus, there may be significant links between the longline fishery and tiger shark populations. A nearshore longline fishery may provide forage to support a tiger shark population, but may also inflict some fishing mortality on the population. Thus, temporal and spatial trends in fishing effort of the pelagic longline fishery may have an impact on the tiger shark population and, ultimately, tiger shark and human interactions.

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