

therefor, they also recommend no restrictions on the Pamlico Sound shrimping operations.

The South Atlantic Section at its meeting in New York, September 7, voted to recommend that each of the four states in the Section impose on out-of-state boats the same license fee as is charged for in-state boats. This will be a long step forward in interstate cooperation if the recommendation is accepted by the legislatures of the four states. The states will still have to determine the conservation regulations to be applied to the "inside waters" in bays and sounds and the "outside waters" of the maritime belt. That these regulations may differ has long been established. A special committee of the whole Commission is now being organized for the purpose of determining in what ways the U. S. Supreme Court decision in *Toomer v. Witsell* permits proper variations in treatment of out-of-state licenses in their operations in these different waters.

The joint federal-state program for fishery research in the South Atlantic Section initiated by the Section two years ago has lagged for want of both state and federal funds. Some federal funds are now available. The Section met on November 12 and a committee of state and federal scientists met again on Nov. 13 for the purpose of discussing these problems. Until their conclusions are made public, little more can be said on this point. One thing is already evident. It would clearly be to the advantage of South Carolina, Georgia, and Florida to adopt Amendment No. 1 to the Atlantic Fisheries Compact. This amendment would permit two or more states having an interest in a common fishery to act jointly through a special section of the Commission. The Amendment has been adopted by Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New Jersey, Pennsylvania, and North Carolina and consented to by the Congress. It might be very useful in handling a joint problem like the management of the South Atlantic shrimp fishery.

The Atlantic States Marine Fisheries Commission has now completed ten years of existence. Much has been accomplished by the cooperating states in that period; much is still in process and much remains to be done. The concept of the Compact under which the Commission functions is that of a long term continuing operation. The Commission is an advisory body only. The achievements that flow from it are those of its member states.

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## **The Effect of Fluctuations in the Availability of Sharks on a Shark Fishery**

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From 1936 to 1950 the shark fishery of south Florida operated continuously, except for a break of a few months in 1939 and 1949 due to over-production. Records of the catch at the Salerno fishing station were made as a standardized routine from the beginning of January 1938 through December 1946, for use by the original station operators, Shark Fisheries, Inc., and its successors, Shark Industries, Inc., and Shark Industries Division of the Border Company. Information on the number, size and kind of sharks in each catch was recorded daily on a standard form which was used as a basis for weekly payments to fishermen, and, along with other information,

as a basis for cost accounting and management of the fishery. Credit is due to the late Robert M. French, President of Shark Industries and subsequently president of Shark Industries Division of the Borden Company, that methods of recording were set up properly and were continued for a long enough period to give the company useful information for the management of the fishery.

Some estimates of production can be made for the period prior to 1938, but no records remain. Records of total landings and total amounts of gear in use are available for 1947, 1948 and 1949 but these records do not have catches recorded by species. The fishing operation was discontinued early in 1950, due to the appearance of low cost synthetic vitamin A on the market.

The shark fishery of the southeastern states was never large. The maximum number of boats in use at Salerno at any one time was five and the greatest number known to have been operating off the entire coast of the southeastern states at one time was sixteen.

The catch per unit-of-effort is defined for this report as the number of sharks caught on 100 baited hooks, set for a minimum of eight hours, and *availability* is used as a term to be derived from catch per unit-of-effort data. The use of *relative apparent abundance* has been suggested by Marr (1951) as a term for the concept of a population to be derived from catch per unit-of-effort data. This writer also points out that standardization is not essential if workers define their terms. His terminology is used in this report.

#### THE FISHERY AREA AND METHODS—1938-1946

The fishing grounds of the Salerno station extended from the vicinity of Jupiter, about 12 miles south of the station, to Bethel Shoal, about 35 miles north. From 1938 through 1946, all fishing was carried on with chain set lines, except for short periods in some summers when one boat set gill nets for nurse sharks close inshore. The chain set lines were used in lengths up to a mile, with hooks on chain leaders about six feet long, the leaders being permanently attached to the main chain about 25 feet apart. Ordinarily one boat set two lines with 100 or more hooks each, baited in the afternoon and pulled the following morning. Each end of the chain line was rigged with the anchor, attached to a buoy. Because of the weight of the chain it was often impractical to fish in depths greater than 25 fathoms, although a few sets were made in depths as great as 50 fathoms when currents were not strong. A number of improvements in the chain rigs were made between 1938 and 1946 but these were primarily improvements to permit easier handling. Probably these improvements did not greatly affect the catch per unit-of-effort since it is defined here as the catch per hundred hooks. Improvements of the gear and the development of special wildcats for pulling chains, some operated electrically and some with hydraulic controls, had the effect of reducing the number of boats and men required to set the same number of hooks and substantially increased the earnings of the fishermen. In 1938, four boats were in operation through most of the year but the number was gradually decreased through part time operation of some boats, so that after 1946 only two were in regular operation and these fished in the Salerno area only a part of the year.

