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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)

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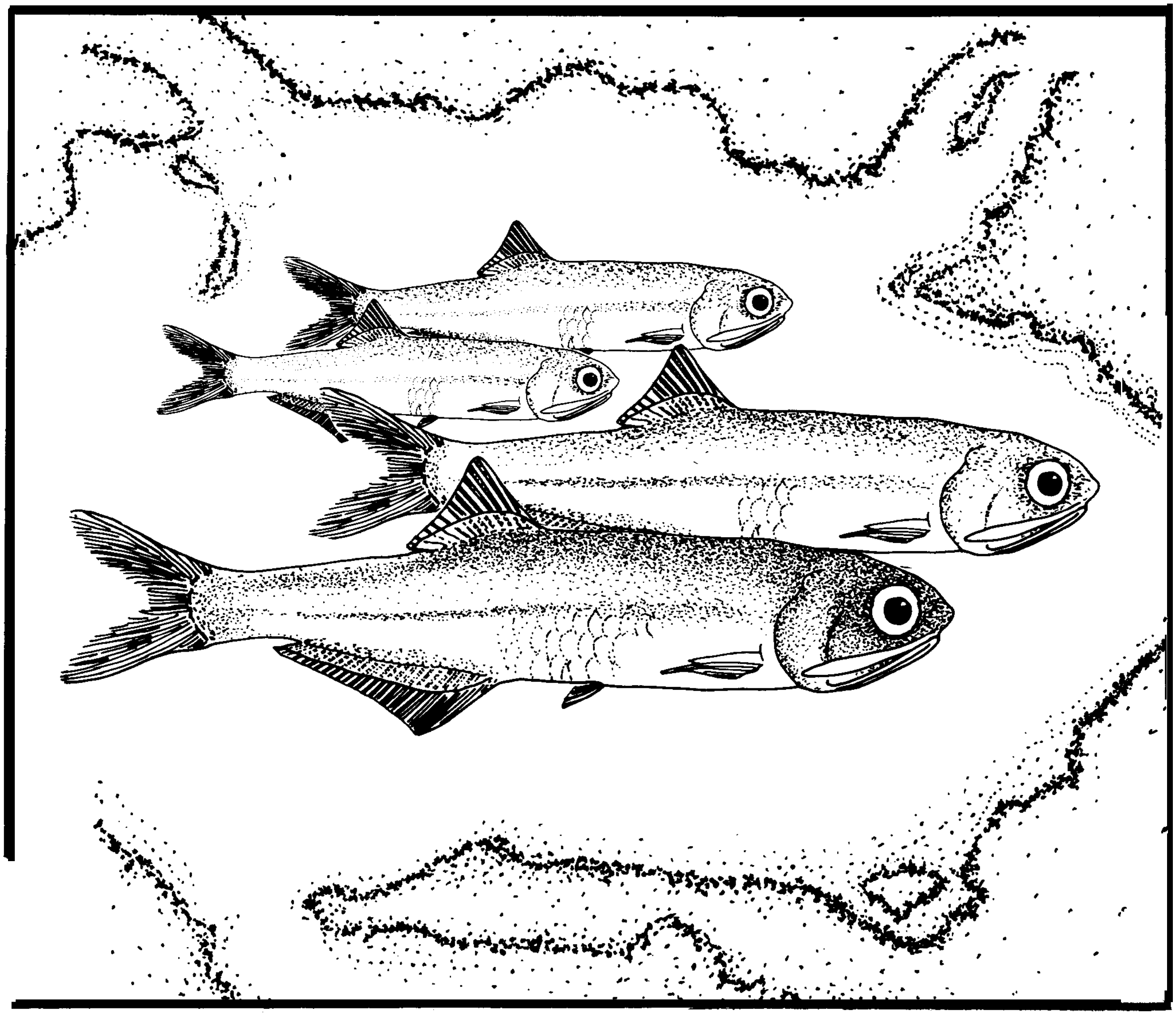

Fish and Wildlife Service
U.S. Department of the Interior

Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

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Species Profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic)

BAY ANCHOVY

by

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PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

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CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
meters (m)	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers (km)	0.5396	nautical miles
square meters (m^2)	10.76	square feet
square kilometers (km*)	0.3861	square miles
hectares (ha)	2.471	acres
liters (1)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters (m^3)	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons (t)	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (°C)	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

Multiply	By	To Obtain
inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
square miles (mi^2)	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
pounds (lb)	0.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (°F)	0.5556 (°F 32)	Celsius degrees

CONTENTS

ACKNOWLEDGMENTS

The reviews by H. Dickson Hoese and Mark A. Konfkoff of the University of Southwestern Louisiana, Lafayette, are gratefully acknowledged.

