# A Preliminary Assessment of Weakfish in the Middle Atlantic Bight

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## Abstract

The range of the weakfish extends from Massachusetts to Florida, however, evaluation of racial studies and tagging information indicate the probable existance of a discrete stock from Cape Cod to Cape Hatteras. Commercial landings from Massachusetts to North Carolina have historically undergone considerable fluctuation. From a maximum of 19,000 MT in 1945, the catch had dropped to about 1,300 MT by 1967. During the period 1967-1976 commercial landings increased from 1,338 MT to 9,133 MT. Estimates of recreational landings parallel the dramatic increases in the commercial fishery since 1967. Total landings (commercial and recreational) increased from 2,837 MT to 18,498 MT (1967-1976). Most commercial catches came from North Carolina, Virginia, and New Jersey, while the majority of sport fish were landed in New Jersey, Delaware, and New York.

The average length of fish taken during inshore surveys has increased, nevertheless a strong 1976 year-class was evident in the autumn survey. Length frequency analysis of trawl survey data and creel census information indicate age 0+ fish are only partially recruited to the recreational fishery. Total mortality rates (z) calculated for fish of age IV and greater ranged from 0.47 to 0.75. Yield per recruit analysis was conducted with natural mortality rates (M) of 0.2, 0.3 and 0.4. An increase in $t_c$ from age 1.0 to 2.0 would result in a 29-32% increase in Y/R at $F_{max}$.

## INTRODUCTION

The weakfish, Cynoscion regalis (Bloch and Schneider), is a near-shore Sciaenid commonly found along the American East Coast from Massachusetts to Florida. Spawning occurs inshore and in estuaries from May to October with maximum production in May and June. North of Cape Hatteras larger individuals migrate northward and inshore in spring, returning offshore to the south during autumn (Bigelow and Schroeder, 1953; Wilk, 1977).

Racial investigations of weakfish have indicated the possible existance of several populations on the basis of meristic studies and scale morphology (Perlmutter et al., 1956; Nesbit, 1954). Joseph (1972) evaluated available evidence presented in racial studies concluding that if stock seperation does exist, the most likely point of differentiation is Cape Hatteras. Tagging data summarized by Nesbit (1954) indicate weakfish marked in the Middle Atlantic area ranged from Montauk, NY, to the vicinity of Cape Lookout, NC.

## LANDINGS

Commercial landings of this species in the Middle Atlantic (MA-NC) have historically undergone considerable fluctuation. From a maximum of approximately 19,000 MT in 1945 (Perlmutter et al., 1956) the catch had dropped to 1,300 MT by 1967 (Table 1). Reasons for the apparent decrease in population abundance are not clear but the decline has variously been attributed to over-exploitation (Perlmutter et al., 1956; Joseph, 1972), destruction of young fish by Virginia pound nets and North Carolina trawls (Higgins and Pearson, 1928; Roelofs, 1950; Wolf, 1972), and pesticide pollution (Joseph, 1972). From 1967-1976 total commercial landings increased by a factor of 6.8 from 1,338 MT to approximately 9,249 MT (Table 1). Recreational catches as calculated in NMFS sport fish surveys (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973; Deuel, pers. commn.) show a concomitant increase of the same order of magnitude

(Table 1). Coverage of the 1974 survey was limited to the area from Massachusetts to Virginia but the census is probably comparable to earlier surveys as recreational catches of weakfish in North Carolina waters are of minimal importance (Hayne, 1968; Deuel, pers. commn.)

Annual total landings for the period 1966-1976 were calculated by interpolating the ratio of sport to commercial landings in non-survey years and multiplying the commercial catch by the appropriate ratio (Table 1). Total landings increased sevenfold from 2,837 MT (1967) to 19,904 MT (1972). Since 1972 the total has stabilized at between 15,699 and 18,902 MT.

The greatest proportion of commercial landings occurs in North Carolina (Table 3). Landings from the Virginia border to the vicinity of Cape Hatteras accounted for about 13% of North Carolina catches from 1966-1976. Otter trawls account for most of the regional production with pound nets, gill nets and haul seines contributing significant catches (Table 2).

