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CONFIDENTIAL

Final Report

A SHARK CONTROL PROGRAM AT KAWAIHAE BAY

The Oceanic Institute

Waimanalo, Hawaii

November 18, 1969

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A SHARK CONTROL PROGRAM AT KAWAIHAE BAY

I. Introduction

In 1966, the Oceanic Institute began an experimental shark control program at Kawaihae Bay on the Island of Hawaii. Our goal was the development of methods of efficient, economical control of specified, local shark populations. Extensive residential and resort development will very soon change the character of the quiet Kona coast, and the coastal waters will be more and more used for recreational activities. The techniques we have developed in the past four years and the new methods we plan will have wide application in those areas where large, local shark populations present a real danger to humans.

The first phase of the program was an intensive 17-day fishing in the deeper waters of the bay by the Oceanic Institute motor vessel IMUA, with a followup fishing every third month thereafter for a period of three days. In June 1967, the Oceanic Institute and the University of Hawaii merged programs to continue these quarterly fishing visits, incorporating our goal of maintaining control of a highly localized population into their larger program of all-Island control. The standard quarterly fishing trips to Kawaihae continued as part of the cooperative program through December 1968.

In September 1968, the Oceanic Institute added the Resident Fisherman Project as a cross-check on the standard fishing and to explore the feasibility and economics of a different approach to local shark control. This experimental program lasted twelve months and made a definite contribution to overall control in the bay at a very low cost. Further, the results indicated that there were at least two separate and highly localized shark populations within the bay, one in the 15-30 fathom area and one in the 4-5 fathom inshore waters. The population in the deeper water was very susceptible to the standard boat fishing and probably included many transient fish. The nearshore population is probably more permanent, and seems to be little affected by the standard boat fishing. These indications are so positive that we propose an extension of the Resident Fisherman Project using additional permanent lines and a recently developed acoustic attracting system.

It must be emphasized that any control program such as ours creates an "ecological vacuum" for sharks that must be maintained artificially or the populations of sharks will return to precontrol levels in a very short time.

II. The Standard Fishing Visits

In January 1966, the Oceanic Institute motor vessel IMUA began standard fishing operations off Kawaihae Bay on the Kona Coast of the Island of Hawaii. Three adjacent fishing stations were selected as shown in Fig. 1, and the stations were fished in rotation, one day per station. A 32-hook line was set in the late afternoon and hauled on the following morning. Figure 2 illustrates the set line, which is approximately one-half mile long. The line was set roughly parallel to the shore in from 18 to 26 fathoms of water, with the hooks fishing approximately mid-water.

The first initial intensive fishing in January was continued for 17 days until the daily catch was greatly reduced. At three later periods during 1966, the IMUA returned for three-day sessions of fishing to test the recovery of the Kawaihae shark populations. Recovery between fishing visits was clearly incomplete, and the four fishing periods of 1966 continued to further deplete the resident shark population.

In 1967, the Oceanic Institute's standard fishing program was merged with the new cooperative program of the University of Hawaii(1). In July the SAILFISH was chartered for the program

(1) Albert L. Tester. "Cooperative Shark Research and Control Program, Annual Report 1967-68", University of Hawaii, Honolulu, Hawaii, June 30, 1968.