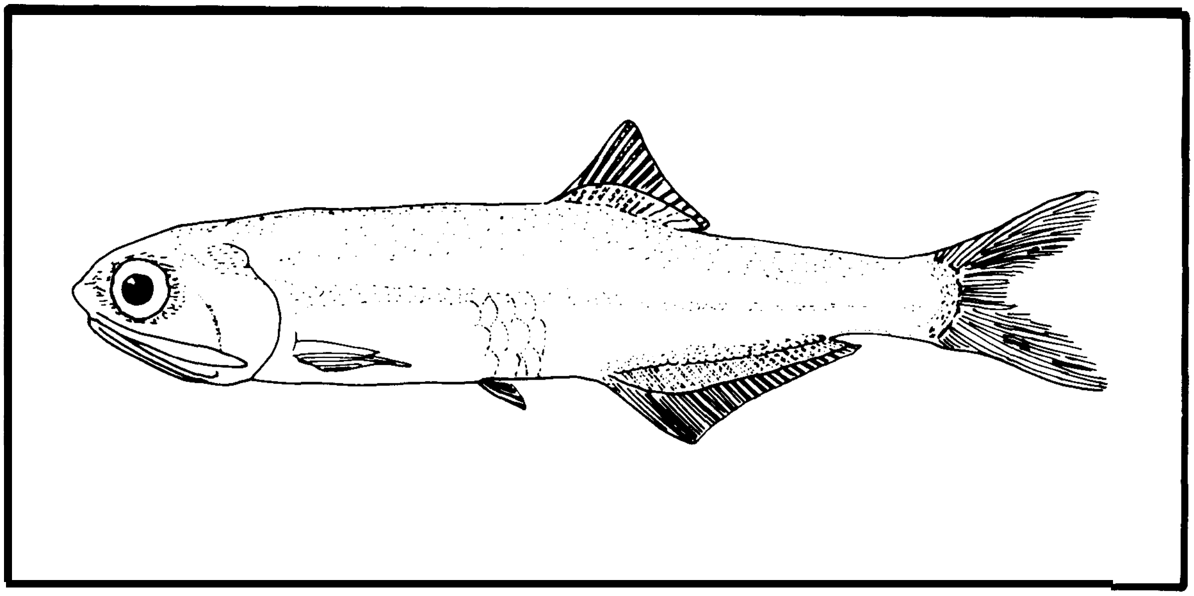


Figure 1. Bay anchovy.

BAY ANCHOVY

NOMENCLATURE/TAXONOMY/RANGE

Scientific name . . . . Anchoa mitchilli (Valenciennes)
Preferred common name .... Bay anchovy (Figure 1)
Other common names . . . . Common anchovy, Mitchill's anchovy, whitebait, little anchovy
Class . . . . Osteichthyes
Order . . . . Clupeiformes
Family . . . . Engraulidae

Geographic range: The bay anchovy occurs along the Atlantic and Gulf of Mexico coasts, from Cape Cod, Massachusetts, to Yucatan, Mexico (Hildebrand 1963), except for the Florida Keys where it is apparently absent (Daly 1970). In the Mid-Atlantic Region (Figure 2), it is considered abundant off Massachusetts and Rhode Island, common off New York, and most abundant at many localities off New Jersey, and in Chesapeake Bay (Hildebrand 1963). It has also been recorded from the waters of Connecticut (Pearcy and Richards 1962), New York (Richards 1976; Ferraro 1980), Delaware (Derickson and Price 1973), and North Carolina (Hildebrand and Cable 1930).

MORPHOLOGY/IDENTIFICATION AIDS

Anchovies are small, schooling fish that resemble herring but have proportionately larger mouths. Four species of anchovies have been recorded from the Mid-Atlantic Region, one of which is known only from its type specimen (Jones et al. 1978). The bay anchovy is by far the most abundant (Ralph Andrews, Coastal Specialist, U. S. Fish and Wildlife Service, Newton Corner, MA; pers. comm.). An adult bay anchovy

