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"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

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EARL WARREN
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Director of Natural Resources

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CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

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SUMMARY OF RECOVERY OF CALIFORNIA SARDINE TAGS ON THE PACIFIC COAST

By JOHN F. JANSSEN, JR.,[1] Bureau of Marine Fisheries, California Division of Fish and Game

From 1936 to 1942 the California Division of Fish and Game conducted an extensive tagging program to measure the movements and abundance of the Pacific sardine (*Sardinops caerulea*). The results of this work, based on returns through the 1943-44 fishing season, were published in Fish Bulletin No. 61 (Bureau of Marine Fisheries, 1945). Since 1944 additional recoveries have been made each year but by the 1946-47 season the number dropped to an inconsequential figure. Because few, if any, returns may be expected in the seasons to come it seems advisable to present the data for the seasons 1944-45 through 1946-47 and to sum up the results of all recoveries.

The cooperation and assistance rendered by the fishing industry in California as well as that rendered by government agencies and the industry in Oregon, Washington and Canada are gratefully acknowledged.

Between March, 1936, and August, 1942, the California Division of Fish and Game tagged 120,948 sardines in California and Lower California waters. Tag recoveries from these fish through May, 1947, have totaled 8,497. In studies of movements of sardines, however, only 115,489 of the fish tagged were considered. These fish yielded 8,425 recoveries. During the period when tagging techniques were being developed there was at times an excessive mortality among the fish. On a few occasions fish were tagged which were too small or in too poor condition for survival. Occasionally an unusual number of predators caused excessive mortality immediately after tagged fish were released. Due to these complications tagging groups totaling 5,459 fish yielded too few returns to justify their consideration in any analysis.

Although a few sardines are caught along the California coast in the spring and summer months, the majority are landed in the fall and winter. In Oregon, Washington and British Columbia they are caught in the late summer and fall months. It is therefore convenient to commence the tag recovery year on June 1st.

Tables 1, 2 and 3 are continuations of Tables 1, 2 and 4, pp. 11-15, of Fish Bulletin No. 61. These tables show the actual number of tags recovered by regions from sardines released off Central, Southern and Lower California as well as the number of tag recoveries which could have been expected had recovery efficiency been 100 percent. Recoveries by regions from 1936-37 through 1943-44 are listed. These figures correspond to the subtotals given in the tables in Fish Bulletin No. 61. Following the recoveries by region through 1943-44 appear the recoveries by season for the three succeeding seasons. In addition, the totals for the period from the beginning of the tagging work through 1946-47 are shown. These tables do not include recoveries made in the season of tagging.

[1] Submitted for publication August, 1947.

TABLE 1

Location of Recoveries by Regions of Sardines Tagged Off Monterey and San Francisco. The Actual Number of Recoveries Are Shown and Also the Number of Tags Which Would Have Been Returned at 100 Percent Recovery Efficiency

Tagged		Season recovered*	British Columbia		Washington		Oregon		San Francisco		Monterey		San Pedro and San Diego		Total*	
Season	Number		Actual	@ 100%	Actual	@ 100%	Actual	@ 100%	Actual	@ 100%	Actual	@ 100%	Actual	@ 100%	Actual	@ 100%
1937-38	9,865	1938-39 through 1943-44	21	31.3	12	22.2	7	18.1	47	95.5	29	46.5	7	15.2	123	231.8
		1944-45 through 1946-47														
		Totals	21	34.3	12	22.2	7	18.1	47	95.5	29	46.5	7	15.2	123	231.8
1938-39	7,937	1939-40 through 1943-44	3	5.3	2	3.1			11	27.7	10	18.0			26	54.1
		1944-45 through 1946-47														
		Totals	3	5.3	2	3.1			11	27.7	10	18.0			26	54.1
1939-40	4,040	1940-41 through 1943-44	8	17.8	3	5.6			33	54.8	38	53.7	12	21.3	94	153.2
		1944-45	1	2.5					3	5.2	2	2.6	1	1.5	6	9.3
		1945-46									1	1.4			2	3.9
		Totals	9	20.3	3	5.6			36	60.0	41	57.7	13	22.8	102	166.4
1940-41	11,951	1941-42 through 1943-44	14	34.8	6	11.9	2	7.7	306	452.4	622	795.1	161	259.3	1,111	1,561.2
		1944-45	6	15.0					13	24.5	17	23.6	3	4.8	39	67.9
		1945-46							1	4.9	1	1.5	1	1.6	3	8.0
		1946-47			1	2.5									1	2.5
		Totals	20	49.8	7	14.4	2	7.7	320	481.8	640	820.2	168	265.7	1,157	1,639.6
1941-42	8,828	1942-43 through 1943-44	1	2.5	3	6.9	1	3.3	82	120.3	259	335.7	129	186.9	475	655.6
		1944-45	5	12.5					8	14.7	19	26.0	6	9.8	38	63.0
		1945-46	3	7.5					1	5.1	1	1.5	1	1.5	6	15.6
		1946-47			2	4.7									2	4.7
		Totals	9	22.5	5	11.6	1	3.3	91	140.1	279	363.2	136	198.2	521	738.9
	42,621	Grand totals	62	132.2	29	56.9	10	29.1	505	805.1	999	1,305.6	324	501.9	1,929	2,830.8

* Recoveries in season "0" not included.

TABLE 2

Location of Recoveries by Regions of Sardines Tagged Off Southern California. The Actual Number of Recoveries Are Shown and Also the Number of Tags Which Would Have Been Returned at 100 Percent Recovery Efficiency

Tagged		Season recovered*	British Columbia		Washington		Oregon		San Francisco		Monterey		San Pedro and San Diego		Total*	
Season	Number		Actual	@ 100%	Actual	@ 100%	Actual	@ 100%	Actual	@ 100%	Actual	@ 100%	Actual	@100%	Actual	@ 100%
1935-36	964	1936-37 through 1943-44	4	5.9	4	7.4	1	1.8	39	111.9	27	65.8	21	55.8	96	248.6
		1944-45 through 1946-47														
		Totals	4	5.9	4	7.4	1	1.8	39	111.9	27	65.8	21	55.8	96	248.6
1936-37	15,141	1937-38 through 1943-44	48	70.8	17	33.6	12	38.9	162	372.0	85	155.8	40	88.3	364	759.4
		1944-45 through 1946-47														
		Totals	48	70.8	17	33.6	12	38.9	162	372.0	85	155.8	40	88.3	364	759.4
1937-38	14,327	1938-39 through 1943-44	34	61.3	10	15.8	8	24.3	305	655.1	197	316.9	148	337.6	702	1,411.0
		1944-45	1	2.5							1	1.3			2	3.8
		1945-46	1	2.5							1	1.4			2	3.9
		Totals	36	66.3	10	15.8	8	24.3	305	655.1	199	319.6	148	337.6	706	1,418.7
1938-39	7,991	1939-40 through 1943-44	20	35.0	11	17.2	2	9.9	130	282.1	156	256.1	77	187.9	396	788.2
		1944-45	2	5.0					1	1.9	4	5.4			7	12.3
		Totals	22	40.0	11	17.2	2	9.9	131	284.0	160	261.5	77	187.9	403	800.5
1939-40	3,464	1940-41 through 1943-44	3	6.4			1	3.6	42	63.2	36	49.9	61	109.6	143	232.7
		1944-45	3	7.5					2	3.5	2	2.8			7	13.8
		Totals	6	13.9			1	3.6	44	66.7	38	52.7	61	109.6	150	246.5
1940-41	10,704	1941-42 through 1943-44	10	25.0	4	9.3	1	3.3	116	165.5	232	291.6	346	524.3	709	1,019.0
		1944-45	3	7.5					5	9.0	17	22.7	7	11.1	32	50.3
		1945-46	3	7.5							2	2.9	2	2.8	7	13.2
		Totals	16	40.0	4	9.3	1	3.3	121	174.5	251	317.2	355	538.2	748	1,082.5
1941-42	4,350	1942-43 through 1943-44	2	5.0	1	2.3			36	53.0	111	144.4	233	340.1	383	544.8
		1944-45							3	5.4	13	17.3	10	15.5	26	38.2
		1945-46									5	7.4	1	1.4	6	8.8
		1946-47			1	2.2							1	1.7	2	3.9
		Totals	2	5.0	2	4.5			39	58.4	129	169.1	245	358.7	417	595.7
	56,941	Grand totals	134	241.9	48	87.8	25	81.8	841	1,722.6	889	1,341.7	947	1,676.1	2,884	5,151.9

* Recoveries in season "0" not included.

TABLE 3

Location of Recoveries by Regions of Sardines Tagged Off Lower California. The Actual Number of Tags Are Shown and Also the Number of Tags Which Would Have Been Returned at 100 Percent Recovery Efficiency

Tagged		Season recovered*	Washington		San Francisco		Monterey		San Pedro and San Diego		Total*	
Season	Number		Actual	@100%	Actual	@100%	Actual	@100%	Actual	@100%	Actual	@100%
October, 1939	4,091	1940-41 through 1943-44			11	23.4	15	19.7	54	95.4	83	138.5
		1944-45					3	4.2	1	1.6	4	5.8
		1945-46					1	1.5	1	1.6	2	3.1
		Totals			11	23.4	19	25.4	56	98.6	89	147.4
October, 1940	6,766	1941-42 through 1943-44			8	13.3	33	43.4	93	141.3	134	198.0
		1944-45			2	3.8	4	5.6	6	9.8	12	19.2
		1945-46			1	4.9	2	3.0	1	1.6	4	9.5
		1946-47	1	2.5							1	2.5
		Totals	1	2.5	11	22.0	39	52.0	100	152.7	151	229.2
November, 1941	5,070	1942-43 through 1943-44			5	9.6	26	36.1	249	373.5	280	419.2
		1944-45			3	5.7	11	15.3	41	66.7	55	87.7
		1945-46					3	4.5	7	10.9	10	15.4
		Totals			8	15.3	40	55.9	297	451.1	345	522.3
	15,927	Grand totals	1	2.5	33	60.7	98	133.3	453	702.4	585	898.9

* Recoveries in season "0" not included.

Table 4 supplements Table 12, p. 23, of Fish Bulletin No. 61. It shows the percentage efficiency of recovery of sardine tags by region for the seasons 1944-45 through 1946-47. San Diego recovery efficiencies are not included as no tags were recovered at this port during the period in question. Fish Bulletin No. 61 contains a complete discussion of methods used to determine the efficiency of recovery within each region.

TABLE 4

Percentage Efficiency of Recovery of Sardine Tags by Region and by Season

Season	Region of recovery					
	British Columbia	Washington	Oregon	San Francisco	Monterey	San Pedro
LARGE TAGS						
1944-45	40			57	77	66
1945-46	40			20	69	71
1946-47		45*				
SMALL TAGS						
1944-45	40			53	72	61
1945-46	40			21	66	64
1946-47		40*				60*

* Conservative estimates. No efficiency tests were conducted in this season.

The present discussion does not include recovery in California of sardine tags released by other than California investigators. Recovery of Canadian tags in California has been fully treated in reports by Hart (1944, 1945) who has shown there is a movement of sardines from Canadian fishing grounds to those of California. The large numbers of fish involved in this movement indicates a definite southward migration.

Fish tagged by the California Division of Fish and Game in Mexican waters have been retaken in Pacific Coast sardine fisheries as far north as Washington (Table 3). Sardines tagged in California waters have been recovered in all the California fisheries as well as in all the sardine fisheries in the Pacific Northwest (Tables 1 and 2) in sufficient numbers to indicate a northward movement of a substantial proportion of the stock. Other reports have pointed out that as a rule the larger fish make the longest northward migration.

Sardine tag recoveries in the past three seasons have not required a revision of conclusions presented in previous reports. It is interesting to note, however, that one Mexican tag was recovered as far north as the State of Washington. This tag was put into a sardine of 170 mm. total length. It was released in San Quentin Bay, 145 nautical miles south of the international boundary, and recovered five years and ten months later.