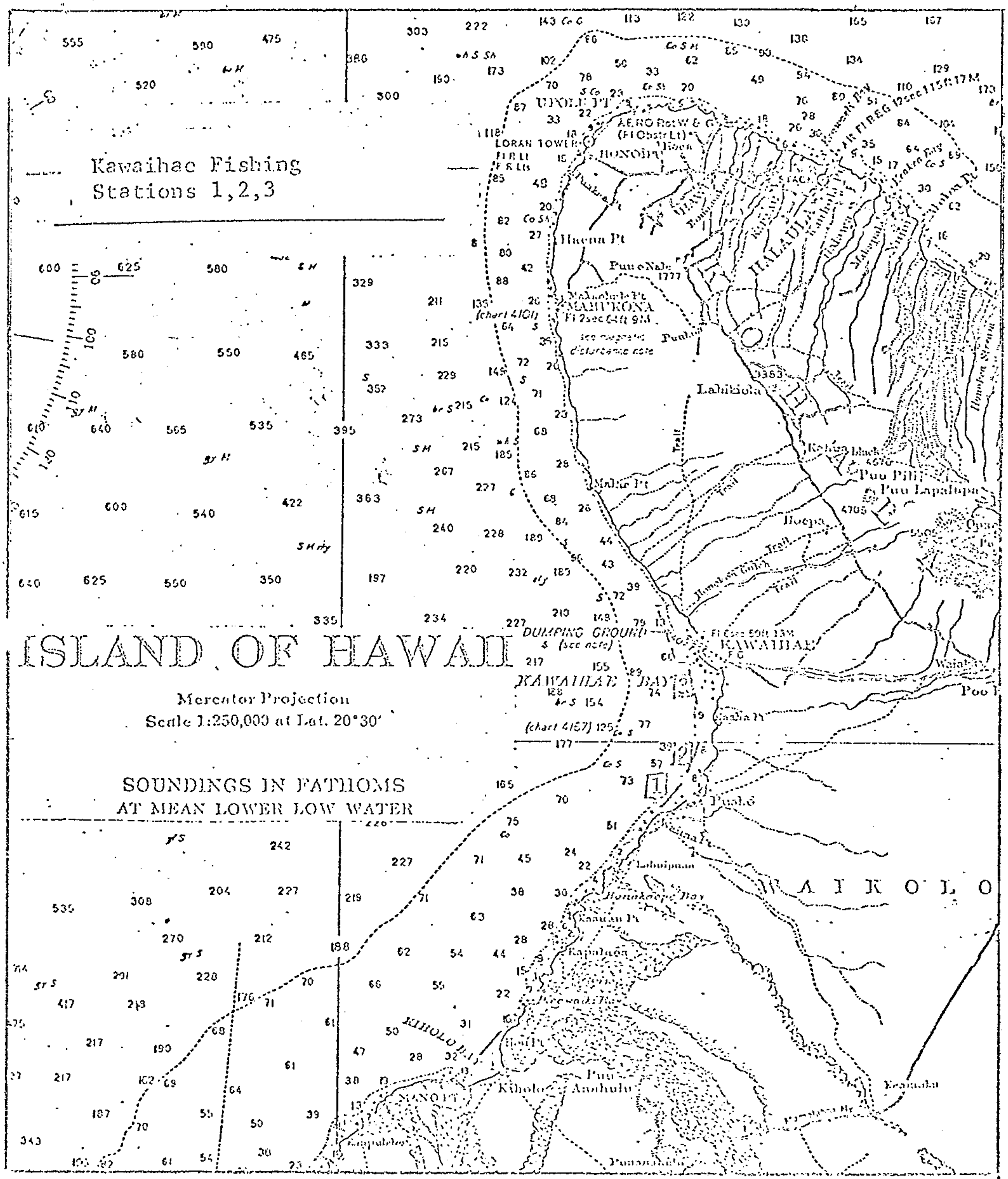

Fig. 1 Kawaihae Fishing Stations--1, 2, and 3
Standard Fishing Visits, 1967-1969

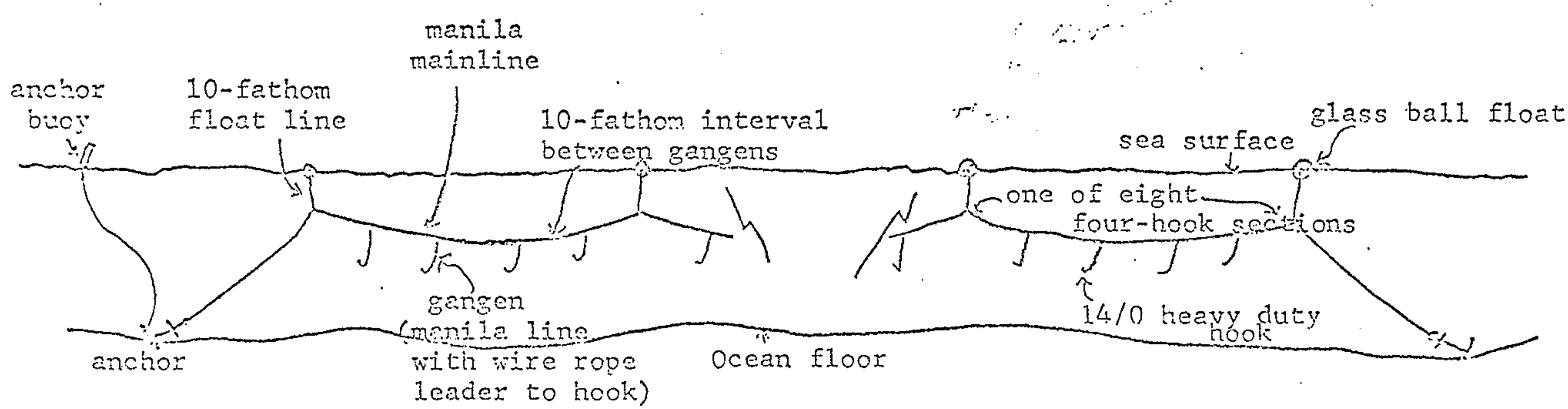

Fig. 2 A Set Section of Standard Fishing Line

and assumed the fishing cycle at Kawaihae. The SAILFISH was able to fish three 1400-yard lines simultaneously, thus significantly increasing the fishing pressure. However, SAILFISH was withdrawn from the program after a major breakdown in September, and was replaced by the ALIKA (owned by Mr. Alika Cooper). The ALIKA fished three ½-mile lines simultaneously, normally set parallel to the shore at different depths from 5 to 200 fathoms. The second year, three experimental sets were made--the three lines were fastened together and set perpendicular to the shore, usually starting at about 100 fathoms and ending in 5 to 10 fathoms. The ALIKA continued making the quarterly cruises to Kawaihae through December 1968.

Catch Rate

The catches for the three years are tabulated by date of the catch and species of shark in Table I. The trend in catch rate over successive trips is shown in Fig. 3. The slightly higher catch rate in the fall of 1967 was attributed to a large influx of pregnant Sandbar sharks, though a repetition of this phenomenon was not observed in the fall of the following year. Increased efficiency of the crew was observed with the change to the vessel ALIKA, and this may have contributed more significantly to the increased catch during the October visit.

TABLE I

SHARK CATCH BY DATE AND SPECIES
KAWAIHAE BAY STANDARD FISHING VISITS, 1966-68

Date	Hooks	Sandbar	Tiger	Blacktip	Great White	Galapagos	Other	Total	Catch per 100 hooks	
Jan 20, 1966	32	12	3		2			17		
21	32	5	2	1				8	31.2	
22	32	4	1					5		
23	32		3					3		
24	32	2						2	8.3	14.6
25	32	2	1					3		
27	32	2		1				3		
28	32	1						1	4.2	
29	32							0		
Feb 1, 1966	32	2		1				3		
2	32	1	1					2	7.3	
3	32	2						2		6.3
9	32		2					2		
10	32		1					1	6.2	
11	32	4						4		
12	32	1						1		
16	32		1					1		
	544	38	15	3	2			58	10.7	
June 9, 1966	32	2	4	3				9		
10	32		2					2		
11	32		4					4		
	96	2	10	3				15	15.6	
Sept 15, 1966	32	2						2		
16	32	2	2					4		
17	32	2	2					4		
	96	6	4					10	10.4	
Dec 11, 1966	32	3						3		
12	32	1	1					2		
13	32		1					1		
	96	4	2					6	6.4	
March 1967 (3 days)	96	2	1					3		
	96	2	1					3	3.1	
July 16, 1967	72		3					3		
17	48							0		
	120		3					3	2.5	

TABLE I (contd.)

Date	Hooks	SB	T	BT	GW	G	O	TOTAL	Catch per 100 hooks
Sept 26, 1967	72	8						8	
Oct 13	72	5	1					6	
14	72							0	
	216	13	1					14	6.5
Dec 20, 1967	72	5	5					10	
21	72							0	
22	72	3						3	
	216	8	5					13	6.0
Apr 15, 1968	72	1	1					2	
16	73	1	2					3	
17	73	1						1	
	218	3	3					6	2.8
Jul 4, 1968	72		1	2				3	
5	72	1						1	
	144	1	1	2				4	2.8
Oct 5, 1968	72			1				1	
6	72							0	
7	72	5	1			1		7	
	216	5	1	1		1		8	3.7
Dec 19, 1968	72							0	
21	72	4						4	
22	72					2		2	
	216	4				2		6	2.8
Totals 48 days	2274	86	46	9	2	3	0	146	

