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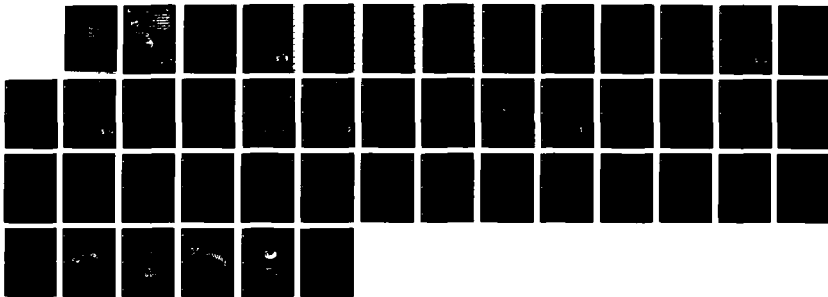
SPECIES PROFILES LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL... (U) FISH AND WILDLIFE SERVICE
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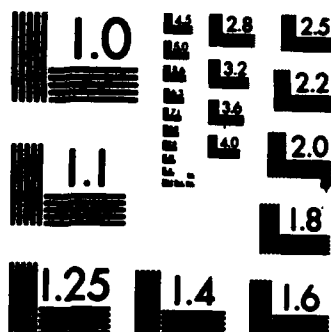
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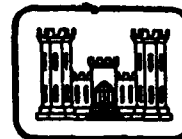




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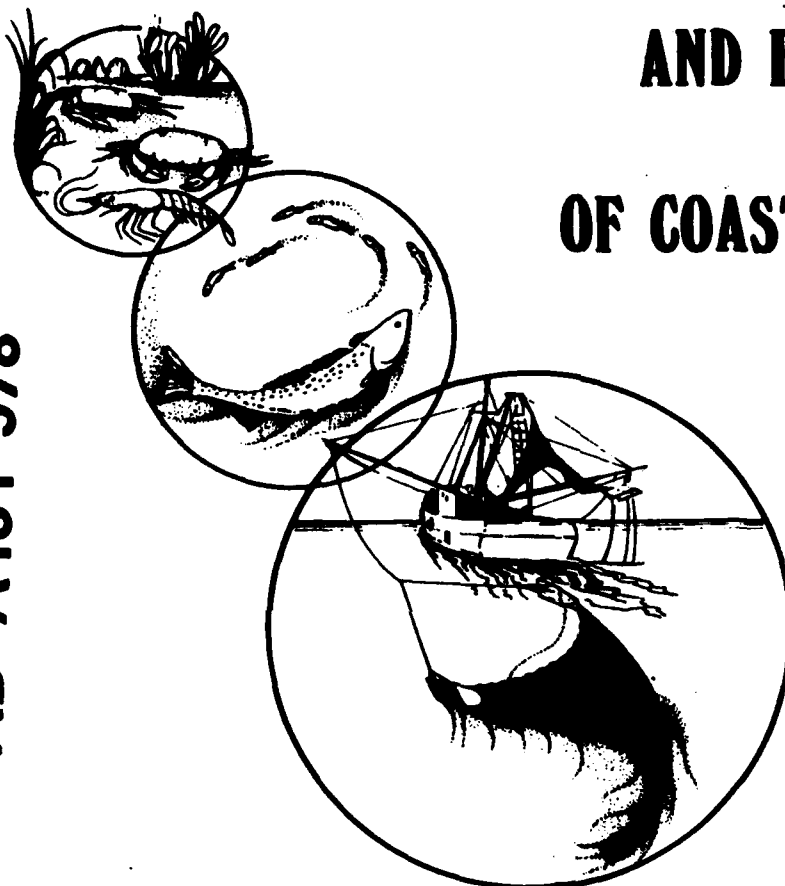


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SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL REQUIREMENTS OF COASTAL FISHES AND INVERTEBRATES

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NORTH ATLANTIC
MID-ATLANTIC
SOUTH ATLANTIC
SOUTH FLORIDA
GULF OF MEXICO
PACIFIC SOUTHWEST
PACIFIC NORTHWEST

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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This document consists of prefaces, maps,
glossary and general anatomy of fish, crab, shrimp
and clam. → 0.4

**SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL FISHES AND
INVERTEBRATES (NORTH ATLANTIC)**

Managed by

National Coastal Ecosystems Team
Division of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior

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Cont

PREFACE

Species Profiles are summaries of the life histories and environmental requirements of selected coastal fishes and invertebrates of commercial, recreational, or ecological significance. They were prepared through an Inter-agency Agreement between the Waterways Experiment Station of the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service. The Corps is developing estuarine water quality models and conducting studies to assess the environmental impacts of modifying estuarine circulation and transport processes. The Profiles will be used to relate life history and environmental requirements of species to coastal numerical water quality models and to assist in evaluating the environmental impacts of altering estuarine habitats. The data for the preparation of Species Profiles are taken from the published and unpublished literature.)

