Age, Length, and Gonadal Stages of Herring from Georges Bank and the Gulf of Maine

BY H. C. BOYAR[1]

Abstract

Age, length, and gonadal stages of adult herring, *Clupea harengus harengus* L., were determined from samples collected in 1960–65 from Georges Bank and the Gulf of Maine. Age-groups IV and V were the most abundant ages in the samples. The 1960 year-class dominated the samples from Georges Bank in 1963–65, and the samples from the Gulf of Maine in 1964–65. This year-class was the most abundant during the period of study. The 1959 year-class was extremely weak on Georges Bank, but was well represented in the Gulf of Maine. The mean lengths of the age-groups IV and V from the 1960 year-class were generally less than those from other year-classes; the slow growth and the apparent high abundance suggest that growth is density-dependent. Differences in the peak of spawning and spawning seasons among the areas were small.

Introduction

Until 1961 the traditional harvest of herring, *Clupea harengus harengus* L., in the Gulf of Maine was largely from the inshore fishery for immature fish (sardines); the only significant fishery for adult herring was in southern Nova Scotia. In 1961, the USSR established a fishery for adult herring on Georges Bank (offshore Gulf of Maine); the annual catch from that fishery has exceeded the inshore catch for the State of Maine in every year through 1965. The average catches for these 5 years by the USSR and the State of Maine were about 108,000 and 47,000 metric tons, respectively. To date the development of the offshore fishery has given no evidence of any effect on the sardine fishery. It is not known whether the offshore spawning contributes to the inshore populations of sardines, or if the adult populations are discrete. One way to determine the relationship of offshore and inshore populations of herring is to compare the biological characteristics of fish from known spawning sites. The data compared in this report include information on age, length, and gonadal stages of herring from the Gulf of Maine and Georges Bank where the spawning has been documented (Moore, 1898; Huntsman, 1919; McNairn, 1933; Fish and Johnson, 1937; Sanders, 1952; Bigelow and Schroeder, 1953; Tibbo, 1957; Leim, 1958; Tibbo, Legare, Scattergood, and Temple, 1958; Colton and Temple, 1961).

Collection of Samples

Samples from the Gulf of Maine were divided into two groups — those from the United States coastal area between Cape Cod, Massachusetts, and Eastport, Maine, and those from the southern coast of Nova Scotia between St. Mary's Bay and Port Mouton (Fig. 1). The US areas are referred to collectively as the Coastal Gulf of Maine. Three sites provided the majority of the samples: Eastport and Boothbay Harbor, Maine, and Cape Cod, Massachusetts. Additional samples were taken from Isles of Shoals, Matinicus, and Monhegan Island. Herring from Isles of Shoals were available only during the spring and late autumn, and herring from Matinicus and Monhegan Islands were taken during the summer.

Samples from Nova Scotia were collected from Trinity Ledges eastward to Port Mouton in June–September. Samples of herring obtained during May, October, and December were from the St. Mary's Bay area on the western coast of Nova Scotia.

In April, Georges Bank herring occurred between the Southwest Part and Southeast Part of the Bank and west of Cultivator Shoals, but were absent from the Northern Part of the Bank. In June and July, herring were evenly dispersed throughout the Bank; approximately equal catches per unit of time were obtained from trawl drags on the Southwest Part, Southeast Part, Northeast Peak, Northern Edge, and the Northern Part as far west as Cultivator Shoals. Our findings of herring throughout the Bank during

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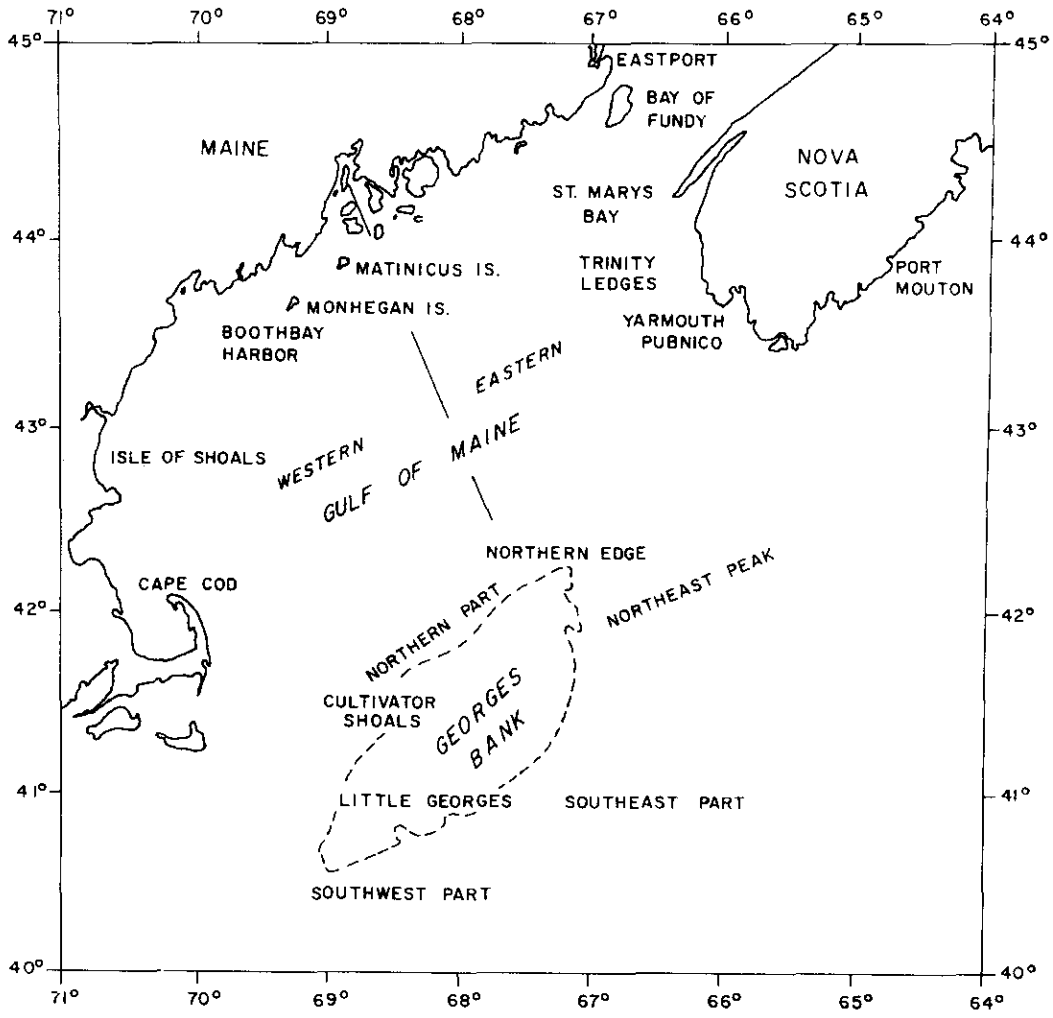