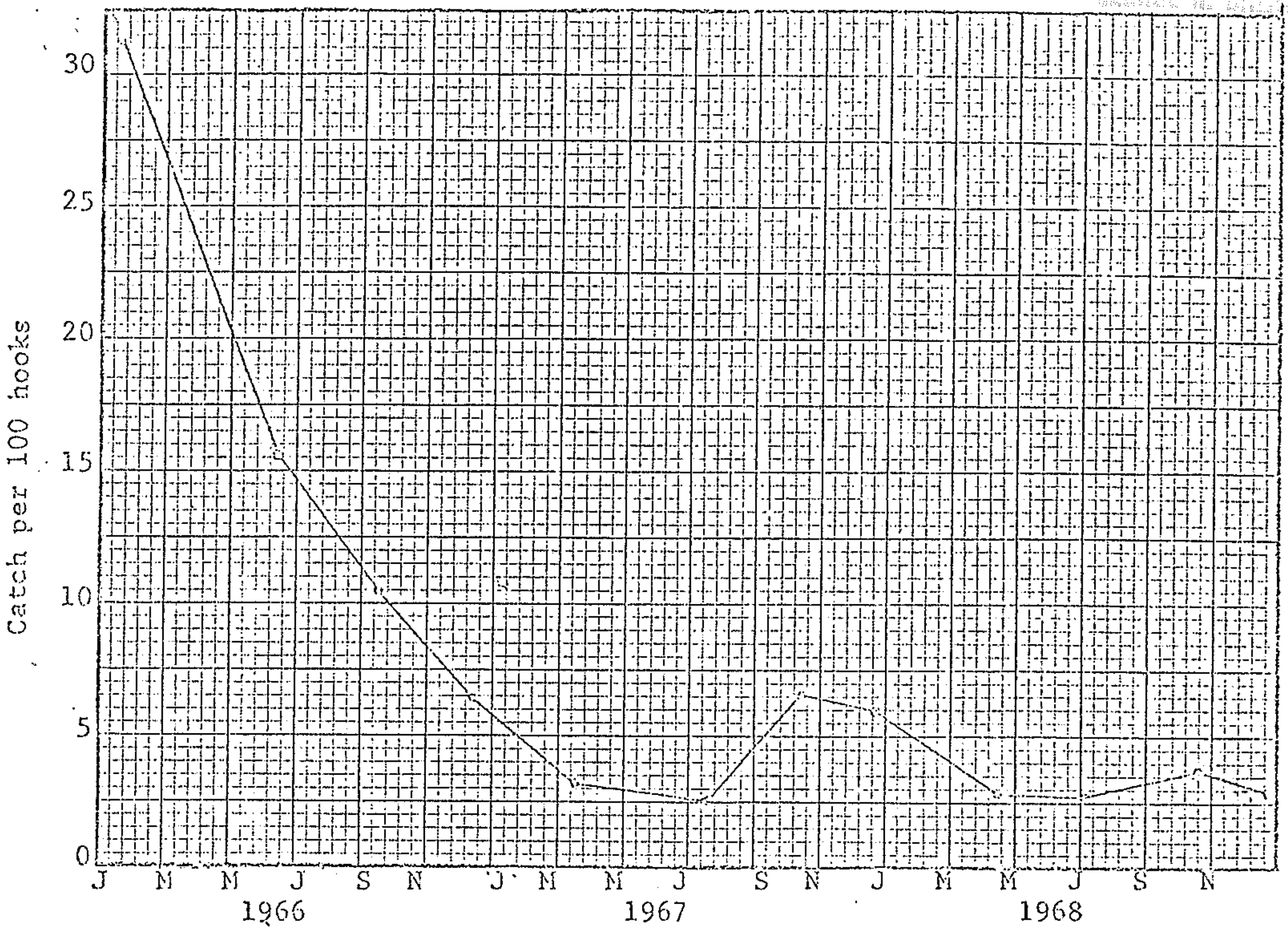

Fig. 3 Shark Catch in Kawaihae Bay, Standard Fishing Visits, 1966-68.

Bait Preference

During the first year of the standard fishing program, frozen mackerel from the mainland was used as the standard bait, though small sharks caught were often used as bait on the following day. When the ALIKA assumed the fishing visits, hooks were normally baited with skipjack, though occasional different baits were tried with no significant changes in the catch rate.

Food of Sharks

Whenever possible the stomach contents of hooked sharks were examined. Bottom-dwelling squid, octopus and crabs, and fish are common to the diets of all species. Sandbar and Blacktip sharks ordinarily swallow small fish whole, and the larger Galapagos sharks usually tear large fish into chunks. Clearly the Tiger shark is the scavenger of our nearshore waters. Besides the usual fish and invertebrates, their stomach contents included turtles, birds, porpoises, other sharks, and a large miscellaneous assortment of garbage (cardboard, sticks, plastic). Over fifty percent of those examined contained the remains of land mammals--pig, dog, goat, and cow.

Pregnant Sharks

Pregnant females were examined for number and size of young. In 1966 a preponderance of Tiger sharks among the pregnant females was observed (nine out of twelve hooked). Excluding sharks who aborted during the night on the hook, the average number of young was 39 pups, ranging in size from 6 to 32 inches. In 1967, the proportion reversed. Of 15 known pregnant females, 13 were Sandbars. The number of young per female averaged 5 pups, ranging in size from 5 to 7 inches. Since eleven of these thirteen pregnant Sandbars were caught during the October visit, the possibility of an annual fall migration of pregnant Sandbars was hypothesized. However, the 1968 catch indicated no cyclic trend for either pregnant Sandbars or Tigers. In fact, of the five Sandbars caught on the October 1968 visit, three were definitely identified as males. The total catch for 1968 was only 24 sharks and several of these had been damaged during the night by predator sharks until the sex could not be determined.

II. The Resident Fisherman Project

The Resident Fisherman Project began in September of 1968, with dual goals of 1) running a cross-check on the standard boat fishing, and 2) exploring the feasibility and economics of a different approach to local shark control. The standard fishing operation had definitely reduced shark numbers to a low level and was maintaining them there with only minor fluctuations. But legitimate questions were: Might there be some sort of undetected cycle, with the standard boat fishing removing only that part of the total population which matched the fishing cycle? Might some sharks swim these waters which were not attracted to the standard skipjack baits or which had learned not to bite? Were there sharks so highly local that we might have depopulated a zone along the 15-30 fathom depth but left others relatively untouched in the shallower waters?

Two permanent lines with three hooks each were set in four to five fathoms of water as shown in the sketch in Fig. 4. Mr. Alika Cooper, a skilled and observant fisherman, and his crew tended the lines daily for 20 days or more each month. The lines were visited each morning for inspection, rebaiting, and removal of any sharks caught. Daily logs were kept reporting bait used, condition of baits and hooks, and measurements of all sharks hooked.