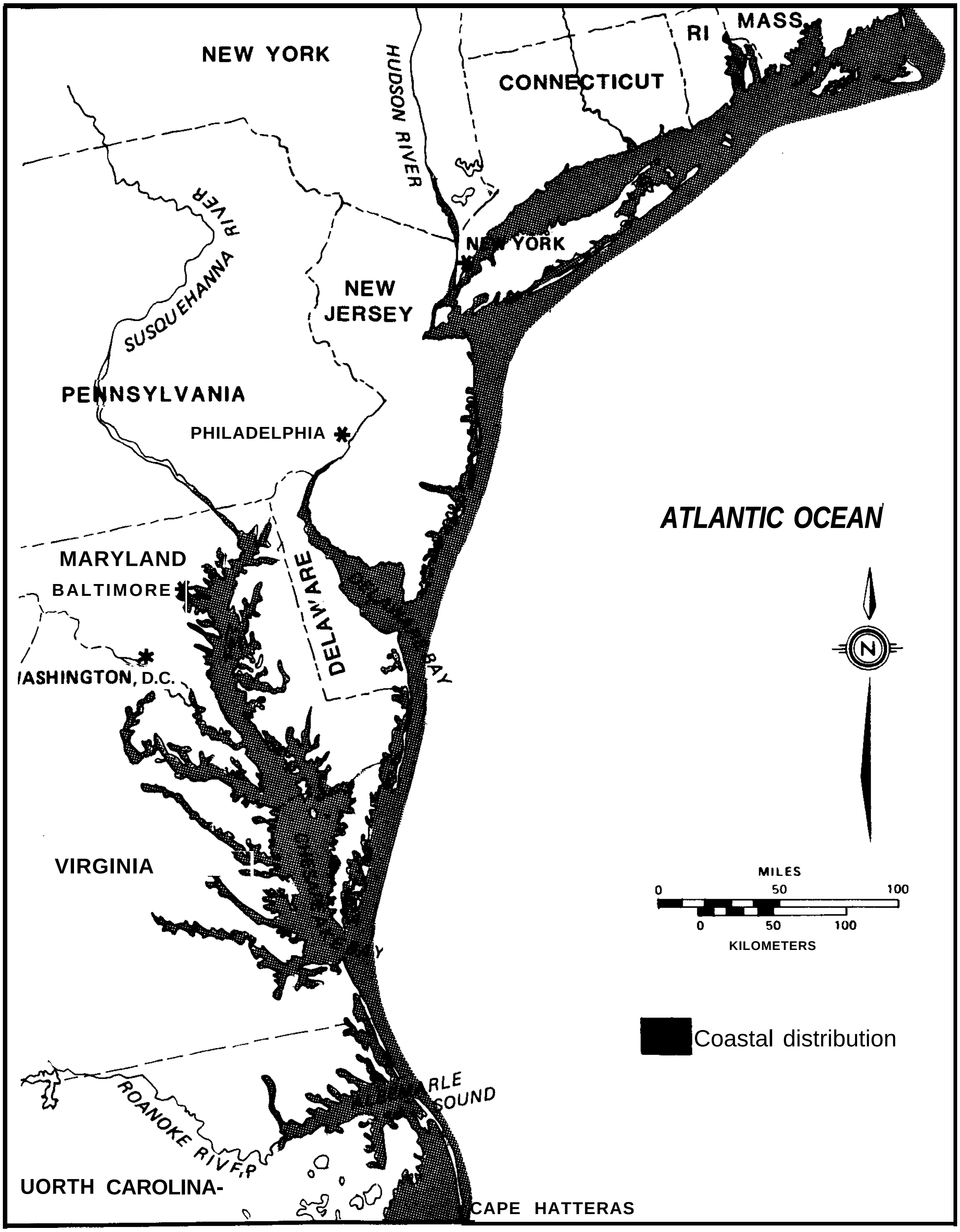


Figure 2. Distribution of the bay anchovy in the Mid-Atlantic Region.

(Anchoa mitchilli) can be readily distinguished from the other anchovies of the Mid-Atlantic by the origin of its anal fin relative to its dorsal fin (Figure 1). In the bay anchovy, the anal fin originates under or slightly posterior to the dorsal fin origin. The bay anchovy has a rounded protuberant snout, large mouth, enlarged maxillary, and a translucent body with a silvery mid-lateral band (Hildebrand 1963; Hoese and Moore 1977; and Jones et al. 1978).

The following description of the morphological characteristics of the bay anchovy was extracted from Daly (1970), Hildebrand (1963), and Jones et al. (1978). Proportional measurements expressed as a percentage of the standard length follow: body depth 16 - 27, head length 22 - 28, eye diameter 5.8 - 9.0, and snout length 3.1 - 7.3. Meristic counts: dorsal fin rays 13 - 17, anal fin rays 23 - 30, pectoral fin rays 10 - 13, scales from upper angle of gill opening to base of caudal 38 - 44, gill rakers 15 - 20 + 20 - 26, and total vertebrae 38 - 44.

