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DEPARTMENT OF THE INTERIOR
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Special Scientific Report No. 16

DECLINE IN ABUNDANCE OF THE BLUE CRAB, CALLINECTES SAPIDUS,
IN CHESAPEAKE BAY DURING 1940, AND 1941,
WITH SUGGESTED CONSERVATION MEASURES

By

JOHN C. PEARSON

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Explanatory Note

This mimeographed Special Scientific Report has been published in limited quantity for the official use of Federal offices and cooperating agencies. It presents the results of an investigation of specific problems and is intended as a guide for administrative and legislative action. The data may be incorporated in a complete publication to be printed and released at a future date.

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SUMMARY

1. The commercial production of the blue crab in Chesapeake Bay has probably declined during 1940 and 1941 at least 50 percent compared to the production of 57 million pounds in 1939.

The principal types of fishing gear used for crabs have shown a reduced yield per unit of effort during 1940 and 1941, compared to 1939. The scrape and dip net, utilized in the soft crab fishery, show the greatest decline.

3. The first indication of depletion of crabs is evident in a lower average daily catch per dredge boat in lower Virginia for the month of December 1939, compared to December 1938. The decline followed a year of high productivity (1939) in the crab fishery throughout Chesapeake Bay.

4. An abnormally low catch of both hard and soft crabs occurred in May 1940, following the second coldest January on record for the Chesapeake Bay region. Large quantities of crabs were reported to have been killed by this severe weather, especially the wintering adult female crabs at the mouth of the bay.

5. The lack of an adequate spawning reserve of females during the summer of 1940 appears to have been reflected in a continued decline in the abundance of soft crabs (1-year-old individuals) during 1941.

6. Preservation of all sponge crabs, although an excellent protective measure, may not be absolutely necessary to insure sufficient reproduction to provide for a self-perpetuating and profitable crab fishery.

7. Recommendations are made for the preservation and restoration of the supply of crabs, including the establishment of crab sanctuaries, enforcement of laws governing size limits, and prohibiting the retention of green crabs in shedding floats; for the collection of detailed fishery statistics by the States, and the conduct of continuous cooperative biological investigations.

INTRODUCTION

This report presents information on the status of the blue crab fishery in Chesapeake Bay which may be of value in any effort on the part of the States of Maryland and Virginia to formulate additional conservation measures for this valuable fishery. State and Federal Governments can scarcely be indifferent to the welfare of a natural resource that brings a livelihood to thousands of citizens in the Chesapeake Bay region, especially at a time when the blue crab population in the Bay appears to have been depleted seriously, and when National war plans call for a larger and more efficient production of all food-stuffs.

A survey of existing conditions in the crab fishery of Chesapeake Bay was conducted by the Fish and Wildlife Service of the United States Department of the Interior at the requests of the Maryland Conservation

Commissioner, Edwin Warfield, Jr., and the Virginia Commissioner of Fisheries, J. Brooks Mapp. The survey extended only from October 15 to December 31, 1941, as it was requested that a report be submitted early in 1942 in order to provide information for immediate legislative and administrative action.

The cooperation of the crab fishing industry of Maryland and Virginia during the survey, and the varied suggestions by fishermen and others as to ways and means of increasing the crab supply are appreciated. While most popular remedies for the present depletion of crabs consist of fishing prohibitions for other people in other localities, nevertheless, many excellent and thoughtful ideas have come to the attention of the writer. It is regretted that past experiences have yielded so little definite knowledge concerning what constitutes adequate and reliable methods of crab conservation.

Only by continuous observation and analysis of the blue crab supply can facts be distinguished from supposition. Until such observations are carried out, guess-work and conjecture will continue to play major roles in all considerations of the problem. The balance of nature can restore itself provided the opportunity is given. It is for us to provide this opportunity to perpetuate the blue crab fishery of Chesapeake Bay.

HISTORY OF BLUE CRAB CONSERVATION

The earliest definitive attempt to apply known biological facts to the conservation and proper utilization of the blue crab of Chesapeake Bay was made by E. P. Churchill, working for the former U. S. Bureau of Fisheries, in 1917. Preceding the publication of his technical monograph, "The Life History of the Blue Crab, Callinectes sapidus, of Chesapeake Bay", (Bulletin, Bureau of Fisheries, Vol. 36, pp. 39-128, 1919) this investigator wrote a report on "The Conservation of the Blue Crab of Chesapeake Bay". (MS. on file in Fish and Wildlife Service).

In 1916, prior to Churchill's report, the State of Virginia enacted a law prohibiting the taking or possession of a sponge or egg-bearing crab during the months of July and August. The same year the State of Maryland also put into effect a law prohibiting the taking or possession of a sponge-bearing crab at any time of the year. The Maryland action was less important from a practical standpoint than that of Virginia for few sponge crabs are found in the Maryland waters of Chesapeake Bay.

In 1917, Maryland enacted a law making it illegal to take or have in possession a hard crab measuring less than 5 inches from tip to tip of its spines. Virginia already had a similar law in effect.

In 1917, Maryland also forbade the taking of a soft crab or peeler crab measuring less than 3 inches from tip to tip of its spines. Also, another law was passed providing that no crab except an actual peeler could be put into or kept in floats. This law meant that no green or hard crab, i. e., one not yet having reached the peeler state, could be kept in a float until the time the crab had molted into a soft state.

Churchill, in his unpublished report, approved the measures already in force and added the following conservation suggestions:

1. The taking or having in possession a crab known as a buckram (a crab just passed the soft shelled state but with watery muscle tissues) should be prohibited because it is valueless commercially.

2. A law also should be adopted by Virginia prohibiting the keeping of green crabs in floats and likewise a law forbidding the handling of soft or peeler crabs under 3 inches in breadth.

3. The dredge season in the lower bay should be shortened to extend from November 15 to April 1 of the succeeding year, rather than remain from November 1 to May 1.

Churchill (1917) wisely admonished: "If, after a trial of one or two seasons, the present legislation (including the herein recommended laws) does not fulfill expectations, as it gives promise of doing, it is recommended that further protection be given the sponge-bearing crab in Virginia waters". It was estimated by Churchill that only about half of the sponge crabs were saved by the existing legislation embracing a closed season during July and August.

Following a record low catch in 1920, a conference was held at Washington on July 13, 1921, to consider concurrent legislation for the conservation of the blue crab in Chesapeake Bay. The following proposals were agreed upon by the conference of official representatives of Virginia, Maryland, and the U. S. Bureau of Fisheries as well as members of the crab industry.

1. That it be unlawful to take or have in possession a sponge-bearing crab at any time of the year.

2. That it be unlawful to take crabs by the use of the trot-line between December 1 and March 31, inclusive, and that the dredging of crabs be allowed only from December 1 to March 31 inclusive.

3. That the minimum size for a peeler crab be established at 3 inches from tip to tip of spine and for a soft crab at $3\frac{1}{2}$ inches.