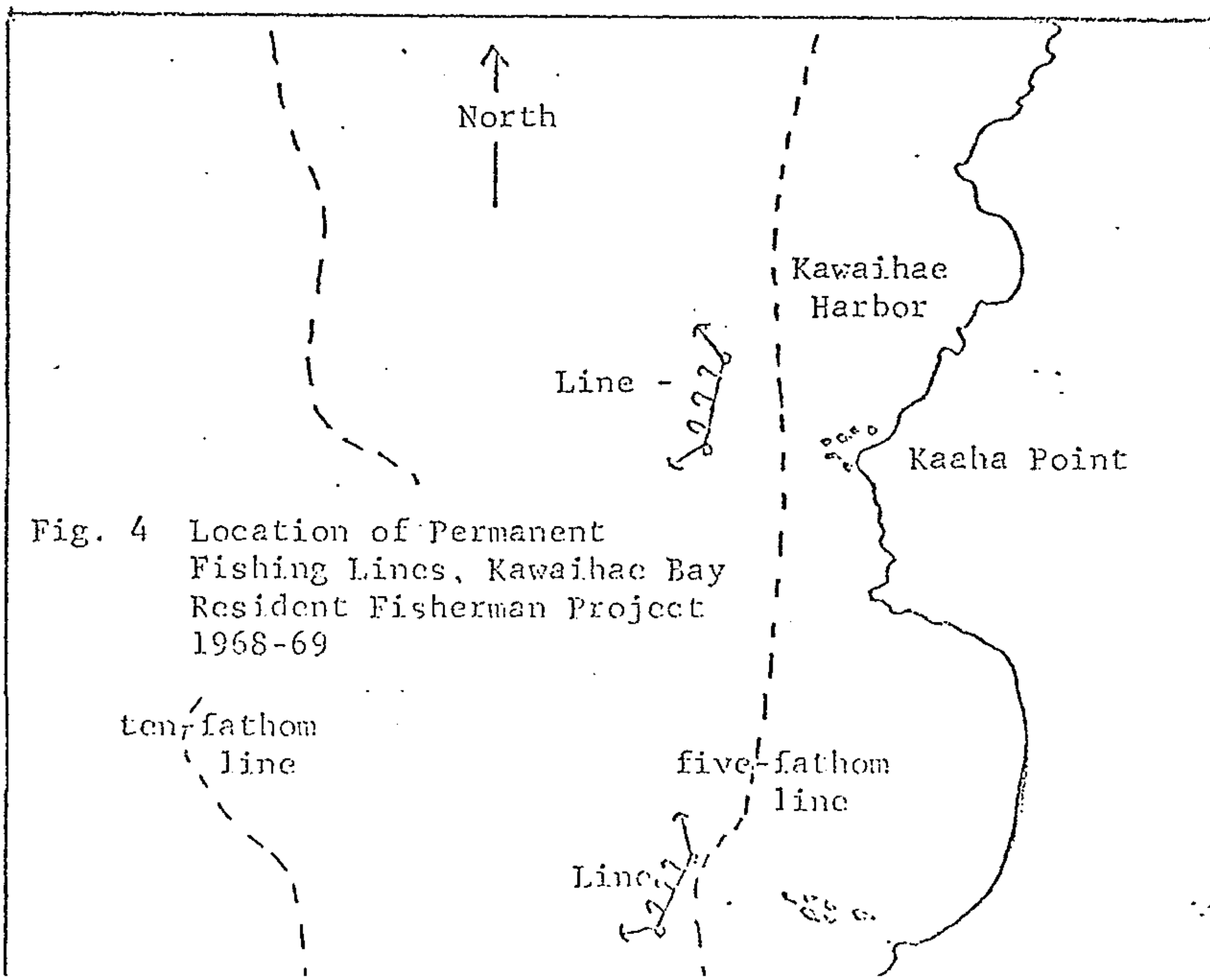

Fig. 4 Location of Permanent Fishing Lines, Kawaihae Bay Resident Fisherman Project 1968-69

Catch Rate

Forty-four sharks were caught during the year, and one-third of these were caught during the first month of the project, repeating the depletion curve of the standard boat fishing. Catches over the remaining eleven months were much lower and fairly stable (Fig. 5). The catch by date, species and sex is tabulated in Table II.

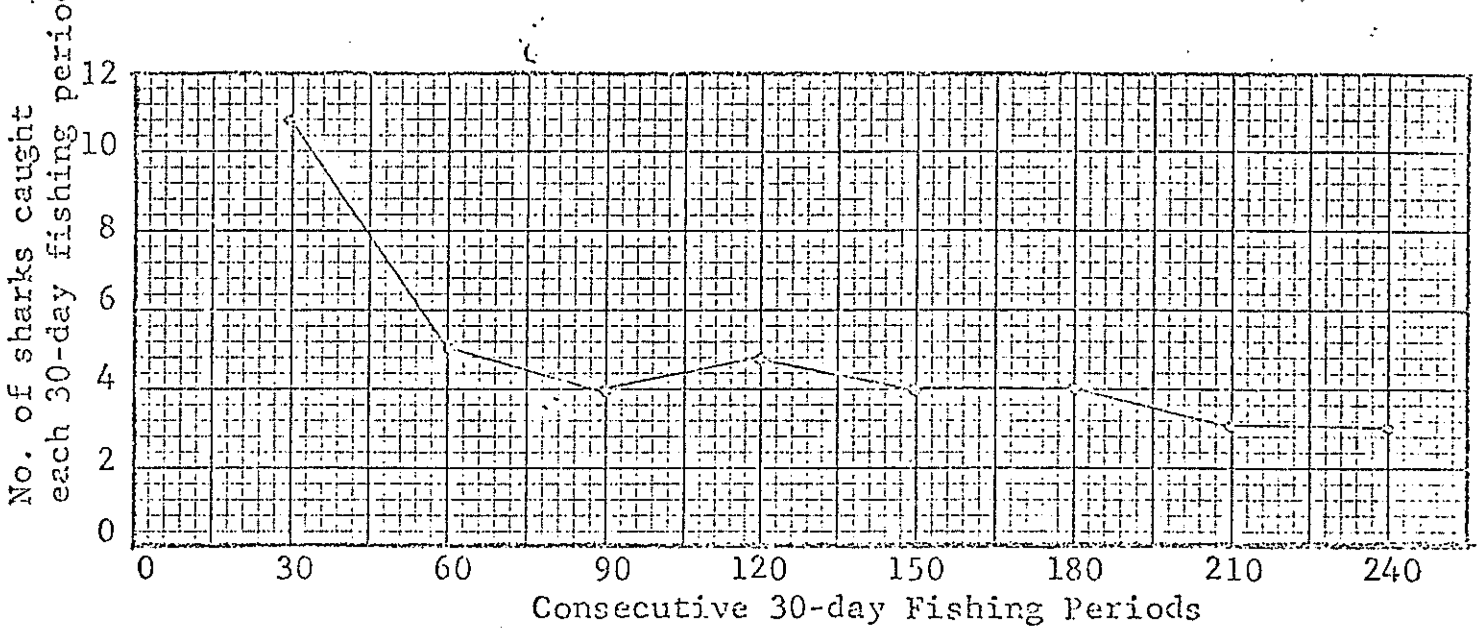

Fig. 5 Shark Catch in Kawaihae Bay, Resident Fisherman Operation, 1968-69.

The permanent lines were being fished on the same days that the standard fishing visits were made to the deeper water, yet the catch rate for each operation remained stable. It appears that there are indeed at least two separate populations, and the methods for fishing each are so selective that they do not affect catch rates in the other.

TABLE II

RESIDENT FISHERMAN PROJECT
Fishing Calendar and Catch by Species and Sex
September 20, 1968-August 14, 1969

SB - Sandbar (*Carcharhinus milberti*)
T - Tiger (*Galocerdo cuvieri*)
BT - Blacktip (*Carcharhinus limbatus*)
GW - Great White (*Carcharodon carcharias*)
SHH- Scalloped Hammerhead (*Sphyrna lewini*)

F - Female
M - Male

Sept	19	Oct	20	Dec	1	Jan	19
	20-F, SB		21		2		20
	F, SB		22		3-M, T		21
	F, SB		23		4		22
	23		24		5		23
	24		25		6		24
	25-F, T		26		7		25
	26-F, T		27		8		26
	27-F, T		28		9		27
	28-F, T		29		10		28
	29-F, T		30-F, BT		11	Feb	1
	30-F, T		31		12		2
Oct	1	Nov	2		13		3
	2		7-M, SB		14		4
	3		8		15		5-F, T
	4		9		16		M, T
	5-M, T		10		17		6-M, T
	6		11-F, T		18		7
	7		12		19		8
	9		13		20		9
	10		14	Jan	2		10-M, SHH
	11		15		3		11
	12		16		4		12
	14		17		5		13
	15-M, T		18-M, SB		12		14
	16-F, SB		19		13		15
	17		20		14		16
	18		21		15-F, SB		17-M, T
	19-M, T		22		16		18
	20-M, T		23		17-M, T		19-F, T
			24		18-M, T		20

TABLE II (contd.)