Fig. 1. Areas of sampling for herring on Georges Bank, coastal Gulf of Maine, and Nova Scotia.

TABLE 1. Length at age and percentage of age composition from samples of herring caught with gill nets, trawls, and purse seines from Georges Bank, Coastal Gulf of Maine, and Nova Scotia, June 1964. Number of fish in parentheses.

Age-group	Georges Bank				Coastal Gulf of Maine				Nova Scotia	
	Gill net (310)		Dutch trawl (762)		Purse seine (200)		Commercial trawl (52)		Gill net (529)	
	%	Average length	%	Average length	%	Average length	%	Average length	%	Average length
		cm		*cm*		*cm*		*cm*		*cm*
III	1	22.8	—	—	5	23.4	5	21.8	—	—
IV	66	26.5	63	26.7	89	25.9	76	26.0	29	25.9
V	8	29.0	7	29.3	4	29.4	11	28.9	9	28.5
VI	20	30.2	21	30.2	2	31.2	8	30.4	22	30.3
VII	5	31.4	9	30.8	—	—	—	—	27	31.4
VIII	—	—	—	—	—	—	—	—	8	32.2
VIII+	—	—	—	—	—	—	—	—	5	33.7

June 1964 and 1965 differed from those of Bryantsev (1966) who reported that herring did not move in a northerly direction beyond the Southeast Slope in June–July 1962. From August through November, herring congregated on the Northern Part of the Bank (west of Cultivator Shoals to the Northern Edge).

Trawls were the principal gear for the collection of herring on Georges Bank. In waters where trawling was not possible, we used gill nets. In the Coastal Gulf of Maine, the majority of the herring were obtained with trawls; occasional samples were collected from gill nets and purse seines. Most of the fish were taken in waters beyond the limit of the stop seines and weirs which are fished in the inshore fishery. Herring from Nova Scotia were obtained primarily by gill nets, but some came from weirs.

The lengths of fish of the various age-groups and the age compositions for herring caught with the different gears used in each area were compared to determine whether there was any bias because of selection of gear (Table 1). Although a detailed analysis of the selective action of the gear is beyond the scope of this report, a limited comparison of the tabulated data reveals no major bias. Herring (exclusive of the immature fish) caught with the various types of gear were similar in size for a particular age-group, and the same age-group (IV) dominated all the samples (weakly in Nova Scotia) regardless of the gear used.

The commercial fishermen used nylon gill nets with a mesh of $2\frac{5}{8}$- to 3-inch (61- to 76-mm) stretched measure and generally caught adult fish. Aboard research vessels, gill nets ranged from 1 to $2\frac{3}{4}$ inches (25 to 70 mm) stretched mesh and caught both immature and adult fish. Fishermen on commercial draggers caught herring with trawls that had a stretched mesh of 2 inches (51 mm) in the body, and 1-inch (25-mm) liner in the codend. Scientists aboard the research vessels caught herring with a Dutch herring trawl that was lined from belly to codend with a 1-inch (25-mm) stretched mesh. The trawls caught all sizes of herring. Samples from purse and stop seines, and weirs ($\frac{1}{4}$- to 1-inch stretched mesh - 6- to 25- mm) were not considered selective either and contained fish of all age groups present on the grounds. Fish of age-group II have been included in the Georges Bank data because they were taken in sufficient abundance to help describe that population. To obtain an index of population structure of the adult herring in Coastal Gulf of Maine, age-groups III and upward were used; very few fish of age-groups I and II (less than 150 fish) were taken. No fish of the age-groups I and II were obtained from Nova Scotia, and no fish of age-group I from Georges Bank.

In 1960–65, 112 samples (9,880 herring) from Georges Bank, 160 samples (11,435 herring) from Coastal Gulf of Maine, and 81 samples (7,436 herring) from Nova Scotia were obtained for study (Table 2). Whenever possible, monthly samples of at least 100 fish were collected.

TABLE 2. Number of samples and total number of herring collected in different years from Georges Bank, Coastal Gulf of Maine, and Nova Scotia, 1960–65.

