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Seattle, Washington

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ABSTRACT

Summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, cooccur within the Middle Atlantic Bight and off southern New England and are important components of commercial and recreational fisheries. The commercial otter trawl fishery for these species is primarily a winter fishery, whereas the recreational fishery takes place between late spring and autumn. The otter trawl fishery generally targets summer flounder, and less frequently scup, while black sea bass occurs as bycatch. Trips in which all three species were present yielded highest aggregate landings per unit of effort (LPUE) levels and occurred more often than trips landing only one or two species. More than 50% of the trips in the trawl fishery landed at least two of the three species. In contrast, greater than 75% of the recreational landings of each species occurred as a result of trips landing only one species. Differences in the fisheries resulted from the interactions of seasonal changes in species distributions and gear selectivity.

Introduction

Fisheries managers have become increasingly aware of the need to manage fisheries as mixed species assemblages rather than as single species stocks (Brown et al., 1976; Dickie and Kerr, 1982; Kerr and Ryder, 1989). Multispecies fisheries may be examined from the perspective of biological interactions or technological interactions, defined as the relationship between a mixed species resource and fishing gear (Pope, 1979). A fishery may be directed toward one species, but any fish caught that has some economic value is likely to be landed. Consequently, management strategies must consider technological interactions to provide effective conservation measures.

Within the Middle Atlantic Bight and southern New England waters (Fig. 1), summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, support important commercial and recreational fisheries (U.S. Department of Commerce, 1991a). The commercial fishery in the Middle Atlantic Bight and southern New England involves several gear types. For each of the three species, the otter trawl produces >60% of total landings. Significant landings of scup are also made by pound nets and floating trap nets (U.S. Department of Commerce, 1991a; Mayo[1]), while fish traps are effective for both black sea bass and scup (June and Reintjes, 1957; Frame and Pearce, 1973; Eklund and Targett, 1991). The inshore fish trap fishery, which occurs between late spring and late autumn, is most species-specific, because greater than 96% of the total catch consists of black sea bass (June and Reintjes, 1957; Eklund and Targett, 1991).

Commercial U.S. landings of summer flounder, scup, and black sea bass have fluctuated widely over the past forty years (U.S. Department of Commerce, 1991a; Fig. 2). Landings of scup changed most dramatically, consistently ranging from 15,000 to 20,000 metric tons (t) between 1950 and 1965 but decreasing to an average of

[1] Mayo, R. K. 1982. An assessment of the scup, *Stenotomus chrysops* (L.), population in the southern New England and Mid-Atlantic regions. Northeast Fisheries Center, National Marine Fisheries Service, NOAA, Woods Hole, MA. Woods Hole Lab. Ref. Doc. 82-46, 59 p.

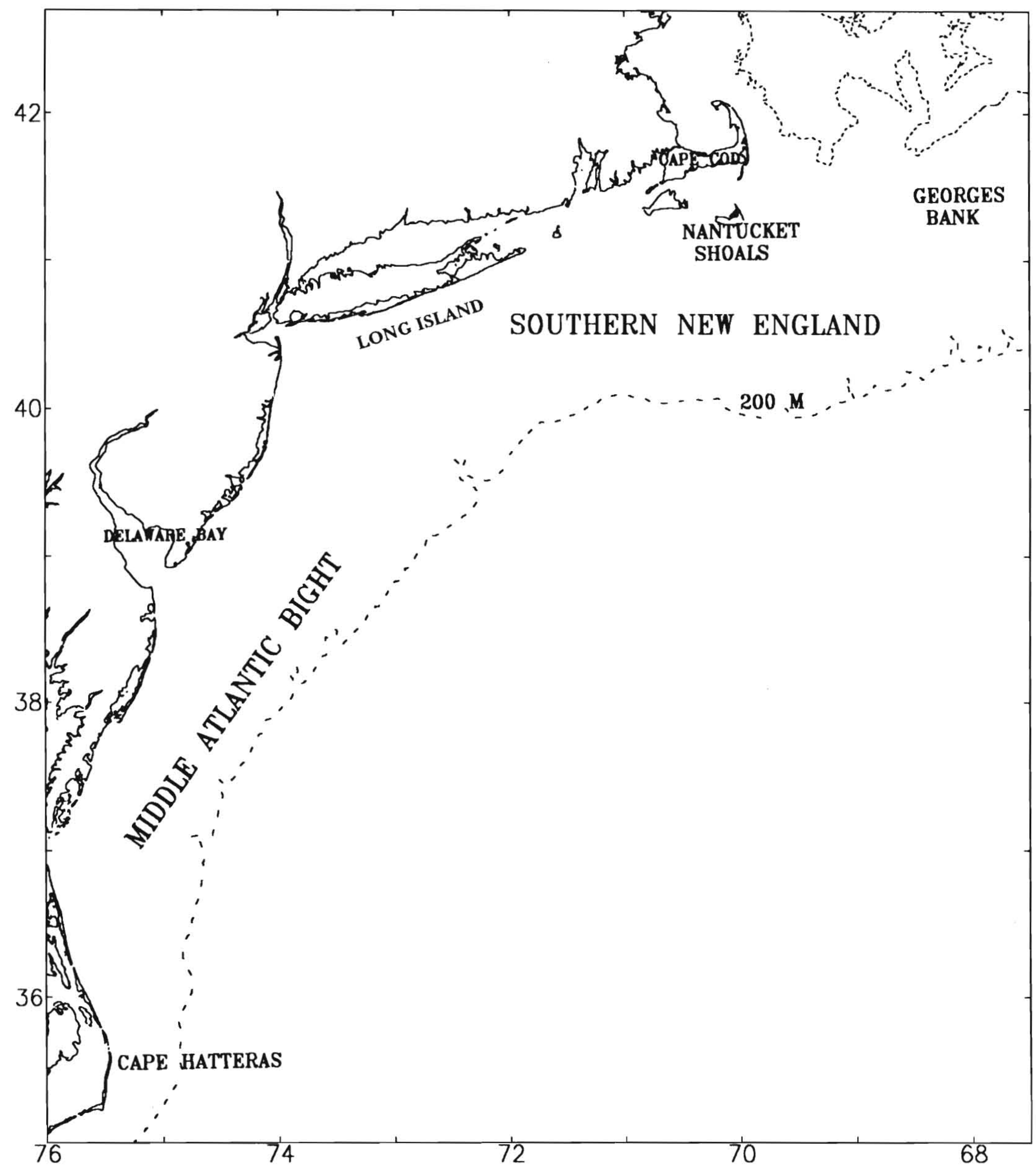

Figure 1
Geographic features of the Middle Atlantic Bight and southern New England area.