No tag recoveries have been reported from reduction plants in Lower California. Facilities for recovering tags were in operation there for only a brief period and the quantity of sardines processed in Mexico is small in comparison with other localities along the coast.

The length of time that some tagged sardines have remained at sea before recapture is indicated in Table 5. This table lists the California sardine tags which have been recovered from fish released six or more years earlier. One tag was out over seven years and eight months. The

fish which bore it was 240 mm. total length when tagged, or about 205 mm. standard length. It is estimated that this fish was in its second or more likely its third year of life when released off Southern California.

TABLE 5

Sardine Tag Recoveries Six or More Years After Release

Date tagged	Date recovered	Elapsed time			Region tagged	Region recovered	Total length of fish when tagged in mms.
		years	months	days			
Dec. 15, 1937	Aug. 28, 1945	7	8	13	Southern California	British Columbia	240
Feb. 15, 1938	Oct. 12, 1945	7	7	27	Southern California	Monterey	215
Feb. 15, 1938	Dec. 19, 1944	6	10	4	Southern California	British Columbia	220
Feb. 7, 1938	Oct. 30, 1944	6	8	23	Southern California	Monterey	205
June 5, 1938	Feb. 9, 1945	6	8	4	Southern California	Monterey	155
Sept. 12, 1939	Feb. 26, 1946	6	5	14	Central California	British Columbia	220
June 5, 1938	Aug. 18, 1944	6	2	13	Southern California	Monterey	180
June 5, 1938	Aug. 8, 1944	6	2	3	Southern California	San Francisco	180
May 19, 1937	July 18, 1943	6	1	29	Southern California	British Columbia	220
Oct. 28, 1939	Dec. 10, 1945	6	1	12	Lower California	San Pedro	145
Aug. 1, 1938	Aug. 28, 1944	6	0	27	Southern California	British Columbia	165
Sept. 23, 1938	Oct. 12, 1945	6	0	19	Central California	Monterey	240
Oct. 28, 1939	Nov. 1, 1945	6	0	3	Lower California	Monterey	175

It was recovered in the British Columbia fishery. Another tag out over seven and one-half years, also inserted in a fish off Southern California, was recovered at Monterey. This fish was 215 mm. total length or about 183 mm. standard length when released. It was perhaps in its first or second year of life. These fish were therefore 8 to 11 years old when caught for the second time.

A comparison of the number of tag recoveries with the number of sardines tagged is misleading unless losses due to tagging mortality and to incomplete recoveries are given consideration. How these factors affect the percentage of tags recovered is shown in Table 6. This table includes the same fish as Tables 1, 2 and 3. However, unlike the other tables it also lists recoveries made in the season of tagging.

Recoveries made in season "0" can be greater than the combined recoveries of succeeding years. If the fish are tagged on the fishing grounds early in the season they are subjected to the fishery for a relatively long period before they have had an opportunity to become well dispersed. On the other hand, if they are tagged very late in the season recoveries will be few in season "0."

A tagging mortality of 43 percent was assigned to the fish in Table 6. This is considered conservative. It represents the weighted average mortality of the fish in Table 13, p. 27, of Fish Bulletin No. 61. Table 6 includes all fish included in that table and in addition some others selected on the basis of less rigid standards.

From the total number of tagged fish (115,489) used in our studies 8,425 tags were recovered or 7.3 percent. Only 65,828 fish, however, were considered effectively tagged (not lost through tagging mortality), and if recovery methods had operated at 100 percent efficiency 14,610 tags would have been recovered or 22.2 percent of the fish effectively tagged.

Tag recoveries during the past three seasons confirmed conclusions previously drawn, that there is a general interchange of the sardine population along the Pacific Coast. In addition these later recoveries

TABLE 6

Actual Releases and Recoveries Compared With Adjusted Releases and Recoveries of Tagged Sardines Used in Studies of Movements

	A	B	C	D	E	F	G	H
	Number of tagged fish used in movement studies	Number of effective tags*	Number of recoveries in "0" season	Number of subsequent recoveries	Total number of recoveries C + D	Recoveries at 100% recovery efficiency	Unadjusted percentage recovery $\frac{E}{A} \times 100$	Adjusted percentage recovery $\frac{F}{B} \times 100$
Tagged off Central California	42,621	24,294	1,995	1,929	3,924	6,125.7	9.2	25.2
Tagged off Southern California	56,941	32,456	1,020	2,884	3,904	7,557.6	6.9	23.3
Tagged off Lower California	15,927	9,078	12	585	597	926.6	3.7	10.2
Totals	115,489	65,828	3,027	5,398	8,425	14,609.9	7.3	22.2

* Based on 43 percent tagging mortality.

have indicated that fish released in Mexican waters will move as far north as the Washington coast, that some sardines may be retaken more than seven years after tagging and will have reached an age of 8 to 11 years. About 22 percent of the effectively tagged fish were retaken by the fishermen during the years covered by the investigation.

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BASKING SHARK FISHERY REVIVED IN CALIFORNIA

By J. B. PHILLIPS [1]
Bureau of Marine Fisheries
California Division of Fish and Game

Introduction

The fishery for basking sharks, *Cetorhinus maximus*, was revived in the fall of 1946, following a period of several years of relative inactivity. As in the past the scene of greatest activity has been Monterey Bay, but a second fishing area developed between San Luis Obispo Bay and Morro Bay, about 100 miles to the southward. In former years Monterey was the port at which was landed the bulk of the sharks taken in Monterey Bay. Now it is the port of Moss Landing, 20 miles to the northward. Two sardine plants have done all the processing there. In the San Luis Obispo area most of the sharks have been landed at Morro, with some at Pismo,

FIGURE 1. Basking shark on truck for transportation to processing plant, after being hauled up slip from water. Moss Landing, March 22, 1947

and processed by a tallow plant near San Luis Obispo. On some occasions surplus carcasses with livers removed at Moss Landing have been trucked to a reduction plant at Petaluma. The meal was used in chicken feed mixtures. At the start of the present season (September, 1947) some

[1] Submitted for publication September, 1947. All photographs by author.

surplus carcasses, with livers removed, were also trucked to a reduction plant in Fresno.

During the period September, 1946, to May, 1947, about 300 basking sharks, averaging approximately one and one-third tons each in the round, were taken along the California coast. This season, is the period during which these sharks are found in central California congregating in numbers near the surface of the ocean. This concentration makes possible a commercial fishery based on harpooning.

Reason for Revival

The primary reason for a revival of the basking shark fishery is the development of new uses for the liver oil. The livers which average close to 25 percent of the total weight of the shark, consists of 60 to 70 percent oil. The oil is of industrial rather than medicinal value since it has a very low vitamin A and D content. A limited amount has been used in livestock feeds and as a tonic. Other therapeutical properties of the oil have not been thoroughly tested.

It was hoped that the oil would find a market in commercial channels, such as in soap or paint manufacture. But the oil, as refined at present, does not saponify in soaps nor dry readily in paints. Trial samples sent to other commercial users of oil yielded no source of disposal and a large amount of oil accumulate in storage tanks. A limited amount of oil is now being used by Mr. L. P. Bodwell, 300 Huntington Avenue, South San Francisco, a leather specialist, who found that by proper blending the oil was satisfactory for tanning leather. Further experimentation may develop other specific uses for the oil.

In March, 1947, Mr. Bodwell also became interested in the hide of basking sharks as a potential source of leather. Not only is there a large expanse of hide on one animal but it is from one-half to three-quarters of an inch thick in large animals. Experiments in tanning the hides have demonstrated that a leather of pleasing appearance can be produced but further work along this line, including the possible commercial uses of such leather, needs to be worked out.

The meal resulting from the reduction of the carcasses is mixed with animal feeds. The labor involved in the reduction process does not make the production of meal profitable, in itself. If the hide of the animal is removed for tanning into leather, the resultant meal should be enhanced in quality.

The Basking Shark

Among sharks, the basking shark, which reaches a length of 45 feet and a weight of four to five tons, is surpassed in size only by the whale shark, *Rhincodon typus*, which is reported to attain a length of 60 feet and weight of 14 tons. The basking shark is found in temperate and arctic waters whereas the whale shark is found in warm and tropic waters. The habits of these two sharks are very similar, both having very small teeth and long, close-set gill rakers for straining out huge quantities of larger planktonic organisms such as minute copepods and other crustaceans as well as small drifting mollusks. Both species are sluggish and prone to bask at the surface of the ocean. The whale shark may be distinguished from the basking shark by a checkerboard pattern of yellowish-white lines and spots on the back and sides, as well as several longitudinal ridges on the sides.

The basking shark may be distinguished from the other sharks by the keel on each side of the caudal peduncle and the exceedingly long gill slits which extend from the back to the mid-line of the throat, nearly meeting at this point. The gill slits number five and the teeth are small, numerous and smooth-edged. The color of the body is bluish gray to brownish gray on the dorsal surface with somewhat paler markings on the ventral surface. As is the case with all sharks, rays and chimeras or ratfish, the skeleton is cartilaginous. The pelvic fins of the males are modified to form claspers, by means of which fertilization of the eggs within the bodies of the females is made possible.

A single species of basking shark is found in Arctic seas and along both sides of the Atlantic Ocean southward to the Mediterranean Sea on one side and to Virginia on the American side. In the Pacific, this shark has been reported as far south as Southern California. It is known to the various fishermen as bone shark, sunfish, sailfish, oilfish, oil shark, elephant shark and hoe-mother.

Up to the present, the only region where these sharks have been reported to breed is in Arctic waters. The smallest specimens that have been taken in California waters have measured at least 10 feet in length. The landed specimens usually measure 15 to 30 feet in total length. Since the gill net and drag net fisheries along the California coast have not yielded any small specimens of this shark, it would appear that the nursery areas are not located along the California coast, and would most likely be found to the northward.

The Fishery

History

According to Jordan (1887a), who reported on the fisheries of the Pacific coast in 1880, the basking shark was valued for the oil in the liver but these fish were captured by whalers and fishermen rather by accident that by design. Apparently, Monterey was the only port along the California coast at which these large sharks were occasionally processed. Reporting on the activities of the Monterey Whaling Company, Jordan (1887b) stated: "This year (1880) 14 whales have been obtained from September to April, * * * besides two basking sharks *(Cetorhinus maximus)*; in all 500 barrels of whale-oil and eight of shark-oil. The basking shark is rare here, sometimes not seen for 20 years. This year several were seen in Monterey Bay."

The basking shark fishery did not develop until 1924, except for occasional specimens that the whalers harpooned and brought to shore for processing, or specimens that became entangled in fishermen's nets, from which the livers were removed for "sun rotting." The oil thus obtained was used for mixing with crude paints or with livestock feeds.

In 1924, Ernest Doelter and Henry Leppert started to harpoon basking sharks in Monterey Bay as a regular sport. The harpooning was done by hand, as it is to this day, from the bow of the *"Pop Ernest,"* a local 40-foot abalone boat. The sport was also indulged in by members of the then-existing Monterey Yacht Club, usually as guests of Doelter aboard the *"Pop Ernest."* The sharks were turned over to Max N. Schaefer for processing in his "Monterey Fish By-Products" plant at Seaside, near Monterey. The livers were reduced to oil and the carcasses to meal. The meal was used in livestock feeds and dog biscuits, while the oil was used

primarily for blending with various animal feeds, and as a tonic called "Sun Shark Liver Oil" advertised as "Nature's own tonic."