Mar.	1	May	1	July	1
	2		2		2-F, T
	3		3-M, GW		3
	4		4		4
	5		6		5
	6		7		6
	7		8		7
	8		9		8
	9		10		9
	10		11		10
	11		12		11
	12		13		14
	13		14		15
	14		15		16
	15-?, T		16		17
	16		17		18-M, T
	17		18		19
	18		19		20
	19		20		21
	20-M, T		21-F, T		22
	21		22		23
	22		23		24
	23		24		25
	24	June	2		26
	25-F, T		3		27-F, T
	26		4		28
	27		5	Aug	1
	28		6		2
	29-M, T		7		3
	30		8		4
	31		9-F, T		5
Apr	14-F, T		10		6
	15		11		7-F, T
	16		12-F, SB		8
	17-M, T		13		9
	M, T		30		10
	18				11
	19				12
	20				13
	21				14

<u>236</u> fishing days

<u>44</u> sharks (24 F, 19 M, 1 ?)

33 Tiger sharks (17 F, 15 M, 1?)
8 Sandbar sharks (6 F, 2 M)
1 Blacktip (M)
1 Great White (M)
1 Scalloped Hammerhead (M)

Bait Preference

The use of permanent, daily-checked lines allowed testing of a wide variety of baits. All the baits used, and any catches, are tabulated in Table III in units of "bait-days". In view of all the factors that can influence bait preference--type of bait; how well bait stays on hook; whether bait is alive or dead, fresh or frozen; how long bait has been left on hook; whether only a single bait or a choice of baits is offered--no significant correlation between baits used and catch rate is obvious.

Stomach Contents

Results of stomach content examination paralleled the evidence from the standard fishing operations: Sandbar sharks are primarily fish eaters; Tiger sharks are the garbagemen of the sea. Remains of birds, porpoise, and goats were found in Tiger stomachs, plus a few new exotics--plastic sheeting, aluminum foil, chunks of wood.

Pregnant Sharks

Of the forty-four sharks caught during the year, only four were pregnant females--two Sandbars caught in September and one

TABLE III

Kawaihae Resident Fisherman Project
Baits used, Days fished, and Sharks caught-
Sept 20, 1968 - Aug 14, 1969

Bait	"Bait-days"	Sharks caught	Baits lost, hooks missing, etc.	catch per bait-day
eel	594	13	156	.022
porpoise	192	6	65	.031
ray	247	10	98	.040
kala	29	5	3	.172
pig	39	3	3	.077
chicken	35		6	-
turtle	32		7	
puffer	44	3	10	.068
Miscellaneous fish				
aliimama	2	1		
mamalea	7		4	
cuttlefish	12			
butterfly	1		1	
maiko	5		4	
aku	24		14	
humuuhumu	8		2	
puala	1			
uhu	10	2	3	
pupaa	1		1	
angelfish	2			
palani	15	1	8	
wehe	1		1	
barracuda head	2		2	
ika	2		2	
turbot	4			
fasan	3		1	
H. salmon	1		1	
kawakawa	1		1	
fish head	7		2	
	109	4	46	.037
Miscellaneous				
owl	10		2	
beef	4		1	
liver	1		1	
lobster	4			
	19		4	
Totals	1340	44	398	.033

in June, with the usual number of 4-7 pups, all less than 1½ inches long. The pregnant Tiger containing many small embryos was caught in July. Of the total caught in the shallow waters of Kawaihae Bay, 24 were females, 19 were males, and one was damaged beyond recognition for sex.

Cost of Programs

The 1966 standard boat fishing operation with the IMUA cost $20,000. Then the cost was reduced slightly when the program merged with the University cooperative program--$17,800 each year for 1967 and 1968. The Resident Fisherman Project, however, cost only $6,619.

IV. Acoustic Attracting Project

We wish to continue the Resident Fisherman Project in Kawaihae Bay with six permanent lines, and at the same time test a new method which promises to improve significantly the ability of such lines to "fish out" an area. Scientists at the University of Miami Marine Laboratory have proven conclusively that certain classes of underwater sound attract sharks in large numbers. By using the sound generator, we hope to bring more sharks into the influence of the baited lines.

Since the sounds from such generators have limited, but defined, range, their effect will be to draw in sharks already in the vicinity without attracting them in from long distances.

The plans for incorporating the experimental acoustic attraction system into the six permanent lines are detailed in a previously submitted proposal (Appendix A). The costs for the three-year development period include both fabrication of the equipment and extensive ocean experimentation. We should be able, very early in the experimentation, to establish radii of influence for different sound signals, and thence to use this information for placement of sound generators. We anticipate that we will eventually be able to supply continuous coverage, by sound attraction devices and permanent fishing lines, all the area previously covered by both the standard fishing operation and the Resident Fisherman Project, at a substantially lower cost than the combined costs of the two separate programs.

V. Conclusions

1. Our data show conclusively that concerted fishing in an area will reduce shark populations by 80-90% and that the resident shark population can be maintained at this level by

inexpensive fishing techniques. The results of the University of Hawaii's cooperative all-Island fishing program further confirm this: "It is reasonably certain that shark abundance in the Kawaihae area has been 'controlled' by fishing effort over the three-year period. During the last two years the catch rate, and presumably the abundance of sharks, has been reduced to about 12% of its original value, i.e., a reduction of about 88%. . . It may also be noted that the catch rate in newly fished areas to the south of Kawaihae during 1967-69 were higher than in Kawaihae, although not nearly as high as that of the initial Kawaihae fishing of 1966. It is likely that the concentrated effort in the area has reduced the abundance along the adjacent Kona coastline. It may also be noted that the initially high rate in Kawaihae was of the same order of magnitude as some of the initial rates in newly-fished areas of the Molokai-Maui region."(1)

2. There appear to be at least two separate shark populations in Kawaihae Bay, and the shallow-water population is probably more permanent than the near offshore population. It was at first believed that this shallow-water population consisted

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(1) Albert L. Tester. "Cooperative Shark Research and Control Program, Final Report 1967-69" (rough draft), University of Hawaii, Honolulu, Hawaii, December 31, 1969.

primarily of very young sharks. However, a comparison of recorded lengths with the much more extensive data from the University program indicates that this is certainly not so. In fact, most of the sharks hooked in the Kawaihae shallow waters were larger than average,[1] indicating a true adult populatio

3. Additional experimentation with shark attracting devices should allow a further reduction and extend the area of population reduction to both inshore and near offshore waters, thus allowing a single fishing effort to control both areas. Such experimentation should cover a three-year period. If the method proves as useful as we expect it to, it can be integrated into the local fisherman effort and carried on at a greatly reduced cost.

