NOAA Technical Memorandum NMFS-F/NEC-89

Proceedings of the NEFC/ASMFC Summer Flounder, *Paralichthys dentatus*, Aging Workshop, 11-13 June 1990, Northeast Fisheries Center Woods Hole, Mass.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Woods Hole, Massachusetts

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67. **Response of the Habitat and Biota of the Inner New York Bight to Abatement of Sewage Sludge Dumping. Second Annual Progress Report -- 1988.** By Environmental Processes Division, Northeast Fisheries Center. July 1989. vii + 47 p., 39 figs., 11 tables, 3 app. NTIS Access. No. PB90-125444/AS.

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NOAA Technical Memorandum NMFS-F/NEC-89

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Proceedings of the NEFC/ASMFC Summer Flounder, *Paralichthys dentatus*, Aging Workshop, 11-13 June 1990, Northeast Fisheries Center, Woods Hole, Mass.

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Woods Hole, Massachusetts

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i.a

NOTE ON SPECIES NAMES

The Northeast Fisheries Science Center's policy on the use of species names in technical publications and reports is to follow the American Fisheries Society's (AFS) lists of common and scientific names for fishes (Robins *et al.* 1991)[a], mollusks (Turgeon *et al.* 1988)[b], and decapod crustaceans (Williams *et al.* 1989)[c]. This policy applies to all issues of the *NOAA Technical Memorandum NMFS-F/NEC* series.

[a] Robins, C.R. (chair), R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1991. Common and scientific names of fishes from the United States and Canada, 5th ed. *Amer. Fish. Soc. Spec. Publ.* 20. 183 pp.

[b] Turgeon, D.D. (chair), A.E. Bogan, E.V. Coan, W.K. Emerson, W.G. Lyons, W.L. Pratt, C.F.E. Roper, A. Scheltema, F.G. Thompson, and J.D. Williams. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. *Amer. Fish. Soc. Spec. Publ.* 16. 277 pp.

[c] Williams, A.B. (chair), L.G. Abele, D.L. Felder, H.H. Hobbs, Jr., R.B. Manning, P.A. McLaughlin, and I. Pérez Farfante. 1989. Common and scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. *Amer. Fish. Soc. Spec. Publ.* 17. 77 pp.

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INTRODUCTION

A workshop to review methods and criteria for aging summer flounder, *Paralichthys dentatus*, cosponsored by the National Marine Fisheries Service's Northeast Fisheries Center[a] (NEFC) and the Atlantic States Marine Fisheries Commission was held at the NEFC's Woods Hole Laboratory during 11-13 June 1990. Attendees included representatives of the federal government and of agencies and/or universities in each of the coastal states from Massachusetts to North Carolina (see List of Participants). The workshop consisted of three sessions, with reviews of the use of age data in past assessments, population biology, and first-year growth presented during a plenary session on the first day. The second day was devoted entirely to a review of sample processing techniques and aging methods, and a final plenary session was held on the third day to discuss in detail the results of the previous day's aging session.

The workshop fulfilled a "special topic" recommendation by the Ninth NEFC Stock Assessment Workshop (SAW) (Northeast Fisheries Center 1989). During the Ninth SAW, members of the Summer Flounder Working Group indicated that there was confusion concerning aging interpretations utilized by age readers at the NEFC and in the Atlantic coastal states, particularly with conventions agreed upon at the 1980 Summer Flounder Age and Growth Workshop (Smith *et al.* 1981). The 1980 workshop was held after a review of the available literature on summer flounder age-and-growth parameters indicated that earlier studies were not in agreement. The Ninth SAW recommended that a second workshop be held to review current knowledge concerning the growth dynamics of the species and to confirm that all age readers were interpreting ages similarly.

There are two major differences between aging methods currently utilized and those methods reported during the 1980 workshop. First, scales are exclusively used now, whereas otoliths were used by most participants prior to 1980. Second, based on results of recent analyses, the first distinct annulus measured from the focus is now used to represent first-year growth. Prior to 1980, there had been considerable disagreement concerning the interpretation of the first opaque zone observed on otoliths. During the 1980 workshop, the major conventions agreed upon were: (1) "the first distinct opaque zone away from the core . . . [of the otolith is] . . . formed at age 2," and (2) the mean length at age 1 is about 170-180 mm (Smith and Daiber 1977). Participants at the 1980 workshop also agreed that data presented by Poole (1961) "represented an atypical[-]fast growing year class" since his data indicated that mean length at age 1 was about 251 mm. Recent studies, however, support Poole's observations that summer flounder exhibit very rapid growth in their first year and reach mean lengths of 250-320 mm at age 1 (Szedlmayer *et al.* 1992).