About 1928, Chester Gilkey and Bert Korf, owners of the 50-foot boat "*Two Brothers*," together with Tom Machado, equipped themselves for harpooning sharks. This started as a sport and as publicity for their fishing-party excursions, but by 1929 the harpooning of these sharks had turned into a profitable side-line. Seven dollars a ton was paid for the sharks up to about 1930. The price then went up to $10 a ton and still later to $20 a ton, the latter price being in effect in 1938, at which time the Monterey Fish By-Products plant at Seaside burned to the ground. Between 1924 and 1938, the yearly average was about 25 sharks, but in one of these years approximately 100 sharks were landed. When too many sharks were brought in at one time, the Hovden Food Products Corporation at Monterey processed some of the carcasses for meal. A few sharks have been taken by this latter concern since 1938.

In times past there has been a fishery for basking sharks along the Norwegian, Irish and Scottish coasts. About the middle of the Eighteenth Century, there was an extensive pursuit of this species along the New England coast and considerable quantities of the oil were produced.

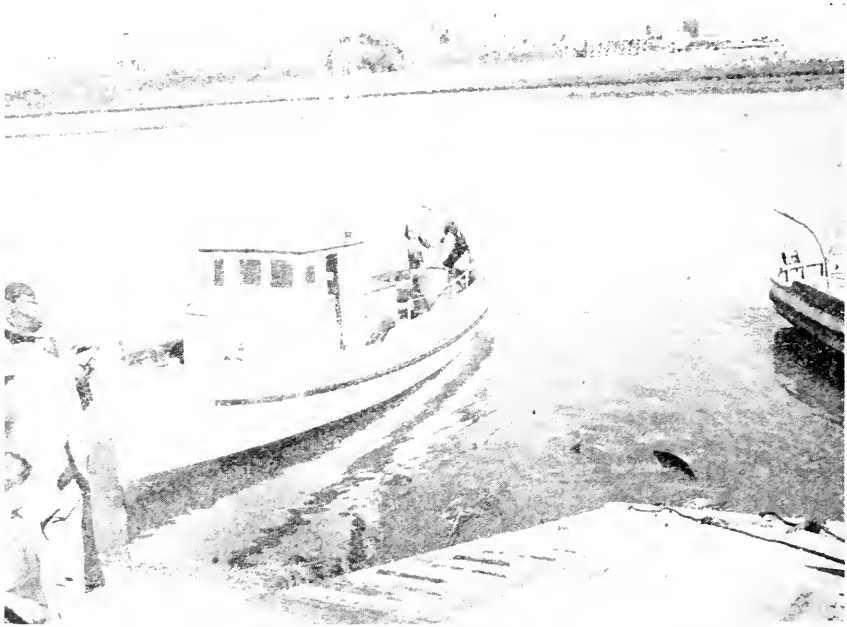

FIGURE 2. The usual type of boat in the basking shark fishery in California. The vessel has just towed in a shark, which will be fastened to the slip along with the other sharks. Moss Landing, March, 1947.

Types of Boats

Boats used for capturing basking sharks range in length from 25 to 50 feet. Most of the vessels are small net boats with a fair amount of deck on the stern portion. (Fig. 2.) In addition to the regular commercial fishing-type of boats, a 30-foot cabin cruiser and two or three former Army landing barges (LCVP) 36 feet long have been used successfully at

Moss Landing. In 1930 and 1931, the McDaniel brothers, new owners of the 50-foot vessel, "*Two Brothers*," used on several occasions a 20-foot dory from which the sharks were harpooned in shallow water. On January 27, 1931, the dory was used to harpoon two sharks in shallow water near Monterey. Four hours were required to land one of these, a 20-foot specimen.

Although the Southern California swordfish boats for a number of years have used a "plank and pulpit" out over the bow, from which harpooning is done, the boats fishing basking sharks out of the ports on Monterey Bay were not thus equipped until March, 1947. (Fig. 3.) At that time, a 13-foot extension was installed on the boat "*Opal*" forward of the bow with a pulpit at the end for the harpooner. Shortly afterward, several other boats were similarly outfitted, including one of the LCVP landing barges. Another landing barge had previously been equipped with a wide platform at the bow end, that could be lowered. The harpooner stood on this platform.

Two swordfish boats from Santa Barbara that started harpooning basking sharks off Morro Bay in September, 1946, were shifted to

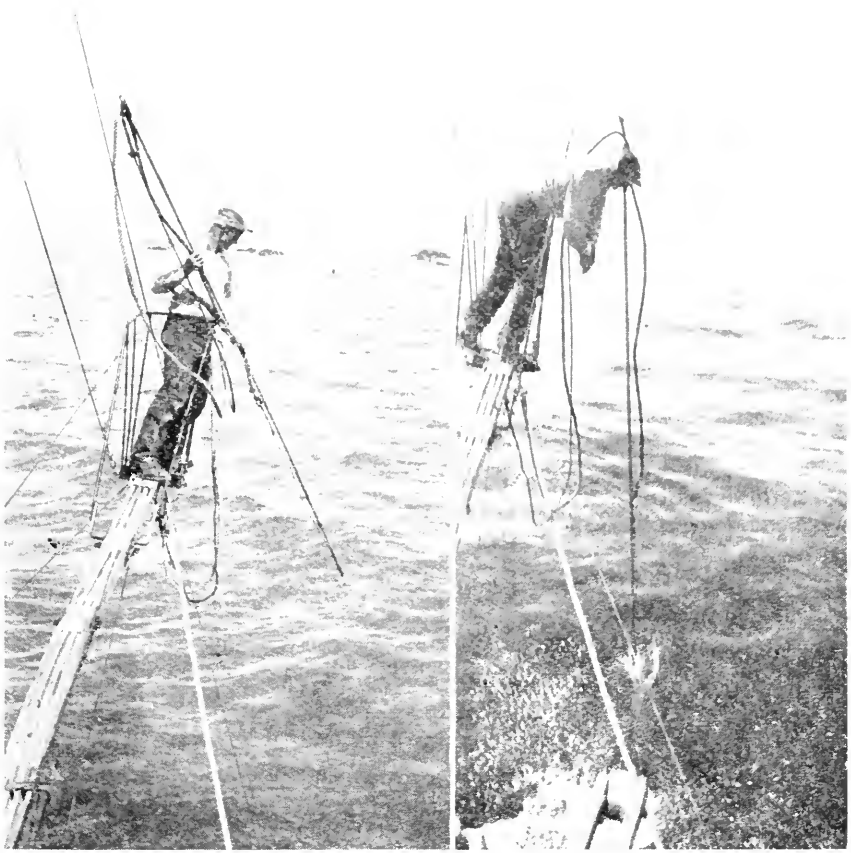

FIGURE 3. Harpooner in pulpit at end of "plank." At the left the harpoon is in a position ready for throwing. At the right the harpoon has been thrown. Monterey Bay, April 1, 1947.

Monterey Bay during the latter part of March, 1947. Each of these vessels had carried a plank and pulpit for several years.

The crew of a boat consists of two men usually, one harpooner and one boat-operator. The operator of a cabin-cruiser at Moss Landing made a practice of having two harpooners who simultaneously harpooned the same shark. (Fig. 4.) This vessel, however, was no more successful than the other boats that carried only one harpooner.

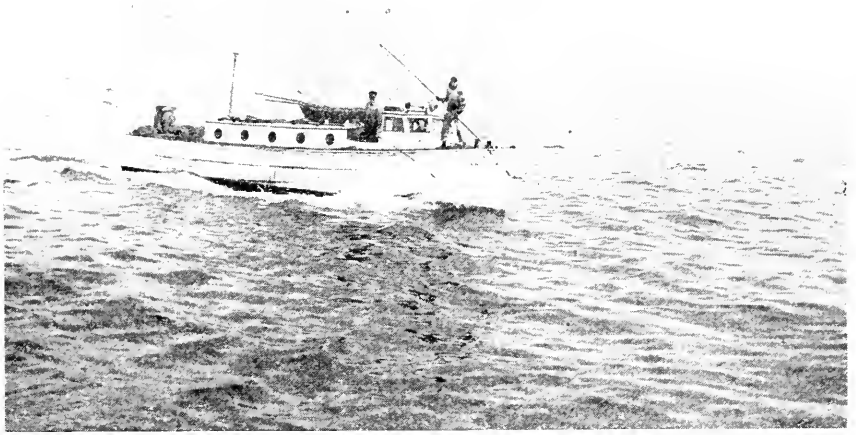

FIGURE 4. A cabin-cruiser type boat searching for basking sharks in Monterey Bay. This type of boat is unusual in this fishery, as are two harpooners. Practically all boats have but one harpooner, stationed at the bow of the vessel in the position of the forward harpooner, March, 1947.

During the period September, 1946, to May, 1947, about 12 boats participated in the fishery at Monterey Bay, and about half that number were engaged in the fishery centered off San Luis Obispo.

Locating the Sharks

The Monterey Bay boats locate basking sharks while cruising within a few miles of shore, where these animals are more often found, sometimes almost in the surf. Their presence is indicated usually by the dorsal fin that projects above water, or by the shadowy bulk which may be seen in shallow water. Sometimes in the spring of the year the animals may break water.

Starting in the fall of 1946, two swordfish boats from Santa Barbara harpooned a number of these sharks off San Luis Obispo and Morro Bays, operating in conjunction with a landplane that was employed to spot the animals from the air. When the pilot of the plane located sharks near the surface, the operators of the two boats were informed by radio and the plane circled the area until the vessels arrived. In this manner,

the crews of the boats utilized their time to best advantage. During the latter part of March, 1947, when fishing became poor to the southward, this boat-plane combination was transferred to Monterey Bay where it operated until the sharks apparently disappeared from this area in May. According to the pilot's report, visibility is better at 2,000 feet or more than it is at 1,000 feet or less. When the water is sufficiently clear the sharks can be seen to a depth of 50 feet.

From present information, there seems to be little correlation between the time of day or the kind of weather and the appearance of basking sharks at the surface. Sharks have been harpooned in the morning and in the afternoon, on sunshiny days and on rainy days. In Monterey Bay, these sharks are apparently present in greatest abundance between October and May. Off San Luis Obispo and Morro Bays, they seem to appear about a month earlier and disappear earlier.

Although these sharks are ordinarily sluggish and prone to bask at the surface, they have been observed to jump out of the water during the early part of the year. On March 22, 1947, the author observed nine of these large sharks break water near shore between Fort Ord and the Salinas river, Monterey Bay, while guest on the boat "*Reliance.*" George Caprivize, captain, and William Madruga, harpooner, stated that such activity had been seen on a few trips previously. At such times, the sharks are not often found basking at the surface.

Harpooning Equipment

The methods employed in harpooning basking sharks have not changed materially from those used in the earlier days of the fishery, and are an adaptation of methods used in early whaling days. Operating from small boats, the fishermen thrust a harpoon into a whale by hand.

As in the capture of a whale, the initial step in the capture of a basking shark is to "fasten on to" the animal by means of a harpoon and line. After this, the animal has to be killed.

The present equipment consists of a metal harpoon that fits onto the end of an 8- to 14-foot wood or metal pipe staff by means of which the harpoon is thrust into the animal by hand. Attached to the harpoon is a galvanized or stainless steel cable, one-quarter inch in diameter and several feet in length, which in turn is connected by means of a shackle and swivel to a one-half to three-quarter inch diameter, manila rope, of which as much as 500 feet may be payed out while the shark is being played. In earlier days, sometimes a section of chain was used to connect the harpoon with the paying-out rope, and sometimes the paying-out rope was connected directly to the shaft of the harpoon.

Usually, a 50-gallon oil drum is tied onto the retrieving rope about 250 feet from the harpoon end, to offer resistance and cause the shark to tire more quickly. During 1947, two vessels were equipped with 30-gallon, reclaimed, household water tanks, which withstood the pressure at greater depths better than the oil drums. Sometimes the outgoing rope is partially snubbed to offer resistance to the shark.

When a shark has been located, the boat approaches the prey from behind, so that the harpooner may thrust the harpoon into the back in an area between the dorsal fin and the gill slits. It has been found that within this area there is less chance for a harpoon to pull out. Harpooners

claim that they can "reach" a shark with a harpoon if it is within 10 feet of the surface.