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1 The University of Hawaii Cooperative shark control program maintained size records for all sharks caught offshore on their quarterly Oahu circuit. They captured 182 female Sandbar sharks, averaging 59.1", and 63 male Sandbars averaging 54.8". Four of our six female Sandbars were at least 14 inches longer than that average, and our two male Sandbars were just slightly shorter. The University sample of female Tigers, 69 fish, averaged 104.0". Twelve of our 17 female Tigers were larger than that average, sever by forty inches, and one exceeded that average by 59 inches. The average length of their 43 male Tigers is 102.0", and twelve of our fifteen exceeded that length--again, several of them exceed it by more than 30 inches.

A SHARK CONTROL PROGRAM FOR THE MAUNA KEA BEACH HOTEL, HAWAII, WITH EVALUATION OF A NEW SHARK CAPTURE METHOD

Introduction

A preliminary shark control experiment performed along the coast of the Island of Hawaii near the Mauna Kea Beach Hotel will be completed on August 20, 1969. The details and conclusions of this test will be submitted shortly thereafter. For our purposes here it sufficies to say that shark populations living along Hawaiian shores seem to consist of two sorts; those generally resident in an area, and oceanic stragglers that periodically wander into an area, perhaps from the open sea and perhaps from adjacent waters near shore. At any rate, persistent fishing does effect considerable reductions (estimated between 50-90%) in the population of sharks that is resident along a stretch of coast at any give time. Such fishing not only prevents the build up of a permanent resident population but tends to attract and capture new arrivals.

This proposal is for the continuation of a six line shark control program in the shore waters near the Mauna Kea Hotel, and at the same time a test of new methods which promise to improve materially the ability of such lines to "fish out" an area. Scientists at the University of Miami Marine Laboratory have proved conclusively that certain classes of underwater sound, which may mimic the sounds of struggling fish, attract sharks in considerable numbers. By combining a sound generator with a hook array, we hope to bring more of the sharks of an area into the influence of bait, and thus capture them. Since the sounds from such generators will have limited range, their effect will be to draw in sharks already in the general vicinity but not to draw them in from long distances.

In addition to the use of the hook arrays, we are proposing the use of nets to capture sharks that come inshore, especially during the breeding season, and which sometimes may become quite numerous, due to the fact that a single female may give birth to many young.

1. Line Fishing: Six permanent lines are to be laid between the Kawaihae breakwater and Puako, with three on each side of the Mauna Kea Hotel. Each of these lines will be equipped with one large shark hook and two smaller shark hooks. This arrangement promotes the capture of various sizes of sharks. Each line will be baited and tended for 20 days each month, for a total of 240 days each year. The lines will be placed approximately one-half mile apart, and our experience indicates that they will effectively

cover the area involved (more lines will not be expected to catch a significant additional number of sharks).

2. Net Fishing: During the months of breeding, the periods when sharks frequent the bay area in schools, we recommend the additional use of nets for control. Such nets can be used to surround entire shark schools that tend to gather at these times. They can be set unobtrusively (usually early in the morning) so that visitors will not be aware of the activity.

During non-breeding months, we suggest setting the nets periodically to capture strays not caught by the hooks. We suggest a schedule of eight sets per month near the hotel in known breeding areas, and at Hapuna Beach, plus sets resulting from air spotting.

We wish to point out that such net fishing will inevitably capture mantas and the smaller eagle rays, and that the management must decide whether this additional activity designed especially to capture smaller newborn and female sharks is more important than the presence of mantas and rays. We feel that it is important, and so recommend. It represents an opportunity to clear out many small sharks that will inevitably tend to repopulate the coastline.

hj.

3. Overflights: We plan to make two overflights per month of the coastline in question. Sharks are often easily sighted from the air and it is not difficult to direct the collection vessel to areas where sharks have been sighted for use of the surround net.

4. Sound Attraction Tests: Low frequency pulsed sounds have been shown to attract sharks with great facility. Such signals have caused sharks to move in upon an underwater sound generator and even to bite it. The sharks often come quickly, and apparently learn rather quickly that the sound does not represent food, and then move away. It is our plan to construct six sound generating buoys in the instrumentation facility at the Oceanic Institute. These will contain an encapsulated electronic circuit for producing the signal, a rechargeable battery pack, and appropriate stuffing glands and cables. A cable will be led from the buoy to a sound generator, protected by heavy metal screen from shark bite, suspended below the buoy. A navigational marker light is planned to be anchored on each of three shark lines; the two nearest Kawaihae and one line second from the opposite end. This leaves the two lines nearest the hotel without such attractant buoys, so that sharks are expected to move away from the hotel beach if they wander into the

area and are attracted to a sound field. By instrumenting one line at the end of our series and not the other end we will, in time, be able to appraise the effects of these generators in drawing sharks in from non-fished waters (Does the hook array at the end of our series of lines with the generator catch statistically more sharks than the array without?) Three buoys will be in the water at any one time and three on shore where batteries can be recharged and repairs made. Our instrumentation specialist tells us that we can expect a battery life (before recharging) of about one a month. A diagram of this buoy is appended in Figure 1. A diagram of the shark line placement is shown in Figure 2. A copy of one scientific paper describing the effects of pulsed low-frequency sound is appended for information.

5. Personnel and Equipment: To perform the routine capture and net operations, one full-time fisherman and one half-time fisherman (Alika Cooper) are planned. A special shark boat will be constructed for the program by Mr. Cooper. This craft is especially designed to allow large sharks to be tied alongside for measurements and removal of stomach contents. Because of the heavy workload planned, and rough seas in the area, this craft is expected to last approximately the life of this program.

The buoys will be constructed under the direction of the Oceanic Institute Bioinstrumentation Laboratory Director, Dr. George Harvey, who has had extensive experience in construction of underwater acoustic gear (vita attached). The program will be overseen by Dr. Kenneth Norris, Director of the Oceanic Institute (vita attached).

It should be understood that the Oceanic Institute cannot guarantee and does not expect that this program will eliminate sharks from the seas near the Mauna Kea Hotel. We do believe, however, on the basis of previous shark capture data, that this program will very materially reduce the risk to bathers in the area by reducing the resident shark population to a small percentage of its natural level. Such reduction creates an "ecological vacuum" for sharks that must be maintained artifically or the populations of sharks will surely return to precontrol levels in a rather short time.