REVIEW OF AGE DATA USED IN PAST STOCK ASSESSMENTS

A review of age data utilized in analyses of the status of the summer flounder stock north of Cape Hatteras, North Carolina, was presented to demonstrate the effects on population dynamics parameters of incorrectly and/or inconsistently aged fish, and to describe to participants the chronology of aging interpretations utilized since the early 1980s. There have been four analyses of summer flounder stock status conducted at the NEFC. During the first assessment (Fogarty 1981), age data from the commercial fishery during 1976-79 and from NEFC bottom trawl surveys during 1976-81 were adjusted downward by one year (*i.e.*, one year was subtracted from all ages except age 1) in an attempt to conform with the 1980 workshop convention. In the second assessment (Northeast Fisheries Center 1986), the adjusted 1976-79 commercial fishery data and adjusted 1976-81 bottom trawl survey data were again used; in addition, 1982-86 survey data were also adjusted downward. In the third assessment, presented at the Ninth SAW in 1989, the adjusted 1976-79 data from both the commercial fishery and surveys were again used, but 1980-89 data were unadjusted, having been re-aged utilizing current information regarding first-annulus location. Prior to the fourth analysis, a 1990 assessment update, **all** age data utilized in the assessment were re-aged and are considered to be consistent.

Age-frequency distributions from NEFC spring and autumn bottom trawl survey data from 1975 to 1989 (Figures 1 and 2) indicate that individuals older than about age 5 have rarely been encountered by the survey gear. During the spring surveys, ages 1-2 have dominated the catches, with ages 3 and older rarely comprising greater than five percent of the total. Age 1 has generally been the dominant age in the autumn surveys, however, age 0 has made up a large proportion of the catch in some years (*i.e.*, 1989).

The age composition of the offshore commercial fishery was made up primarily of age 1-2 individuals (Figure 3) during 1982-89, with ages 3 and older generally comprising a small percentage of the total in each year. In 1982 and 1983, however, age 0 individuals made up 12 and 10 percent of the total, respectively. These young individuals, while often large enough to be included in the commercial catch, are generally not available to the offshore fleet due to their estuarine existence during their first year.

The effects of the changes in the age distributions on growth parameters and calculations of yield per recruit and instantaneous total mortality (Z) were also presented. The results of these comparative analyses indicated that there was little overall difference in the von Bertalanffy growth parameters (L_{inf}, t_0, and K) or F_{max} values between the three assessments, but that Z values presented at the Ninth SAW (Northeast Fisheries Center 1989) were significantly higher than those estimated in the 1986 assessment (Northeast

[a] On 28 July 1991, the Northeast Fisheries Center changed its name to Northeast Fisheries Science Center. The former name has been retained throughout the body of this report, though, since the workshop covered by the report was held prior to the name change.

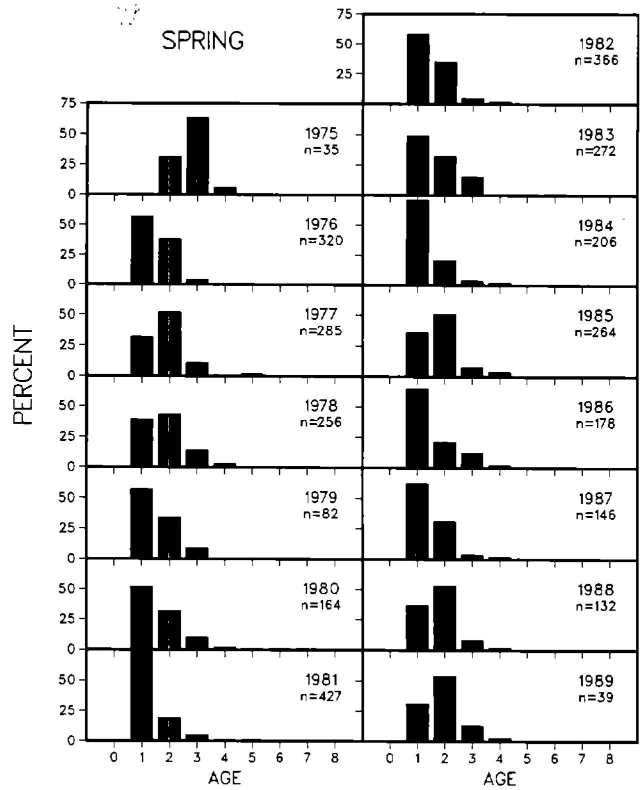

Figure 1. Age composition (percent) of NEFC spring bottom trawl survey samples of summer flounder during 1975-89.