It was further agreed that an effort would be made by officials of the respective States to secure concurrent legislation covering these proposals for the protection of the industry.

No action was taken on the first and most important of these proposals (the complete protection of sponge crabs) and any action taken on the other proposals apparently had little effect for, in 1924, the U. S. Bureau of Fisheries was requested to make another survey of existing conditions. In December, 1925, O. E. Sette and R. H. Fiedler, issued a report, "A Survey of the Conditions of the Crab Fisheries of Chesapeake Bay". (Sp. Mem. 1604-14, Bureau of Fisheries).

After indicating that the commercial catch of crabs took about 75 percent of the adult crabs out of the water annually and treating the

subject as exhaustively as data permitted, Sette and Fiedler made the following recommendations:

1. That the taking of sponge crabs be prohibited at all times.
2. That the taking of buckram crabs be prohibited at all times.
3. That the peeler crab be designated as one having the new soft shell fully formed under the outer hard shell, which can be detected by the "pink" sign on the last pair of legs.
4. That at least a 30 percent reduction be effected in all forms of crab fishing.
5. That provision be made for the collection of statistics and biological data continuously throughout future years in order that the effect of any new regulations may be known.

Definite action was taken on several of these recommendations. In 1926 Virginia enacted a law prohibiting the capture or possession of sponge crabs throughout the year in an attempt to remedy the situation. No action was taken on the fourth and fifth recommendations.

Following the passage of the Virginia law prohibiting the capture of sponge crabs, a marked increase in the annual catch of crabs occurred until it attained the unprecedented maximum of 68,000,000 pounds in 1930 compared to the low catch of 22,000,000 pounds in 1920. Most unfortunately, the important recommendation by Sette and Fiedler that collection of statistics and biological data be made continuously was not carried out either by Maryland or Virginia. Consequently, only circumstantial evidence exists as an indication that the large increase in the catch was due directly to the complete protection of sponge crabs.

Whatever the real cause of the phenomenal increase in the abundance of crabs up until 1930, Virginia, because of economic reasons, soon considered that there no longer was any justification for protecting the sponge crab throughout the year. In 1932, therefore, it became lawful in Virginia to take sponge crabs from April 1 to June 30, during the season of their greatest abundance. The annual catch of crabs began to decrease following the peak of 1930 and the annual catch in 1934 had declined to 38,000,000 pounds. In 1936, Virginia amended its sponge-crab law, making it unlawful to catch sponge crabs, but not unlawful to possess them, after June 30 of each year. Although the capture of sponge crabs was forbidden during July and August, difficulties in enforcement and interpretation of the law restricted the conservation benefits. In 1938 Virginia shortened the legal season for taking sponge crabs from April 1 to May 28.

No important changes were made in the crab-conservation laws of Maryland or Virginia during 1939 and 1940, for contrary to general expectations, the catch of crabs rose gradually from the 38,000,000-pound level of 1934 to 57,000,000 pounds in 1939.

When a scarcity of crabs became apparent after a poor 1940 fishing season, Maryland, in 1941, passed a law prohibiting the use of crab pots

in most State waters. Crab pots were assumed to be unduly destructive to undersized crabs and also were known to be a highly efficient type of gear which had recently been introduced into Chesapeake Bay waters. Crab packing interests at Crisfield, Maryland, perhaps recalling an earlier experiment about 1929, caused to be introduced into local waters a quantity of live sponge crabs brought by truck in boxes from Virginia spawning areas.

At the instigation of the Hampton Crab Packers Association, Virginia tried a new conservation method by setting aside a large crab sanctuary at the mouth of the Bay to be closed to all crab fishing during July and August, 1941. This method was another approach to the old vexing problem of saving more sponge crabs as a spawning reserve. The sanctuary, temporarily created by proclamation of the Commissioner of Fisheries, included an area of 300-400 square miles, bounded by a line from the Nansemond Hotel at Ocean View to Thimble Shoal Light, thence seaward to Cape Charles and southward to Cape Henry. The area included some known concentration points for spawning crabs, particularly the region in and about Lynnhaven Roads.

The above account summarizes briefly the principal conservation measures suggested or adopted over the period of the past 25 years. It is emphasized, however, that no exhaustive or critical study of either legal or extra-legal crab conservation measures has been attempted.

EVIDENCES OF DEPLETION

The Fish and Wildlife Service of the United States Department of the Interior, as part of its essential services to the public, annually collects and tabulates statistics on the commercial production of blue crabs in Chesapeake Bay and other areas. However, it is not possible to complete this annual census until from 12 to 15 months following the end of the calendar year. Consequently, 1939 is the latest year for which the total crab catch in Chesapeake Bay is known at the present time (Figures 1 and 2). While the crab industry and allied interests have experienced a decline in crab abundance during 1940 and 1941, no actual statistics or estimates of total production during these years are available.

The average daily catch per crabber or some other unit of effort (insofar as records exist) has been adopted as the best and most reliable index of the general trend in abundance of crabs during the years 1940 and 1941. As remarked by Churchill in 1917, the general opinions of crab fishermen have value but can not be so conclusive as figures. Data on the quantity of crabs handled by any one firm or number of firms from one season to the next also have only a limited value because any changes observed may be only the result of the expansion or contraction of the business due to causes entirely foreign to the supply of crabs available for capture. Like those of Churchill, and Sette and Fiedler, conclusions in this report have been based primarily upon the trend in the average daily catch per crabber from year to year, supplemented by data from the other two sources mentioned above.

No crabber was found who had kept a daily catch record over a period of at least the past 3 years. However, some crab packers do keep records