	Georges Bank		Coastal Gulf of Maine		Nova Scotia	
	Number of		Number of		Number of	
Year	Samples	Fish	Samples	Fish	Samples	Fish
1960	5	571	1	106	5	384
1961	3	588	6	282	4	490
1962	13	1,080	1	251	7	850
1963	24	3,044	35	2,398	20	1,797
1964	35	2,549	46	3,565	20	1,787
1965	32	2,048	71	4,833	25	2,128
Total	112	9,880	160	11,435	81	7,436

Age and Length

Age determinations were made from otoliths. The age was recorded as the number of actual or virtual summer growth zones on the otolith. The year-class to which a fish belonged was also recorded and refers to the year of deposition and hatching of the majority of the eggs. It was assumed that all fish spawned in the autumn were hatched before 1 January; for fish spawned in the spring, hatching took place between April and June. Virtually all of the spawning, however, occurred in the fall. In accordance with International Commission for the Northwest Atlantic Fisheries (ICNAF) procedures, all fish older than age-group VIII were combined into a VIII+ category. Since the I and II group fish were eliminated from the Coastal Gulf of Maine and Nova Scotia samples, the age scale is from II to VIII+ for herring of Georges Bank, and III to VIII+ for herring from Coastal Gulf of Maine and Nova Scotia (Fig. 2).

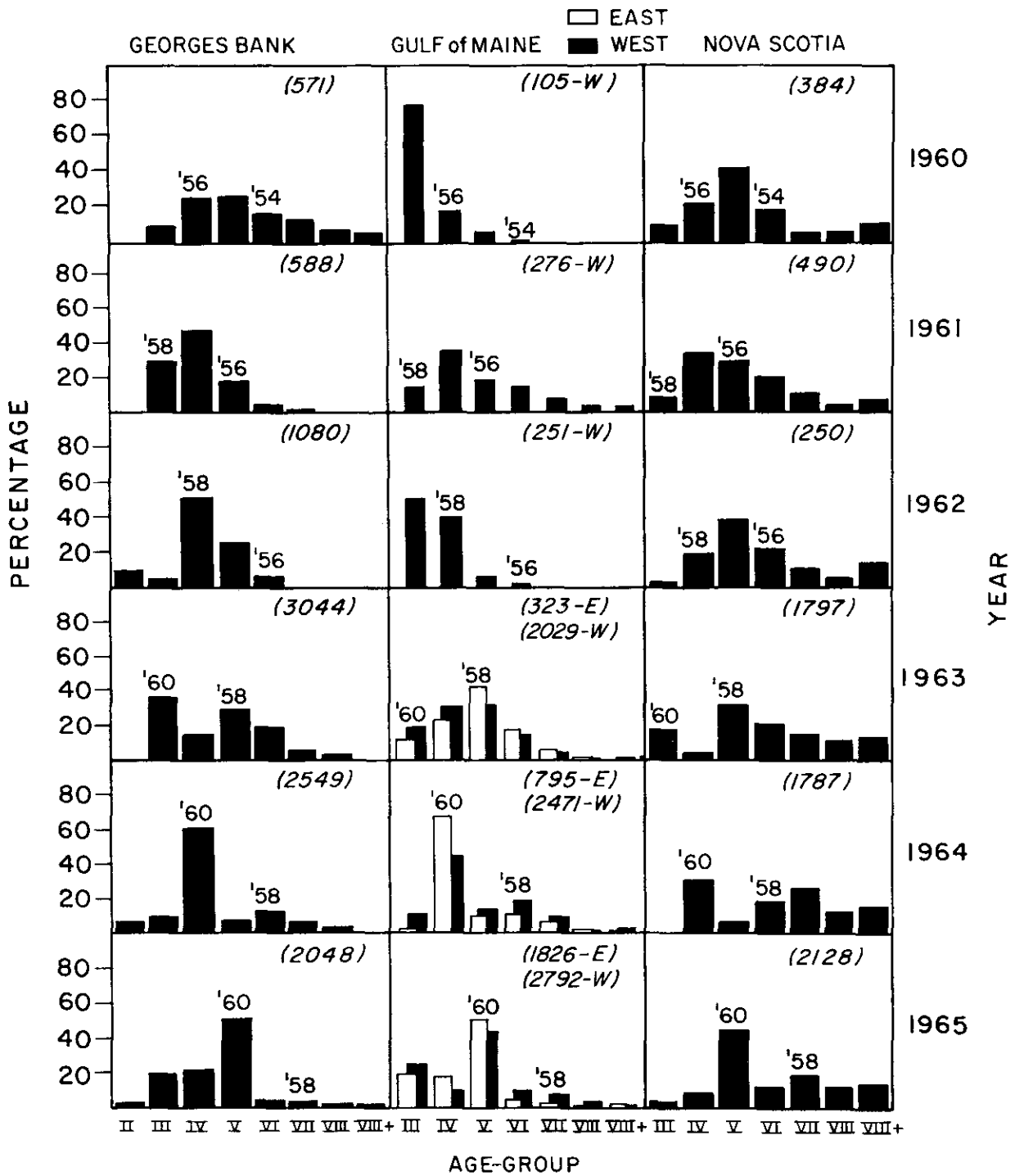

Fig. 2. Age and year-class composition of herring from Georges Bank, coastal Gulf of Maine, and Nova Scotia, 1960–65. Numbers of fish in parentheses.

Fish were measured from the tip of the lower jaw to the end of the longest lobe of the tail, with the fish lying in a natural position (natural total length). When the tail was damaged, fish were measured from the tip of the lower jaw to the silvery area on the caudal peduncle (standard length), and the length was converted to natural total length (TL = 2.80 + 1.157 SL where SL = standard length in millimeters). Length data, recorded to the nearest millimeter, have been grouped into 1-cm intervals.