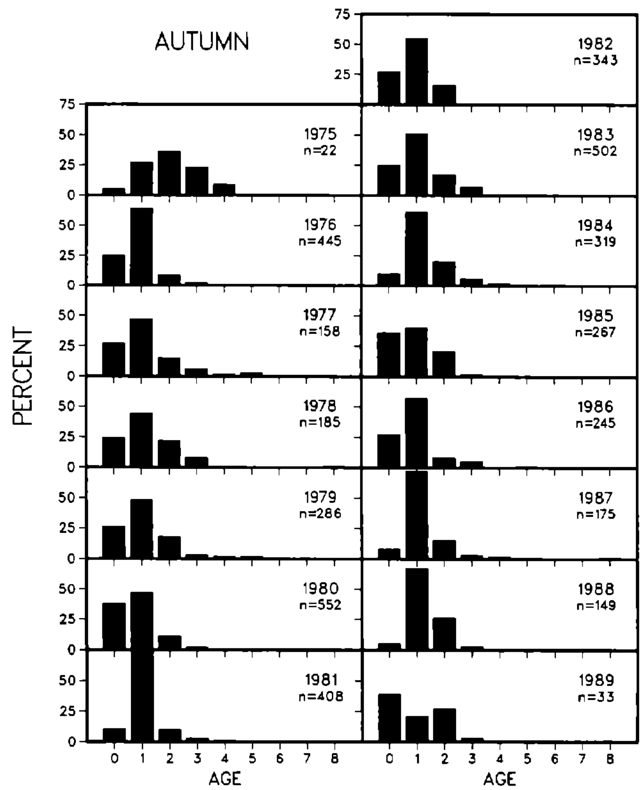

Figure 2. Age composition (percent) of NEFC autumn bottom trawl survey samples of summer flounder during 1975-89.

Fisheries Center 1986), indicating that fishing mortality levels may have been significantly higher than presented in the previous assessments. The implications of these results were not discussed at this workshop since a full review of the changes in fishing mortality was presented at the Ninth SAW.

SPAWNING TIMES AND LOCATIONS

Current knowledge of spawning periodicity and locations was discussed since it is apparent that the protracted spawning period of this species has had implications on the interpretation of ages for individuals from different areas. There have been several studies to describe the spawning periodicity and locations of summer flounder, including: (1) examination of the distribution of eggs and larvae from monthly surveys along the continental shelf (Herman 1963; Smith and Fahay 1970; Smith 1973); (2) calculation of "maturity indices" of ovary weight/total weight (Morse 1981); and (3) weekly, biweekly, and monthly seine, plankton, and trawl surveys in Middle Atlantic waters (Able *et al.* 1990; Monaghan 1990). Results of these studies indicate that, in general, summer flounder spawning occurs over a very wide area from Georges Bank to Cape Hatteras and from inshore to the edge of the continental shelf. Smith (1973) indicated that the area of greatest abundance of eggs