5,000 t in the early 1970's (Mayo[1]). Although landings increased during the late 1970's and early 1980's to 8,000–10,000 t, they have since steadily declined to 4,200 t in 1990 (U.S. Department of Commerce, 1991a). Landings of black sea bass have fluctuated between 1,000 and 2,000 t since the mid 1960's (1,500 t in 1990), although landings were as high as 9,900 t in 1952 (Kendall[2]). Landings of summer flounder were generally stable between 7,000 and 10,000 t from 1950 to 1962 but declined to 3,000 t by 1969 (U.S. Department of Commerce, 1991a). Although highly variable from year to year, landings increased until 1988. Summer flounder landings have declined to about 6,000 t since 1988 (U.S. Department of Commerce, 1991a).

Estimates of recreational landings for all three species have varied considerably over the last twelve years (Fig. 3). Summer flounder landings declined dramatically from a peak of 16,000 t in 1983 to a record low

[2] Kendall, A. W., Jr. 1977. Biological and fisheries data on black sea bass, *Centropristis striata* (Linnaeus). Northeast Fisheries Center, National Marine Fisheries Service, NOAA, Sandy Hook Lab., Highlands, NJ. Tech. Sers. Rpt. 7., 29 p.

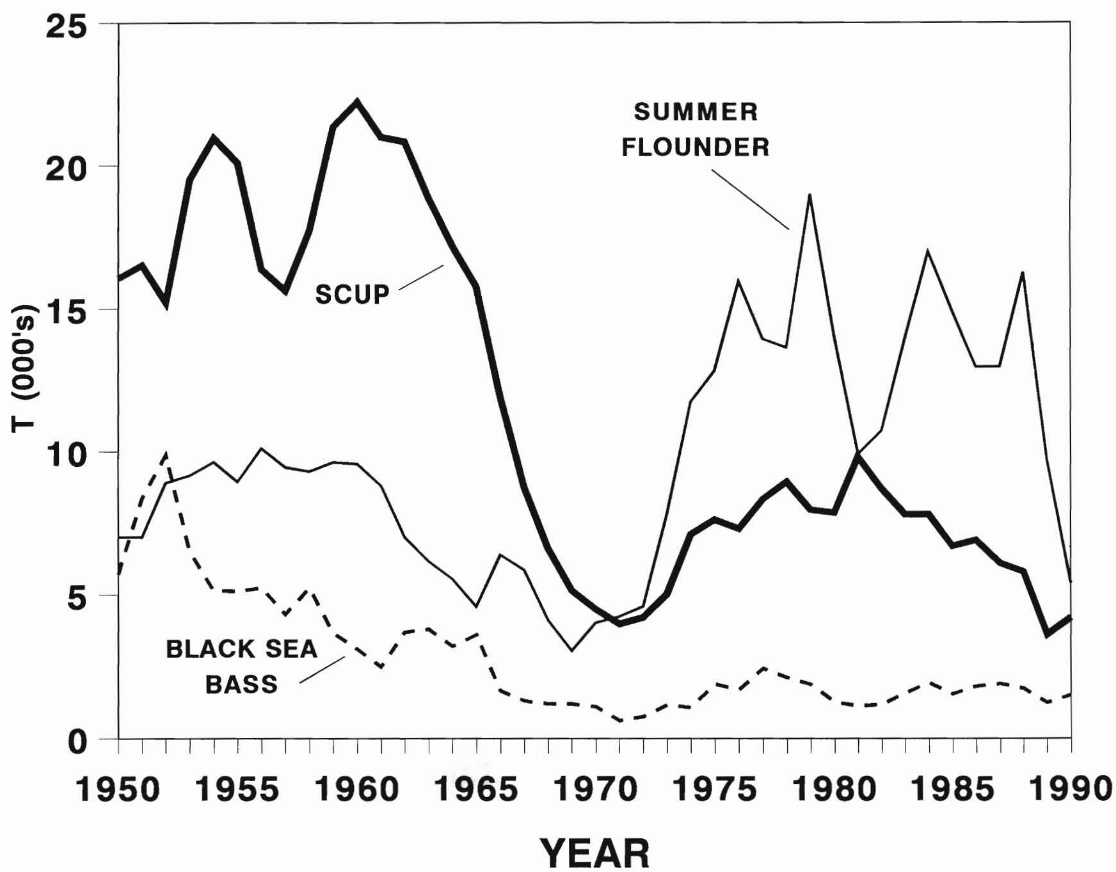

Figure 2

Annual commercial landings (thousands of t) of summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, 1950–1990.

level of 1,600 t in 1989 (U.S. Department of Commerce, 1991a). Black sea bass landings were 8,100 t in 1982 and 6,300 t in 1986 but have otherwise been consistently around 1,000 to 2,000 t annually (U.S. Department of Commerce, 1991a). Scup landings varied between 2,000 and 4,000 t annually with the exception of 1986 when landings reached 5,500 t (U.S. Department of Commerce, 1991a).

Fluctuations in recreational landings may partially reflect changes in fishing effort. Total trips that targeted one of the three species varied from 4.9 million trips per year in 1986 to 2.8 million trips per year in 1989 (U.S. Department of Commerce, 1991b). The recreational fishery has been primarily a boat-based fishery. Approximately 70% of the trips occur on party, charter, or private boats, with the remaining 30% of trips from shore (U.S. Department of Commerce, 1991b).

Spatial cooccurrence and feeding habits across two decades of studies suggest that summer flounder, scup, and black sea bass form a consistent assemblage of interacting species. Patterns of cooccurrence among the three species have been previously documented. Musick and Mercer (1977) examined faunal associations in the Middle Atlantic Bight using fishery-independent otter trawl data and found a statistically significant cooccurrence among summer flounder, scup, and black sea bass. Gabriel (1989) used cluster analysis to categorize multispecies assemblages between North Carolina and Nova Scotia and also identified an association among summer flounder, scup, and black sea bass.