Georges Bank

In 1960–65, age-group IV was dominant in the samples, followed in abundance by age-groups V, III, and VI. (Fig. 2). The highest frequency of occurrence of age-group IV was in 1964 (1960 year-class). The 1960 year-class entered the fishery in 1962 when it ranked third in percentage occurrence; in 1963–65 it ranked first. The 1960 year-class belonged to age-group II in 1962, age-group V in 1965. The 1960 year-class was not dominant or was absent from occasional samples taken in areas away from the Banks. In a sample from 40°46′N lat, 67°50′W long (June 1964), the 1958 and 1957 year-classes formed 61% of the sample, and the 1960 year-class, 24%. In a sample from 41°04′N lat, 66°12′W long (June 1965), the 1958 and 1957 year-classes formed 75% of the sample and the 1959 and older year-classes, 25%; the 1960 year-class was not represented. In a sample from the Northeast Peak in August 1964, the 1959 and 1958 year-classes accounted for 50% of the sample; the 1960 year-class, 25%. It seemed evident from the above samples, that the fish schooled according to age and to size.

The distribution of immature fish appeared to be restricted to the Banks proper, and the samples in which they dominated the catch were obtained from the vicinity of Cultivator and Georges Shoals and Northeast Little Georges. Immature herring were not caught farther east than Georges Shoals. Apparently these fish prefer the shallow areas (20 fathoms or less) of the Banks during the summer and early autumn, possibly because the bottom temperatures are higher than in the deeper areas as shown below.

Month and year	Range in temperature (°C)	
	Shallow water	Deeper water
June 1964	9.2–9.8	3.0–8.2
October 1964	13.1–15.1	4.8–13.1
September 1965	11.0	2.4–5.4

Comparable data are not available for Coastal Gulf of Maine and Nova Scotia.

The length of fish of each age-group increased from late spring through the summer, but during spawning season, the mean lengths of a particular age-group were frequently equal to or even less than the mean lengths before the spawning season. The apparent decrease of length in some samples can be explained on the assumption that the larger fish of an age-group spawn first, move off the spawning grounds, and are replaced by the smaller fish of the age-group. The dominance of the smaller fish of age-groups persists in the samples throughout the first few months of the following year. The last of the autumn spawning occurs at this time.

The mean length of a given age-group collected in August–September did not vary more than 1 cm, among the year-classes, except for the III-group fish (Table 3). The average increase in annual length from the III- to the IV-group fish was 2.8 cm; from the IV- to the V-group, 1.6 cm; and from the V- to the VI-group fish, 1.3 cm.

Coastal Gulf of Maine

Evidence supports a separation of eastern and western stocks of herring along the Gulf of Maine. Sindermann (1959) reported differences among parasites of herring in the eastern and western areas, and Sherman (1966) found differences in hydrographic conditions and abundance of zooplankton. On the basis of these differences, I have also divided herring samples from the Coastal Gulf of Maine into western and eastern groups. In 1960–65, herring of age-group V

TABLE 3. Mean lengths (cm) of herring of various age-groups and year-classes from Georges Bank in August–September, 1960–65.

	Year of capture					
Year-class	1960	1961*	1962	1963	1964	1965
1956						
Age-group	IV	V	VI	VII	VIII	—
Length	27.6	29.3	30.6	31.4	33.0	—
1957						
Age-group	III	IV	V	VI	VII	VIII
Length	25.6	27.8	29.3	30.4	32.1	33.3
1958						
Age-group	—	III	IV	V	VI	VII
Length	—	24.9	27.8	29.4	30.6	32.0
1959						
Age-group	—	—	III	IV	V	VI
Length	—	—	25.5	27.9	29.4	30.8
1960						
Age-group	—	—	—	III	IV	V
Length	—	—	—	24.3	27.3	28.9
1961						
Age-group	—	—	—	—	III	IV
Length	—	—	—	—	23.7	27.1

*Only data available were for October.

dominated the samples in both sections (Fig. 2). The order for other major age-groups was IV, III, and VI in both sections. The dominant year-class was always more abundant in the eastern section than in the western section. In both sections the 1960 year-class was first evident in the samples in 1963 (age-group III) and was dominant in 1964 and 1965 (age-groups IV and V). The relative abundance of fish of the 1959 year-class was greater along western and eastern Coastal Gulf of Maine than on Georges Bank. In 1963 and 1965 fish of the dominant year-class were plentiful in all samples. A few 1964 samples from Provincetown, Massachusetts, and Boothbay Harbor, Maine, were dominated by fish of the 1958 and 1959 year-classes, and fish of the 1960 year-class made up less than 10% of the collections.

The length frequencies of fish from the western and eastern sections were similar in 1965 and 1963, but in 1964 differences between lengths of fish from these sections were highly significant. The mean length of fish of an age-group collected in August–September did not vary more than 1 cm among year-classes, except for IV-group fish from the eastern section (Table 4). In the western section, the average increase in annual length from III- to the IV-group fish was 2.7 cm; from IV- to the V-group, 1.3 cm; and from V- to the VI-group, 1.4 cm. In the eastern section, the average increase in length from IV- to the V-group was 1.4 cm; and from V- to the VI-group, 1.5 cm.

Nova Scotia

Herring of age-group V were dominant in the samples in 1960–65 (Fig. 2) followed in percentage occurrence by age-groups VII, VI, and IV. Fish in age-groups V and VIII were more abundant in the samples than fish in age-group IV, except in 1961 and 1964. The 1960 year-class which ranked third in abundance in 1963 (age-group III) was dominant in 1964 and 1965. In general, the samples from Nova Scotia contained a higher percentage of older fish than the samples from either Georges Bank or the Gulf of Maine. The 1959 year-class, as on Georges Bank, was noticeably weak.

Although the 1960 year-class contributed 43% of all fish collected in 1965, some samples from St. Mary's Bay, Port Mouton, and Lockeport contained less than 10% of this year-class. Fish of the 1958 and 1957 year-classes were abundant in these collections. In 1964, the

TABLE 4. Mean lengths (cm) of herring from various age-groups and year-classes from Coastal Gulf of Maine in August-September, 1960–65 (W—Western Section, E—Eastern Section).