About three out of four harpooned sharks will head for the bottom of the ocean where they try to roll the harpoon out, as evidenced by bent harpoon shafts. The fourth shark is apt to take off in any direction and tow the vessel for a time.

After the shark has tired sufficiently, it is hauled in alongside the boat and another harpoon is thrust into the body, as a precautionary measure in case the first harpoon is ready to pull out. As soon as possible after that, it is shot through the head with a high-powered rifle. The best place to shoot is through an eye or between the eyes. The basking shark has an exceedingly small brain encased in a cartilaginous skull, which makes it difficult to penetrate a vulnerable spot.

It is uncommon practice to fill the body cavity of a dead or dying shark with compressed air, although this has been done in the past, on some occasions. It does not take much lift to keep this shark afloat, perhaps because of the large amount of oil in the huge liver. One vessel was equipped with compressed air during the spring of 1947. When used, the air, under about 60 pounds pressure, is introduced into the body cavity with the aid of a section of metal pipe sharpened and perforated at one end. It hastens the death of the animal because of the internal pressure. It also makes the cutting-out of a harpoon a little easier.

After a shark has been killed, a rope is fastened around the small part of the body just anterior to the tail and the shark is towed to port, tail first. This method of towing offers the least resistance in the water. Sometimes more than one shark is harpooned from a boat on one trip. Although a vessel is equipped with several harpoons, usually the harpooner's favorite harpoon is in the first shark and an attempt is made to cut the harpoon free, if it is not too deeply imbedded. Where more than one shark is killed on a trip, the dead sharks are tied to a buoy until the vessel is ready to return to port, then all the captured sharks are towed at once.

It usually takes about one-half hour to kill and secure a shark after it has been harpooned. Tom Machado of Monterey may have established a record when he harpooned, with the same harpoon, and killed, six basking sharks in two and one-half hours, off Del Monte Beach, Monterey Bay, March 28, 1946.

Although it has always been standard practice to harpoon sharks by hand there have been at least two unsuccessful attempts to shoot a harpoon by means of a powder charge in a shotgun. Henry Porter of Monterey tried this in 1925, and a Moss Landing harpooner tried it in 1947.

No deck guns, as used by modern whalers, have been tried. As long as a harpooner can approach within harpooning distance of a basking shark, a power gun is not needed. There have been instances where a harpooner has plunged a heavy harpoon through both sides of an animal. It is possible that a harpoon released by compressed air might prove satisfactory because the force behind the missile can be regulated.

Another development of the whale fishery, the bomblance was simulated by Tom Machado in 1930 when he tied a quarter-stick of dynamite to his harpoon. The short fuse was lit just before the shark was harpooned. The shark was disabled and easily killed. However, the soft liver was turned to mush, and since this is the valuable part of the animal, it was not tried again.

According to Brown (1885), the primitive or typical harpoon was the sagittate or arrowheaded form, which the old-time whalers referred to as a "two-flued iron"; the next step was the harpoon with one fixed barb, the "one-flued iron" and the third the iron with a movable barb or toggle which acts upon the principle of the lily-iron of the swordfishermen. The lily-iron was evidently suggested by the adjustable bone and ivory harpoon heads of the Eskimo tribes, but it was not strong enough for most whales. It is quite satisfactory for porpoises, swordfish and large sharks.

The heavy harpoons fired from deck cannon of modern whalers may have two to four heavy barbs or "flukes" hinged to the head, which open up within the whale.

Harpoons employed in the basking shark fishery in California vary from standard, five-inch long, one-piece, brass darts, weighing about four ounces (often referred to as swordfish darts) to two-foot long, custom-made toggle irons weighing up to five pounds. There are a variety of designs, some only slightly different from others, in use on the different boats. I have seen three different designs on one boat, two of which had been discarded as unsatisfactory. Because of the flabby nature of the flesh and the cartilaginous skeleton in the basking shark, it has been difficult to find an ideal design that will not work out of the body during the struggles of this animal.

Except for a few unsuccessful, experimental attempts to shoot a harpoon by means of a shotgun, the harpoons have been driven into a shark by hand. In all cases, the staff with which the harpoon is thrust into the animal is either pulled free from the harpoon-head, or if thrown it is jerked free by a short rope attached to the top of the staff and the boat.

The harpoons fall into three general group-types. (Fig. 5.) The first includes the dart-type harpoon with no shaft but with a shaft-seat on one side into which fits the end of a shaft on the harpoon staff. A hole near the middle of the dart permits the attachment of a steel cable, which in turn is connected to the retrieving rope coiled on the deck of the vessel. The posterior, or wing portion of the dart has a slight outward flare so that the pull exerted on the dart after it has been thrust into the animal, is on the side of the dart that is slightly convex. This reduces the chance for the dart to cut itself out of the animal.

The second group of harpoon-types is the toggle-iron, or lily-iron with a head hinged near its center to a shaft. (Fig. 6.) In throwing position the head and shaft are in line, longitudinally, but when an animal is harpooned, the pull of the retrieving rope connected to the end of the shaft causes the head to pivot to a position that is cross-wise to the shaft. A matchstick inserted in a small hole through the posterior portion of the head and the shaft that it embraces, keeps the head longitudinal with the shaft until the harpoon is thrust into the animal. The outward curve of the posterior portion of the head sets up a resistance to the pull of the retrieving rope connected to the end of the shaft and the matchstick breaks permitting the head to pivot.

The third group of harpoons includes the fluke-type, which consists of a sharp, wedge-shaped head and a shaft, with a pair of movable flukes on opposite sides of the shaft. One end of each fluke is hinged to the posterior end of the head. The free ends of the flukes are tied to the shaft in

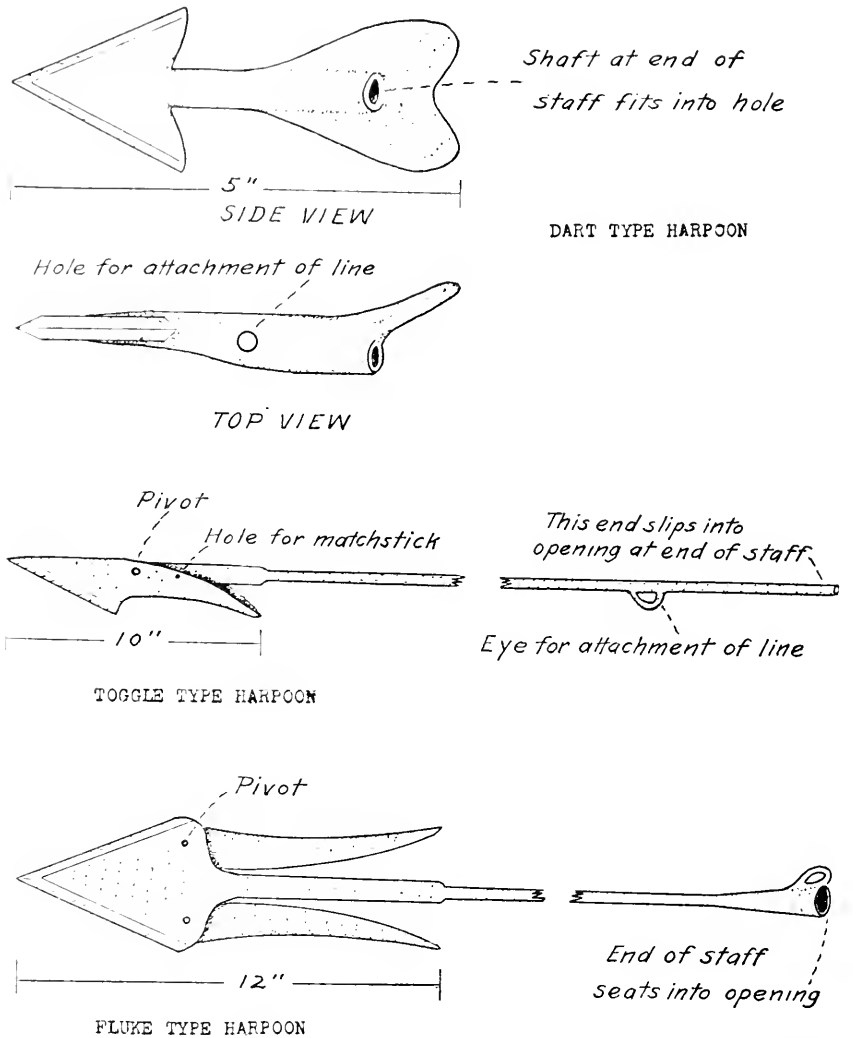

FIGURE 5. Three types of harpoons used in the basking shark fishery of California. A variety of designs in harpoons have been used but, in general, they revolve around these three types.

throwing position. After the harpoon enters the body of the animal, the pull on the shaft is resisted by the outward-flaring tips of the flukes, breaking the twine and allowing the flukes to pivot to a position that is cross-wise to that of the shaft.

In the latter two groups of harpoons, the head of the harpoon is of hard metal, usually iron, while the shaft is of soft iron that will bend when the animal goes to the bottom and attempts to roll the harpoon out. The fluke-type harpoon is not common. The dart-type and the toggle-type are the most popular.

Processing

Livers

In the San Luis Obispo area, the basking shark livers have been processed at a tallow plant located at the town of San Luis Obispo. Some of the carcasses have been processed at this plant, also. When the present season got underway in this region in September, 1947, the one plant could not handle all the carcasses, on occasions, and some were shipped to Fresno for processing.

In the Monterey region, two sardine processing plants at Moss Landing have handled all the livers and the bulk of the carcasses landed

FIGURE 6. One of the popular types of harpoons used in the basking shark fishery in California is the toggle-iron, or lily-iron, illustrated here in throwing position at the left and in the open position as it would be in the shark, at the right. The iron loop near the end of the shaft is for attachment of a line, by means of which the shark can be played and later hauled in. The end of the shaft seats into the lower end of the harpoon staff. Moss Landing, April, 1947.

during the past season. The dead sharks are towed to the plants, where the livers are removed and processed for oil, while the carcasses are cut up into pieces and reduced to meal. (Fig. 7.) Some surplus carcasses have been trucked to Petaluma for processing into meal that is mixed with chicken feeds.

The liver of the basking shark is about 25 percent of the total weight of the animal, and yields 60 to 70 percent oil. The method of extracting

oil from livers, currently employed by the Hovden Food Products Corporation, Moss Landing, according to Lloyd Phillips, superintendent, is the settling tank system which some plants still use in the recovery of oil from sardines. First, water is run into the tank to a depth that will cover the steam pipes on the bottom. This water is heated to a temperature between 165 and 205 degrees, F. The shark livers, which have been chopped to a paste-like consistency, are introduced at the upper end of the long rectangular tank. As the oil breaks free, it comes to the top and gradually drifts to the lower end of the tank and overflows. When the

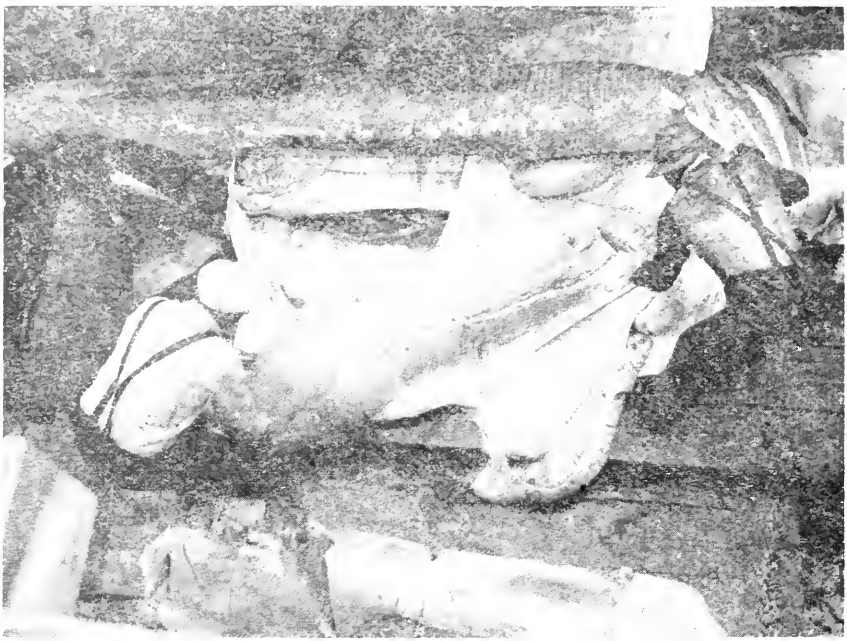

FIGURE 7. Removing the liver from a basking shark landed at Moss Landing. One lobe of the liver has been removed already and is on the table in the foreground. The man with the white cap is grasping the posterior end of the remaining lobe, and the other man is freeing the anterior end. March 22, 1947.

day's run is completed the heat is turned off. After several hours, the oil remaining in the tank is run off by raising the level of the water under the oil. This decanted oil is run directly to storage tanks and the remaining sludge is centrifuged for any remaining oil.