In addition to spatial overlap, diets overlap among summer flounder, scup, and black sea bass. Smaller individuals feed primarily on benthic worms, crustaceans, and molluscs, whereas larger individuals may also consume small fishes (Bigelow and Schroeder, 1953; Steimle and Ogren, 1982; Mack and Bowman[3]). This dietary overlap indicates that these species occupy similar trophic niches. Although the potential for biologi-

[3] Mack, R.G., and R.E. Bowman. 1983. Food and feeding of black sea bass. Northeast Fisheries Center, National Marine Fisheries Service, NOAA, Woods Hole, MA. Woods Hole Lab. Ref. Doc. 83-45, 20 p.

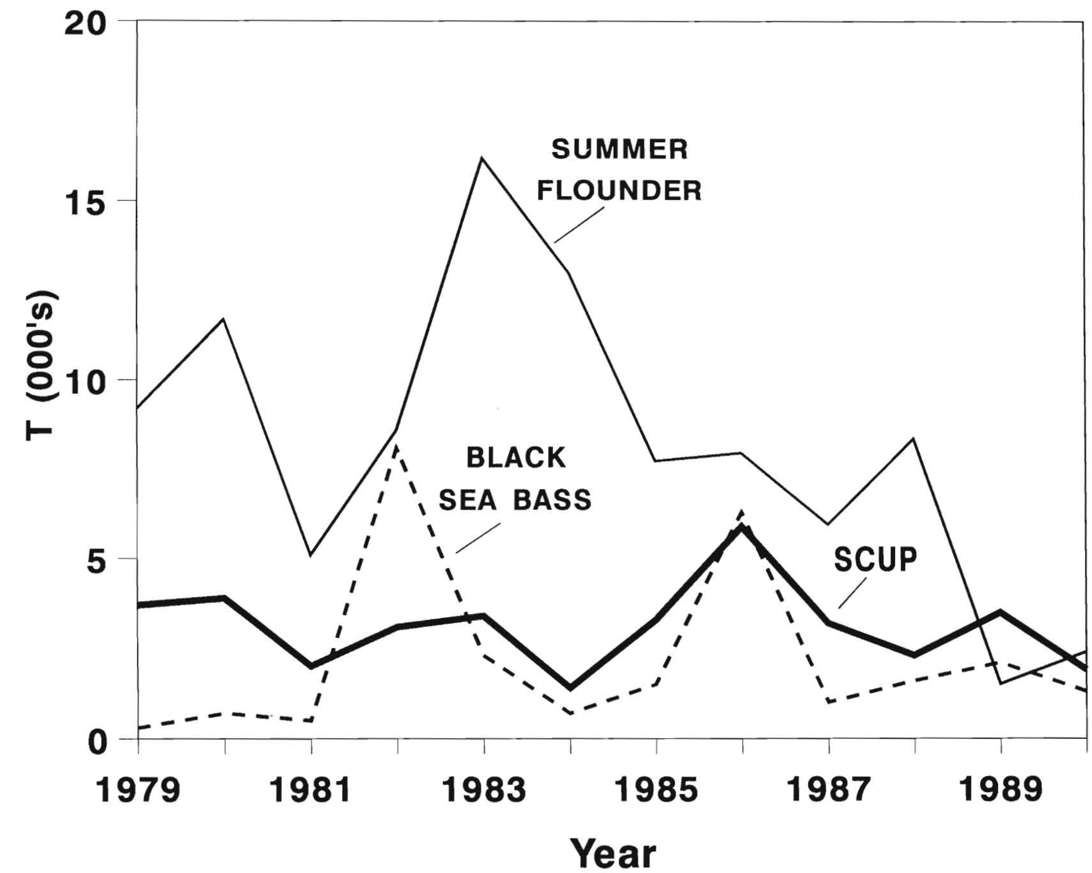

Figure 3
Annual recreational landings (thousands of t) of summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, in the Middle Atlantic Bight and southern New England area, 1979–1990.

cal interactions among the three species has been established, understanding the multispecies nature of the fisheries is necessary to establish a basis for management. The characteristics of single-species commercial and recreational fisheries for summer flounder, scup, and black sea bass have been previously described (Nesbit and Neville, 1935; June and Reintjes, 1957; Jensen, 1974; Murawski et al., 1983), but the multispecies aspect of the fishery has never been examined in detail. Our objectives were 1) to describe the geographic and seasonal nature of the commercial otter trawl and recreational hook-and-line fisheries for summer flounder, scup, and black sea bass in the Middle Atlantic Bight and southern New England and 2) to characterize the technological interactions within those fisheries.

Methods

Fishery-independent data were collected during Northeast Fisheries Science Center (NEFSC) biannual bottom trawl surveys conducted between the Gulf of Maine and Cape Hatteras, North Carolina. Sampling tows were conducted in depths from 9 to 366 m at locations chosen in a stratified random survey design. At each sampling location, individual fish lengths (total length) and total weight of the catch were recorded for each species. Survey history and methodological details were summarized by Azarovitz (1981) and the U.S. Department of Commerce (1988). Species distributions based on survey data were examined for the years 1982 to 1990.

Commercial landings data were collected by trip at various ports from Maine to Virginia by the NEFSC. Data on species composition and weight of the landed catch (kg), effort (days fished), area and depth fished (m), and vessel characteristics (i.e. gross tonnage and gear characteristics) were collected from dealer slips (weighouts) and captain interviews (Burns et al., 1983). Interviews also provided information on targeted species that ranged from species-specific targets (i.e. summer flounder) to general categories (i.e. flatfish). Only trips that landed at least one of the three species were included in the analysis. We confined our analysis to data collected between 1982 and 1990 because data were not collected from Maryland and Virginia ports before 1982. Landings per unit of effort (LPUE) was calculated for trips as

$$\text{LPUE} = \frac{\text{fish landed per trip (kg)}}{\text{days fished (df)}}$$

where

$$\text{fish landed} = \text{fish caught} - \text{fish discarded},$$

and

$$\text{days fished} = \frac{\text{hours towed per trip}}{24}.$$

Geographic distribution of commercial landings were aggregated to the nearest 10'×10' square for each quarter of 1987–1989.