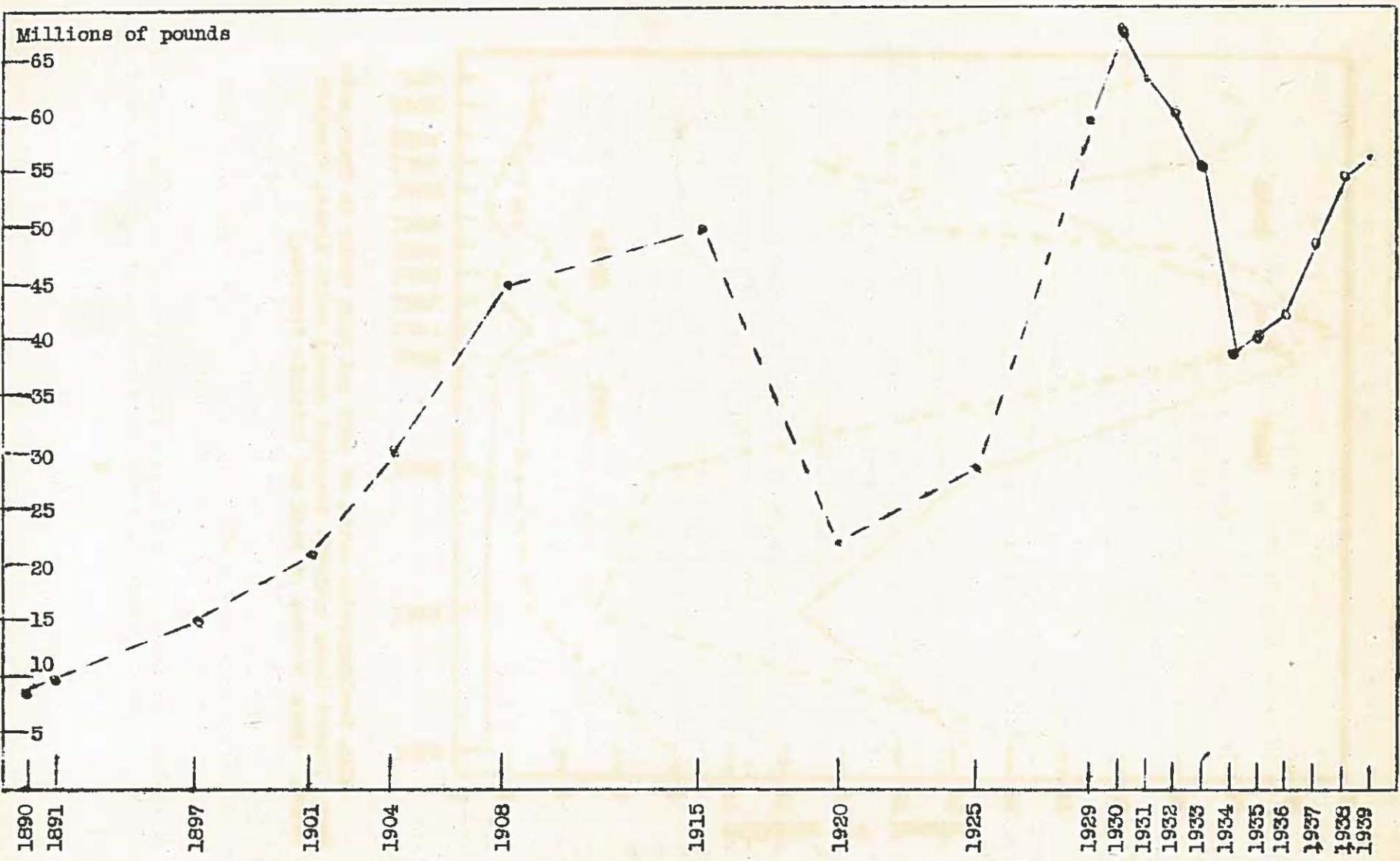


Fig. 1 -- Catch of blue crabs in Chesapeake Bay, 1890-1939. (From records of Fish and Wildlife Service.)

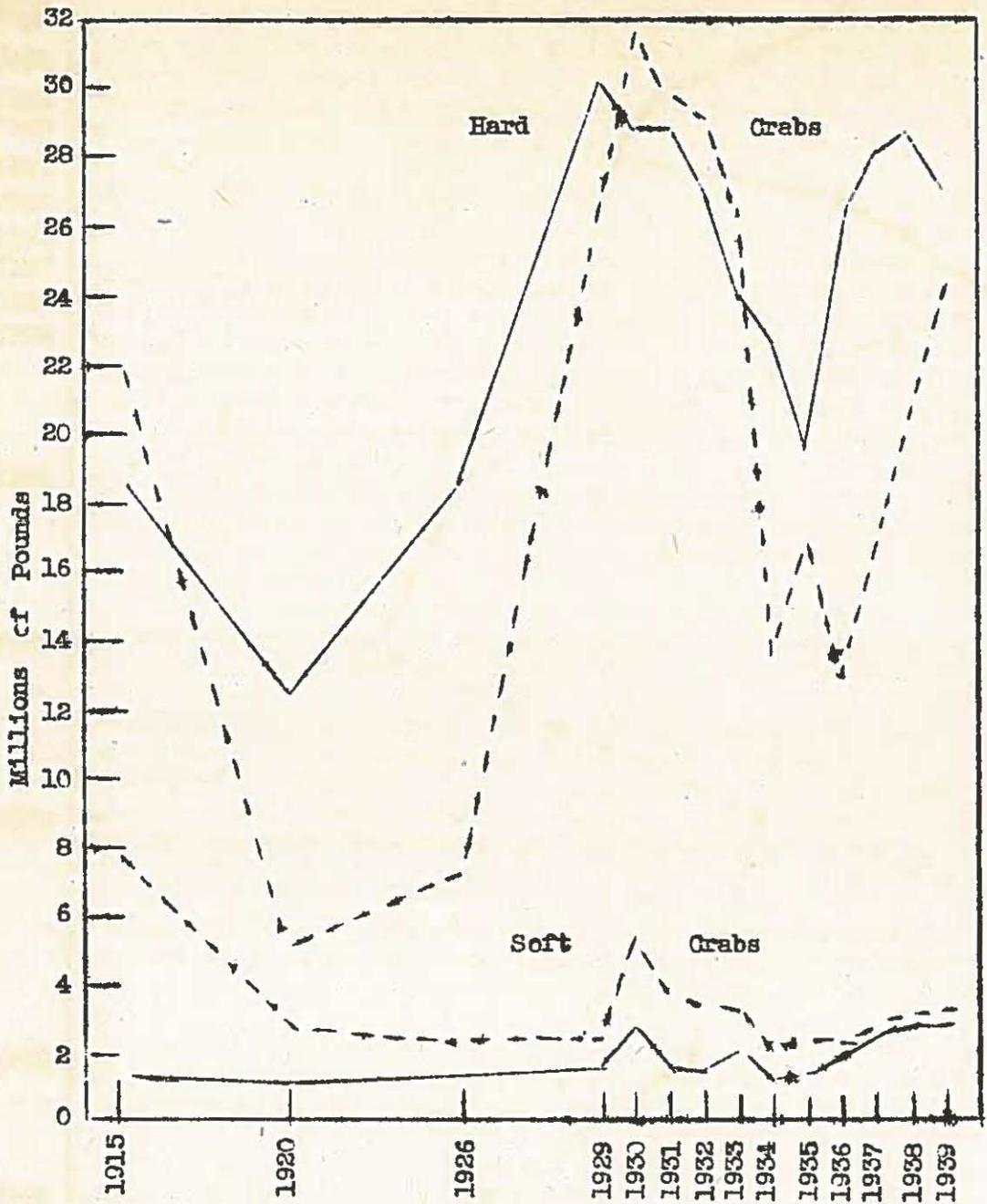


Fig. 2—Commercial catch of soft and hard crabs in Chesapeake Bay. Dotted lines indicate Maryland catch; solid lines, Virginia catch. (From records of Fish and Wildlife Service.)

of the daily catches of individual fishermen or vessels over a limited period of years, and the records of those crab packers were used to determine the rise or fall in the average daily catch of individual fishermen since 1939. Daily catch records were obtained from all types of gear employed in the crab fishery except the recently introduced crab pot. A larger series of records might have been secured had additional time been available to seek out and analyze such material.