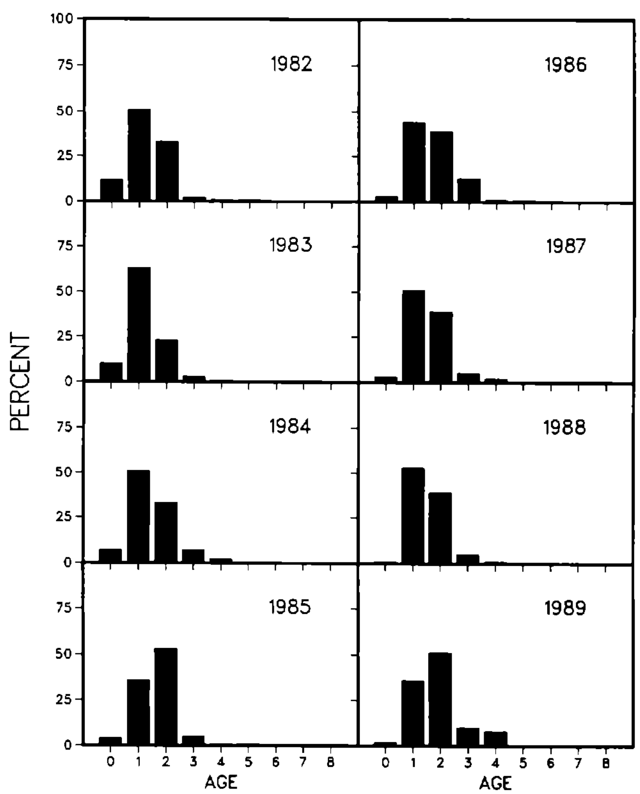

Figure 3. Age composition (percent) of offshore commercial fishery samples of summer flounder during 1982-89.

and larvae during 1965-66 was off the New York-New Jersey coast; however, Able *et al.* (1988) indicated that the center of reproduction during 1980-86 was from New York to Massachusetts.

Spawning begins in the northern areas (Georges Bank and Southern New England waters) as early as September, occurs progressively later further south, and continues as late as March off Virginia and North Carolina. In the northern region, peak spawning occurs in October-November. In North Carolina waters, where the season extends from November to March, peak spawning occurs during the last part of December (R. Monaghan, pers. comm.[b]). It was evident from discussions during the workshop that uncertainty remains concerning spawning behavior of summer flounder, and that additional information defining more specific areas and timing of spawning for this species is necessary.

FIRST-YEAR GROWTH

A comprehensive study of first year growth and mortality was recently conducted by Szedlmayer *et al.* (1992), a summary of which was presented at the workshop. The objectives of their study were to determine growth and mortality rates of young-of-the-year summer flounder in a New Jersey estuary which was assumed to be representative of the species' estuarine nursery areas. Extensive biweekly and monthly sampling was carried out in the study area with a variety of gear types (*e.g.*, plankton nets, otter trawls, block nets) from November 1988 to October 1989 to document the growth of a single year class during their first year of life. For each successive sampling period, a single length mode was observed that increased in size over the previous period clearly demonstrating that a single, fast-growing cohort was being sampled (Figure 4). Initial samples consisted of metamorphosing larvae that entered the estuary in the winter and early spring (spawned in late autumn); individual fish reached lengths of 200-300 mm total length by the next autumn. None of the larger fish examined had an annulus on either their scales or otoliths. The report also indicated that summer flounder grew at a rate of approximately 2 mm per day during mid-June to early September, one of the fastest rates for juvenile fish reported in the literature. These conclusions are corroborated by data collected during monthly trawl surveys and tagging studies in the Chesapeake Bay area conducted by the Virginia Institute of Marine Science during 1986-89, and by length-frequency data collected during monthly surveys in the Albemarle-Pamlico Sound region conducted by the North Carolina Division of Marine Fisheries during 1987-89.

The results of these studies show that summer flounder inhabiting estuarine areas of the Middle Atlantic states during their first winter can attain lengths of up to at least 300 mm, in support of Poole's (1961) conclusions.