Commercial catch data for individual tows were collected by observers on 130 commercial otter trawl trips during 1989 and 1990. Trips that included an onboard observer were not interviewed by a port agent and included in weighout-based LPUE estimates. Species composition and weight of the discarded portion, tow location and depth, tow duration, characteristics of the gear and vessel, and environmental conditions during the tow were recorded. Tow duration was scaled to a 24-hour time period to equate a unit of effort on a per tow basis with total trip effort. Because the entire catch was sampled rather than the landed catch, catch per unit of effort (CPUE) of individual tows was calculated as

$$\text{CPUE} = \frac{\text{fish caught per tow (kg)}}{\text{tow duration (h/24)}}$$

where

$$\text{fish caught} = \text{fish landed} + \text{fish discarded},$$

and

$$\text{tow duration} = \frac{\text{hours towed per haul}}{24}.$$

Only tows that were examined by the observer and that included any one of the three species were analyzed.

Information on recreational fisheries along the Atlantic coast has been collected annually since 1979 by the National Marine Fisheries Service as part of the Marine Recreational Fisheries Statistics Survey (MRFSS) program. The survey, conducted in bimonthly intervals, estimated catches by species with data collected during dockside interviews (intercepts) and telephone surveys (U.S. Department of Commerce, 1991b). Anglers were considered participants in a summer flounder–scup–black sea bass fishery if they caught any one of the three species during a trip, similar to the criteria used for the commercial fisheries. Following the U.S. Department of Commerce (1991b), CPUE was calculated from intercept data as

$$\text{CPUE} = \frac{\text{number of fish caught}}{\text{angler trip}}$$

where

$$\text{angler trip} = \text{number of anglers per interviewed trip.}$$

Results

Seasonal Distribution

Data collected during the NEFSC spring and autumn bottom trawl surveys show a seasonal shift in distribution for all three species from offshore in the spring to inshore in the autumn (Fig. 4). Scup were distributed along the 200-m contour between Cape Cod, Massachusetts, and Cape Hatteras, North Carolina, during spring. Black sea bass occupied the same area but also occurred further inshore, particularly south of Delaware Bay, while summer flounder were dispersed across the continental shelf. By early autumn, all three species were aggregated in coastal waters and their distributions overlapped extensively. All three species may also be distributed in deeper water (i.e. > 366 m) beyond the area covered by the bottom trawl survey.

Commercial Fishery

The distribution of the commercial fishery was consistent with species distributions based on fishery-independent survey data. Seasonal distribution of commercial landings for all species are presented in Figure 5. During winter (January–March), the fishery operated along the edge of the continental shelf, most frequently south of Nantucket Shoals (Fig. 5). Summer flounder landings were from areas farther north and east than those of scup or black sea bass. An increase in landings of all species in coastal waters began during the spring (April–June), particularly toward Long Island and Nantucket Shoals (Fig. 5). Summer flounder landings also increased from areas further east onto Georges Bank. By summer (July–September), the frequency of trawl landings for all species declined as the fish were distributed further inshore and presumably into areas less accessible to large otter trawlers (Fig. 5). Autumn (October–December) was a transitional period when all three species migrated towards offshore wintering grounds along the shelf edge; landings for all species were generally distributed across the shelf during this period (Fig. 5).

Average monthly landings based on commercial weighout data also reflected the seasonal nature of the

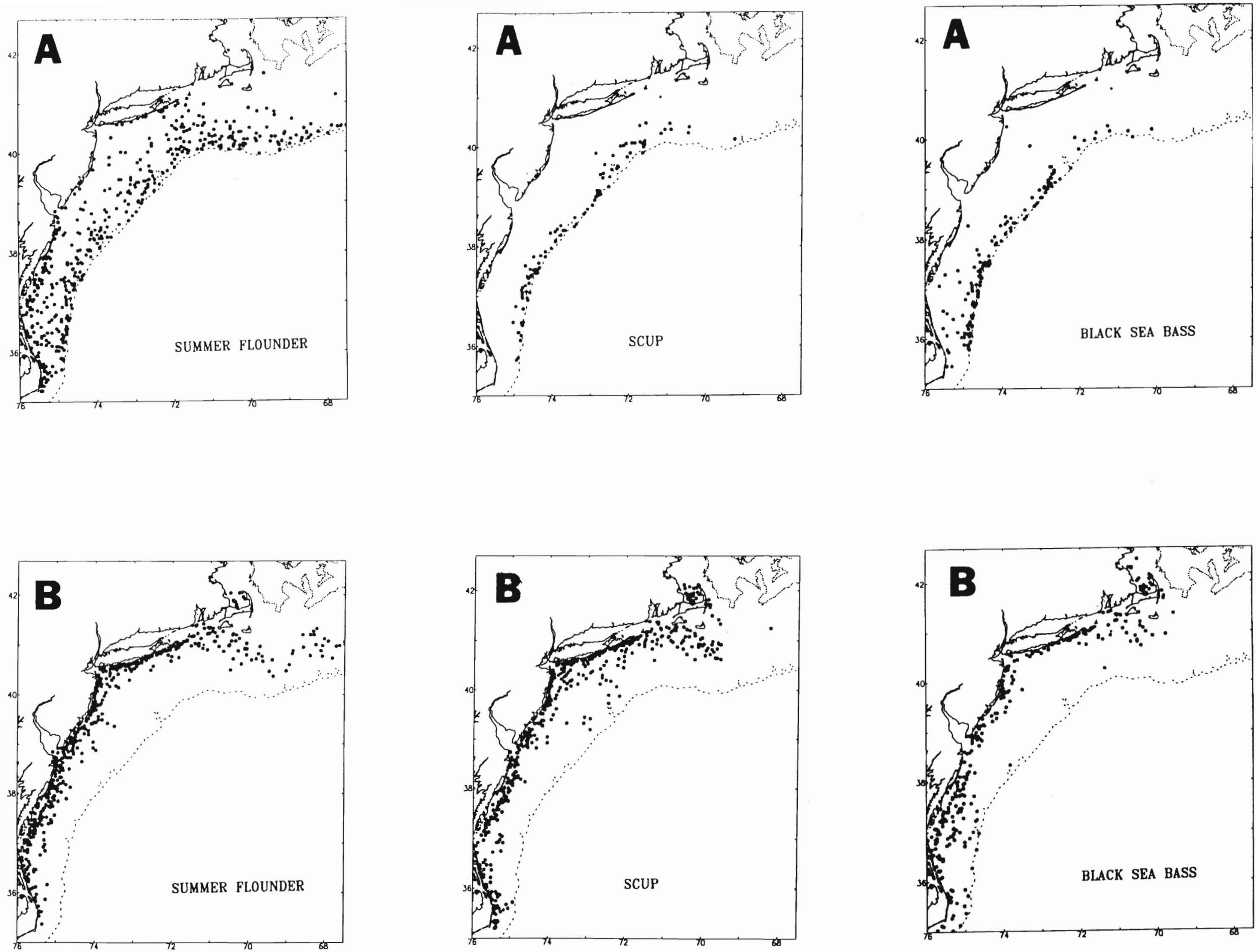

Figure 4

Distribution of summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, captured in the Northeast Fisheries Science Center spring (A) and autumn (B) bottom trawl surveys, 1982–1990.