The Soft Crab Fishery

The scrape net is the most important gear in producing soft and peeler crabs in Maryland (accounting for 62 percent of the catch) and is employed largely in and adjacent to the shallow waters of Tangier and Pocomoke Sounds in Chesapeake Bay. It captures soft, peeler, and hard crabs although it is operated primarily for the soft and peeler crabs. Sails were used exclusively as power for the scrape boats until June, 1941, when the use of gasoline engines was permitted. The scrape fishery is carried on from May 1 to November 1 although the normal 20-week season ends October 1. The scrape net and boat are operated by a single fisherman who usually fishes from dawn until mid-day before returning to the shedding house with his catch.

An analysis of a series of daily records of catches of soft and peeler crabs for a group of five scrape fishermen who operated in the northern section of Tangier Sound from 1935 to 1941 (omitting 1940 for lack of records) indicates a severe decline in the catch of crabs per unit of effort from 1939 to 1941. The average daily catch for this group of fishermen declined from 192 crabs in 1935 to 143 crabs in 1937, then rose to 154 crabs in 1938 and 187 crabs in 1939, followed by a decline to 65 crabs in 1941. The drop in catch from 1939 to 1941 amounted to 65 percent, based on the average daily catch during these years (Tables 1 and 2).

The general trend of the average daily catches of individual fishermen for the years 1935 to 1941 was quite similar to the average catch of the entire group of fishermen.

Table 1 indicates that most of the fishermen fished fewer days during 1941 than in other years due to the prevailing scarcity of crabs that discouraged fishing and often caused the fishermen to adopt more remunerative occupations ashore.

The dip net is the second most important gear for catching soft and peeler crabs in Maryland and the most important gear in Virginia. It is utilized in waters not well adapted for dragging the sled-like scrape. Such waters may be too deep or too shallow, too heavily covered with eel-grass, or too restricted in area to permit maneuvering of the sail boats that drag the scrapes. Keen eyes and constant vigilance are required in the dip net fishery. As a reward, the catches are frequently larger and of better quality than those taken by the scrape.

An analysis of a series of daily catch records of soft and peeler crabs for a group of nine dip-net fishermen, operating in Tangier Sound,

Table 1. Catch of soft and peeler crabs by a group of 5 scrape fishermen on Tangier Sound, Maryland, from 1935 to 1941 (omitting 1940).

No.	1935		1936		1937		1938		1939		1941	
	Number of crabs	Number of days										
1	33,565	109	19,424	80	23,843	106	20,650	100	--	--	7,351	83
2	24,469	137	14,335	97	15,193	113	13,831	99	22,626	106	2,124	32
3	9,469	68	14,184	88	20,138	115	16,793	101	25,148	111	2,422	28
4	20,989	134	11,528	101	11,582	122	9,874	85	16,527	117	2,181	42
5	1,827	22	--	--	9,549	105	13,347	99	11,160	67	2,981	76
Total	90,319	470	59,471	366	80,305	561	74,495	484	75,091	401	17,059	261
Av. per day	192	--	162	--	143	--	154	--	187	--	65	--

Table 2. Decrease in soft crab production in 1940 and 1941 expressed as percentage of decline from 1939 production at various points in and adjacent to Chesapeake Bay and by various types of fishing gear.

Gear	Locality	Period	Percentage Decrease
Scrape.	Tangier Sd.	1939 to 1940	-- 1/
Av. daily catch.	Maryland.	1940 to 1941	-- 1/
Dip-net.	5 crabbers	1939 to 1941	65
Av. daily catch.	Tangier Sd.	1939 to 1940	49
Scrape and dip-net.	Maryland	1940 to 1941	29
Total catch.	9 crabbers	1939 to 1941	63
Dip-net and trot-line.	Smiths I. Md.	1939 to 1940	30
Total sales.	25 shedding houses.	1940 to 1941	45
		1939 to 1941	61
	Rappahannock	1939 to 1940	--
	R. Virginia	1940 to 1941	64
	Shedding house	1939 to 1941	--

1/ No records available for 1940.

Maryland, from 1937 to 1940, again indicates a decline in the catch per unit of effort during 1940 and 1941. The average daily catch rose from 120 crabs in 1937 to 219 crabs in 1939, then declined to 114 crabs in 1940 and 79 crabs in 1941 (Table 3). A loss of 49 percent occurred from 1939 to 1940 and a further loss of 29 percent resulted from 1940 to 1941. A total decline of 63 percent in the average daily catch occurred from 1939 to 1941 (Table 2).

A broader estimate of the decline in crab production in the scrape and dip-net fisheries in Chesapeake Bay can be made on the basis of the catch of peeler and soft crabs made during 1939, 1940, and 1941 at Smiths Island, Maryland. The catch, as compiled, includes all crabs brought by 25 shedding houses in the general vicinity of Smiths Island. A catch of 2,427,000 crabs was recorded in 1939; 1,686,000 crabs in 1940, and 938,000 in 1941 (Figure 3 and Table 4). These figures represent a decline of 30 percent from 1939 to 1940; 45 percent from 1940 to 1941; and a total of 61 percent from 1939 to 1941.

As an index of the abundance of soft and peeler crabs in Virginia waters, there is available a complete daily record of shipments of soft crabs from a shedding house near the Rappahannock River for 1940 and 1941. A total of 272,616 crabs were produced in 1940 compared to 97,884 crabs during 1941. This decline amounted to 64 percent (Table 2).

Another index of the decline in production of soft crabs, especially interesting from a regional standpoint, is an analysis of the quantities of soft crabs shipped in 80-pound box units from three shedding houses on Smith's Island, Maryland, and three shedding houses located on the "sea-side" of Virginia in Accomac and Northumberland Counties. The analysis shows that shipments decreased 47 percent from 1940 to 1941 at Smiths Island but that shipments increased 12 percent for this period in the Virginia area lying outside of Chesapeake Bay. The crab industry is well aware that the scarcity of soft and peeler crabs within Chesapeake Bay along with good consumer demand for soft crabs has led to more intensified fishing activity at points distant from the principal shipping center at Crisfield, Maryland. Many areas, relatively remote from Crisfield, have been utilized since 1939 in an effort to fill orders. Both the soft and hard crab fishery of such areas has been exploited to a greater degree than if more normal supplies of crabs had been available in the Bay.

In conclusion, it can be assumed on the basis of these varied catch records composed of (1) the average daily catches of a group of scrape fishermen and dip-net fishermen, (2) the actual production from an area producing at least 25 percent of the annual Maryland catch of soft crabs, and (3) the production from a shedding house in Virginia waters of the Bay that a decline of about 60 percent in soft crab production has occurred from the highly productive year of 1939 to and including the year 1941.