JANUARY-MAY (INCLUSIVE)

Bait, Days Fished, and Sharks Caught

BAIT	NO. OF BAIT-DAYS	NO. OF SHARKS CAUGHT
Eel	256	5
Porpoise	88	5
Ray	120	6
Pig	16	1
Owl	12	0
Liver	1	0
Kala	2	1
Puffers	17	0
Aku	11	0
Turtle	13	0
Beef	5	0
Shark	2	0
Misc. Fish	42	1

		TOTAL
Bait untouched or little damaged		
Bait On	339	
Part Gone	38	
Sub-total	377	377
Bait lost, hook missing, etc.		
Bait Off	173	
Hook Bent	2	
Hook Gone	14	
Sub-total	189	189
Sharks hooked and taken	19	
Sub-total	19	19
		585 Bait Days

FIGURE 1

DIAGRAM OF SOUND GENERATOR BUOY FOR SHARK CONTROL PROJECT

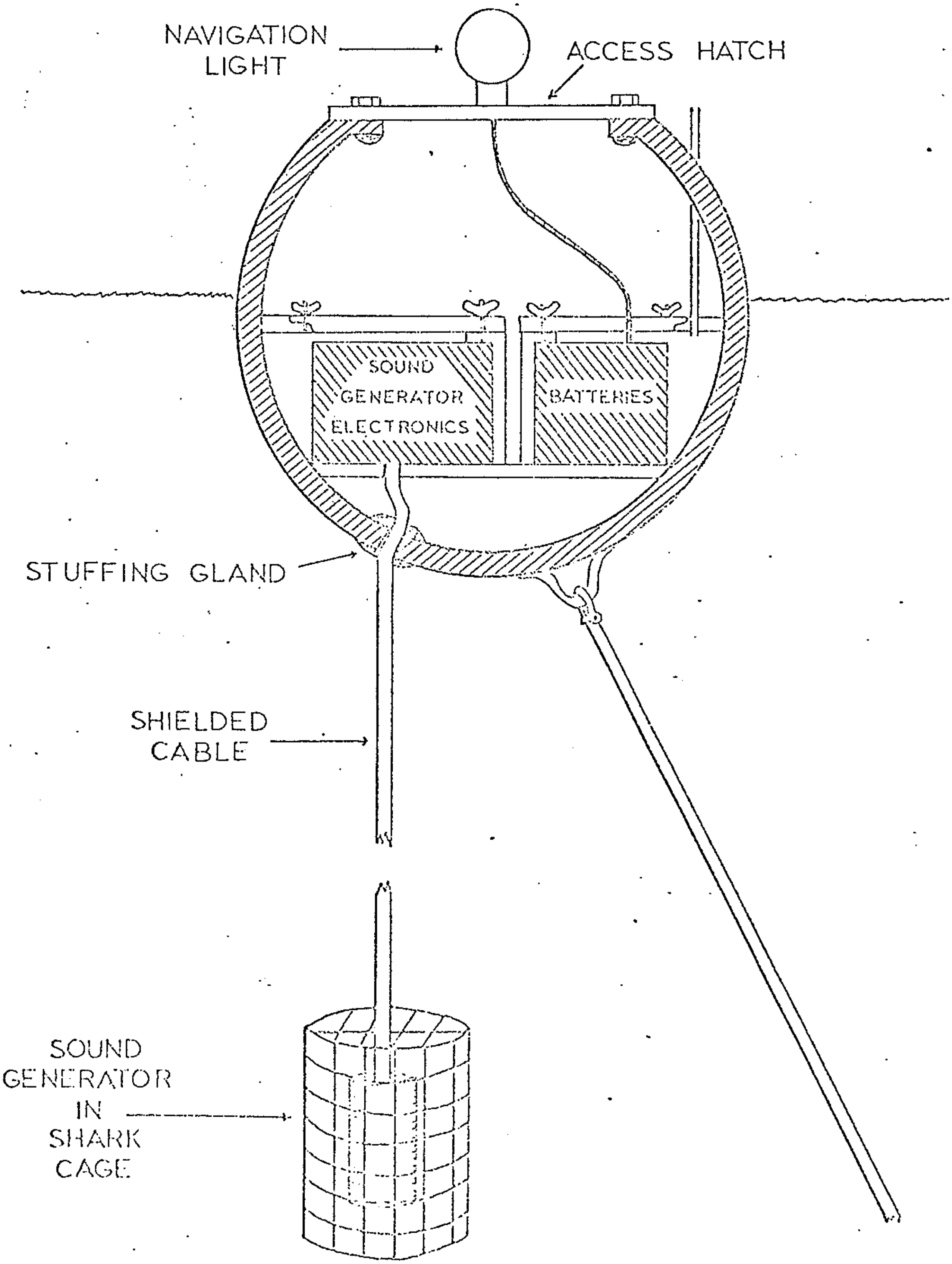
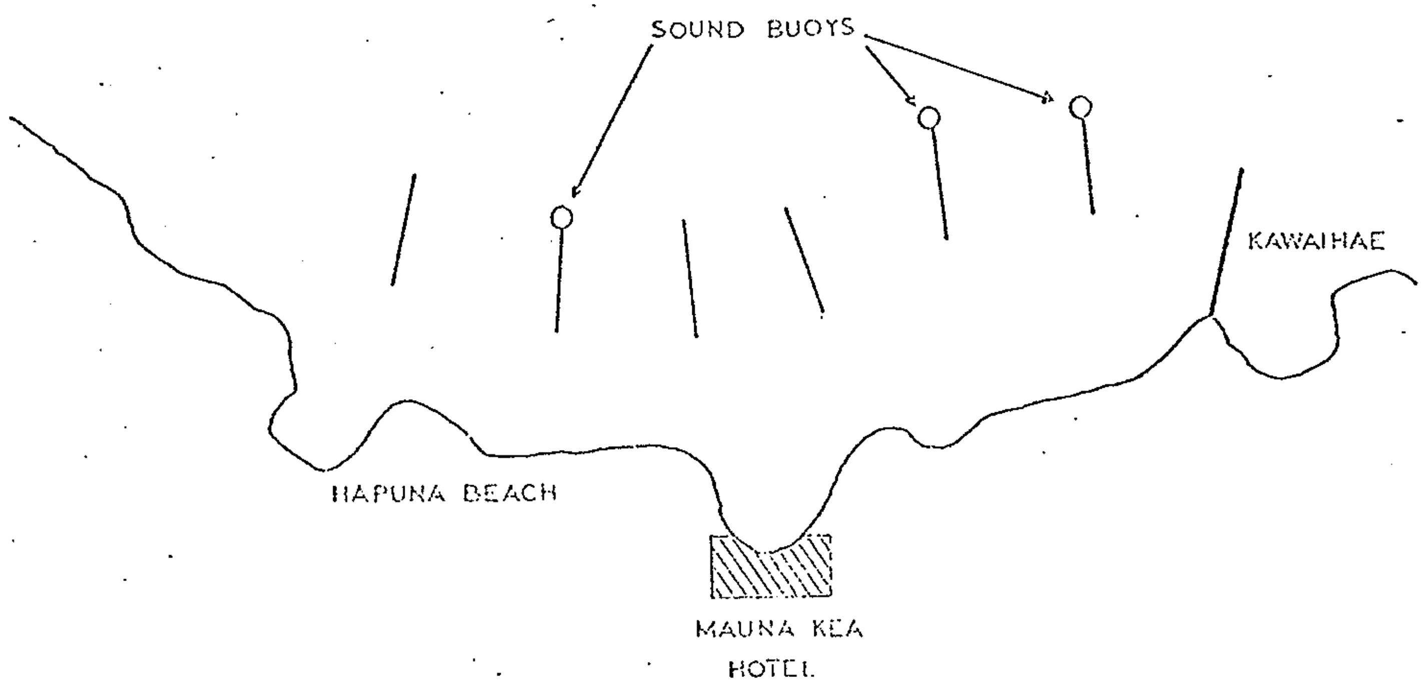