fisheries (Fig. 6). Landings of trawl-caught summer flounder typically peaked between September and January, whereas scup landings peaked between March and May. Peak black sea bass trawl catches were similar to scup, occurring between February and April. Landings by otter trawlers declined during the summer for all three species. Monthly LPUE by otter trawlers for the three species followed the same trends.

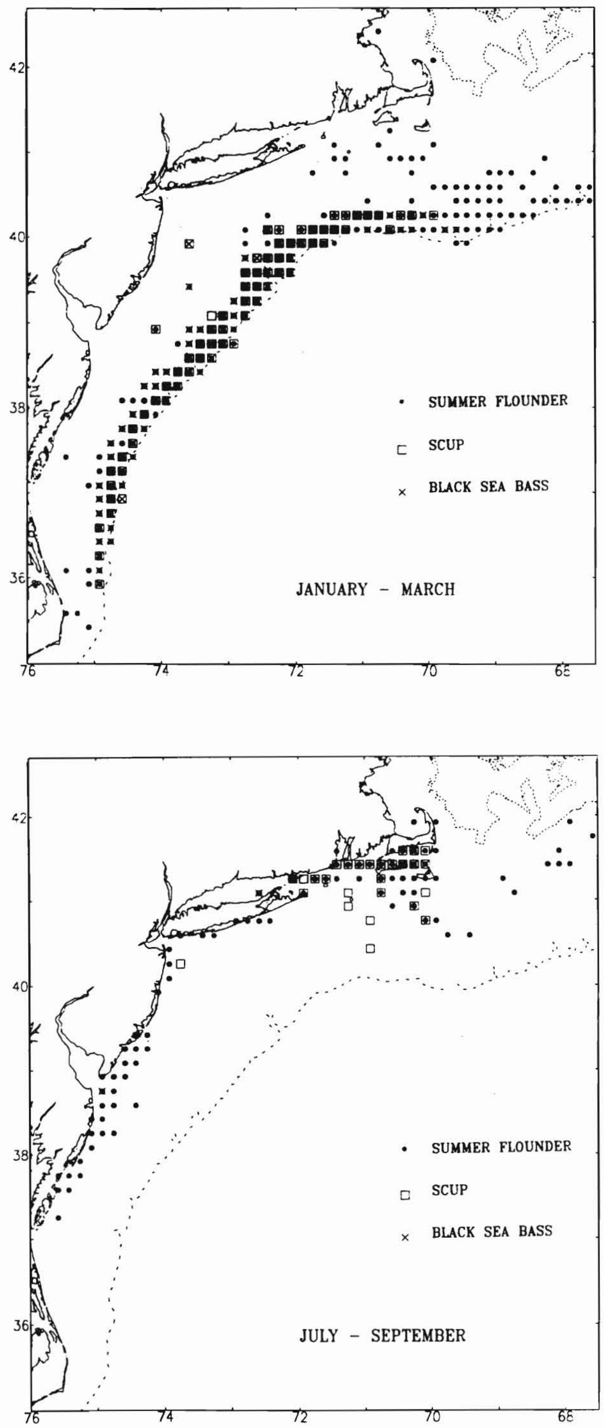

Figure 5
Seasonal distributions of commercial trawl fishery for summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, in the Middle Atlantic Bight and southern New England area, 1987–1989. Catch locations are by species per 10' square.