The Hard Crab Fishery

The trot line provides the bulk of the catch of hard crabs in both Maryland (98 percent) and Virginia (78 percent). It is a simple type of gear utilized by thousands of fishermen throughout Chesapeake Bay from

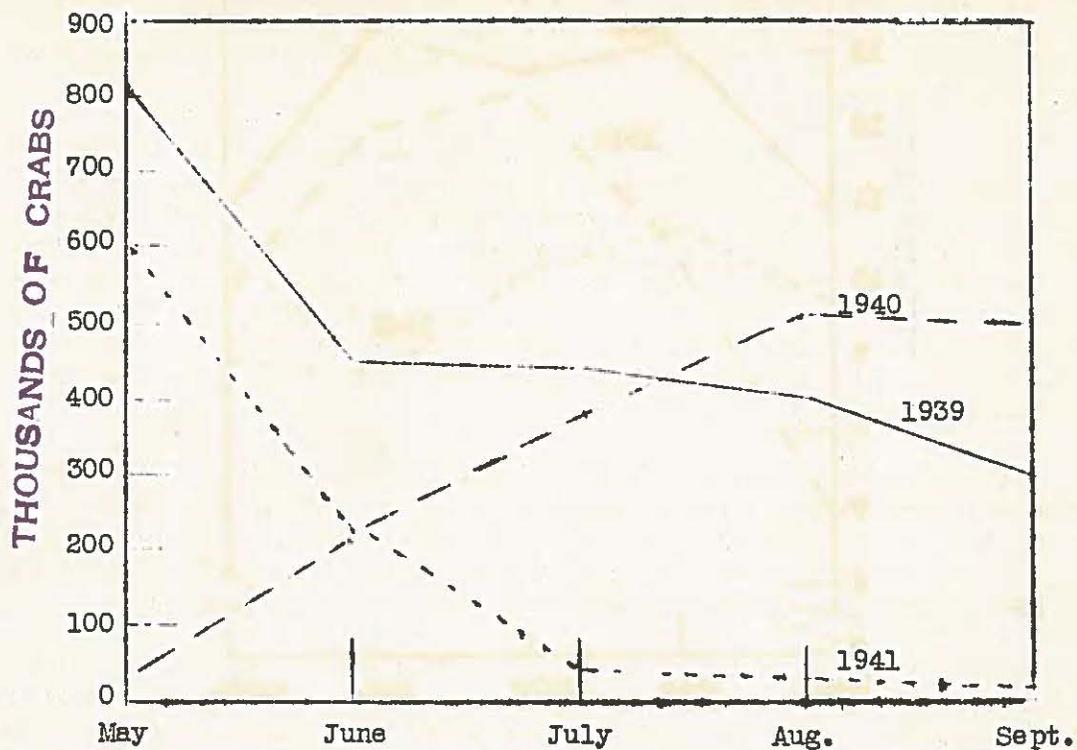


Fig. 3--Monthly catch of soft and peeler crabs received at 25 shedding houses at Smiths Island, Md., 1939-1941. (From State of Maryland records.)

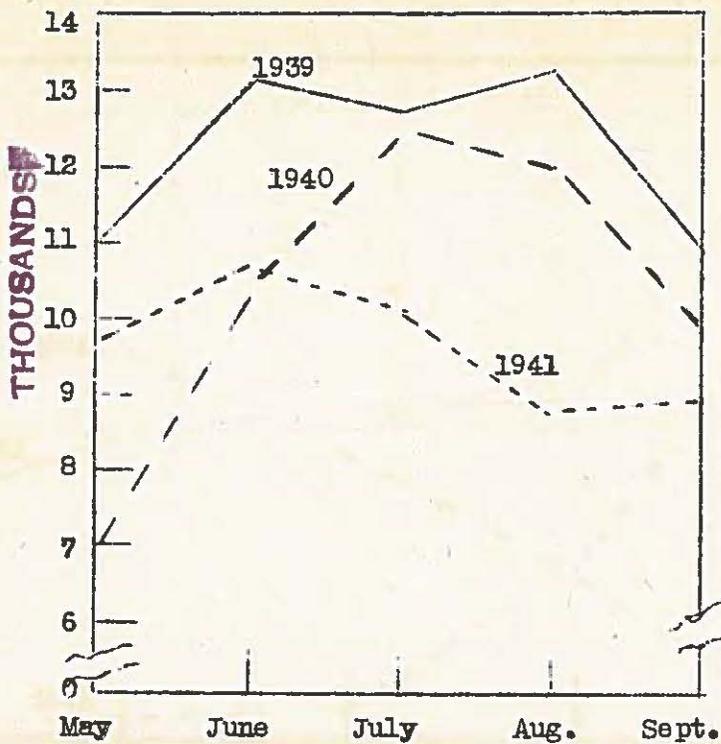


Fig. 4--Number of parcels shipped monthly by railway express from Crisfield, Md., 1939-1941. Soft and hard crabs in various packed forms are estimated to comprise approximately 90 percent of the totals.

Table 3. Catch of soft and peeler crabs by a group of 9 dip-net fishermen on Tangier Sound, Maryland, from 1937 to 1941. (Number of crabs caught and number of fishing days with average daily catch)

Year	Number of crabs	Number of days	Average per day
1937	72,422	605	120
1938	72,341	517	142
1939	143,658	655	219
1940	61,593	541	114
1941	59,810	759	79

Table 4. Monthly catch of soft and peeler crabs at Smith's Island, Maryland, 1939-41, in numbers of crabs. (Reports of 25 packers to State)

Month	1939	1940	1941
May	811,650	32,895	611,428
June.	452,556	223,788	229,432
July.	447,503	386,198	39,045
August.	412,300	505,644	33,600
September	303,682	501,725	25,175
October	--	45,815	--
Total.	2,427,691	1,696,065	938,580

April 1 to December 1 in Virginia, and from April 1 to November 1 in Maryland. Daily catch records for trot-line fishermen are most difficult to secure and usually are destroyed at the end of each week's work. Furthermore, few trot-line fishermen sell regularly to the same packer for a period of more than a year.

An analysis of the average daily catch for three patent trot-line fishermen, operating in the Hampton Roads, Va., area, fails to show any conclusive or significant decline in the hard crab supply in that vicinity for the period from 1939 to 1941. One fisherman caught a daily average of 7.9 barrels of hard crabs during 1939; 2.2 barrels during 1940 and 3.7 barrels in 1941. A second fisherman caught a daily average of 6.1 barrels in 1939; 7.5 barrels in 1940; and 5.8 barrels in 1941. A third fisherman obtained an average daily catch of 5.6 barrels in 1939; 3.8 barrels in 1940; and 5.4 barrels in 1941 (Table 5). The decline in production for these three fishermen, based on the average daily catch, from 1939 to 1941 amounted to 53 percent, 5 percent, and 3 percent respectively (Table 6). More adequate sampling of trot-line catches in the Hampton Roads area may explain the wide variation in decline here indicated.