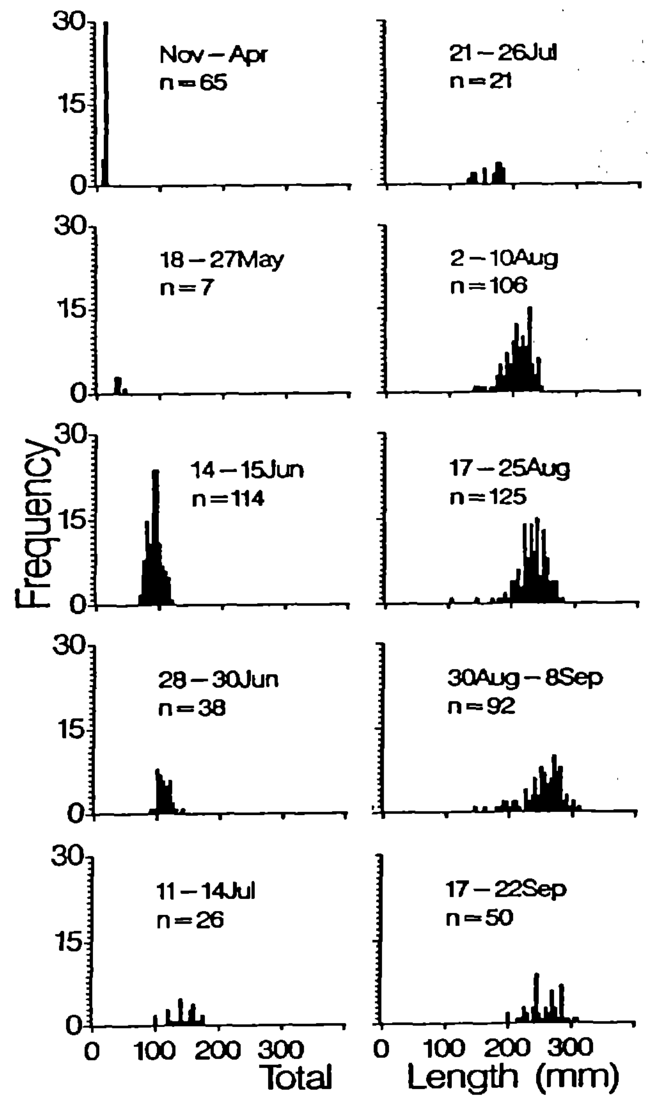

Figure 4. Length-frequency distributions of young-of-the-year summer flounder collected during 1988-89 sampling in a New Jersey estuary (from Szedlmayer *et al.* 1992).

PROCESSING AND AGING METHODS

During the second day of the workshop, processing methods were examined in detail. Participants agreed that sound processing techniques are necessary in order to provide the age reader with a clear view of annuli and to enable the reader to distinguish these marks from checks or false annuli. All of the participants currently utilize scale impressions when aging summer flounder; the validity of using this structure was provided in Shepherd (1980). The technique for preparing scale impressions is as follows (from Penttila and Dery 1988): after placing several scales, sculptured side up, on a heavy base slide of 1-mm (0.04-inch) thick cellulose acetate, a plastic laminated slide, soft side down, is placed over the scales. A second heavy plastic

[b] North Carolina Division of Marine Fisheries, Morehead City, NC.

Table 1. Regions from which representative samples of summer flounder scales were examined, and the agencies/institutions which supplied those samples

Region	Agency/Institution
Cape Cod - Cape Hatteras	Northeast Fisheries Center
Cape Cod area	Massachusetts Division of Marine Fisheries
Middle Atlantic Bight	New York Department of Environmental Conservation
Long Island Sound	Connecticut Department of Environmental Protection
Virginia	Virginia Marine Resources Commission
Delaware - Cape Hatteras	Virginia Institute of Marine Science
North Carolina	North Carolina Division of Marine Fisheries

slide is then placed over the laminate, and the "sandwich" of slides is rolled through a jeweler's press. The heavy acetate slides act as cushions to equalize the pressure over thin and thick areas of the scales, resulting in a more uniform impression. The impressing procedure, when done in a smooth, continuous motion, avoids distortions on the laminate and provides a clear view of annuli required to age this species.

Following the review of sample processing techniques, participants examined representative samples (approximately 150-200 individuals) from the entire range of the species' distribution (Table 1).

Aging criteria for summer flounder provided in Dery (1988) were accepted by the workshop participants. Major elements are as follows:

- Annuli consist of cutting-over or erosion marks on the scale. A cutting-over mark must be continuous and intersect the ctena to be interpreted as a true annulus. Ctenii only may be used as an area of last resort on scales that are difficult to age.

- Circulus spacing is **not** used as a criterion for annulus interpretation.

- The first annulus is interpreted as the first continuous cutting-over mark formed on the scale.

- For summer flounder in more northerly waters (*e.g.*, off Southern New England and New Jersey), the distance from the focus to the first annulus is relatively great, reflecting 18 to 21 months of growth from hatching to formation of the first cutting-over mark (second spring following hatching) (Figures 5 and 6). Annulus formation generally occurs in late spring - early summer in this region.

- Further south, with a later spawning season, the distance from the focus to the first annulus is diminished, reflecting 10-16 months of growth (Figures 7 and 8). In this region, annulus formation may occur as early as January or February.

Table 2. Mean lengths (cm) at age for male and female summer flounder collected in Northeast Fisheries Center spring and autumn bottom trawl surveys during 1975-89

Sex	Age					
	0	1	2	3	4	5
			Spring Surveys			
Male	-	26.4	35.5	43.6	49.8	50.0
Female	-	26.5	39.2	46.5	56.4	60.7
			Autumn Surveys			
Male	26.6	34.8	41.1	47.3	50.7	53.7
Female	26.2	38.2	46.8	54.1	59.0	66.6

Mean lengths at age from samples collected during NEFC bottom trawl surveys in the spring and autumn, following the standard convention of a common January 1 birthdate, demonstrate the rapid growth of this species. Table 2 lists mean lengths at age from combined 1975-89 surveys, showing that females grow faster and attain greater lengths than males.