Carcasses

The carcass of the shark is cut up into small pieces and placed in a standard, steam-batch dryer with 70 pounds steam pressure and two inches of vacuum. The cooking lasts for six to eight hours. The resultant meal is light, fluffy and oily. About nine pounds of fresh carcass, with liver removed, yields one pound of the dried meal. Other controlled methods of drying the carcass to meal have proved satisfactory also.

Price

During the first season of this revived fishery, September, 1946, to May, 1947, fishermen have been paid 7 to 9 cents a pound for the livers. In

the San Luis Obispo area, the price of 9 cents prevailed, for the most part, while in the Monterey area a price of 7 cents a pound was paid for most livers. The average weight of the livers of the sharks landed was close to 700 pounds. Occasionally, an extremely large liver will weigh close to 2,000 pounds.

Just before the close of the past fishing season, the price quoted for basking shark liver oil dropped and this resulted in a price of 5 cents a pound to fishermen for livers delivered after the middle of April, 1947. At the start of the present season, September, 1947, a price of 5 to 6 cents a pound was paid in both the San Luis Obispo and Monterey areas.

Nothing has been paid for the shark carcasses after removal of the liver. The returns from the sale of the meal about compensates for the expense involved in reduction. This is because of the present laborious methods of handling the huge animals, coupled with a low meal yield. Improved methods of handling carcasses, together with further experimentation on the use of some of the now undifferentiated waste products may enhance their value in the future.

Other Products

Preliminary experiments with the hide as a potential source of leather for certain commercial uses has shown promise, and will be explored further this season. The possibility of a market for the dried fins for Chinese trade will also be explored. Some potential uses for which there is a limited commercial demand are cholic acid from bile, insulin from pancreas, enzymes from the digestive tract, amino acids from protein material, fish glue from the hide and squalene, a constituent of the unsaponifiable part of shark liver oils, used as a mordant for certain synthetic fibres.

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BREEDING SEASON AND PRODUCTIVITY IN THE INTERSTATE DEER HERD[1]

By John E. Chattin
Bureau of Game Conservation
California Division of Fish and Game

Deer herd productivity and breeding seasons are important factors in any program relating to deer management. The study of embryos furnishes an important source of information for determination of breeding potential and breeding dates of a deer herd. Studies currently in progress on the Interstate Deer Herd have afforded an opportunity to gather data bearing on this subject.

The Rocky Mountain Mule Deer herd occupying a summer range on the Fremont National Forest in southeastern Oregon and wintering in an area south of Clear Lake in Modoc County in northeastern California, has been termed the Interstate Deer Herd in recent studies. (Fischer, et al., 1944; Fischer, et al., 1945; Interstate Deer Herd Committee, 1946; Interstate Deer Herd Committee, 1947.) Studies to determine the number of deer in this herd indicate that an irruptive peak was reached in 1936 and the population remained high (18,000) until 1945-1946, when a drop in numbers to 13,600 was recorded. (Fischer, et al., 1944; Leopold et al., 1947; Interstate Deer Herd Committee, 1947.) Census figures taken during the 1946-1947 season on the winter range indicate the present population to be about 12,400. (Interstate Deer Herd Committee, 1947.) Other pertinent figures on herd composition are shown in Table I and Table II.

TABLE I

Percentage Composition of Herd *

Winter census	Calculated population	Bucks	Does	Fawns	Number classified
Average 1937-1942	14,000	10.0	53.0	37.0	5,500+
1943-1944	18,000	8.6	63.2	28.2	5,986
1944-1945	18,000	8.0	55.0	37.0	3,007
1945-1946	13,600	6.4	60.4	33.2	1,696
1946-1947	12,400	9.0	57.0	34.0	1,603

* From Interstate Deer Herd Committee, 1946, 1947.

TABLE II

Buck-Doe and Doe-Fawn Ratios by Census Years *

Year	Buck-Doe ratio	Doe-Fawn ratio	Number of deer classified
1937-38	1:5.6	1:0.81	1,262
1938-39	1:3.5	1:1.25	2,882
1939-40	1:4.9	1:1.03	1,338
1943-44	1:7.4	1:0.45	5,986
1944-45	1:6.6	1:0.67	3,007
1945-46	1:9.5	1:0.54	1,696
1946-47	1:6.2	1:0.60	1,603

* From Interstate Deer Herd Committee, 1946, 1947.

[1] Submitted for publication September, 1947.

Significant facts revealed by comparison of these tables are (1) that a high herd population existed in 1943-44 and 1944-45 following the high doe-fawn ratio recorded for the two previous winter census years, and (2) that the last two years (1945-46 and 1946-47) indicate a drop in herd size correlated with low fawn survival rates for the two previous years. Observations on breeding potential to be presented indicate that low fawn survival and not reduced breeding potential is the effective factor in over-all productivity in the Interstate Deer Herd.

Census figures of other deer herds may be cited for comparison with the Interstate Deer Herd, as presented in Table III. The significant figure in Table III is the 1:6.2 buck-doe ratio in the Interstate Deer Herd. Data presented in this paper indicate that this relatively low ratio of bucks does not constitute a critical factor as regards herd productivity.

TABLE III

Miscellaneous Census of Deer Herd Composition *

Herd or area	Year	Number deer classified	Buck-Doe ratio	Doe-Fawn ratio
Glass Mountain, Modoc Co., California	1944-45	432	1:3.8	1:0.71
Glass Mountain, Modoc Co., California	1945-46	587	1:3.9	1:0.65
Glass Mountain, Modoc Co., California	1946-47	437	1:4.0	1:0.60
Fremont Forest, Oregon	1936-45	12,137	1:3.0	1:0.63
Fish Lake, Utah†	1939-43	2,529	1:2.9	1:0.69
Interstate Herd	1946-47	1,603	1:6.2	1:0.60

* Interstate Deer Herd Committee, 1947.
† Robinette and Olsen, 1944.

The collection of deer from the Interstate Deer Herd for critical study of food habits and parasite-disease incidence on their California winter range has furnished a source of data relating to the breeding potential, dates of breeding, and sex ratio of fawns. This study was initiated during the winter of 1945-46 and 14 deer (2 males, 12 females) were taken. During the winter of 1946-47 the study was continued and permit was granted to collect 60 female deer. Beginning in November, 1946, 10 deer were taken each month (five at the first of each month, and five at the fifteenth of each month). Collection was continued in this pattern through the fifteenth of April, 1947, following which time the seasonal spring migration to the summer range in Oregon was largely completed. Two deer killed accidentally by automobiles were also examined and these records have been used to supplement the data here presented.

Breeding Dates

Recent studies by Cheatum and Morton (1946) on white-tailed deer in New York State, establishing a growth curve for deer embryos based on a series of specimens of definitely known ages, make possible the age determination of embryos from which breeding dates may be readily calculated. This established curve was assumed to be equally applicable to mule deer and was applied to Rocky Mountain mule deer (*Odocoileus h. hemionus*) embryos taken at autopsy from 43 female deer from the Interstate Deer Herd, January through April, 1947. Only those embryos

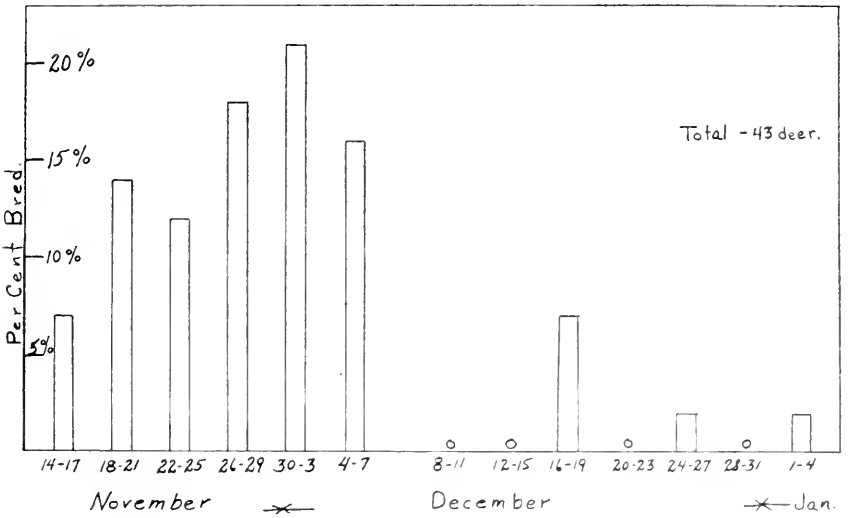

FIGURE 8. Seasonal distribution of breeding, based on embryo development. (Data grouped by four-day periods.)

calculated to be over 50 days of age were used since accurate criteria for aging younger embryos were not available. Results of these calculations are presented in Figure 8. Examination of data indicates that 38 (88 percent) does were bred during a 22-day period (November 15th-December 6th). The remaining five deer (12 percent) were calculated to have been bred within a 17-day period (December 18th-January 3d). Apparently none of the does was bred during the 11-day interval (December 7th-17th) following the primary breeding period. This hiatus would seem to indicate the occurrence of breeding on the part of some does during some recurrent period of estrus subsequent to the initial peak of breeding of the bulk of the deer herd, although no histological examination of ovarian tissue was made to substantiate this view.

In addition to forehead-rump measurements of embryos for determining age, hind foot measurements were also recorded. Once the age had been arrived at by using forehead-rump measurements the determined age in days was replotted in terms of hind foot length. Since hind foot length of embryos is a simple and easy measurement to take (Fig. 9), its use is suggested as being a valuable criterion for age determination of embryos by field personnel. Figure 10 presents the pertinent data relative to use of hind foot length of embryos for age determination.

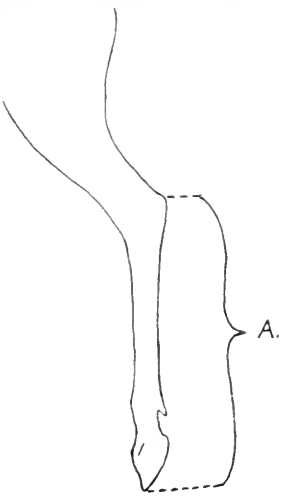

FIGURE 9. Diagram of hind leg showing how measurement of the hind foot is taken; A = measurement of hind foot.