The dredge is operated only in Virginia waters near the mouth of the Bay from December 1 to April 1, where it accounts for 19 percent of the catch of hard crabs. The methods of fishing are comparable from season to season although individual dredge-boat catches vary considerably from day to day depending on the availability of crabs and on the skill and knowledge of the boat captain in locating the semi-hibernating crabs, the majority of which are fertilized females.

An analysis of the average daily catches for 4 dredge boats, operating from Hampton; for the fishing seasons 1938-39, 1939-40, and 1940-41 shows a steady decline in production per unit of effort. The average daily catch for 1938-39 season ranged from 11.8 to 13.8 barrels of hard crabs per boat. This average declined to from 8.1 to 11.2 barrels per boat for the 1939-40 season and fell still more to from 7.9 to 9.0 barrels per boat during the 1940-41 season (Table 7). The decline in the average daily catch per dredge boat from the 1938-39 season to the 1940-41 season ranged from 27 percent to 42 percent (Tables 6 to 8).

The scarcity in soft and peeler crabs during 1941 should be again reflected in a reduced catch of hard crabs during the 1941-42 dredge season. The crabs composing the greater part of the soft-crab supply in 1941 are of the same age-group as those forming the bulk of the dredge catch the winter of 1941-42.

The production of hard crabs in Maryland waters of the Bay from 1939 to 1941, as reported by 16 Maryland packers to the State of Maryland, declined from 19,749 barrels in 1939 to 11,622 barrels in 1940 and further to 9,854 barrels in 1941. The decrease in production was 40 percent from 1939 to 1940, 16 percent from 1940 to 1941; and a total of 50 percent from 1939 to 1941 (Table 6). In the foregoing analysis of hard crab production within Maryland waters of the Bay, the catch attributed to the Crisfield area (the largest processing and shipping center for crab meat in Maryland) has been omitted from consideration because large quantities

Table 5. Catch of hard crabs per year by three patent trot-line fishermen at Hampton, Virginia. (Number of 100-pound barrels of crabs caught and number of fishing days with average daily catch).

Year	Fisherman No. 1			Fisherman No. 2			Fisherman No. 3		
	Number of barrels	Number of days	Average per day	Number of barrels	Number of days	Average per day	Number of barrels	Number of days	Average per day
1935	--	--	--	160	24	6.7	--	--	--
1936	--	--	--	110	33	3.3	--	--	--
1937	--	--	--	218	24	9.0	--	--	--
1938	--	--	--	38	5	7.6	--	--	--
1939	830	105	7.9	439	71	6.1	778	138	5.6
1940	172	78	2.2	219	29	7.5	572	147	3.8
1941	297	79	3.7	181	31	5.8	640	118	5.4

Table 6. Decrease in hard crab production in 1940 and 1941 expressed as percentage of decline from 1939 production at various points within and adjacent to Chesapeake Bay and by the various types of fishing gear. (Dredge season includes months of December through March)

Gear	Locality	Period	Decrease
Trot-line. 16 packers production	Md. Bay waters	1939-1940	40
		1940-1941	16
		1939-1941	50
Trot-line. 3 packers production	Md. Sea- side	1939-1940	40
		1940-1941	33
		1939-1941	60
Trot-line. av. daily catch. No. 1	Hampton Rds., Va.	1939-1940	78
		1940-1941	+40
		1939-1941	53
Trot-line. av. daily catch. No. 2	Hampton Rds., Va.	1939-1940	+18
		1940-1941	22
		1939-1941	5
Trot-line. av. daily catch. No. 3	Hampton Rds., Va.	1939-1940	32
		1940-1941	+39
		1939-1941	3
Dredge. av. daily catch. No. 1	Hampton, Virginia	1939-1940	13
		1940-1941	22
		1939-1941	33
Dredge. av. daily catch. No. 2	Hampton, Virginia	1939-1940	41
		1940-1941	2
		1939-1941	42
Dredge. av. daily catch. No. 3	Hampton, Virginia	1939-1940	28
		1940-1941	2
		1939-1941	30
Dredge. av. daily catch. No. 4	Hampton, Virginia	1939-1940	20
		1940-1941	8
		1939-1941	27

Table 7. Average daily catch of hard crabs per season (Dec.-Mar.) by four dredge boats at Hampton. (Catch given in barrels of 100 pounds)

Dredge No.	Months	Season of 1938-39	Season of 1939-40	Season of 1940-41
1	Dec.-Mar.	13.0	11.2	8.7
	Jan.-Mar.	9.2	8.8	5.1
	Dec.	18.2	16.3	17.3
2	Dec.-Mar.	13.8	8.1	7.9
	Jan.-Mar.	9.7	6.5	4.3
	Dec.	18.2	11.7	16.0
3	Dec.-Mar.	12.9	9.2	9.0
	Jan.-Mar.	8.9	6.8	5.7
	Dec.	22.2	14.9	20.5
4	Dec.-Mar.	11.8	9.4	8.5
	Jan.-Mar.	8.7	6.9	5.6
	Dec.	17.8	16.2	17.0

Table 8. Percentages of decrease in the average daily catch of hard crabs by four dredge boats at Hampton, Virginia

Dredge No.	Season 1938-39 to 1939-40			Season 1939-40 to 1940-41			Season 1938-39 to 1940-41		
	Dec.	Jan-Mar.	Dec-Mar.	Dec.	Jan-Mar.	Dec.-Mar.	Dec.	Jan-Mar.	Dec-Mar.
1	10	4	13	+6	42	22	4	44	33
2	36	33	41	+27	33	2	12	55	42
3	33	23	28	+29	33	10	7	35	30
4	8	20	20	+4	18	9	4	35	27

of hard crabs are shipped into this area from Virginia, New Jersey, Delaware, North Carolina, and "sea-side" Maryland, and are difficult to separate from local production within Chesapeake Bay. Importations of hard crabs from distant States are increased as much as economically feasible during periods when the local supply is small.

The production of hard crabs in Maryland waters adjacent to the Atlantic Ocean (Sinepuxent Bay), as reported by four packers operating in the region, declined from 24,800 barrels in 1939 to 14,725 barrels in 1940, and to 9,961 barrels in 1941. This decline amounted to 40 percent from 1939 to 1940; 33 percent from 1940 to 1941; and a total of 60 percent from 1939 to 1941 (Table 6).

As a final picture of the recent decline in the blue crab production within Chesapeake Bay, monthly shipments by the Railway Express Agency at Crisfield, Maryland, for the years 1939, 1940 and 1941 are of interest. These shipments are expressed as number of parcels and at least 90 percent of these parcels consist of boxes of soft crabs and barrels of crab meat packed in cans (Figure 4). While a number of disturbing factors enter into these shipments of crab products, the essential fact is that the crab population in Chesapeake Bay has suffered heavily from depletion during 1940 and 1941 and that the resultant shortage has affected fishermen, packers, shippers, and the consumer alike.