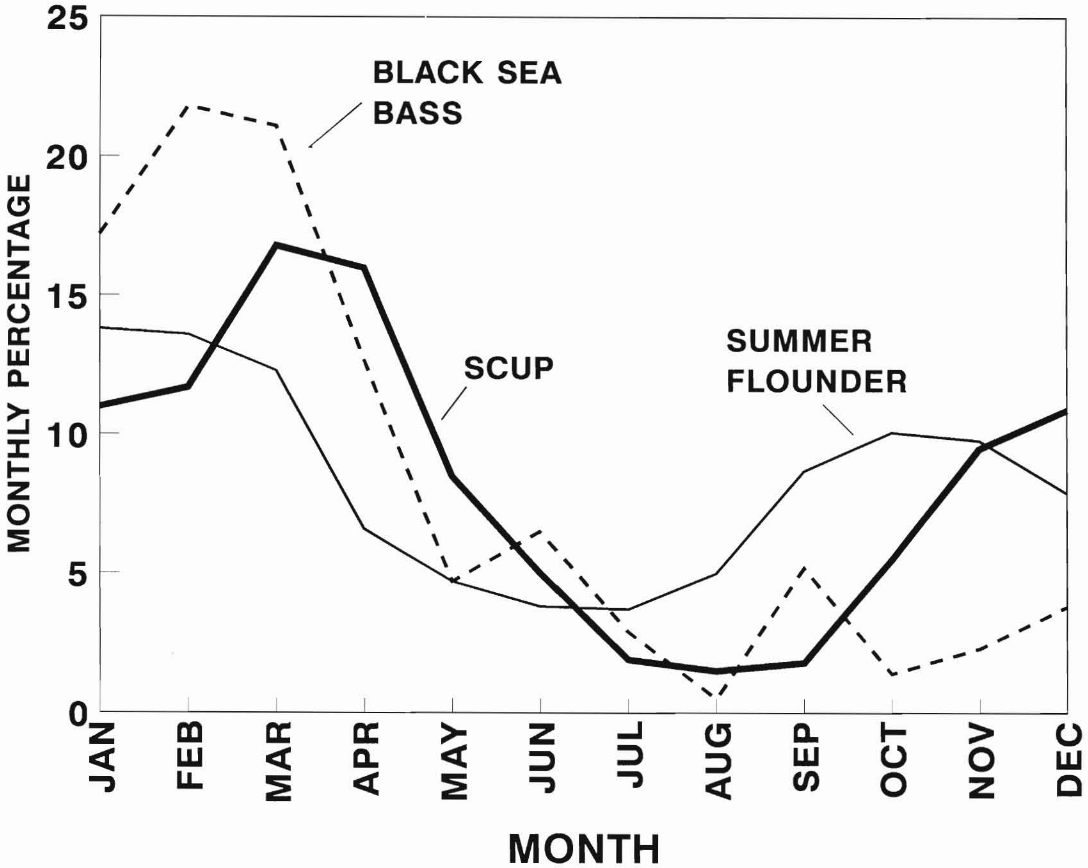

Figure 6
Monthly percentage of total annual commercial otter trawl landings of summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, in the Middle Atlantic Bight and southern New England area, 1982–1990.

Recreational Fishery

The temporal distribution of landings in the recreational fishery was the opposite of the commercial trawl fishery. The recreational fishery peaked during summer and early autumn when the fish were distributed in estuaries and coastal waters (Fig. 7). Summer flounder catch consistently peaked during July through August; scup and black sea bass catches peaked in either May through June or September through October.

Commercial Interactions

Catch rate and degree of cooccurrence of the three species in the commercial fishery varied according to the targeted species, despite overlapping distributions. The average LPUE for target species based on the weighout data was 594.9 kg/df for summer flounder, 345.4 kg/df for scup, and 68.3 kg/df for black sea bass. The highest LPUE for summer flounder was obtained on trips designating summer flounder as the targeted species (1193.5 kg/df). Scup LPUE was highest in trips targeting groundfish (1346.9 kg/df), although catch rates were above average in trips targeting squid (356.1 kg/df) and pelagics (939.8 kg/df). Highest catch rates (LPUE) of black sea bass were in trips that targeted finfish in general (1037.3 kg/df).

Trips landing summer flounder without scup or sea bass were most frequent (37.0%; Table 1). The second largest component consisted of trips landing all three species (30.7%). Trips landing only black sea bass, only scup, or scup with black sea bass were relatively rare (1.9%, 4.5%, and 4.1%, respectively). Most trips (56.6%) landed a multispecies catch with at least two of the three species.

Landings per trip of each species varied with the associated species landed. The LPUE of summer flounder was highest when landed in combination with black sea bass (975.4 kg/df), although the percentage of trips landing these two species without scup was 10.9% (Table 1). Highest levels of LPUE of scup and black sea bass

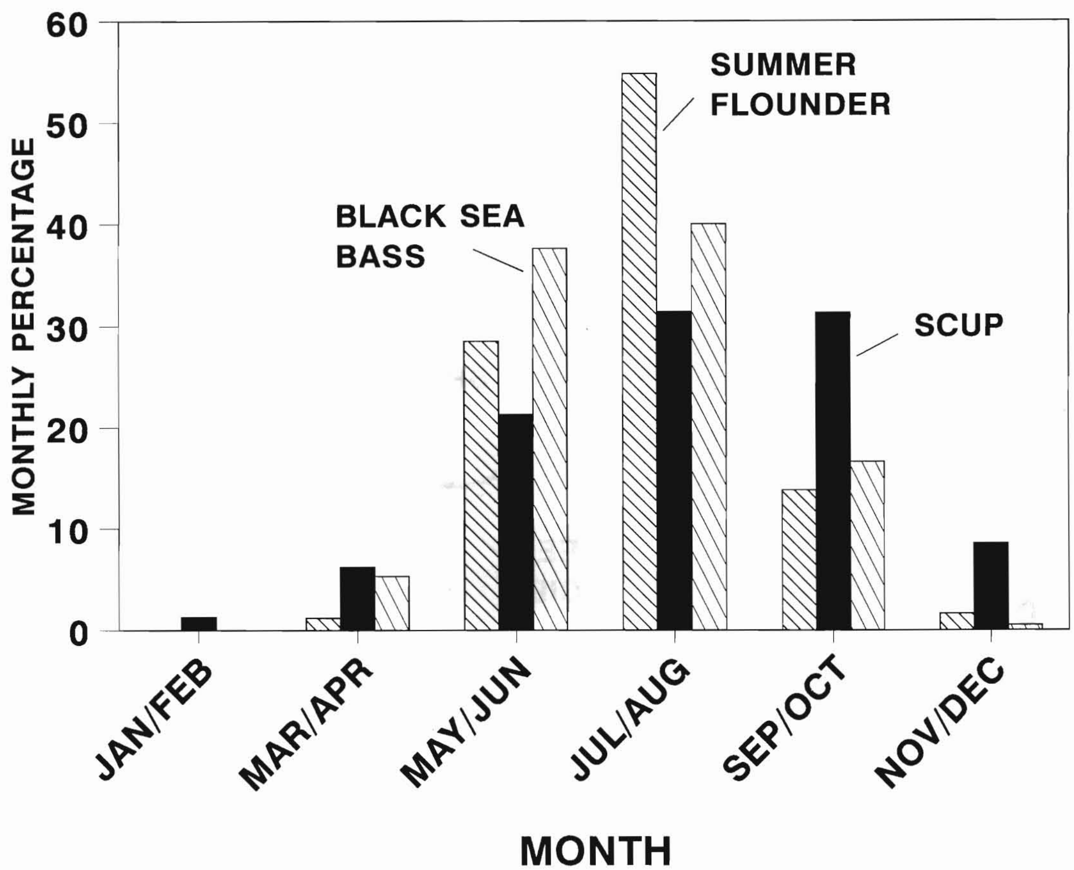

Figure 7

Bimonthly percentage of total annual recreational catch of summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, in the Middle Atlantic Bight and southern New England area, 1979–1990.

Table 1

Mean annual landings per unit of effort (LPUE in kg/day fished) and percent occurrence for a species caught with an associated species, based on total catch landed per trip (any trip landing summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*, 1982–1990) by commercial otter trawl trips within the Middle Atlantic Bight and southern New England area as determined from Northeast Fisheries Science Center weighout data. Number of trips = 85,655.