During the 1974 survey most of the recreational landings (in weight) were from New Jersey (49.7%) with Delaware (18.7%), New York (16.6%), Virginia (8.4%), and Rhode Island (3.3%) adding significantly to the sport catch.

## POPULATION PARAMETERS

Age and growth data are biased on inshore trawl surveys form Cape Cod to Cape Hatteras, conducted by NMFS, since 1972. Inshore strata (1-15 fathoms) were sampled by different vessels and gear in some years but survey design and methods have remained the same (Grosslein, 1969). Length frequencies of weakfish obtained in fall surveys are presented in Figure 1. Growth relationships estimated from survey data are:

$$W = 1.2053 \times 10^{-5} FL^{2.9631}$$

and

$$l_t = 790 \left[1-e^{-0.270 (t-0.074)}\right]$$

(Fork length in mm, total weight in g).

The mean length of fish taken during the trawl survey increased from 14.6 cm (1972) to 20.4 cm (1976). The progression of modes of several strong year classes probably explains this phenomenon. Daiber and Smith (1971) noted a similar trend for weakfish in Delaware Bay from 1966-1970. McHugh (1977) recounts observations that increases in the abundance of Delaware Bay weakfish preceded those of the New York Bight by 3 years. Thus to some extent increases in population abundance are associated with an increase in relative abundance of larger fish. Although a pre-recruit index has not been developed, a large 1976 year class is indicated by its predominance in the autumn survey.

The length distribution of weakfish taken by party and charter boat anglers along the New Jersey coast during the fall of 1976 was used for comparison with trawl data (Figure 1). Figure 2 illustrates the differences in age composition estimated for the two sets of NMFS data from the fall of 1976. Age 0 + fish are not fully selected by the sport fishery, whereas the catch curve descends from age 0 for trawl samples. Total instantaneous mortality rates estimated from these data, for several ranges of ages, are presented in Table 3. Clearly the apparent total mortality rate is much higher for the trawl data if younger ages are included. Differential spatial distribution or physical selectivity of the gears probably account for the differences in age composition of the two groups. Mortality rates calculated for fish of age 4 and greater are relatively close suggesting the total mortality coefficient ranges from 0.47 - 0.75.

## YIELD-PER-RECRUIT ANALYSIS

Yield-per-recruit analysis was conducted for weakfish utilizing the Beverton-Holt equation (Beverton and Holt, 1957) and the following population parameters:

$W_\infty$ = 4,645.7 g

K = 0.270

$t_o$ = 0.074 yrs

$t_r$ = 0.25 yrs

$t_c$ = 0.5, 1.0, 1.5, 2.0 yrs

$t_\lambda$ = 8.0 yrs

M = 0.2, 0.3, 0.4

F = 0.1 - 1.0

Several values of M, the instantaneous natural mortality rate, were used due to the lack of information relative to this parameter. Results of the analysis are presented in Table 5. If the present age at first selection ($t_c$) is assumed to average 0.5 - 1.0, the value of $F_{max}$ ranges from 0.3 - 0.4 depending on the value of M. Thus present estimates of Z (Table 4) approximate those resulting in maximum yield-per-recruit (0.5 - 0.8). An increase in $t_c$ from age 1.0 to 2.0 would result in a 29-32% increase in Y/R at $F_{max}$, depending on the value of M. These analyses therefore suggest that management implications are not sensitive to the absolute value of the natural mortality coefficient.

## SUMMARY

Estimated annual total landings of weakfish in the Middle Atlantic appear to have stabilized at slightly under 20,000 MT during the past six years. Recreational and commercial catches presently account for approximately equal proportions of the total. An increase in average fish size is indicated by research cruise information. Autumn survey results suggest the presence of a strong 1976 year-class. Although data are tentative, indications are that under present harvest conditions, optimum exploitation rate has been achieved. If age at first selection is increased from 1 to 2 for all fisheries, an increase in yield-per-recruit approximating 30% is anticipated.