	Year of capture											
	1960		1961		1962[a]		1963		1964		1965	
Year-class	W	E	W	E	W	E	W	E	W	E	W	E
1956												
Age-group	IV	—	V	—	VI	—	VII	VII	VIII	VIII	—	—
Length	27.7	—	29.4	—	30.2	—	31.9	32.1	33.4	33.1	—	—
1957												
Age-group	III	—	IV	—	V	—	VI	VI	VII	VII	VIII	VIII
Length	25.0	—	28.2	—	29.2	—	30.8	30.5	32.0	32.1	33.2	33.0
1958												
Age-group	—	—	III	—	IV	—	V	V	VI	VI	VII	VII
Length	—	—	25.7	—	27.4	—	29.5	29.0	30.8	30.6	31.9	32.0
1959												
Age-group	—	—	—	—	III	—	IV	IV	V	V	VI	VI
Length	—	—	—	—	25.3	—	28.0	27.9	29.6	29.6	30.9	30.8
1960												
Age-group	—	—	—	—	—	—	III	III	IV	IV	V	V
Length	—	—	—	—	—	—	25.2	23.1	27.8	26.6	29.2	28.9
1961												
Age-group	—	—	—	—	—	—	—	—	III	—	IV	IV
Length	—	—	—	—	—	—	—	—	23.6	—	27.5	26.8

[a]Only data available were for October.

TABLE 5. Mean lengths (cm) of herring of various age-groups and year-classes from Nova Scotia in August–September, 1960–65.

	Year of capture					
Year-class	1960	1961	1962	1963	1964	1965
1956						
Age-group	IV	V	VI	VII	VIII	—
Length	27.7	29.5	30.9	32.1	33.0	—
1957						
Age-group	—	IV	V	VI	VII	VIII
Length	—	27.9	29.1	30.8	32.0	33.4
1958						
Age-group	—	—	IV	V	VI	VII
Length	—	—	27.2	29.2	30.7	32.1
1959						
Age-group	—	—	—	IV	V	VI
Length	—	—	—	27.2	29.6	30.9
1960						
Age-group	—	—	—	III	IV	V
Length	—	—	—	23.7	26.4	28.9
1961						
Age-group	—	—	—	—	—	IV
Length	—	—	—	—	—	27.2

1960 year-class was dominant, but some samples from Port Mouton, Lockeport, and Pubnico were dominated by the 1957 and 1958 year-classes. The 1958 year-class dominated the samples in 1963, but some samples from Trinity Ledges, Carleton Village, and Yarmouth were dominated by the 1960, 1957, or 1956 year-classes.

The range in lengths of herring of the various year-classes collected in August–September varied little from year to year. The mean length of fish for any age-group did not vary more than 1 cm, except for IV-group fish (Table 5). The average increase in length from age-group IV- to the V-group was 2.0 cm; from V- to the VI-group, 1.5 cm.

Stages of Maturity

Most herring from Georges Bank, Coastal Gulf of Maine, and Nova Scotia are mature at age-group IV, although in some years large percentages of fish may mature at age-group III (Table 6). The length of the fish at the time of its first spawning did not differ appreciably between the sexes. Scattergood (1952) reported the same for the herring he examined and stated, "there seems to be no reason to believe that the size at maturity is markedly different between males and females." Although the lengths of fish at the time of their first spawning varied slightly from year to year and from area to area, in general, fish of age-group III which had matured were approximately 26.0 cm long. Fish of age-group IV which had matured were approximately 27.5 cm long. The fish of age-group IV which had not matured and which would not spawn until the following year were usually less than 27.0 cm long.

TABLE 6. Percentage of mature herring for age-groups III and IV collected during the spawning season from Georges Bank, Coastal Gulf of Maine, and Nova Scotia, 1960–65.

	Georges Bank		Coastal Gulf of Maine		Nova Scotia	
	Age-group		Age-group		Age-group	
Year	III	IV	III	IV	III	IV
1960	62	97	2	79		100
1961	6	87	0	92		95
1962	56	95	15	66	—	91
1963	33	97	27	96	7	100
1964	9	93	1	92	—	84
1965	10	79	7	70	0	94

Data on state of gonads pooled for 1960–65 were compared by month for each of the three areas. The maturity scale proposed by the International Council for the Exploration of the Sea in 1963 and adopted by ICNAF in 1964 was used in the classification of the various gonadal stages (Table 7). Eight stages of gonadal development were recorded, but to simplify the comparison, the stages were grouped into four categories: II and III — Maturing; IV and V — Full; VI and VII — Spawning and Recently Spent; and VIII — Recovering Spent. Fish of stage I were omitted from the comparisons.

TABLE 7. Gonadal stages and the description of the gonads and eggs of herring in the various stages.[a]

Stage	Description
I	Virgin herring. Gonads very small, threadlike, 2–3 mm broad. Ovaries wine red. Testes whitish or grey brown.
II	Virgin herring with small sexual organs. The height of ovaries and testes about 3–8 mm. Eggs not visible to the naked eye but can be seen with magnifying glass. Ovaries a bright red colour; testes a reddish grey colour.
III	Gonads occupying about half of the ventral cavity. Breadth of sexual organs between 1–2 cm. Eggs small but can be distinguished with naked eye. Ovaries orange; testes reddish grey or greyish.
IV	Gonads almost as long as body cavity. Eggs larger, varying in size, opaque. Ovaries orange or pale yellow; testes whitish.
V	Gonads fill body cavity. Eggs large, round; some transparent. Ovaries yellowish; testes milkwhite. Eggs and sperm do not flow, but sperm can be extruded by pressure.
VI	Ripe gonads. Eggs transparent; testes white; eggs and sperm flow freely.
VII	Spent herring. Gonads baggy and bloodshot. Ovaries empty or containing only a few residual eggs. Testes may contain remains of sperm.
VIII	Recovering spents. Ovaries and testes firm and larger than in virgin herring in stage II. Eggs not visible to naked eye. Walls of gonads striated; blood vessels prominent. Gonads wine red colour. (This stage passes into stage III.)