Body rather slender and moderately compressed. Snout short, no more than one-fourth of its length projecting beyond the tip of the mandible. Maxillary pointed, extended near margin of opercle. Cheek short and broad, about as long as eye. Dorsal fin rather low with a nearly straight margin. Anal fin origin under or slightly posterior to fifth or sixth dorsal ray. Pelvic fin small, not reaching halfway to origin of anal fin. Pectoral fin variable, fails to reach base of pelvic fin by distance equal to diameter of eye or greater.

Live bay anchovies are greenish with bluish reflections above the narrow silvery lateral band masked by scales, and are pale below with translucent abdominal walls (Hildebrand 1963; Jones et al. 1978). They seldom exceed a total length (TL) of 100 mm (4 inches); the average size approaches 75 mm (Hildebrand 1963; Hildebrand and Cable 1930).

REASON FOR INCLUSION IN SERIES

The bay anchovy, because of its abundance and widespread distribution in the Mid-Atlantic Region, is a very important component of the food web of many sport and commercial fishes (Derickson and Price 1973; Richards 1976) as well as sea birds. Although it has no apparent commercial value, its indirect economic importance as food for recreationally and commercially important species is significant. It is one of the most abundant shallow-water, euryhaline fishes.

LIFE HISTORY

Spawning

The spawning period of the bay anchovy is long. Hildebrand and Cable (1930) collected the eggs of Anchoa mitchilli from late April to late September at Beaufort, North Carolina, and they postulated from the presence of fry in December that spawning continued even later. Hildebrand and Schroeder (1928) and Pearson (1941) found evidence of spawning from May through September in Chesapeake Bay. Schauss (1977) collected larvae that were assumed to be Anchoa mitchilli from July through October in Lynnhaven Bay, Virginia.

In Long Island Sound, spawning typically occurs in water less than 20 m deep (Richards 1959). Jones et al. (1978) believed, however, that spawning may occur out to the edge of the continental shelf. Kuntz (1914) and Hildebrand and Cable (1930) concluded that bay anchovies spawn between 1800 and 2100 h (13 to 16 h after sunrise). This time of spawning was verified more recently by Ferraro (1980), who concluded that Anchoa mitchilli spawn primarily in the evening or at night (16 h after sunrise). In the Mid-Atlantic Region, spawning generally occurs in estuarine waters where water temperatures are at least 12 °C and salinities are usually over 10 ppt (Dovel 1981) Spawning may occasionally occur at 9 °C (see temperature section). Bay anchovies that hatch early in the season may become sexually mature during their first summer. Hildebrand (1963) took bay anchovies 45-60 mm long TL with well developed roe in late July and early August at Beaufort, North Carolina.

Eggs

The pelagic eggs of the bay anchovy are found throughout the water column but tend to be concentrated near the surface, in salinities of 8 to 15 ppt (Hildebrand 1963; Jones et al. 1978). Fertilized eggs are slightly elongate (Kuntz 1914), highly transparent, and have no oil globules (Hildebrand 1963). The size of bay anchovy eggs, measured along the major and minor axes, decreases with an increase in water salinity (Dovel 1971). Bay anchovy eggs hatch in about 24 h at temperatures of 27.2 to 27.8 °C (Kuntz 1914).

Larvae

Yolk-sac larvae are 1.8 to 2.0 mm TL and have a pear-shaped yolk tapering to a point posteriorly (Kuntz 1914; Hildebrand 1963). The yolk is almost completely absorbed within 25 h after hatching (Houde 1974). At 2.7 mm TL, the body is long and slender with a terminal mouth that is apparently functional (Jones et al. 1978). Dorsal and anal fins begin to develop when larvae reach 5 mm TL, and some larvae may possess full ray counts at 7 to 8 mm SL (Kuntz 1914). By 16 mm TL, body depth is one-twelfth the total length (Hildebrand and Schroeder 1928). Larvae are highly transparent but have some pigmentation in the thoracic region and at the base of the anal fin at lengths of 7.0 to 8.0 mm (Kuntz 1914).

Juveniles

In general, the body of the bay anchovy becomes deeper with age, as evidenced by the following proportions: body depth is about one-ninth of body length in specimens 20 mm in length and about one-fifth of body length in 25 mm fish (Hildebrand and Schroeder 1928). The terminal mouth, the short rounded maxillary that does not reach the margin of the opercle, and the absence of a definite silvery band differentiate juveniles from adults (Hildebrand and Schroeder 1928). The characteristic projecting snout is developed when the fish reach lengths of about 20 - 25 mm (Hildebrand 1963). Adult characteristics are acquired at a length of about 60 mm (Hildebrand and Schroeder 1928).