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ble 1 Commercial and recreational landings (MT) of weakfish in the Middle Atlantic Bight 1960-1976.

| Year | Commercial | | | | | | | | Rct'l | Estimated |
|---|---|---|---|---|---|---|---|---|---|---|
| | NE* | NY | NJ | DE | MD | VA | NC | Total | Total | Total |
| 1960 | 1 | 41 | 239 | 4 | 123 | 367 | 1,016 | 1,790 | 1,742 | 3,532 |
| 1961 | 1 | 24 | 190 | 61 | 127 | 542 | 1,047 | 1,991 | | 3,711 |
| 1962 | 6 | 22 | 295 | 65 | 88 | 675 | 980 | 2,129 | | 3,743 |
| 1963 | 1 | 39 | 151 | 67 | 43 | 498 | 799 | 1,598 | | 2,640 |
| 1964 | 1 | 25 | 247 | 58 | 78 | 723 | 892 | 2,023 | | 3,128 |
| 1965 | 2 | 33 | 270 | 100 | 113 | 910 | 888 | 2,317 | 1,027 | 3,344 |
| 1966 | + | 12 | 156 | 4 | 68 | 472 | 860 | 1,609 | | 2,864 |
| 1967 | 1 | 14 | 207 | 4 | 39 | 272 | 802 | 1,338 | | 2,837 |
| 1968 | 1 | 29 | 241 | 2 | 69 | 508 | 1,037 | 1,888 | | 4,644 |
| 1969 | 6 | 53 | 845 | 10 | 79 | 395 | 698 | 2,085 | | 5,841 |
| 1970 | 10 | 134 | 889 | 67 | 146 | 971 | 1,107 | 3,324 | 7,113 | 10,440 |
| 1971 | 91 | 580 | 1,405 | 97 | 185 | 1,058 | 1,653 | 5,069 | | 14,958 |
| 1972 | 83 | 829 | 1,442 | 184 | 142 | 1,186 | 3,344 | 7,210 | | 19,904 |
| 1973 | 85 | 576 | 1,162 | 152 | 245 | 2,313 | 2,822 | 7,353 | | 18,902 |
| 1974 | 233 | 647 | 1,218 | 102 | 169 | 1,389 | 2,747 | 6,505 | 9,137 | 15,642 |
| 1975 | 214 | 620 | 1,982 | 100 | 405 | 1,855 | 3,050 | 8,226 | | 18,097 |
| 1976 | 154 | 610 | 2,586 | 116 | 156 | 1,676 | 3,952 | 9,249 | | 18,498 |

*-NE = MA, RT, CT

+ Indicates less than 0.5 MT

Table 2. Percent commercial landings by state and gear type 1972 and 1973.*

| State | % Total Landings | | % State landings by gear | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Otter Trawl | | Pound Net ** | | Gill Net | | Haul Seine | | Hand Line | | Purse Seine | |
| | '72 | '73 | '72 | '73 | '72 | '73 | '72 | '73 | '72 | '73 | '72 | '73 | '72 | '73 |
| MA | <0.1 | <0.1 | 100.0 | 67.9 | -- | 32.1 | -- | -- | -- | -- | -- | -- | -- | -- |
| RI | 1.1 | 1.1 | 22.1 | 16.8 | 71.2 | 82.2 | -- | -- | -- | -- | 0.5 | 1.1 | 6.2 | -- |
| CT | -- | <0.1 | -- | 84.3 | -- | -- | -- | -- | -- | 15.7 | -- | -- | -- | -- |
| NY | 11.5 | 7.8 | 19.8 | 29.2 | 17.3 | 24.3 | 19.3 | -- | 32.7 | 35.2 | 10.9 | 11.4 | -- | -- |
| NJ | 20.0 | 15.8 | 73.5 | 67.8 | 7.5 | 7.9 | 17.9 | 23.7 | -- | -- | 1.1 | 0.5 | -- | 0.1 |
| DE | 2.6 | 2.1 | -- | -- | -- | -- | 93.1 | 95.4 | -- | -- | 6.9 | 4.6 | -- | -- |
| MD | 2.0 | 3.3 | 83.0 | 91.3 | 9.0 | 4.7 | 6.9 | 3.1 | 1.1 | 0.7 | 0.1 | 0.1 | -- | -- |
| VA | 16.5 | 31.5 | 10.2 | 8.3 | 60.8 | 74.4 | 19.6 | 10.8 | 9.1 | 6.1 | 0.3 | 0.4 | -- | --- |
| NC | 46.4 | 38.4 | 89.7 | 81.5 | 0.8 | 1.9 | 5.7 | 6.0 | 3.9 | 10.7 | -- | -- | -- | -- |
| TOTAL | 100.1 | 100.0 | 62.2 | 50.2 | 14.8 | 28.4 | 14.2 | 11.5 | 7.1 | 8.8 | 1.7 | 1.2 | 0.1 | <0.1 |