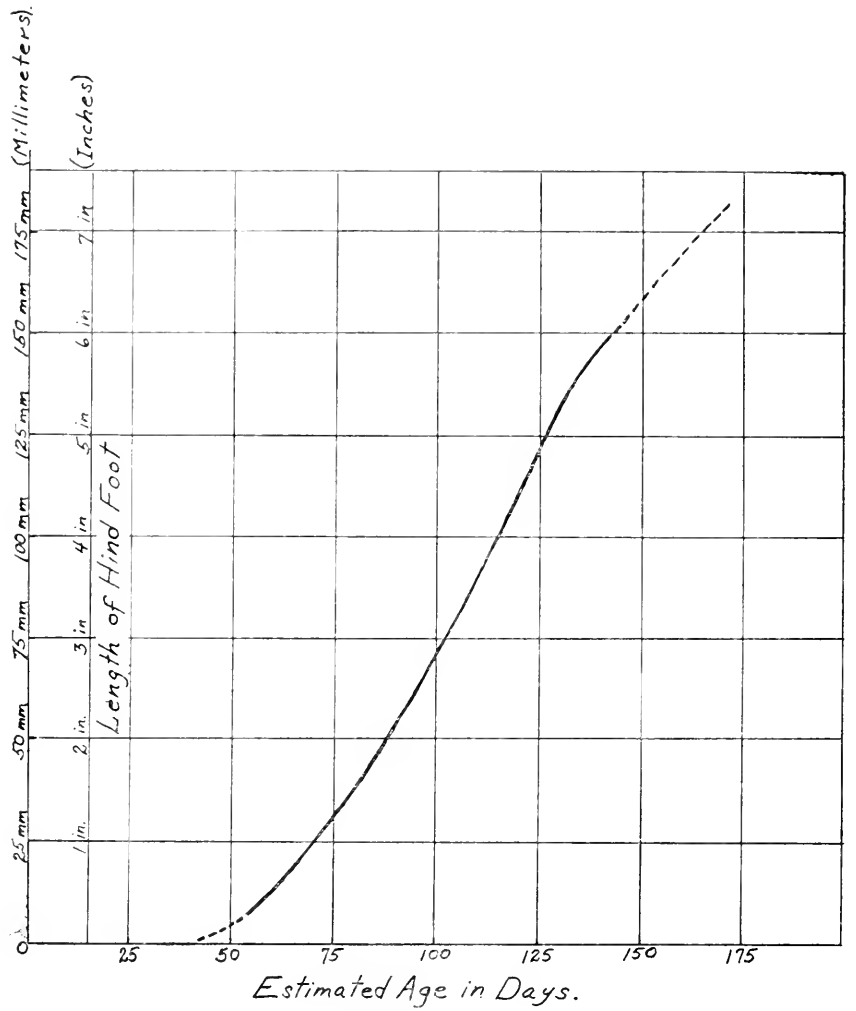

FIGURE 10. Growth curve of hind foot of deer embryo. For field estimation of age of embryo measure hind foot length in millimeters or inches and use curve to convert to age in days. (Probable accuracy ± five days.)

Productivity

Findings relative to breeding potential of the Interstate Deer Herd are summarized in Table IV. Examination of these figures indicates that even though the irruptive peak of the herd has presumably passed, the reproductive potential based on incidence of pregnancy of adult does remains at a high level. The average number of embryos (1.75) per pregnant doe likewise is high. No concrete information regarding survival rates of twins versus single fawns is available, so it is highly speculative whether or not the high rate of twin fawn production may be considered as tending to raise the over-all productivity of the herd.

TABLE IV

Breeding Data—Interstate Deer Herd

	1945–46	1946–47	Total
♀Deer examined*	12	37	49
Number deer pregnant	12	36	48
Percent deer pregnant	100	97.2	98
Number embryos	20	64	84
Number embryos/pregnant doe	1.67	1.78	1.75
Frequency of occurence of single embryos	4	10	14
Frequency of occurence of twin embryos	8	24	32
Frequency of occurence of triplet embryos	0	2	2
Percent singles by occurrence	33.3	27.7	29.2
Percent twins by occurrence	66.7	66.7	66.6
Percent triplets by occurrence	0	5.6	4.2
Number barren does (yearling)	0	1	1
Percent barren does (yearling)	0	2.7	2

* Includes all females taken after January 14th. By this date pregnancy was determinable macroscopically.

Embryo Sex Ratio

Data on sex ratio of embryos examined and frequency of occurrence of embryos by sex are summarized in Table V. The sex ratio of 117 ♂ ♂ : 100 ♀ ♀ resulting from examination of 64 embryos is of doubtful significance in view of the small sample. Robinette and Olsen (1944) in examination of 1,719 fawns report the sex ratio to be 101.4 ♂ ♂ :100 ♀ ♀. The ratio of twin embryos of identical sex to twin embryos of opposite sex (1 :1.4), as evidenced by Table VI, would probably approach equality in a larger sample.

TABLE V

Embryo Sex Ratio—Interstate Deer Herd

	1945-46	1946-47	Totals
Sex of embryos (total sexable)	9♂–8♀	25♂–22♀	34♂–30♀
Occurrence of embryos (by sex)			
1♂	2	2	4
1♀	1	5	6
1♂ 1♀	5	9	14
2♂♂	1	5	6
2♀♀	1	3	4
3♂♂♂	0	1	1
2♀♀, 1♂	0	1	1
Single, (not sexable)	1	3	4
Twin, (not sexable)	1	7	8
Embryo sex ratio	112♂♂: 100♀♀	118♂♂: 100♀♀	117♂♂: 100♀♀
Basis of sex ratio	17 embryos	47 embryos	64 embryos

TABLE VI

Sex Ratios of Twin Embryos

	Number sets opposite sex	Number sets ♂♂	Number sets ♀♀	Number sets identical sex	Sets examined
Utah*	15	8	10	18	33
Interstate Herd	14	6	4	10	24
Totals	29	14	14	28	57

* Robinette and Olsen, 1944.

Breeding Age

Since all specimens taken for this study, except one yearling, were mature does, no information on incidence of pregnancy in fawns or yearlings is available for this deer herd. The sample included several animals of advanced age (as evidenced by excessive degrees of tooth wear), all of which were pregnant. The single female examined (February 15) which apparently was unbred was a yearling probably about 20 months old (last lower molar in place and functional; last upper molar barely erupted and showing no wear (McLean, 1936)).

Comparative Productivity

Some data relative to comparative productivity of the Interstate Deer Herd with other deer herds is presented in Table VII. That significant differences in productivity exist between deer herds has been previously pointed out by Morton and Cheatum (1946) and speculations as to possible causes have been advanced. Seemingly significant data in Table VII are the figures for No. of Embryos Per Pregnant Doe cited for the Interstate Deer Herd, Utah, and southern region of New York State. On the basis of these examinations the figure 1.7 is indicated as being perhaps normal reproductive potential for breeding does. There is also close agreement among the same herds for the figures on single-twin embryo ratios. Variations from the 30% :70% single-twin embryo ratio might be assumed to indicate reduced reproductive potential. The Utah and New York figures showing percent barren does differ from those of the Interstate Deer Herd to some degree. It is believed that inclusion of "long yearlings" in their data may serve as a reason for higher rates of barren does observed. It seems significant, however, that in the present study all mature does examined were pregnant.

TABLE VII

Comparative Productivity of Selected Deer Herds

	Mule deer (*O. hemionus*)		White-tailed deer (*O. virginianus*)	
	Interstate deer herd	Utah*	New York† Northern region	Southern region
Deer examined	49	59	86	156
Percent pregnant	98	86.5	77.9	92.3
Number embryos per pregnant doe	1.75	1.73	1.2	1.7
Percent singles	29	27.4	80.6	33.3
Percent twins	66.6	72.6	17.9	59.7
Percent triplets	4.2	0.0	1.5	6.9
Percent barren	2.0	13.5	22.1	7.7

* Robinette and Olsen, 1944.
† Morton and Cheatum, 1946.

Summary

Examination of 48 mature deer of the Interstate Deer Herd at autopsy January 14-April 17, 1947, revealed an average of 1.75 embryos per pregnant doe. Ratio of singles, twins, and triplets was 7 :16 :1. Of a total of 49 female deer taken after January 14 only one (a yearling) was

apparently unbred. The remaining 48 mature does, including several of advanced age, were pregnant.

Breeding dates, calculated from measurements of embryos, indicate a peak of breeding to occur between November 15th and December 6th with a subsequent period, December 18th to January 3d, during which the remaining does (12%) were bred.

Observations on breeding potential indicate that fawn survival rather than reduced breeding potential or low buck ratio is the effective factor in reduction of productivity in the Interstate Deer Herd.

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THE CALIFORNIA VALLEY QUAIL IN NEW ZEALAND[1]

By Henry A. Hjersman
Bureau of Game Conservation
California Division of Fish and Game

Many servicemen visiting New Zealand during the course of the war against Japan were startled to hear the assembly call of the California valley quail *(Lophortyx californica)* or to see the plump gray form. Being a Californian, it was imperative to me that the history of the presence of this trim upland game bird in such a distant place be investigated. Hunter (1915) and McLean (1930) touch briefly upon the introduction of the valley quail in New Zealand, but they do not elaborate upon the success of the liberations. The author made the acquaintance of Mr. Colin Gordon, secretary of the Auckland Acclimatization Society during 1943. Mr. Gordon was very co-operative in furnishing data kept by the Society relative to game birds and in making available a bibliography of source material.

When the white man first settled New Zealand there were few animals present which could be termed game species. The native New Zealand quail *(Coturnix novae-zelandiae)* became extinct about 1870, leaving only waterfowl, the tui *(Prosthemadera nova-zealandiae)*, the native pigeon *(Hemiphaga nova-zealandiae)*, and the pukeko or purple swamp hen *(Porphyrio poliocephalus)* to provide sport for the hunters. There were no game mammals of any description, though it is possible that native rats furnished emergency food when early supply ships were delayed.

New Zealanders are firm supporters of all kinds of outdoor sports, and it is only natural that the sportsmen should desire fresh-water fishing and upland and big game hunting. The introduced red deer *(Cervus claphus)* increased to such an extent that it was necessary to offer bounties to control the tremendous numbers. A mushrooming of population has also occurred with introduced rabbits, and poisons have been used for their control for over a half century. Some of the best rainbow trout fishing in the world is to be had in New Zealand as a result of stocking with California fish.

Most of the known species of game birds have been introduced in New Zealand at one time or another. One of the very few species which has succeeded in establishing itself is the California valley quail. Literature on the subject is misleading, for much of it places this bird with the successfully introduced Australian quail *(Synoicus ypsilophorus)* in the inclusive category of "quail"; liberations of both species having been made during the same period. Among other quail unsuccessfully introduced have been the California mountain quail *(Oreortyx picta)* and the bobwhite *(Colinus virginianus)*.

It is known that valley quail crossed the Pacific Ocean as early as 1864, for the newspaper *Southern Cross* (succeeded by the *New Zealand*

[1] Submitted for publication, October, 1947.

Herald) on April 15, 1864, advertised for sale a few pairs of California quail on the ship "Mary and Edith." There were hopes that the birds would be bought on behalf of the Auckland Acclimatization Society. It is pointed out that the various groups administering game species are provincial societies of private individuals, and the introduction of exotic game species and subsequent trapping and movement to shot-out areas has been through their efforts, rather than through any governmental agency. For this service the societies are authorized by the government to issue and sell hunting licenses, meeting the bulk of the cost of liberations in this manner. Local clubs are affiliated with the society of the province in which they are located. Figure 11, shows provincial boundaries of New Zealand and place-names mentioned in the text.

The fate of the "Mary and Edith" birds is not known, but California quail were first brought to Nelson in 1865 from an unknown source. This area met with a high degree of success of acclimatization at an early date, and the subsequent events are worthy of note.