	LPUE		
Associated species	Summer flounder	Scup	Black sea bass
Summer flounder	434.9 (37.0%)	345.8 (10.9%)	49.3 (10.9%)
Scup	546.8 (10.9%)	1,267.8 (4.5%)	380.7 (4.1%)
Black sea bass	975.4 (10.9%)	3,891.8 (4.1%)	67.1 (1.9%)
Summer flounder–Scup–Black sea bass	786.6 (30.7%)	736.3 (30.7%)	183.6 (30.7%)

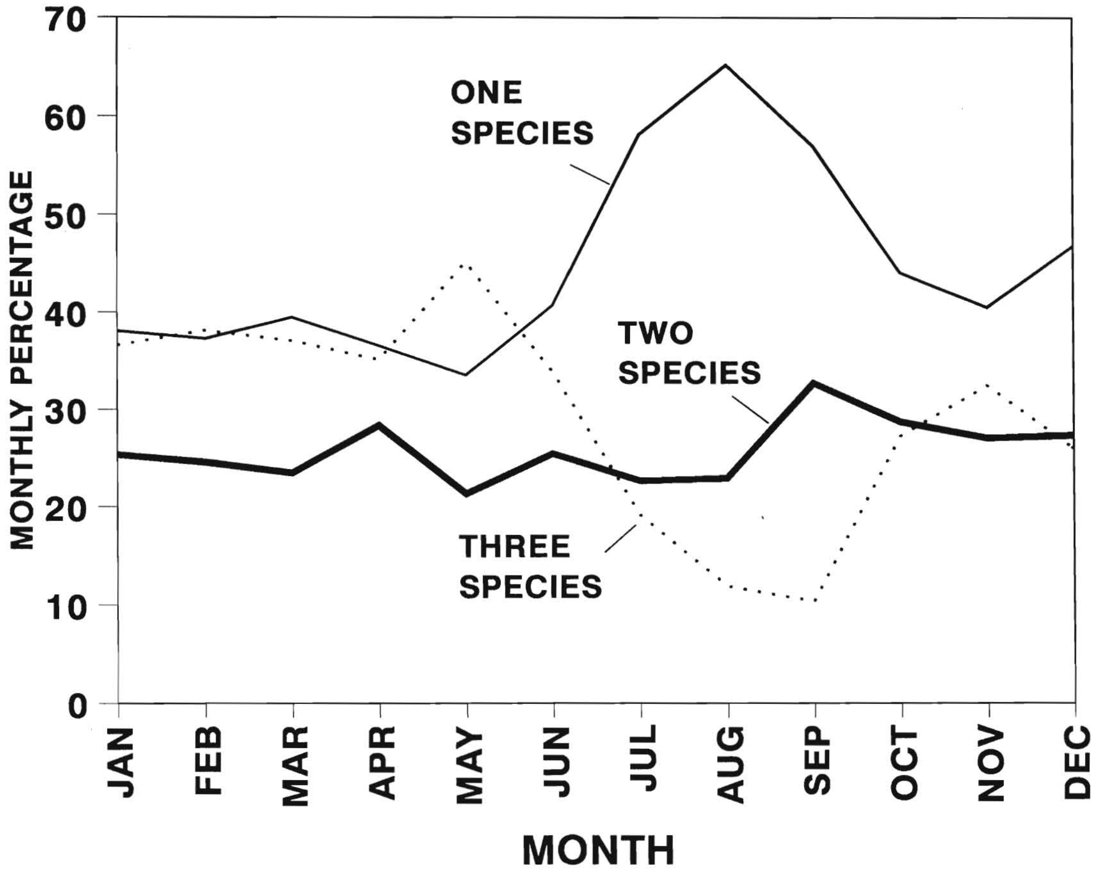

Figure 8

Species composition (percentage of mean commercial trawl landings, 1982–1990) per month, in the Middle Atlantic Bight and southern New England area with a combination of one, two, or three species from the multispecies assemblage of summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, and black sea bass, *Centropristis striata*. The two species categories include trips landing any combination of two.

were obtained in trips where the two species cooccurred without summer flounder, yet such trips were infrequent. Trips landing all three species had the largest combination of individual species LPUE and percent occurrence among all trips.

The number of species landed per trip varied seasonally. During the winter months, trips with one, two, or three species were all common (Fig. 8). The number of trips landing all three species increased slightly during the spring then fell sharply through the summer months. Meanwhile, trips landing just one of the three species (predominantly summer flounder) increased dramatically during the summer months, then declined by early autumn. The percentage of trips landing a combination of two species was relatively constant at 20–30% throughout the year.

On a smaller spatial scale, data collected by observers on commercial vessels provided information about species cooccurrence, including the smaller discarded fish, within the area covered during a single otter trawl tow. Table 2 presents the frequencies of cooccurrence and CPUE based on the data gathered at sea. Effort in these tows was directed primarily at summer flounder. Thirty-two percent of tows caught summer flounder with neither scup nor black sea bass, at a rate of 489.6 kg/day fished. In comparison, the frequency of black sea bass in a single tow without scup or summer flounder was only 0.5% with CPUE of 26.4 kg/day fished. Scup was caught equally often alone (16.8% of tows), in combination with summer flounder (19.3%), or with all three species (18.1%). The combination of scup and black sea bass was the least likely (3.7%), although the highest catch rates of scup (4080.0 kg/day) and black sea bass (122.4 kg/day) were observed from this set of tows. Similar to the weighout data, 50.7% of the tows caught at least two of the three species. The lowest catch rates of summer flounder and scup occurred when the two species were caught together without black sea bass.

Table 2

Mean annual catch per unit of effort (CPUE in kg/day fished) and percent occurrence for species caught with an associated species, based on total catch per tow from sea sample tow data (all observed commercial otter trawl tows catching summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, or black sea bass, *Centropristis striata*, within the Middle Atlantic Bight and southern New England area, 1989–1990. Number of tows = 1,211.