GROWTH CHARACTERISTICS

Houde (1978) fed copepod nauplii and copepodids to bay anchovy larvae at known concentrations to determine how survival, growth, and production were related to food supply. At a concentration of 100 food organisms/bay anchovy, mean weight increased by 13.4 times from hatching to 16 days. In an earlier study, Houde (1974) concluded that mass starvation of bay anchovy larvae could occur at low food concentrations normally found in subtropical marine ecosystems if the larvae did not encounter a "patch" of suitable food. The "critical period" during which these larvae must feed was determined to be within 2.5 days after hatching (Houde 1974). Houde and Schekter (1978) found that bay anchovy larvae were most susceptible to starvation mortality during the first 6 days after hatching. Their results implied that larval bay anchovies, because they were not as successful as the larvae of other species in using food conditions to improve thefr rate of survival, may require high and stable prey densities to survive and grow under natural conditions. They postulated that, at low prey concentrations, larval bay anchovies would be required to expend a relatively large amount of energy to obtain the minimum amount of food required for growth and maintenance, and would therefore be susceptible to starvation and predation.

FOOD

Hildebrand and Schroeder (1928) examined the contents of 44 bay anchovy stomachs and found that mysids were the principal food of adults and that copepods were the principal food of young. Reid (1954), McLane (1955), and Springer and Woodburn (1960) conducted qualitative studies of the bay anchovy food habits that indicated that small crustaceans were the primary food, and that small mollusks and larval fish occasionally contributed to the diet. Stevenson (1958) found that copepods were the primary food of bay anchovies in Delaware Bay.

Darnell (1958, 1961) and Odum (1971) conducted quantitative studies of bay anchovy food. Darnell found that bay anchovies 35 to 40 mm long fed primarily on rotifers, copepods, detritus, and undetermined organic matter; those 60 to 65 mm long fed mostly on macrozooplankton (especially mysids), small shrimp, and larval fishes. Odum (1971) found planktonic copepods and copepod larvae to be the primary food of bay anchovies less than 25 mm long; larger specimens consumed an array of small benthic crustaceans, especially amphipods, mysids, harpacticoid copepods, ostracods, and small mollusks.

Odum (1971) believed that bay anchovies selectively captured organisms, rather than non-selectively straining water for food. His belief was supported by Detwyler and Houde (1970), who found that bay anchovies discriminantly selected copepod nauplif, copepodftes, and adult copepods over other potential food organisms.

ANCHOVY POPULATIONS

A search of the literature revealed no quantitative biomass data for the bay anchovy in the Mfd-Atlantic Region. This species is, however, generally consfdered to be the most abundant fish in Chesapeake Bay (McHugh 1967; Musfck 1972). Hildebrand (1963) considered the bay anchovy to be common in New York waters and exceedingly abundant from New Jersey to North Carolfna. It has been recorded from all states in the Mid-Atlantic Region.

In ichthyoplankton samples collected in lower Chesapeake Bay from 1971 to 1976, bay anctiovy eggs accounted for 96% and larvae for 88% of all eggs and larvae taken (Olney 1983). Olney's data revealed clearly defined peaks of bay anchovy egg abundance from May to August. The occurrence of larvae paralleled that of the eggs, but lagged temporarily, peaking in July and August (Olney 1983).

Bay anchovy larvae and eggs have also been found to be dominant in Magothy Rfver (Dovel 1967), upper Chesapeake Bay (Dovel1971), Lynnhaven Bay (Schauss 19771, Long Island Sound (Perlmutter 1939; Wheatland 1956), lower Hudson Estuary (Dovel1981), and a Virginia estuary (Cowan and Birdsong 1985). Data collected by Pearson (1941), Dovel (1971), and Olney (19831 indicated that Chesapeake Bay is a major spawning site for the bay anchovy.

COMMERCIAL FISHERY VALUE

Although the bay anchovy is considered exceedingly abundant in portions of the Mid-Atlantic Region, the species has little commercial attractiveness, probably because of its small size and fragile body tissues. It is used to a limited extent in the preparation of anchovy paste and as bait (Hildebrand 1963). Bay anchovies are apparently not adversely affected by the commercial harvest of other species. In a study of the fish taken incidentally in the commercial menhaden purse seine fishery in the Gulf of Mexico, Christmas et al. (1960) found that bay anchovies were not taken.