[a]Descriptions are verbatim from the official ICNAF definition.

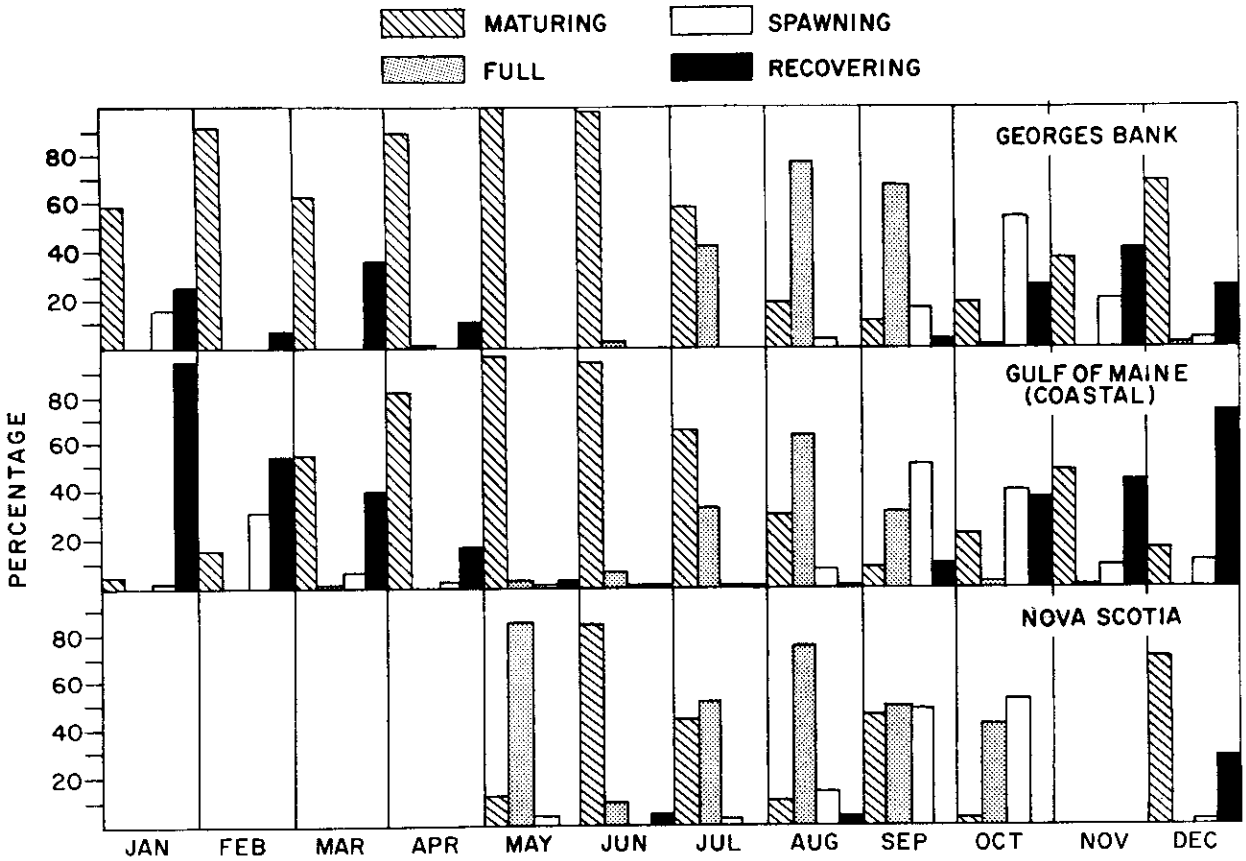

Fig. 3. Annual trend in gonadal stages of herring from Georges Bank, coastal Gulf of Maine, and Nova Scotia, 1960–65 (pooled data).

Georges Bank

During the first 7 months of the year most herring were maturing (Fig. 3). The percentage of maturing fish decreased in August and reached a minimum in September. The number of maturing fish increased gradually from late October through December due to an influx of virgin herring. The first full fish were taken in April; they reached their peak by August, and decreased during September and October. Spawning began in the latter part of August and yolk-sac larvae were first collected in September. The percentage occurrence of spawning fish increased through September. Spawning and recently spent fish were usually in the majority during October and were still present in January. Recovering spent fish were first collected in September and numbers increased during the late autumn. Recovering spent fish also were collected from January to April.

Coastal Gulf of Maine

As on Georges Bank, most herring were maturing during the first 7 months of the year (Fig. 3). Full fish, first taken in March, increased through July, and reached their maximum frequency by August. The number declined sharply in September and only a few full fish were caught in October and November. The capture of a few spawning fish (less than 2% of those sampled) from Eastport, Maine, and Cape Cod, Massachusetts, during the spring and early summer indicates some spring spawning. The percentage of spawning fish in the monthly samples was highest in September in 1964 and 1965 and in October in 1963. The onset of spawning was during August in 1964 and 1965, and in September in 1963. The percentage of spawning fish decreased from November through March. The collection of recovering spent fish during most months provided additional evidence of limited spring spawning in the coastal waters.