	CPUE (percent occurrence)		
Associated species	Summer flounder	Scup	Black sea bass
Summer flounder	489.6 (32.0%)	1,224.0 (19.3%)	105.6 (9.5%)
Scup	391.2 (19.3%)	2,256.0 (16.8%)	122.4 (3.7%)
Black sea bass	969.6 (9.5%)	4,080.0 (3.7%)	26.4 (0.5%)
Summer flounder–Scup–Black sea bass	710.4 (18.1%)	1,980.0 (18.1%)	115.2 (18.1%)

Recreational Interactions

Participants in the recreational fishery were most likely to catch only one species per trip. For 1979–1990, 87.7% of angler trips catching any one of the three species landed only one species (Table 3). Conversely, only 12.3% of the trips landed more than one species. Trips catching only summer flounder accounted for 48.5% of the trips whereas scup and black sea bass were caught alone in 16.4% and 22.8% of trips. The most likely multispecies combination was summer flounder and black sea bass, occurring together in 7.5% of trips. Most of the harvest of each species comprised catches of only one of the three species per trip. An average of 87.7% of the summer flounder harvest was from catch of that species only (Table 4). Similarly for scup, an average of 78.8% of the annual catch was from catch of scup only and 76.0% of the harvest of black sea bass was from catch of black sea bass only.

Catch rates (number of fish per angler trip) for all three species were highest in single-species catches. When scup alone were caught, CPUE was 67% greater than catch rates based on the most productive multispecies combination (9.1/angler trip vs. 5.4/angler trip for scup/black sea bass). For black sea bass, CPUE from single-species trips was nearly twice that of trips in the most productive multispecies category (4.4/angler trip vs. 2.2/angler trip for scup/black sea bass) (Table 4). The catch rate of summer flounder from

Table 3

Mean catch per unit of effort (CPUE as number of fish/angler trip) and percent occurrence of species combinations within trips from Marine Recreational Fisheries Statistics Survey dockside sampling data (any trips landing summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, or black sea bass, *Centropristis striata*; Middle Atlantic Bight and southern New England area, 1979–1990).

	CPUE (percent occurrence)		
Associated species	Summer flounder	Scup	Black sea bass
Summer flounder	3.6 (48.5%)	4.6 (0.9%)	2.1 (7.5%)
Scup	2.4 (0.9%)	9.1 (16.4%)	2.2 (3.4%)
Black sea bass	3.3 (7.5%)	5.4 (3.4%)	4.4 (22.8%)
Summer flounder–Scup–Black sea bass	2.4 (0.5%)	2.9 (0.5%)	1.7 (0.5%)

Table 4

Mean percentage of annual recreational dockside samples of catch (1979–1990) by species, accounted for by various combinations of catches of summer flounder, *Paralichthys dentatus*, scup, *Stenotomus chrysops*, or black sea bass, *Centropristis striata*.

Catch combinations	Percent of catch
Summer flounder catch	
Summer flounder	87.7
Summer flounder + Scup	1.0
Summer flounder + Black sea bass	10.8
Summer flounder + Scup + Black sea bass	0.5
Scup catch	
Scup	78.8
Scup + Summer flounder	3.5
Scup + Black sea bass	16.2
Scup + Black sea bass + Summer flounder	1.5
Black sea bass catch	
Sea bass	76.0
Sea bass + Summer flounder	14.0
Sea bass + Scup	8.7
Sea bass + Summer flounder + Scup	1.3

trips in the single-species category was only marginally higher than from trips in the summer flounder/black sea bass category (3.6/angler trip vs. 3.3/angler trip).

Discussion

Fisheries for summer flounder, scup, and black sea bass can be categorized as a winter offshore trawl fishery, an inshore pot fishery (spring through autumn), and an inshore recreational fishery (spring, summer, and autumn). Summer flounder, scup, and black sea bass are generally distributed throughout the Middle Atlantic Bight and southern New England waters but undergo seasonal migrations (Sherwood and Edwards, 1901; Finkelstein, 1971; Weber and Briggs, 1983). The migratory patterns of all three species produce two points in time and space where the degree of overlap in distributions are greatest: late winter along the edge of the continental shelf and summer in coastal waters. Species interactions vary depending on where in the migratory route the fishery occurs and the type of gear used in the fishery.

The catch distributions and survey results suggest that the three species disperse across the continental shelf during an autumn migration and reaggregate upon reaching the offshore overwintering grounds. During the autumn dispersal, effort is directed at summer flounder, with less scup or black sea bass bycatch, and consequently the probability of large catches of summer flounder increases. The catch rates for all three species begins to increase during this period and peaks between October and February when the species assemblage reaggregates along the edge of the shelf.

Inshore migrations begin earlier in spring for summer flounder, while scup and black sea bass remain on the overwintering grounds. During this period, when the relative abundance of summer flounder in the overwintering area declines, combined scup and black sea bass LPUE peaks, as does the frequency of trips landing just two of the three species. Although the catch rates are high, this delay in the migration is brief and creates a low annual frequency of encountering just two species. Once the spring migration begins for all three species, catch rates within the commercial trawl fishery decline. The overall catch rates and frequency of cooccurrences suggest that the trawl fishery is directed primarily at summer flounder or scup, with black sea bass taken as bycatch. The species that dominate the catch composition during a particular period depends on gear configuration, variations in population abundance, and market demand.

Following the inshore spring migration, the assemblage is concentrated in coastal waters. Habitat usage appears to differ among the three species: scup and black sea bass frequent hard bottom and structure; summer flounder appear to favor sandy or muddy bottom (Bigelow and Schroeder, 1953). Consequently, the recreational and pot fisheries can target specific habitats and produce single-species catches. By the nature of the gear, an otter trawl will integrate the catch across all the bottom covered in a tow and is likely to produce multispecies catches.

The nature of catches within the recreational and commercial fisheries suggests that management measures need to be tailored to address different degrees of multispecies interactions. Among recreational, trap, and trawl fisheries, it is only the latter that is truly a multispecies fishery. Although the multispecies nature of the trawl fishery varies with season and area, the chance of harvesting only one of the three species in a tow averaged less than 50%. This level of interaction may vary with relative changes in population abundance, yet changes in fishing mortality on one species will have direct implications for all three. The species interactions in the trap and recreational fisheries are relatively minor and these can be considered directed fisheries. The problem of estimating fishing mortality is relatively simple for single species within a directed fishery, but predicting mortality of the targeted species following changes in regulation or perceived abundance remains a problem. In either situation, it is apparent that species interactions within the fisheries are dynamic and must be considered in the development of management strategies.

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