FIGURE 2

MAP OF COAST OF HAWAII SHOWING PROPOSED PLACEMENT OF SHARK LINES AND SOUND ATTRACTION DEVICES



BUDGET

YEAR 1: SEPTEMBER 1, 1969-AUGUST 31, 1970

	Rockefeller Funding	OI Funding	Total
Salaries and Wages			
Project Director, (½ time)	$7,000		$7,000
Project Supervisor, (1/8 time)		$3,700	3,700
Instrumentation Lab Director, (1/8 time)		2,500	2,500
Fisherman, (100% time)	5,500		5,500
Benefits (Social security, unemployment, Jones Act-seaman's insurance, ocean insurance and liability - 28%) - (OI Benefits - 10%)	3,500	620	4,120
Total	16,000	6,820	22,820
Contracted Services and Rentals			
Spotting plane, 2 times per month @ $20/hr	480		480
Engine and boat repair	300		300
Telephone @ $10/mo	120		120
Freight, buoys to Kawaihae	50		50
Boat rental, $10/day, 240 days	2,400		2,400
Freezer costs, bait storage @ $20/mo	240		240
Rental, storage room for nets and gear, Kawaihae	180		180
Total	3,770	-	3,770
Equipment and Supplies			
Documentation materials (photographic)	50		50
Materials for preparation of 6 shark lines			
15 coils polypropylene rope, ½" @ $50 coil	750		750

	Rockefeller Funding	OI Funding	Total
Equipment and Supplies (Contd)			
10 coils polypropylene rope, 7/16" @ $26 coil	260		260
100 shark hooks, #14 @ $0.75/ea	75		75
25 hooks, special blacksmith type, 6, 12" @ $5/ea	125		125
Gaffs, knives and killers	80		80
Galvanized steel cable, 1/8", 1 coil	120		120
Chain for large hooks	37		37
Shackles @ $0.75/ea	37.50		37.50
Swivels, sleeves, floats	200		200
Pliers, cutters, crimps	25		25
Anchors, #40 @ $20/ea	320		320
Materials for preparation of 1 shark net			
Netting, nylon, 24-30 test, @ $3/lb	900		900
Floats, 2000, @ $0.12/ea	240		240
Lead, @ $0.30/lb	300		300
15 coils polypropylene rope, 7/16"	315		315
Patching cord, 25 lbs	50		50
Shuttles, 50, @ $0.25/ea	12.50		12.50
15 lb anchors, 10	75		75
Office supplies	25		25
Ammunition	75		75
Bait, 8/lbs/gang of hooks, 6 gangs @ $0.25/lb, or $12/day	2,980		2,980
Fuel	1,420		1,420
Materials for construction of 6 sound generator floats range 300 feet, producing wide band 1 msec pulses at rep rate of 800-1000 sec, (1 sec modulation)			
Circuit construction, 6 @ $300/ea	1,800		1,800

	Rockefeller Funding	OI Funding	Total
Equipment and Supplies (Contd)			
Sonabuoy hydrophones, 6 @ $150/ea	700		700
Rechargable batteries, 6 banks @ $50/ea	300		300
Cable @ $50 per unit	300		300
Connectors, 6 @ $25/ea	150		150
Float fabrication, $300/ea	1,800		1,800
Total	11,740	-	11,740
Travel			
Shore transportation, Mr. Cooper (gear etc.) @ $0.12/mile	345		345
Oceanic Institute scientific staff, travel and consultation, (between Makapuu and Kawaihae during sound tests plus per diem and car rental-	1,200		1,200
Total	1,545	-	1,545
Indirect Cost - 55%-salaries and wages	8,800	3,751	12,551
Total Budget (Year 1)	41,855	10,571	52,426

BUDGET

YEAR 2: SEPTEMBER 1, 1970-AUGUST 31, 1971

We suggest a re-evaluation of the project at the end of the second year for possible continuation.

Salaries (including benefits)	$16,000
Contracted Services and Rentals	3,720
Equipment and Supplies	
Replacement of shark lines (2/3 of original cost)	1,385
Shark net replacement (½ of original cost)	991
Documentation	50
Upkeep on sound generators (20% of cost)	1,010
Bait	2,980
Office supplies	25
Ammunition	75
Fuel for boats	1,420
Total	7,936
Travel	
Shore transportation, (gear etc.) @ $0.12/mile	345
Oceanic Institute Staff travel (½ of previous year, as initial sound test will be completed and work will become routine in years 2 and 3)	600
Total	945
Indirect Cost (55% salaries and wages)	8,800
Total Budget (Year 2)	$37,401

BUDGET

YEAR 3: SEPTEMBER 1, 1971-AUGUST 31, 1972

We suggest a re-evaluation of the project at the end of the third year for possible continuation.

Salaries (including benefits)	$16,000
Contracted Services and Rentals	3,720
Equipment and Supplies	
Replacement of shark lines (2/3 of original cost)	1,385
Shark net replacement (½ of original cost)	991
Documentation	50
Upkeep on sound generators (20% of cost)	1,010
Bait	2,980
Office supplies	25
Ammunition	75
Fuel for boats	1,420
Total	7,936
Travel	
Shore transportation, (Mr. Cooper) (gear etc.) @ $0.12/mi.	345
Oceanic Institute Staff travel (½ of previous year, as initial sound test will be completed and work will become routine in 2 and 3	600
Total	945
Indirect Cost (55% salaries and wages)	8,800
Total Budget (Year 3)	$37,401

APPENDIX A

PROPOSAL

TO

LAURANCE S. ROCKEFELLER

Title:	A Shark Control Program for the Mauna Kea Beach Hotel, Hawaii, with Evaluation of a New Shark Capture Method
Institution:	The Oceanic Institute Makapuu Oceanic Center Waimanalo, Hawaii 96795
Principal Investigator:	Dr. Kenneth S. Norris, Director Oceanic Institute
Co-Principal Investigator:	Dr. George W. Harvey, Director Bioinstrumentation Division
Proposed Starting Date:	September 1969
Project Period:	Three Years
Funds Requested:	First Year $41,855 Second Year $37,401 Third Year $37,401

Dr. Kenneth S. Norris, Director
The Oceanic Institute

Stephen J. Achong, Controller
The Oceanic Foundation

George W. Harvey

Dr. George W. Harvey
Co-Principal Investigator