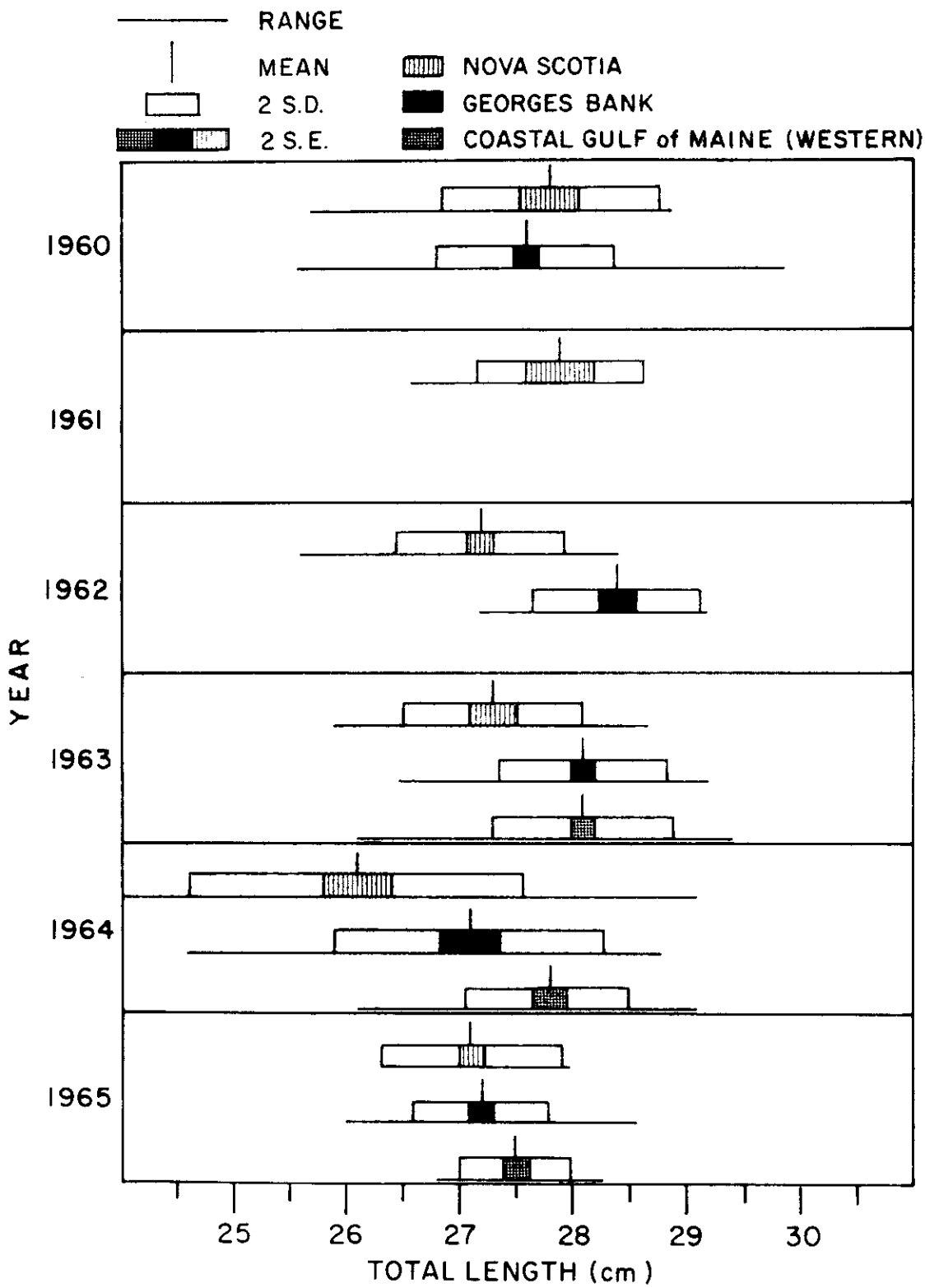

Fig. 4. Lengths of herring of age-group IV from Georges Bank, coastal Gulf of Maine and Nova Scotia in August, 1960–65.