The Auckland Society provided 42 quail in 1868 which were liberated in the Nelson district. Observers in the same year recorded a kingfisher killing a quail. Quail were lauded for observed destruction of caterpillars, which fact was made much of by persons interested in quail introductions. Further liberations were made in 1871 in unknown numbers, but the rolling snowball was already growing in size. Between 1878 and 1880 valley quail became a rather large item of export. Mr. Kirkpatrick began canning trapped valley quail by the thousands about 1890, at which time he was paying 3d. (approximately six cents) per pair of birds (Thomson, 1922). Prices rose with succeeding years until 10d. per pair caused the discontinuance of canning as unprofitable. Simultaneously, large quantities of birds were being shipped to the Wellington and West Coast markets. Mr. Kirkpatrick stated that he had seen 10 or 12 four-bushel sacks of valley quail at a time on the Nelson wharf awaiting shipment. Twenty thousand frozen quail from New Zealand were reported to have arrived in London in one shipment.

That the peak of the Nelson valley quail population had already passed is reflected by the increase in price from 3d. to 10d. per pair and in the attempt by sportsmen and authors to find a logical reason for the decline. Rabbits had been introduced for meat and fur into the Nelson area about 1865. The tremendous increase of the rabbit population throughout New Zealand from the many liberations caused range damage, and poisoning was resorted to as a method of control. This heavy poisoning was immediately blamed for causing the decrease of the quail population. Thomson pointed out that the quail gradually disappeared from the neighborhood of Dunedin and from both shores of Otago Harbor, where poisoned grain was not a factor. He placed the blame upon stoats, weasels, and ferrets, which had been introduced to prey upon rabbits, rats, and black shag *(Phalacrocorax carbo)*, a suspected predator of trout. Thomson also mentioned the serious food competition offered by countless numbers of starlings *(Sturnus vulgaris)*, which were first introduced by the Nelson Society in 1862. During the period of 1911-15, the Nelson Society reported quail as being quite common, but the reasons for increase were not given.

The Taranaki region is interesting from the standpoint that it did not experience any marked quail population decrease. It is thought that

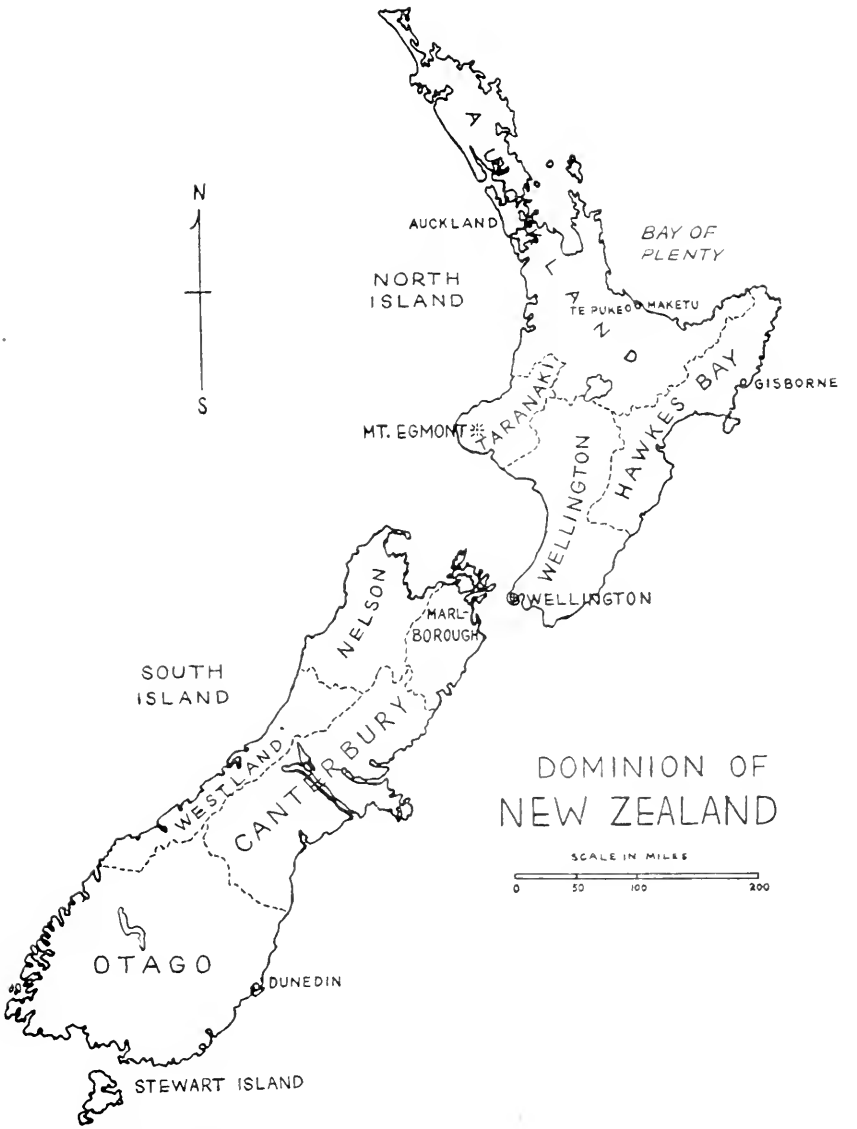

FIGURE 11. Map of New Zealand, showing provincial boundaries and place-names mentioned in the text. (Copied from 6th Ed., New World Loose Leaf Atlas, C. S. Hammond & Co., N. Y.)

quail moved into the area from nearby Auckland as early as 1874, when they were first noted spreading in some districts of Taranaki, for no liberations had yet been made.

The first Taranaki liberation was made in 1880 of 60 birds, presumably obtained from Nelson. These birds were reported to have increased steadily, and by 1904 they were "plentiful in all parts." Later reports testify to the continued abundance of quail in Taranaki, and Thomson

stated that they were to be found on Mt. Egmont up to a 6,000 foot elevation during the summer. Complaints of crop damage came from this area and from almost every agricultural community where quail had become numerous.

Thomson quotes Drummond as saying, "At Te Puke, in the Maketu district, quail live largely on clover, taking both seed and the young plants in the bush-clearings." Other damage was reported to newly sown and germinating turnip seed. In general, most of the complaints were of clover damage.

The indiscriminate wholesale introduction of exotic species has proved detrimental in New Zealand. The problem of preventing the irruption of an introduced population, with insufficient or no natural control, is difficult to solve. The practice of doing a little at a time and measuring the results before attempting the introduction of additional exotics, is far more productive in the end. The balance of nature is far too complicated for man to attempt to rebalance in one fell swoop.

It is impossible to generalize on population trends for the various areas, but the indications are that valley quail were abundant until 1880, when the numbers began to decrease. They became plentiful again about 1900 and then gradually declined over the years until the scarcity became striking in the middle 1930's. With a few local exceptions, the California valley quail population of New Zealand is diminishing at the present time. The condition became so serious that the Auckland Acclimatization Society was seriously considering hiring a biologist to determine the cause or causes of the decline and to devise methods of restoring the quail population to former abundance. The New Zealand sportsmen have a high regard for the California import as a game bird, and it is hoped that their problem will be solved.

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SABLEFISH RUN AT MONTEREY BAY

For the first time in history sablefish (*Anoplopoma fimbria*) appeared in vast numbers in the vicinity of Monterey and were caught by the thousands from the municipal pier. The run was first discovered on the afternoon of July 11th; word of the bonanza spread rapidly, and the pier was soon crowded with anglers. Men, women, and children stood shoulder to shoulder, with a varied assortment of tackle, all hauling in fish as fast as they could throw in their lines. Boxes, sacks, five-gallon cans, and washtubs were rapidly filled with 12 to 20-inch fish. Slack periods occurred during the morning and again in the afternoons, but they were of short duration usually lasting only half an hour or less; then the fish would be back seemingly in greater numbers than before. Each day the pier would be jammed with crowds of from 2,000 to 3,500 fishermen and spectators, some having driven as far as 200 miles.

On July 26th, the run stopped as abruptly as it had begun, and although over 5,000 fishermen were on hand the next day, only a few fish were caught. During the 15 days of the run, the Bureau of Patrol Division of Fish and Game, estimated that over 110 tons had been landed. —*Keith W. Cox, Bureau of Marine Fisheries, California Division of Fish and Game*, September, 1947.

REARING MARINE FISHES IN THE LABORATORY[1]

The rearing of marine fishes under experimental conditions has important applications in studies of speciation and evolution as well as in certain aspects of marine fisheries research. It seems appropriate, therefore, to describe methods which have resulted in the successful rearing of two marine species of the family Atherinidae, namely the grunion (*Leuresthes tenuis*) and the bay smelt (*Atherinops affinis littoralis*). These methods have been developed in the course of experiments designed to test the role of certain environmental factors in the determination of the number of vertebrae and of fin rays.

Under laboratory conditions the larvae of marine fishes have seldom been hatched and carried past the prolarval stage. The embryonic and early larval stages of a wide variety of marine species have been described from artificially reared material, but often the later stages have not been available, because, under laboratory conditions, the larvae have ordinarily died at the critical stage at which the yolk sac is absorbed and feeding begins.

Large-scale propagation of cod and other marine fishes has been carried out in both North America and Europe, but the practice has been to liberate the larvae in the sea shortly after hatching. Young plaice hatched in captivity have been held in outdoor ponds for several months (Herdman, Ann. Rep. Liverpool Mar. Biol. Comm., 1904, pp. 26-37). These ponds, however, had a standing crop of plankton organisms and additional feeding was not attempted. More recently it has been reported by Rollefsen (Cons. Perm. Int. Expl. Mer, Rapp. et Proc.-Verb., vol. 109, pt. 3, no. 26, 1939, p. 133) that plaice larvae have been reared by feeding with nauplii of the brine shrimp, *Artemia salina*. Our success also is largely due to the use of this food.

The procedure has been as follows. Eggs are fertilized by the dry method, well mixed, and allowed to stand for about one minute. The

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 355.

excess milt is then washed off and the eggs are placed in beakers containing a liter of sea water, in which they sink to the bottom. Percentage mortality is increased if more than a single layer of eggs covers the bottom of the container. Aeration is provided and the stream of air adjusted so that the eggs do not circulate. Successful incubation is also obtained in trays of mosquito netting suspended in running-water aquaria.

On hatching, the prolarvae are transferred to previously prepared five-gallon aquaria of aerated standing sea water containing an adequate crop of plankton. To hasten the plankton production a culture of microorganisms may be introduced from a stock tank. Nets should not be used in handling the early stages, which should be transferred to the tanks directly by pouring, or by means of a suitable dip-tube.

For a food supply, brine shrimp are cultured from dried eggs in jars of aerated sea water.[2] The freshly-hatched nauplii are introduced into the tanks well before the yolk sac of the fish is absorbed. Grunion and bay smelt prolarvae begin feeding when about two days old, while still provided with a yolk sac, although they will live for several days without feeding. Nauplii are added daily in quantities sufficient to maintain a moderate excess.

Best results have been obtained by allowing the water to stand unchanged so that a considerable growth of attached filamentous green algae develops. Larvae have also been reared in running water, but more than half of these developed abnormalities such as crooked bodies and open mouths, perhaps because of nutritional deficiencies. Most of the young fish thus reared were preserved at the end of 30 days since they were sufficiently far advanced for the purpose of the experiments. At this time all the vertebrae were ossified and usually the fin rays and some of the scales were formed. Some fish, however, have been held for longer periods. At the time of writing one sample is in its fourth month of life.

To date it has not been possible to obtain normal growth or completely balanced development. For example, growth in length is apparently slower than it is in nature, although ossification may progress at almost the same rate. It is hoped that through improved technique normal development can be approximated in aquaria. The method could then be applied to a very wide range of investigations.

The authors wish to thank Dr. Carl L. Hubbs for his interest and advice during the course of the work.—*J. L. McHugh and Boyd W. Walker, Scripps Institution of Occanography, La Jolla, California,* August, 1947.