* - latest available figures

** - includes floating trap and fyke net

Table 3. Instantaneous total mortality rate (z) calculated from slope of regression line fitted to catch at age data for Middle Atlantic Bight Weakfish.

| Data | Age at Selection | Z | r* |
|---|---|---|---|
| 1976 NJ Fall Creel Survey | 1 | 0.353 | 0.9562 |
| | 2 | 0.405 | 0.9344 |
| | 3 | 0.436 | 0.9257 |
| | 4 | 0.470 | 0.8848 |
| | 5 | 0.658 | 0.9062 |
| 1976 NMFS Fall Trawl Survey | 1 | 0.705 | 0.9236 |
| | 2 | 0.733 | 0.9704 |
| | 3 | 0.645 | 0.9549 |
| | 4 | 0.523 | 0.9184 |
| | 5 | 0.752 | 0.9664 |

* - correlation coefficient of fitted line

*Table 4.* Yield-per-recruit (g) for various instantaneous rates of fishing and natural mortality (F,M) and ages at first selection ($t_c$) for weakfish in the Middle Atlantic Bight*

| | $t_c$ = 0.5 | | | $t_c$ = 1.0 | | | $t_c$ = 1.5 | | | $t_c$ = 2.0 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | M= .2 | .3 | .4 | .2 | .3 | .4 | .2 | .3 | .4 | .2 | .3 | .4 |
| 0.1 | 243 | 155 | 101 | 255 | 162 | 106 | 264 | 166 | 108 | 269 | 167 | 107 |
| 0.2 | 317 | 208 | 141 | 348 | 228 | 153 | 377 | 244 | 163 | 399 | 255 | 167 |
| 0.3 | 320 | 216 | 150 | 368 | 248 | 172 | 415 | 227 | 189 | 456 | 299 | 200 |
| 0.4 | 296 | 206 | 147 | 356 | 247 | 175 | 418 | 286 | 200 | 474 | 318 | 218 |
| 0.5 | 264 | 188 | 138 | 333 | 236 | 172 | 405 | 284 | 203 | 474 | 324 | 227 |
| 0.6 | 232 | 170 | 127 | 306 | 223 | 166 | 386 | 276 | 202 | 464 | 324 | 230 |
| 0.7 | 203 | 152 | 117 | 280 | 208 | 158 | 366 | 267 | 198 | 450 | 320 | 231 |
| 0.8 | 179 | 137 | 107 | 257 | 195 | 150 | 346 | 257 | 194 | 435 | 314 | 230 |
| 0.9 | 158 | 123 | 97 | 236 | 182 | 143 | 327 | 247 | 189 | 421 | 308 | 228 |
| 1.0 | 140 | 111 | 89 | 218 | 171 | 136 | 311 | 238 | 184 | 407 | 301 | 225 |

*underlined values indicate $Y/R_{max}$

Figure 1. Length frequencies from NMFS survey data, 1972-1976.