CAUSES OF DEPLETION

It is proper to inquire as to what factors have contributed to the pronounced decline in crab abundance within Chesapeake Bay since 1939. What series of events has caused the commercial catch to drop probably 50 percent from the highly productive year 1939 to a point in 1941 where it was no longer profitable to fish for crabs in many localities? Has this depletion been the sole result of continued overfishing and certain wasteful practices within the industry or has some recent natural phenomenon contributed to the decrease in the crab population within the Bay? Unfortunately, these questions cannot be answered with certainty at the present time for essential observations were not made at the right time and at the right places.

Natural Factors Affecting Abundance

There is little information concerning natural fluctuations in abundance of the crab populations within Chesapeake Bay. Nature provides rigorous limiting factors to keep the population of crabs within the bounds of the available food supply. Many natural enemies including jellyfishes, true fishes, and fishermen are continuously depleting the prodigious numbers of young crabs hatched each year and thereby are lowering the spawning reserve to the extent that at times a crab population sufficient to support a profitable fishery cannot be maintained.

Severe cold weather is believed to play an important part in fluctuations in the abundance of crabs. Many fishermen and crab packers recall that the severe winter of 1917-18 (the coldest on record in the Chesapeake Bay region) was accompanied by the death of large numbers of blue crabs while the commercial catch of hard crabs, 2 years later in

1920, fell to an all-time low. There is no record of the catch of crabs for the years 1918 or 1919 following this severe winter but it is possible that a seriously depleted spawning reserve in 1918 resulted in a severe reduction in the number of young crabs produced that year. This reduction might be reflected further in the commercial catch of hard crabs in 1920, for the catch would have been composed largely of crabs hatched during 1918.

The winter of 1939-40 was extremely cold. The United States Weather Bureau (Climatological Data Bulletin for January, 1940) reported as follows: "This January was the coldest since 1918 . . . Rivers and lakes, the tributaries of Chesapeake Bay, and the Upper Chesapeake Bay were frozen over throughout the month. Ice was making during the first decade and was making rapidly during the 16-20 in the Lower Chesapeake Bay which was frozen over or was mostly filled with ice during the third decade and prevented oystering". The monthly mean air temperature for the Maryland section of the Bay was 22.4°F.; 10.8°F. below normal.

The average daily catch of dredge boats declined during the 1939-40 fishing season compared to the season of 1938-39. However, the greater part of this decline was during the month of December 1939, prior to the severe cold weather of January (Table 8). It seems probable that the total decline in catch for the dredge boats was not due entirely, if at all, to the cold winter but to the fact that the catch had been excessive prior to December and that overfishing was now indicated for the first time in the reduced number of crabs available to the dredge boats.

Nevertheless, limited evidence exists, based on observations by fishermen throughout the Bay and especially in the lower areas where dredges are used, that large quantities of crabs were killed by this January cold weather. It is generally recognized that many 2 to 3-year-old crabs are killed each winter owing to general senility and their inability to withstand cold.

Certain significant variations in the monthly catch of hard and soft crabs occurred during 1940 following the cold weather in January. First, the catch of soft and peeler crabs for the month of May in that year was far below that of May 1939, and May 1941 (Figure 3). Some fishermen believe that the low catch in May 1940, was the result of the cold winter with sub-normal water temperatures during May which retarded the movement of immature crabs from the deeper channels to the shallow molting areas where the crabs become accessible to the fishermen. Other fishermen believe, however, that large numbers of the older immature crabs were killed during the cold winter. It is believed that the smaller crabs are not affected as greatly by the cold weather as the larger and older crabs. Since older and larger immature crabs predominate in the catches during May, it is likely that the catch of soft and peeler crabs fell to a low level during May 1940, simply because they had been decimated during the winter. As the 1940 season progressed, however, the smaller and younger crabs of the previous winter entered the fishery in customary numbers.

The high production of May 1941, was unusual in proportion to the succeeding monthly catches, and while it reflected the normal accumulation of immature crabs from October 1 to May 1 (when there is little

fishing activity for soft and peeler crabs), it would seem that nearly the entire available supply of crabs was exhausted after 2 months of fishing. An insufficient spawning reserve in 1940 probably was directly responsible for this shortage.

Similar effects of the severe winter of 1939-40 on the catch of hard crabs in Maryland waters of the Bay during 1940 is indicated by a reportedly low catch during May. This condition lends support to the belief that subnormal water temperatures prevailed during May and prevented extensive feeding on trot-line bait by the hard crabs. The general decrease in production of hard crabs throughout 1940 and 1941 could have resulted in part from a high natural mortality during January 1940. It may be significant that the percentage of decrease in hard crabs was greater from 1939 to 1940--the year immediately following the cold spell--than from 1940 to 1941 (Table 6).

A combination of overfishing during 1939 and a severe winter during 1939-40 probably was responsible for the decline in the production of hard and soft crabs during 1940 and 1941. As no human control over adverse weather conditions is possible, it is essential to examine more closely the problem of overfishing, especially if it is accompanied by wasteful practices.

Intensity of Commercial Fishing

The crab population in Chesapeake Bay is exploited throughout the year. The ease with which the blue crab is caught and the proximity of excellent markets to the sources of supply have encouraged the utilization of all crabs from 1 year old until natural death at from 2 to 3 years of age. The remarkable recuperative power of the blue crab population was shown by the rise in the commercial catch from 22,000,000 pounds in 1920 to 68,000,000 pounds in 1930. Fishing effort certainly did not increase three-fold during this decade, and the increase in catch must have been due largely to successful reproduction, aided by conservation measures.

There has been constant agitation, controversy, and some effort to cut down wasteful practices in the crab industry. The capture of 2-year old egg-bearing or sponge crabs near the mouth of the Chesapeake Bay during the summer months has long been regarded by the Fish and Wildlife Service as biologically wasteful. After successfully escaping from the activities of fishermen for a year, the sponge crab which carries externally about 1,500,000 eggs for several weeks before they hatch, has enhanced value to the resource. Many people believe that the record breaking catch of crabs in 1930 was due to complete protection afforded to the sponge crab beginning in 1926 and that any subsequent decline in the catch has been the result of legally permitting many sponge crabs to be caught since 1932 when restrictions were eased. However, the commercial catch of crabs increased nearly 30 percent from 1935 to 1939 (and probably has decreased 50 percent from 1939 to 1941) despite the fact that sponge crabs have been taken quite intensively each year from 1932 to 1941.