ECOLOGICAL ROLE

Ecologically, the bay anchovy is one of the most important species in the Mid-Atlantic Region. It is of enormous trophic importance as a primary forage item for many economically important predators and is an important link in the estuarine food web (Figure 3). It is an important source of nutrition for many species of piscivorous birds. In a study of the age, growth, and food of the bluefish (Pomatomus saltatrix) in Long Island Sound, Richards (1976) found that bay anchovies (5 - 20 mm long) were frequently taken. They were probably the most abundant source of food for the bluefish in 1987 (Ralph Andrews, pers. comm.). Derickson and Price (1973) noted that the bay anchovy was among five species of fish that were ecologically important as food for many of the connnercially important species in Delaware coastal waters. It was also an imoortant food of vouna weakfish. Cynoscion regalis (Chao and Musick 1977; Merriner 1975; Thomas 1971). Gardinier and Hoff (1982) found that striped bass (Morone saxatilis) in the Hudson River estuary were almost totally piscivorous by the time they exceeded 200 mm in total length and that the bay anchovy was one of six forage species consumed. It was also an important prey species of striped bass in Albemarle Sound, North Carolina (Manooch 1973), and in the surf waters of Long Island (Schaefer 1970).

ENVIRONMENTAL REQUIREMENTS

Temperature

The bay anchovy tolerates a wide range of temperatures, as evidenced by its extensive geographic range; however, although it does not migrate to warmer latitudes in winter, all sizes vacate shallow water for deeper bay waters in winter (Ralph Andrews, pers. comm.). In a study in the Lower Hudson Estuary, New York (Dovel 1981), bay anchovies were collected at water temperatures of 2.2 to 27.1 "C. In a study near the thermal discharge outfall of a power plant in Galveston Bay, Texas, Gallaway and Strawn (1974) found that bay anchovies were apparently unaffected by water temperatures exceeding 32 °C. Spawning of bay anchovies occurs at water temperatures of 9 to 31 °C, and peaks above 20 °C (Dovel 1971). Bay anchovy eggs incubate in about 24 h at water temperatures of 27.2 to 27.8 °C (Kuntz 1914).

Salinity

Gunter (1945), Reid (1954), Kilby (1955), and Springer and Woodburn (1960) all agreed that salinity has little influence on the distribution of the bay anchovy. Indeed, the bay anchovy has been taken from fresh water (64 km above brackish water) in Virginia rivers (Massmann 1954) and from hypersaline waters (80 ppt) in Upper Laguna Madre, Texas (Simmons 1957). In the Mid-Atlantic Region, salinities greater than 35 ppt are rare (Ralph Andrews, pers. comm.). In Chesapeake Bay, bay anchovies spawned at salinities of 9 ppt or greater; spawning peaked between 13 and 15 ppt (Dovel 1971).