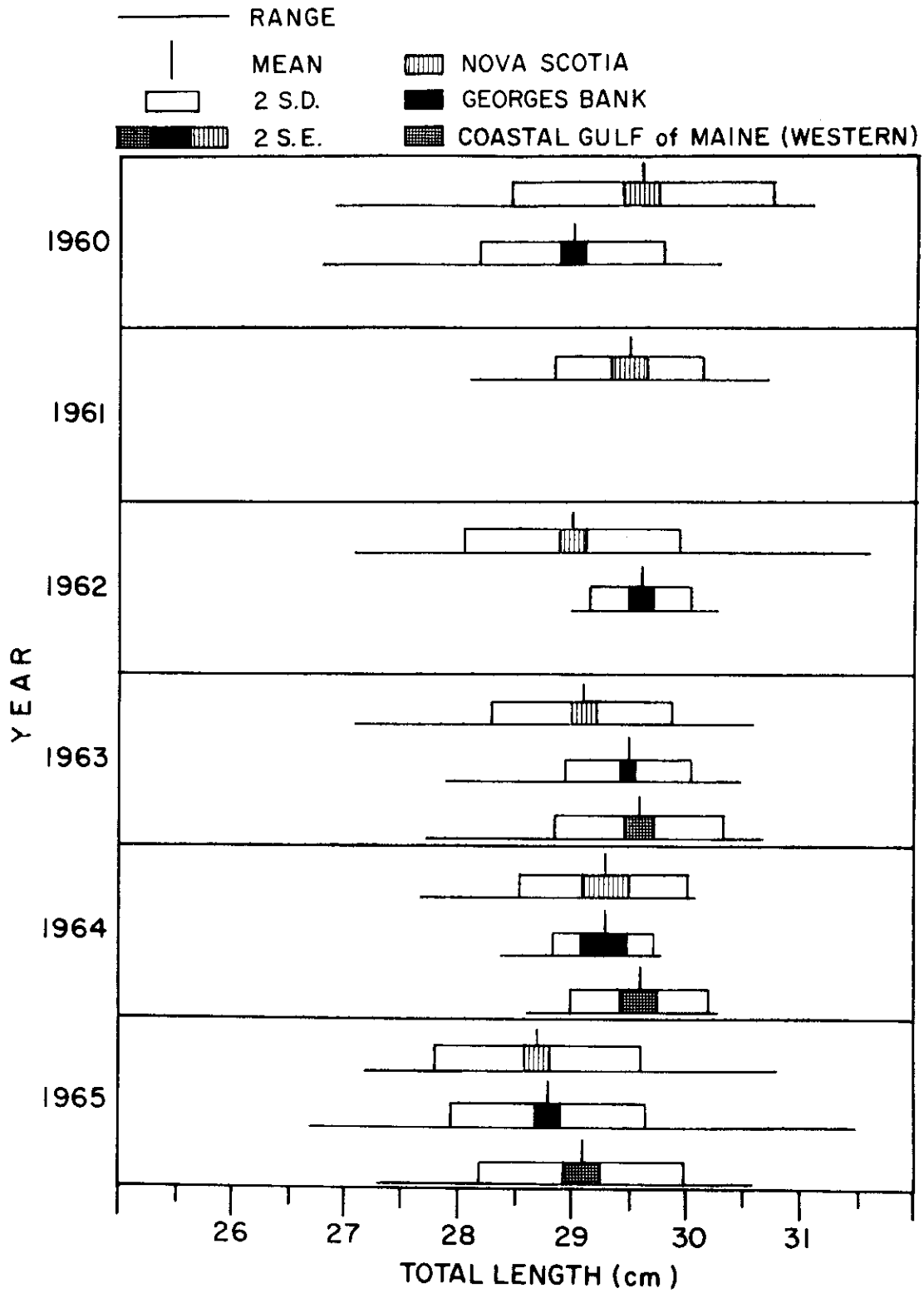

Fig. 5. Lengths of herring of age-group V from Georges Bank, coastal Gulf of Maine, and Nova Scotia in August, 1960–65.

Nova Scotia

Most samples from Nova Scotia were collected from May to October (Fig. 3). Most fish were maturing in June, and by August the percentage of mature fish had decreased considerably. Full fish were first collected in May, and predominated in July and August. The capture of a few spawning fish in late spring and early summer suggests some spring-summer spawning. Autumn spawning began in August, and as indicated by the percentage of full fish in September, reached its peak during October. A few recovering spent fish taken in September provide additional evidence that the peak of spawning came later than September. The high incidence (over 80%) of full fish (stage V) in the sample of May 1962 suggests that these fish would have spawned in the spring. These fish were taken from St. Mary's Bay. The presence of several fish in stage VIII in July samples indicates that they had spawned sometime in the spring.

Comparison of Maturity, Age, and Length Frequency Distributions

Even before the start of the extensive offshore fishery on Georges Bank, biologists in the Northwest Atlantic were interested in the relationships among the populations of herring from Georges Bank and the Gulf of Maine (Tibbo *et al.*, 1958; Sindermann, 1959; Colton and Temple, 1961). Basic information on the biology of adult herring from Nova Scotia had been documented (Tibbo, 1957), but knowledge about adult herring from Georges Bank and the Coastal Gulf of Maine, until recent years, had been almost negligible. The present report, based on herring collected in 1960–65, provides additional information on the biology of adult herring from these areas.

The IV- and V-group fish dominated the samples in the three areas for every year except 1963, when age-group III was dominant on Georges Bank and in 1960 and 1962 when age-group III was dominant in the Coastal Gulf of Maine. The 1960 year-class dominated the samples in the three areas in 1965 and 1964. The 1960 year-class was dominant on Georges Bank in 1963 and the 1958 year-class was dominant in the Coastal Gulf of Maine and Nova Scotia. In 1962, the 1958 year-class dominated on Georges Bank, the 1957 year-class in Nova Scotia, and the 1959 year-class in the Coastal Gulf of Maine. The 1957 year-class dominated the samples from all three areas in 1961. In 1960, the 1955 year-class was dominant on Georges Bank and off Nova Scotia, but the 1957 year-class dominated the samples from Coastal Gulf of Maine.

The mean lengths of fish from the 1960 year-class in August 1964 and 1965 were less than the mean lengths of age-groups IV and V collected in the other years, except for age-group IV from the Coastal Gulf of Maine in 1965 (Fig. 4 and 5). The mean lengths of age-groups IV and V from the Coastal Gulf of Maine were consistently greater than those of fish of the same age from Georges Bank; the Georges Bank fish, except in 1960, were longer than fish from Nova Scotia.

The mean lengths of fish of the 1960 year-class were generally smaller than those of fish of the same age from other year-classes. Because the 1960 year-class was dominant in many samples, the growth may be density-dependent. The 1959 year-class which dominated the samples in Coastal Gulf of Maine during 1962 and ranked second in occurrence in 1963 was extremely weak in the other two areas. In no year did it rank higher than fourth in either Georges Bank or Nova Scotia.

Differences in spawning time of herring were slight. From 1960 through 1965, herring from Georges Bank and Nova Scotia began to spawn in August; in Coastal Gulf of Maine, the spawning began either in August or September. The peak of spawning on Georges Bank and Nova Scotia always came in October. The peak of spawning in Coastal Gulf of Maine was in October in some years, and September in others. Evidence is lacking for any spring spawning on Georges Bank, but a few spring spawners were collected in Coastal Gulf of Maine and in Nova Scotia.

The differences in age composition and length of fish of a given year-class and the slight differences in spawning time, along with the obvious geographic separation of the three spawning stocks studied, suggest that the stocks may be independent subpopulations. Before conclusions can be reached as to the discreteness of each spawning stock, data from meristic characters and other racial information must be analyzed.

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