The policy of the station operators limited the amount of fishing effort in the area. Fishermen were furnished boats, gear, fuel and bait without charge. Catches were purchased at a fixed rate for each shark having a hide length of 55 inches or more. In the later part of the period between 1938 and 1946

an additional amount (bonus) was added for any shark twelve feet or more in total length. Also, in the later period, a bonus was paid for high production. However, at least until after 1946, no special inducement was offered for catching a particular kind of shark and all kinds of sharks were bought at the same rate. Under these circumstances the fishermen preferred to catch the sandbar shark, *Eulamia milberti*, because in the Salerno area the species almost always had a hide length of 55 inches or slightly more, and the amount of labor in handling it was less than for other species. From the point of view of the fisherman, the objective was to get as many sharks as possible, regardless of kind, and if there was any practice that was selective it was in favor of the sandbar shark. It seems doubtful, however, that fishing was appreciably selective of species from 1938 through 1946. No carcasses were ever dumped overboard off Salerno regardless of their condition because it was the belief of the fishermen that shark carcasses dumped on the fishing grounds caused sharks to stop biting.

Heads, small sharks and badly damaged carcasses were brought in, although these were not counted in reports. In a number of instances seines, gill nets, float lines and other kinds of gear were tried for catching sharks at Salerno on an experimental basis. Catches from these sources are not included in the figures shown in the tables.

Until 1946 the bait furnished by the station was any kind of fish available. The fish were often iced and were as fresh as possible. Jacks (*Caranx hippos*) and little tuna (*Euthynnus alleteratus*) weighing more than two pounds each were preferred by the fishermen and were generally supplied. The bait, whether frozen or fresh, was cut to approximately one pound size at the time of use. Before 1947 almost all trips began at or before dawn and the boats returned with catches in the afternoon. Neither mechanical refrigeration nor ice was used.

The trends of fishing success at Salerno are shown in Table 1 by the catch per unit-of-effort for all species. It will be noted that there is a cycle in apparent availability, with a peak every three years, and that this cycle is more clearly shown for one species, *Eulamia milberti*, in the partial breakdown by species. In combination, the first three year period, (1938-1940), has a catch per unit-of-effort value of 6.00, the second three year period 5.45, and the third period 6.09.

There are a number of conditions that may have had some effect on relative availability of sharks during the period from 1938 through 1946. It does not seem possible to assess their comparative importance and it is likely that only some of the more obvious ones have been noted. However, each of the following conditions have affected production in one or more years.

The year 1937 before these records begin, was said to have been a year of very good catches. It was characterized, however, by a remarkable run of *Carcharhinus leucas*, the bull shark. This species was relatively much less common in the southeast Florida area for the following 12 years. The bull shark is probably the most important predator on young or small sharks when it is common, and the 1937 run may have reduced the number of young sharks of that year.

The Salerno fishing in 1940 was discontinued after August. Table 2 shows that this eliminated production in the quarter of the year with the poorest catch rate and this should have contributed to the peak catch rate recorded for the year. Nevertheless, the last quarter of the year 1940 was an unusually

TABLE 1  
LANDINGS AT SALERNO, FLORIDA SHARK FISHING STATION  
(Combined Figures For Each Three Year Period Are Given in Parenthesis)

Number of sharks All species Total landings	Number of units of-effort Totals for year	Catch per unit-of-effort All species	Year	<i>Eulamia</i>		<i>Eulonia</i>		<i>Carcharhinus</i>		<i>Galeocerdo</i>		<i>Sphyrna</i>	
				<i>milberti</i> catch u/e	<i>obscurus</i> catch u/e	<i>leucas</i> catch u/e	<i>leucas</i> catch u/e	<i>leucas</i> catch u/e	<i>leucas</i> catch u/e	<i>leucas</i> catch u/e			
5017	1099	4.57	1938	2.02	.67	.52	.45	.17					
6754	1154	5.85	1939 <sup>1</sup>	3.99	.69	.15	.28	.15					.15
4870	519	9.38	1940 <sup>3</sup>	6.86	.85	.23	.23	.34					.34
(16,641)	(2772)	(6.00)		(3.75)									
4360	896	4.87	1941	2.59	.98	.14	.14	.28					.28
3628	724	5.01	1942	2.78	1.08	.19	.19	.33					.33
4836	731	6.61	1943	4.27	1.05	.11	.12	.41					.41
(12,824)	(2351)	(5.45)		(3.17)									
3209	851	3.69	1944	1.90	.54	.16	.16	.26					.26
7626	1106	6.90	1945	3.90	.96	.17	.37	.59					.59
9426	1372	6.87	1946	4.19	.68	.11	.32	.37					.37
(20,261)	(3329)	(6.09)		(3.52)									
10,514	1345	7.82	1947										
9283	1076	8.63	1948										
9047	944	9.10	1949										
(28,844)	(3365)	(8.57)											

Catch records by species not available for this period. A major change in gear and methods permitted greater depth range for fishing. Fishing at Salerno not continuous for all months of the year.

<sup>1</sup> Unit of effort is defined as 100 baited hooks set for a minimum of 8 hours.

<sup>2</sup> Fishing discontinued after August.

<sup>3</sup> Fishing carried on for five months only, April through August.