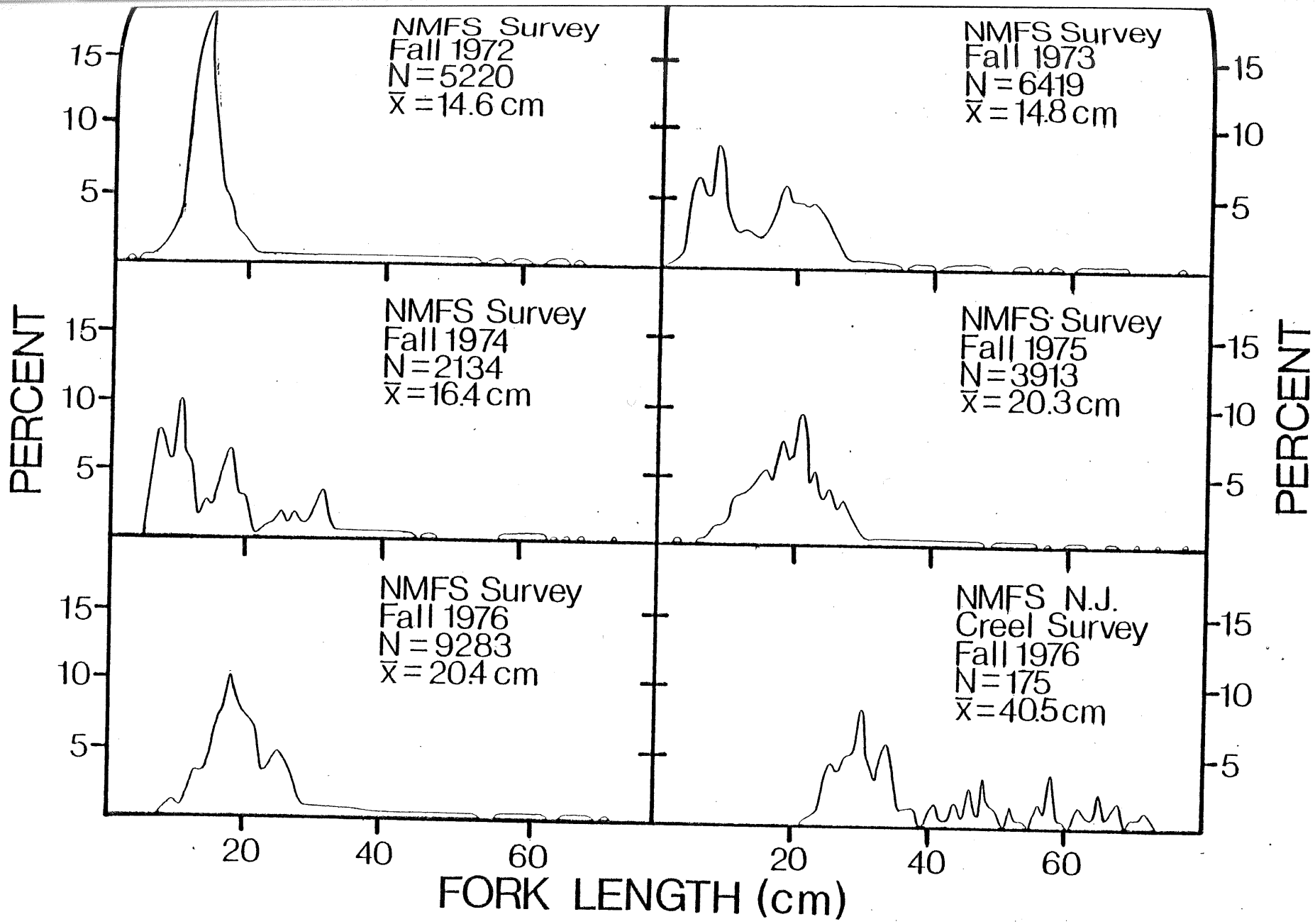
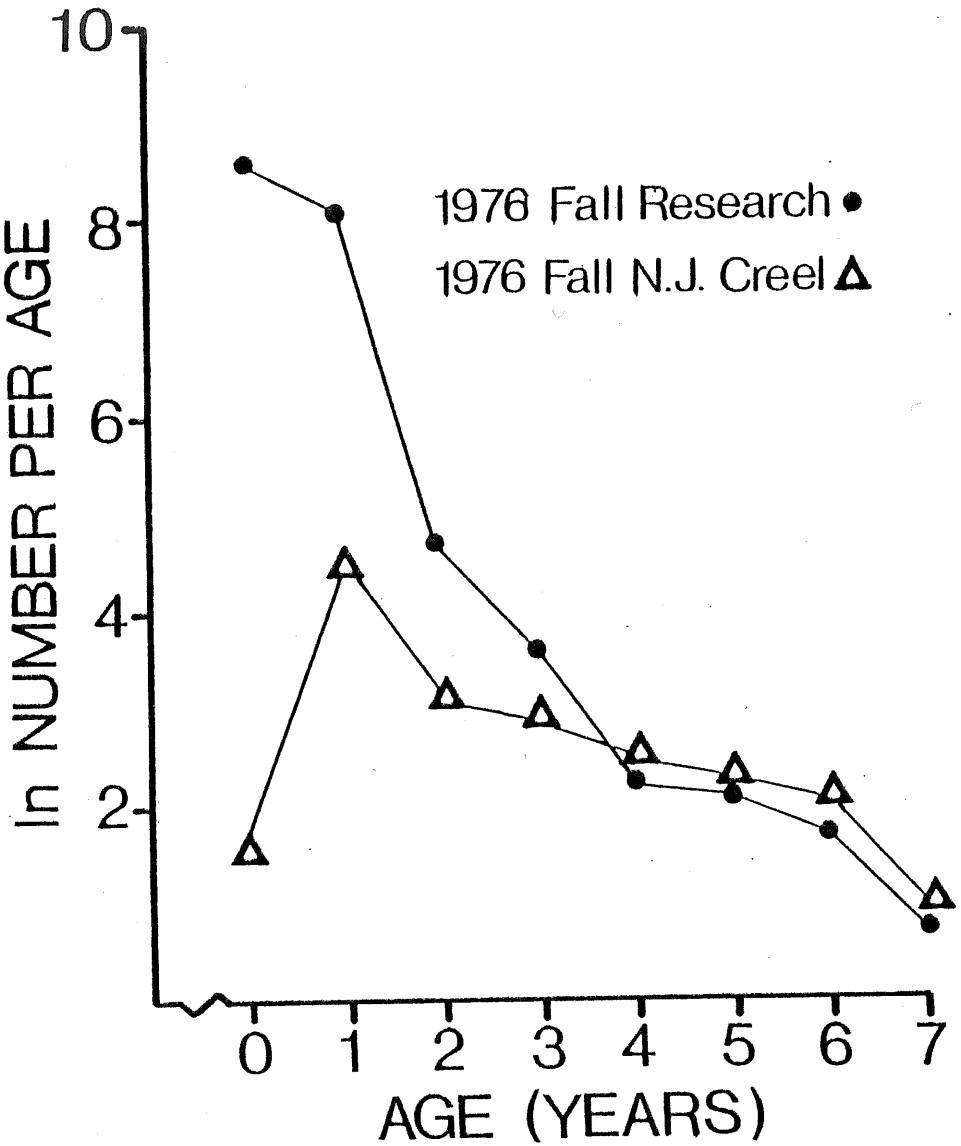

NMFS Survey
Fall 1972
N=5220
x̄=14.6 cm
NMFS Survey
Fall 1973
N=6419
x̄=14.8 cm
NMFS Survey
Fall 1974
N=2134
x̄=16.4 cm
NMFS Survey
Fall 1975
N=3913
x̄=20.3 cm
NMFS Survey
Fall 1976
N=9283
x̄=20.4 cm
NMFS N.J.
Creel Survey
Fall 1976
N=175
x̄=40.5 cm
PERCENT
PERCENT
15
10
5
20
40
60
FORK LENGTH (cm)

Figure 2. Catch curves from NMFS survey data, 1976.


10
8
6
4
2
ln NUMBER PER AGE
1976 Fall Research
1976 Fall N.J. Creel
0
1
2
3
4
5
6
7
AGE (YEARS)