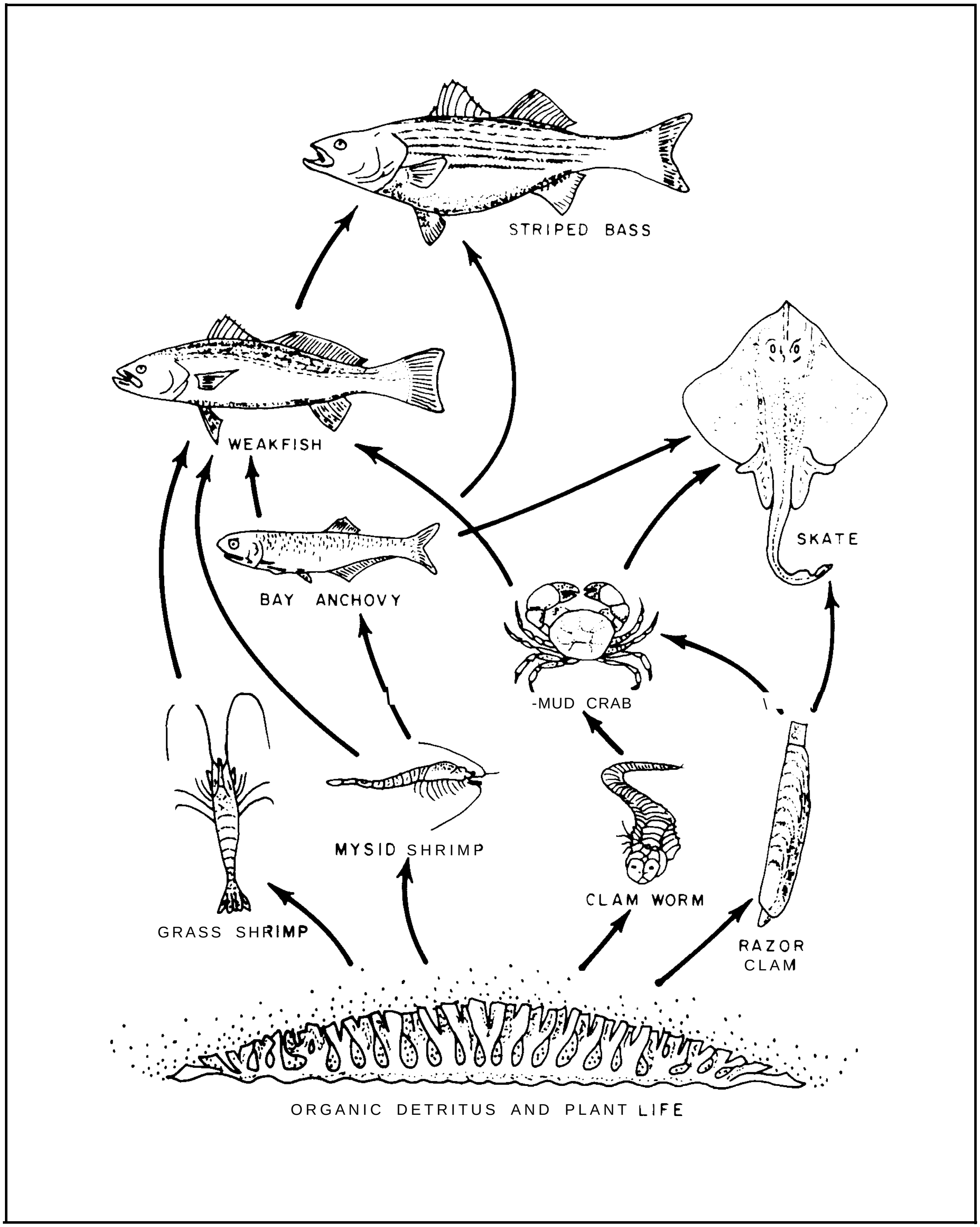


Figure 3. Simplified food web, showing some pathways in a food pyramid involving the bay anchovy. Arrows point to the consumers (modified from Daiber 1959).

Habitats

Bay anchovies are ubiquitous inhabitants of the Mid-Atlantic Region. Adults inhabit shallow and moderately deep offshore waters (Hildebrand 1963), nearshore waters off sand beaches (Reid 1954; Kilby 1955), open bays and muddy coves (Hildebrand and Schroeder 19281, grassy areas along beaches (Hildebrand 1963), waters around the mouths of rivers (Bigelow and Schroeder 1953), bayous and coastal waters (Springer and Woodburn 1960), seagrass beds (Weinstein and Brooks 1983), and freshwater rivers (Massmann 1954). Derickson and Price (1973) found that substrate type and vegetation were of little significance in the distribution of the bay anchovy.