TABLE 2

SALERNO SHARK LANDINGS, BY MONTHS FROM 1938-1946

Month	Number sharks landed	Number of <i>Eulamia milberti</i> only	Total units-of-effort	Catch per unit-of-effort <i>Eulamia milberti</i> only	Catch per unit-of-effort
January*	3859	2213	561	3.9	6.9
February*	3893	2601	544	4.8	7.2
March*	4027	2591	626	4.1	6.4
April	5936	3928	948	4.1	6.3
May	7901	5227	1234	4.2	6.5
June	8651	4645	1356	3.4	6.4
July	7224	4231	1278	3.3	5.6
August	3570	1518	848	1.8	4.2
September**	1075	349	312	1.1	3.4
October**	745	277	148	1.9	5.0
November**	1154	538	289	1.9	4.0
December**	1691	966	308	3.1	5.5

\*No fishing in these months in 1940

\*\*No fishing in these months in 1939 and 1940

good shark fishing period in the Florida Keys as shown by some catch records at Lower Matecumbe, and was followed by such poor fishing in 1941 that a relatively large shark fishing operation begun at Matecumbe in 1940 was discontinued the following year.

An examination of the hide records for 1940 indicates that there may have been a summer run of silk sharks, *Eulamia floridanus*. These may have come closer inshore than usual, with the result that they were picked up on the chain set lines. Since this species and some other common Salerno sharks had not been described in 1940, and since the forms that had been provided for recording landings did not list any species not known to biologists, there were occasional "force fits" of catches to the recording forms, even though the fishermen and dock workers recognized the undescribed species as distinct kinds of sharks.

There was some reduction of fishing intensity at Salerno during the war and fishing boats were restricted to daylight operation. Probably this did not affect the catch per unit-of-effort. However, difficulties in procurement of good hooks and other gear and the loss of some experienced fishermen to the armed forces and to other fisheries probably adversely affected the rate of catch.

In late 1945 and in all of 1946 new boats and new equipment were being prepared. Production was not discontinued but a substantial part of the Salerno fishing was carried on by relatively inexperienced men.

#### CHANGES IN GEAR AND METHODS—1946 THROUGH 1949

The sharks landed at Salerno were processed there and any portion of the production not utilized as liver oil, dried fins, hides, or fresh or salted shark meat was made into meal. The processing operation not only required certain minimum landings to be profitable, but was practical only if landings were to some extent predictable.

Had the catch per unit-of-effort remained at the average for each year, or had it declined or increased gradually, it is probable that no determined attempts would have been made by the management to improve the situation.

The effect of the irregular production was so serious on the flow of material to the processing plant that a program was started in late 1944 to increase the production at predictable times. It was felt that this could be done by increasing the depth range of the fishing, extending the range of the fishing boats somewhat, and by bringing some of the information shown in the statistical summaries to the attention of the fisherman. The program involved the use of new boats and equipment for fishing, the availability of frozen bait, and the use of mechanical refrigeration on the boats. The program was not all put into effect at one time and some of the changes in gear were initially unpopular with the fishermen. Nevertheless, at the beginning of 1947 the depth range of the fishery was expanding and the records show that the catch per unit-of-effort for the last three years increased 46 per cent over the mean rate for the preceding nine years.

Production increases of this magnitude were not apparent in shark fishing operations in other areas in 1947 and in the opinion of the writer the increase does not reflect any important increase in the abundance of sharks in the Salerno area. It does not seem possible to point to any particular part of the program as being the only instrumentality for the production increase. New boats, larger and better equipped, were in use in late 1945. The use of cable set lines instead of chain set lines permitted fishing in deeper water, up to 200 fathoms, but one of the Salerno boats still used chain gear at the beginning of 1950. At the beginning of 1947 the co-operation between the fishermen was improved. Also the liaison between the fishermen and the shore establishment on fishing problems was much closer. To give fishermen an interest in the fleet's production, a bonus arrangement for high production in any calendar month was established. The bonus was calculated on the basis of total landings of all Salerno shark fishing boats, and this encouraged greater exchange of knowledge between boat captains and stimulated production.

#### SUMMARY

1. The availability of sharks off Salerno, Florida, as shown by the catch per unit-of-effort, fluctuates in a 3 year cycle. (Data over a period of 12 years.)
2. A breakdown of the data by species for the first 9 years of a 12 year period shows that this fluctuation reflects only the availability of the most abundant species, *Eulamia milberti*, the sandbar shark.
3. During the period of 12 years of managed and limited fishing at Salerno there was no indication that fishing pressure affected the availability of the most abundant species (*Eulamia milberti*) since year to year increases and decreases in the catch per unit-of-effort occurred independently of the intensity of the fishery.
4. Since recurrent bad years threatened the existence of the fishery, a program of operation was worked out on the basis of data on previous catches. Changes in equipment and methods and in fleet management were accompanied by an increase of 46 per cent in catch per unit-of-effort for the last 3 years of a 12 year period although the effect of the three year cycle remained notable.
5. Cooperation between parts of the fleet appeared to be a factor of importance in raising the catch per unit-of-effort as well as cooperation between fishermen and the shore establishment in one proper utilization of improved gear.