CONCLUSIONS

During the plenary session held on the third day of the workshop, participants agreed on the following general conclusions:

1. There is consistency in aging techniques and interpretations for summer flounder throughout the coastal

Figure 5. Scale impression of a 26-cm, age-1 summer flounder collected in May from northern waters [Figure 4 from Dery (1988)].

Figure 6. Scale impression of a 31-cm, age-2 summer flounder collected in March from waters off the New Jersey coast [Figure 7 from Dery (1988)].

Figure 7. Scale impression of a 61-cm, age-4 summer flounder collected in May from waters off the New Jersey coast [Figure 12 from Dery (1988)].

Figure 8. Scale impression of a 38-cm, age-2 summer flounder collected in May from southern waters [Figure 6 from Dery (1988)].

state & federal agencies and universities conducting research on this species. This consistency may preclude the need for formal age structure exchanges; however, informal interactions between neighboring states are encouraged to ensure that aging reliability is maintained.

2. Recent studies have established that first-year growth of this species is extremely rapid, explaining the confusion during the 1980 Summer Flounder Age and Growth Workshop concerning the interpretation of first annulus location.

3. There is still some uncertainty concerning the spawning time of summer flounder in northeastern waters which may confound some studies, *e.g.*, species/stock distribution; however, this uncertainty does not affect aging interpretations.

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68. **MARMAP Surveys of the Continental Shelf from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia (1984-87). Atlas No. 3. Summary of Operations.** By John D. Sibunka and Myron J. Silverman. July 1989. iv + 197 p., 36 figs., 2 tables. NTIS Access. No. PB90-160656/AS.

69. **The 1988 Experimental Whiting Fishery: A NMFS/Industry Cooperative Program.** By Frank P. Almeida, Thurston S. Burns, and Sukwoo Chang. August 1989. v + 16 p., 9 figs., 11 tables, 1 app. NTIS Access. No. PB90-160664/AS.

70. **Summer Distribution of Regulated Species on Georges Bank with Reference to the 1988 Experimental Whiting Fishery.** By Frank P. Almeida, Sukwoo Chang, and Thurston S. Burns. September 1989. v+ 25 p., 74 figs., 1 table. NTIS Access. No. PB90-206525/AS.

71. **Allocation of Statewide-Reported MRFSS Catch and Landings Statistics between Areas: Application to Winter Flounder**. By Frank P. Almeida. September 1989. v + 18 p., 5 figs., 6 tables, 2 app. NTIS Access. No. PB90-246745.

72. **Status of the Fishery Resources off the Northeastern United States for 1989.** By Conservation and Utilization Division, Northeast Fisheries Center. December 1989. iv + 110 p., 50 figs., 93 tables. NTIS Access. No. PB90-170622/AS.

73. **Surface and Bottom Temperature Distribution for the Northeast Continental Shelf.** By David G. Mountain and Tamara J. Holzwarth. December 1989. iii + 32 p., 31 figs. NTIS Access. No. PB90-252172/AS.

74. **Shell Disease of Crustaceans in the New York Bight.** By C.J. Sindermann (chair.), F. Csulak (EPA coord.), T.K. Sawyer (rapp.), R.A. Bullis, D.W. Engel, B.T. Estrella, E.J. Noga, J.B. Pearce, J.C. Rugg, R. Runyon, J.A. Tiedemann, and R.R. Young. December 1989. vii + 47 p., 7 figs., 4 tables, 4 app. NTIS Access. No. PB90-195058/AS.

75. **An Indexed Bibliography of Northeast Fisheries Center Publications and Reports for 1988.** By Jon A. Gibson. December 1989. iii + 32 p. NTIS Access. No. PB91-112912.

76. **Finfish Maturity Sampling and Classification Schemes Used during Northeast Fisheries Center Bottom Trawl Surveys, 1963-89.** By Jay Burnett, Loretta O'Brien, Ralph K. Mayo, Jeffrey A. Darde, and Margot L. Bohan. December 1989. iii+14 p., 11 tables, 1 app. NTIS Access. No. PB91-128389/AS.

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