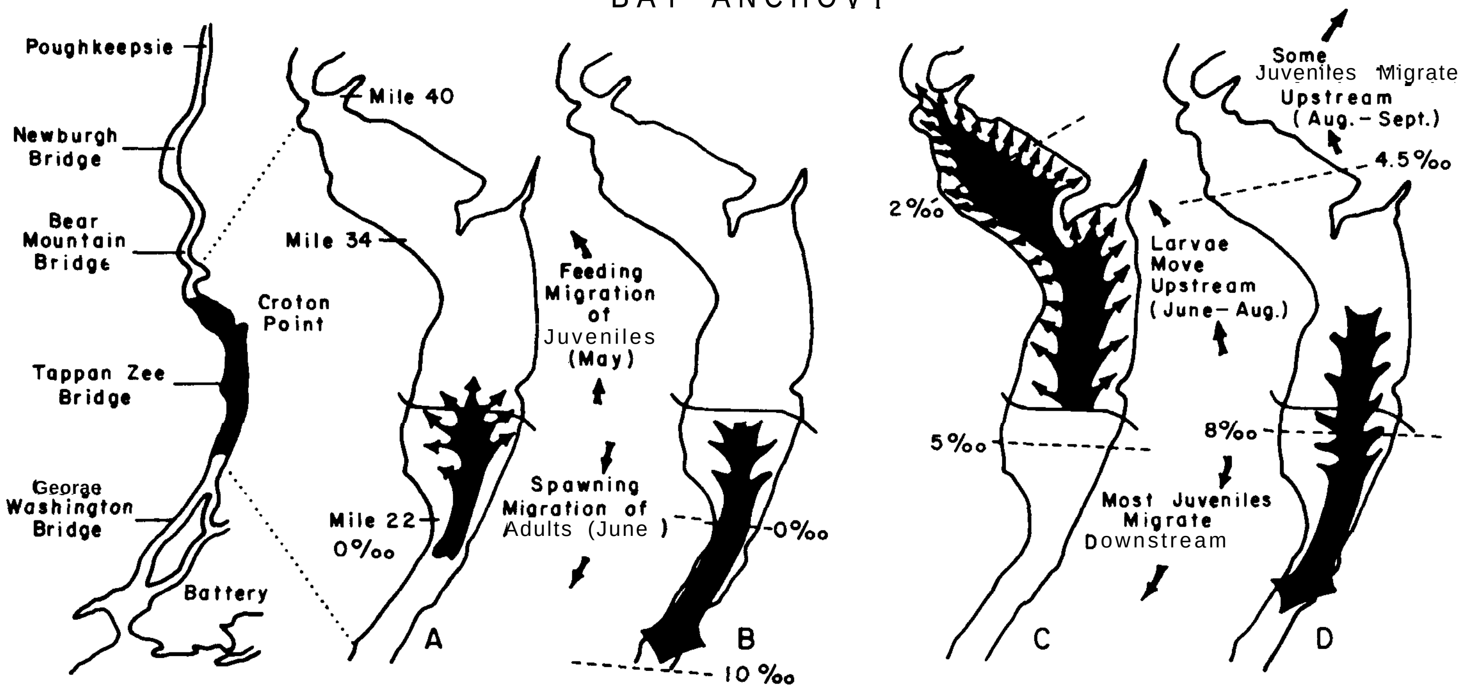
Temporal and Spatial Distribution

Two studies by Dovel (1971, 1981) yielded similar data on patterns of relative abundance and spatial distribution of estuarine fish with respect to salinity gradients. The following discussion of the temporal and spatial distribution of bay anchovies was taken from Dovel (1981). Distribution of larval bay anchovy in several Chesapeake Bay areas was found to be identical to that in the Hudson Estuary. Densities were highest in both systems at salinities of 4.2 to 6.0 ppt, at or shortly after the time of maximum water temperature.

A basic pattern of larval movement (Figure 4) was presented by Dovel (1981). Juvenile and possibly some adult bay anchovies move to fresh water to feed when estuarine waters begin to warm. Mature bay anchovies move downstream to spawn when water temperatures reach at least 12 °C and salinities are generally 10 ppt or greater. Newly hatched larvae then move upstream to waters of less than 10 ppt salinity to feed. Larval and juvenile bay anchovies begin to move into more saline waters in early fall. By late November, anchovies occur only in salt water. The movement of the larvae to lower salinity nursery areas and the subsequent migration of juveniles and adults toward the open sea are probably characteristic of other engraulids (Dovel 1981).

For impact assessment purposes, the temporal and spatial distribution of a targeted species within the area of potential impact would be useful to a project impact analyst. The information presented for the bay anchovy by Dovel (1981) may provide the resource planner with valuable insight into the population dynamics of the bay anchovy.

BAY ANCHOVY



A. SPRING FEEDING MIGRATION OF JUVENILES AND POSSIBLY ADULTS INTO FRESHWATER AS WATER TEMPERATURES APPROACH 10° C.

B. MATURE FISH MIGRATE TO SALINE WATERS (>10.0 ppt) TO SPAWN AS WATER TEMPERATURES APPROACH 15° C.

C. LARVAE MOVE UPSTREAM TO LOW SALINITY WATERS RICH IN ZOOPLANKTON.

D. LARGER JUVENILES MOVE FARTHER UPSTREAM INTO FRESHWATER, WHILE MOST OF THE 0 AGE GROUP REMAIN IN SALINE WATERS. THE LARGER JUVENILES MOVE DOWNSTREAM INTO SALINE WATERS AS WATER TEMPERATURES DROP BELOW 10° C WITH THE ONSET OF WINTER.

Figure 4. Basic seasonal movements of the bay anchovy in the Hudson River (modified from Dovel 1981).

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16. Abstract (Limit: 200 words)

Species profiles are literature summaries of the taxonomy, morphology, range, life history, and environmental requirements of coastal aquatic species. They are prepared to assist in environmental impact assessment. The bay anchovy, Anchoa mitchilli, is one of the most important species in the Mid-Atlantic Region because it is a primary forage item for many economically important commercial and sport fishes. Bay anchovies are ubiquitous inhabitants of the Mid-Atlantic Region. In this area, spawning apparently occurs in estuarine waters when water temperatures are at least 12 °C and salinities are over 10 ppt. Zooplankton constitutes the major portion of the diet of bay anchovies. They have been collected at water temperatures ranging from 2.2 to 27.1 °C and from water salinities ranging from 0.0 to 80 ppt.

17. Document Analysis a. Descriptors
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Fishes
Populations
Food habits

b. Identifiers/Open-Ended Terms

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Anchoa mitchilli	Embryology
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