There appears to be several objections to any program of crab conservation based principally on total elimination of sponge crabs from the

catch. First, a large group of fishermen and crab packers is penalized severely by any year-round restriction on the taking of sponge crabs, for the greater part of the summer catch of hard crabs in lower Chesapeake Bay consists of sponge crabs. Second, it is known that the adult crab spawns once and perhaps twice before natural death--in any case, the crab seldom lives beyond the third year of life. Therefore, it is considered economical to capture a share of these crabs before natural death causes complete waste. Third, experience has shown that most fishermen in the lower Bay capture unavoidably some sponge crabs with their trot lines and in their pots while the less conscientious fishermen merely remove the egg-cluster or sponge, thereby permitting the crab to enter the commercial catch legally. The eggs die when they are removed and thrown back into the water. Fourth, there is no definite evidence to indicate that the protection of all sponge crabs is required to maintain a crab population sufficient to support a profitable fishery.

In an effort to evolve a workable method of maintaining an adequate reserve of sponge crabs, Virginia, in 1941, created a temporary crab sanctuary during July and August at the mouth of the Bay, in an area which includes some potential spawning grounds. It was reported that the spirit of this conservation measure was respected generally by the fishermen and conscientiously enforced by officials. A sanctuary for sponge crabs in the lower Bay offers much promise of meeting the primary conservation requirement that a sufficient number of spawning crabs be protected to maintain a supply adequate to support the industry throughout Chesapeake Bay. The boundaries and seasonal operation of such a sanctuary can be changed readily to coincide with changes in the population of crabs as indicated by increases or decreases in the commercial catch.

The effectiveness of a sanctuary for spawning crabs, however, depends upon the relative number of crabs that survive to the spawning stage. Judging by the recent history of the fishery, it would appear that a sufficient number escapes to maintain the fishery when natural conditions are favorable. If the intensity of the fishery increases over that of 1935 to 1939, for example, other measures limiting the amount or kinds of gear, or the number of fishermen, may be required.

No data have been obtained for this report concerning the destructiveness of crab pots. There seems to be no doubt that the crab pot is highly efficient, of low cost, and provides employment to many boys and old men who might otherwise be eliminated from the crab fishery. Limited experimental work has indicated that the crab pot, in certain localities at least, is not unduly destructive to small and unmarketable crabs. Serious objections to the crab pot may be based on the socio-economic problems created by its introduction into a fishery hitherto dominated largely by the trot line. Its chief danger lies in the possibility of a great increase in fishing intensity.

Such an increase in gear operated seems to have occurred since 1939 as shown by the development and extended use of the crab pot. According to the Virginia Commissioner of Fisheries, 370 crab pots were licensed in the lower Bay in 1938, and 94 in 1939. In 1940 the number increased to 2,780, and reached 20,265 in 1941. Maryland outlawed the crab pot in 1941,

believing that existing stocks of crabs could not withstand the strain of this new gear. It is a general opinion also that crab pots destroy many immature individuals of unmarketable size. Virginia appears to be aware of the possible dangers of crab pots as they affect the crab supply and the operation of other types of gear.

Waste in Commercial Fishery

Waste has been occasioned in the past by placing green crabs in shedding floats to obtain a larger percentage of soft crabs by subsequent molting. Sette and Fiedler (1925) showed that in some cases 75 percent of the crabs bought by shedder houses died in the floats, the average loss at that time was 53 percent. Doubtless this loss has been reduced materially in recent years by legal regulation and improved practices adopted voluntarily, but the loss of crabs in floats is still reported to be unnecessarily large. Obviously no accurate records of such loss could be obtained by direct observation during this survey. Most shedding houses disapprove attempts to shed green crabs in floats where mortality rates are sometimes excessive. However there is little cooperation in the soft crab industry to keep the mortality rate at a minimum. We cannot urge too strongly the necessity for rigid enforcement of all laws prohibiting the retention of green crabs in shedding floats.

Recommendations

1. A basic principle of crab conservation is protection of sponge crabs throughout the year. To guarantee the fullest degree of natural reproduction Maryland should continue to enforce its law prohibiting the capture, possession, and sale of sponge crabs. Virginia should enact laws with the same objective.
2. The establishment of crab sanctuaries is recommended as an alternative approach to the problem of conserving the future supply of crabs. Preservation of all sponge crabs, although an excellent protective measure, may not be absolutely necessary to insure sufficient reproduction to provide for a self-perpetuating and profitable crab fishery. Thus the capture and sale of some sponge crabs may be in the interest of better economic utilization of the resource and at the same time be consistent with the aims of conservation.
3. It is recommended that the State of Virginia create a crab sanctuary at the mouth of Chesapeake Bay to aid in the maintenance of an adequate spawning reserve of female crabs. The sanctuary should encompass a potential spawning area bounded by a line running from Willoughby Spit to Old Point Comfort through the Rip Raps, thence to Thimble Shoal Light, thence seaward to Cape Henry following the route of the ship channel as marked by buoys. This sanctuary area is believed to harbor large numbers of sponge crabs, particularly those bearing eggs in the later stages of development. The area can be enlarged in future years if experience demonstrates that too few sponge crabs are being protected.
4. The sanctuary should be closed to all types of crab fishing from May 15 to September 1 of each year, with a provision written into the law

establishing the sanctuary permitting the Commissioner of Fisheries to extend the boundaries of the sanctuary and the dates of closure in accordance with the trend of the crab fishery. An annual production of less than 50 million pounds should call for appropriate adjustment of boundaries and season.

5. The State of Maryland should establish crab sanctuaries on a seasonal basis in favorable areas in the vicinities of Tangier and Pocomoke Sounds in order that many smaller soft and peeler crabs may have a better opportunity to attain large size and a greater market value. A more even seasonal distribution in the catch of soft and peeler crabs may also be obtained through the gradual migration of protected crabs from the sanctuaries into commercial fishing areas. The provision of these sanctuaries might aid in preventing gluts in the market for soft crabs during the early part of the fishing season.

6. All crabs, including sponge crabs, outside of the sanctuary areas should be subject to legal capture and sale. Such capture should be governed by existing laws in the States of Virginia and Maryland establishing a minimum size limit of 5 inches for hard crabs, 3 inches for peeler crabs, and $3\frac{1}{2}$ inches for soft or buckram crabs. It is essential that the laws establishing the size limits prohibit capture, possession, and sale and that penalties to be imposed upon conviction be sufficiently stringent to discourage violation.

7. The retention of green crabs in shedding floats to obtain a larger percentage of soft crabs through subsequent molting is a wasteful practice and should be prohibited in Virginia and Maryland.

8. The submission of detailed reports on all phases of the crab fishery to the conservation officials of Virginia and Maryland at regular intervals is essential for sound management of the fishery, and laws should be enacted making such reports compulsory as a condition of granting a license.

9. It is recommended that adequate and continuous research be conducted on the many problems associated with the blue crab fishery in Chesapeake Bay and in Atlantic Coast and Gulf States where it occurs. The research program should include: (a) An unbiased study of the effects of crab pots and pounds on the crab population and existing fishery; (b) the development of methods to detect promptly trends in the soft and hard crab fisheries; (c) the development of a technique to be applied to the measurement of an adequate spawning reserve; (d) cooperative investigations with the States on the biology of the blue crab.

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