OCCURRENCE OF THE BLACK SKIPJACK *(EUTHYNNUS LINEATUS)* OFF SOUTHERN CALIFORNIA

On July 7, 1939, a specimen of the common black skipjack, *Euthynnus lineatus* Kishinouye, was caught off the Southern California coast by the purse seiner *"Blue Sea"* and brought to the California State Fisheries Laboratory for identification. The fish was found in a two and one-half ton catch of bluefin tuna made, according to the vessel's captain, "close to" Santa Barbara Island, which lies about 40 miles southwest of Los Angeles harbor.

[2] Brine shrimp eggs, from salt works on San Francisco Bay, were kindly supplied by Dr. Wilbert M. Chapman of the California Academy of Sciences. Such eggs are sold by the San Francisco Aquarium Society, Golden Gate Park, San Francisco.

The species is abundant south of Cape San Lazaro, Lower California, but had not previously been reported further north. This record thus extends the range by some 600 miles.

Publication was withheld at the time, as there was doubt expressed as to whether this species was in fact the *Euthynnus lineatus* of Kishinouye. A more detailed study was planned but did not prove possible prior to the war. Since there is no prospect of work on the species in the near future, it was thought best to publish this distribution record, reserving the question as to whether the species is properly named.—*Phil M. Roedel, Bureau of Marine Fisheries, California Division of Fish and Game, September, 1947.*

AN EXTENSION OF THE RANGE OF *LUVARIS IMPERIALIS* RAFINESQUE

On or about September 1, 1947, a specimen of louvar was captured 30 miles west of Pt. St. George, Crescent City, California, at latitude 41° 50′ N., longitude 124° 41′ 30″ W. The fish was caught in a shark drift net by L. E. Thomas of the fishing vessel "Hornet." Warden Walter Gray, through the courtesy of the Tom Lazio Fish Company of Eureka, sent this specimen to the Bureau of Marine Fisheries, Stanford University. It arrived in a cleaned condition without respiratory or internal organs but with the head intact.

Description

In general this louvar agreed with the description published by Bolin.* However, the small pink spots along the base of the dorsal were not evident, although there was a light pink spot immediately anterior to the insertion of the ventrals. The caudal was edged with black similar in coloration to the black spot at the base of this fin. The periphery of the pectoral spot coincided with the angle formed by the pectoral rays at the point where these rays straighten out laterally from the insertion.

The body musculature was firm in texture and pearly white in appearance. Both the dorsal and ventral musculature was highly infested with a worm-like parasite. A sample of the meat was reported by Mr. Leo Shapovalov to have a flavor and consistency not unlike that of abalone.

Measurements and Counts

Unfortunately all the measurements made by Bolin could not be duplicated because of the cleaned condition of the fish and because the fins were somewhat frayed.

Standard length 670 mm. Furcal length 713 mm. Cleaned weight (viscera and gills removed) 12.22 lbs. Measurements in percentage of standard length: greatest depth ca. 30.6; least depth of caudal peduncle 2.8; width of caudal peduncle including keels 7.7; length of caudal peduncle 10.1; length of head 24.3; diameter of fleshy orbit 4.0; length of snout (to anterior margin of fleshy orbit) 9.0; length of upper jaw (to posterior end of maxillary) 5.1; width of maxillary 2.4; length of

* Bolin, Rolf L., A redescription of *Luvarus imperialis* Rafinesque based upon a specimen from Monterey, California. *California Fish and Game*, vol. 26, no. 3, July, 1940, pp. 282-284.

exposed dorsal base 34.0; height of dorsal (9th ray, longest intact) 7.2; distance from snout to anal ca. 50.1; length of exposed anal base ca. 35.4; height of anal (5th ray) 6.0; distance from snout to pectoral 24.5; vertical distance from dorsal body margin to pectoral insertion 18.5; vertical distance from ventral body margin to upper end of pectoral insertion ca. 12.5; length of pectoral (longest rays frayed) ca. 25.4; width of pectoral base 5.0; width of pectoral base ca. 1.6; length of pelvic 3.2.

Fin. formula: D. 6 + XIV; A. 4 + XIV; C. 7 + 14 + 7; P. I, 17 + 1 (?); V. I.—*Wm. Ellis Ripley, Bureau Marine Fisheries, California Division of Fish and Game,* September, 1947.

RETIREMENT OF A. E. BURGHDUFF

A. E. (Cap) Burghduff, Supervisor of Fish Hatcheries, Bureau of Fish Conservation, retired October 15, 1947. He commenced work for the California Division of Fish and Game in 1929 in the position of Fish Hatchery Inspector, in charge of fish planting and distribution. He was assistant executive officer, in charge of the Los Angeles Office from 1932 to 1935, when he reverted to his former position as Fish Hatchery Inspector. He was promoted to Supervisor of Fish Hatcheries in 1940, continuing in this position until his retirement. Before coming to California he was with the Fish and Game Department of the State of Oregon. For many years he has been active in the affairs of the Western Association of State Game and Fish Commissioners. Our best wishes go to Cap Burghduff for a long and happy retirement.—*A. C. Taft, Chief, Bureau of Fish Conservation, California Division of Fish and Game,* October, 1947.

RETIREMENT OF LOUIE I. PHILLIPS

Louie I. Phillips, Assistant Supervisor of Fish Hatcheries, retired on September 15, 1947, after 39 years' service in the Division of Fish and Game. He first commenced work with the Bureau of Fish Culture on August 14, 1908, at the Mt. Shasta Hatchery. In 1910, and for many years thereafter, he was spawntaker during the winter months at the various Klamath River Egg Collecting Stations, working during the summer months on the fish distributing cars. He was appointed Superintendent of Fish Car 01 on January 1, 1915, and held this position until August, 1927, when he was called to the central office and assigned to the duties of Fish Hatchery Inspector. He was appointed Assistant Supervisor of Fish Hatcheries on March 1, 1942, in which position he remained until his retirement. Louie was one of the oldest employees of the Division of Fish and Game, and during the period of his employment the activities of the Division have grown and multiplied many times. To both Mr. and Mrs. Phillips in their new home at Bandon, Oregon, go our best wishes on their retirement.—*A. C. Taft, Chief, Bureau of Fish Conservation, California Division of Fish and Game,* October, 1947.

FISH CASES

July, August, September, 1947

Offense	Number arrests	Fines	Jail sentences (days)
Abalone: possession undersized; no license; out of shell; failure to show on demand; failure bring ashore alive; overlimit; import improperly marked	133	$3,900 00	
Angling: other than with rod and line held in hand; more than one rod; within 150 feet of dam; no license; in closed waters; failure show license on demand; false statements obtaining license; using another's license; possession spear 300 feet of a river; transferring license to another; operating set line; in refuge at night in fish ladder	239	4,281 50	
Barracuda: overlimit; sale of undersized; on boat with purse seine net	12	400 00	
Bass: possession undersized; after sunset; overlimit; in closed stream; use of more than one line	165	5,020 00	2
Catfish: selling without tags; closed season; taking undersized	4	115 00	
Chumming: using extra line; in inland waters; for trout with cluster salmon eggs	14	585 00	
Clams: overlimit horse; no license; taking closed season; taking undersized; from state preserve	94	3,461 00	12
Cockles: taking and possessing overlimit; no license	22	940 00	
Commercial: using and operating beach seine Dist. 4; selling game fish no license; failure to register with Fish & Game; operating party boat no license; no packer's license; failure report fish for packing; failure keep catch records; selling untagged trout; failure pay privilege tax	33	1,330 00	
Crabs: taking undersized; failure issue market receipts when crabs received; possession undersized	3	350 00	
Crappie: overlimit	1	25 00	
Lobster: possession unpunched; possession undersized; possession closed season	7	740 00	
Perch: selling without tags; closed season	1		
Pollution	11	1,750 00	
Salmon: taking undersized; overlimit; with snag hooks	9	340 00	
Scallops: taking, no license	2	20 00	
Sunfish: overlimit; no license	100	2,580 00	
Trout: taking overlimit; no license; more than two attractor blades; within 300 feet mouth of a stream; refusal to exhibit on demand; at night; with set lines; with three rods; closed stream; using explosives	71	2,750 00	
Totals	921	$28,587 50	14

GAME CASES

July, August, September, 1947

Offense	Number arrests	Fines	Jail sentences (days)
Antelope: closed season	1		
Bear: taking closed season	3	$50 00	
Deer: possession closed season; taking female deer; spotlighting; failure to tag; taking in refuge; purchasing a fawn; selling fawn; failure retain antlers; illegal bullet; transporting tag not validated; transferring tag; failure fill out, punch deer tag; shooting on highway; overlimit; use A deer tag in one deer district; possession other's deer tags while hunting; borrowed deer tags	224	26,406 50	
Deer Meat: possession closed season; selling, closed season	22	1,345 00	290
Doves: taking closed season; no license; shooting closed season ;overlimit; shooting from a car; unplugged gun; w-22 rifle rim fire; before noon opening day; shooting after sunset	128	4,705 00	5
Ducks: taking with shotgun more than three shells; closed season; no license	10	432 50	150
Frogs: taking overlimit	2	100 00	
Gallinule: taking closed season	1	75 00	
Game Bird s Eggs: taking, no license	1	15 00	
Geese: possession closed season; keeping in captivity	2	50 00	
Grouse: possession	2	75 00	
Hunting: at night; with spotlight; killing in refuge; shooting from auto; no license; closed season; possession firearms in refuge; possession light, guns in deer area at night; false statements obtaining license; no tags in possession; buying license unlawfully; shooting across highway; illegal gun; with 22 rim fire on posted land; in game refuge	167	12,323 00	127
Nongame Birds: shooting, no license	2		
Pheasants: taking hen; no license; possession closed season; asst. taking; shooting from auto; license improperly displayed	71	6,606 00	142
Quail: possession closed season; no license	12	585 00	
Rabbits: taking closed season; no license; shooting from motor vehicle	51	1,145 00	
Trapping: taking state trapper's traps	1	100 00	
Totals	700	$54,013 00	714

SEIZURE OF FISH AND GAME

July, August, September, 1947

Fish:	
Abalone	314
Abalone, pounds	224
Barracuda	71
Barracuda, pounds	2,112
Bass	635
Bass, pounds	3,936
Carp, pounds	500
Catfish	30
Catfish, pounds	210
Clams	6,175
Cockles	7,995
Halibut	5
Lobster	25
Lobster, pounds	6,467
Salmon	9
Salmon, pounds	300
Scallops	144
Sturgeon	1
Sunfish	1,204
Sunfish, pounds	10
Trout	945
Trout, pounds	132
Game:	
Antelope	1
Bear	1
Bear meat, pounds	20
Deer	120
Deer meat, pounds	606
Doves	539
Ducks	9
Gallinule	1
Grouse	1
Hare	1
Nongame Birds	2
Pheasants	94
Quail	35
Rabbits	81

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Notice of Commission Meetings to Establish Season and Bag Limits on Sports Fishes

The Fish and Game Commission will meet in San Francisco on January 9 and 10, 1948, to hear recommendations for the coming fishing season as they pertain to seasonal bag limits. The commission will consider these recommendations under the regulatory powers section of the Fish and Game Code, which says that the commission "* * * shall receive recommendations from its officers and employees, from public agencies, from organizations or private citizens, and from any interested party."

The second meeting will be held in Los Angeles on January 30 and 31, 1948, and at or prior to this second meeting the commission will publicly announce its determinations and the orders it intends to make. The commission will hear and consider any objections to its determinations and proposed orders, as well as any further discussions on the recommendations as submitted at the earlier meeting.

The commission, according to the code, may:

(a) Establish, extend, shorten, or abolish open seasons and closed seasons.
(b) Establish, change, or abolish bag limits and possession limits.
(c) Establish and change territorial limits for the taking of any or all species or varieties.
(d) Prescribe the manner and the means of taking any species or variety.
(e) Establish, change, or abolish restrictions based upon sex, maturity, or other physical distinctions.

EMIL J. N. OTT, JR., Executive Officer
California Fish and Game Commission
December, 1947