For this program the marine coastline of the continental United States was divided into the following seven biogeographic regions, (see map):

1. North Atlantic - Canadian border to Cape Cod, Massachusetts;
2. Mid-Atlantic - Cape Cod to Cape Hatteras, North Carolina;
3. South Atlantic - Cape Hatteras to Cape Canaveral, Florida;
4. South Florida - Cape Canaveral to Cedar Key on the Gulf of Mexico;
5. Gulf of Mexico - Cedar Key to U.S.-Mexico border;
6. Pacific Southwest - U.S.-Mexico border to Cape Mendocino, California;
7. Pacific Northwest - Cape Mendocino to Canadian border.

The Species Profiles are assembled in loose-leaf volumes by biogeographic region. Forty species or species groups were selected in order of priority by offices of the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service for each biogeographic region. Some species are included in several volumes because of their wide distribution, but specific life requirements for each region are described. To assist users, a glossary and labeled diagrams of the external adult anatomy of a finfish, shrimp, clam, and crab follow this preface.

This volume includes species profiles from the North Atlantic coastal region (see map), which is characterized by rocky or sandy shorelines, cool and fertile waters, high tides, and a wide continental shelf. The tidal shoreline of the region is 8,251 km (5,127 mi) long, but the general shoreline is only 697 km (433 mi) long. The coast is noted for its many relatively small bays and harbors. The shoreline from the Canadian border to Portland, Maine, is rocky with some sandy beaches. Sandy beaches, occasional salt marshes, and rock outcrops are common shoreline characteristics south of Portland. A large number of rocky islands are located along the Maine coast and several off Cape Cod, Massachusetts.

④

The primary ocean current that influences the region is the Labrador Current flowing from the north. The tides are semidiurnal and range from 5.5 m (18 ft) at the United States-Canada border to about 2.7 m (9 ft) at Cape Cod. The Continental Shelf is 241 to 402 km (150 to 250 mi) wide and supports a highly productive ocean fishery, particularly on George's Bank east of Cape Cod.

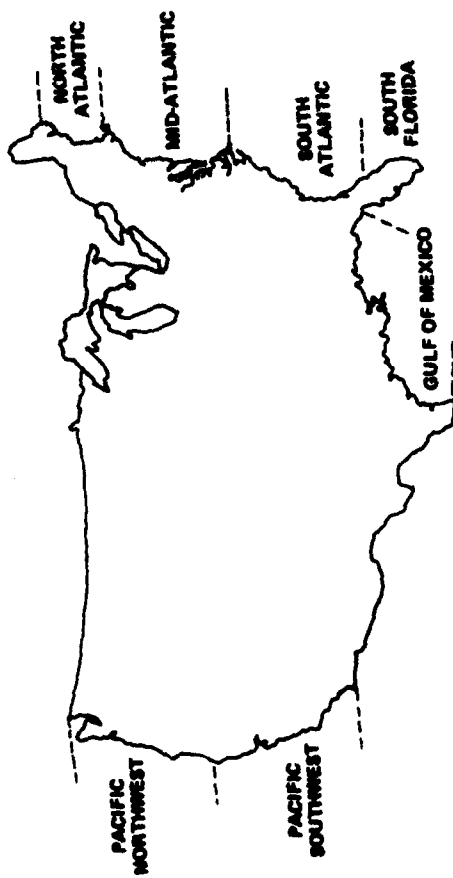
The drainage basin is heavily forested. Agriculture is primarily restricted to river bottoms and is not subject to heavy erosion. The underlying rocks are granites, other igneous rocks, and some sedimentary sandstones. Glaciation and wave action sculptured the rugged shoreline, and drastic changes in shoreline configuration have not occurred since the last glaciation.

Rivers flowing into the ocean carry low sediment loads, and there is little delta development. The mean annual freshwater runoff to the ocean is about $2,039 \text{ m}^3/\text{s}$ (71,997 cubic feet per second [cfs]) or about $0.4 \text{ m}^3/\text{s}$ (14 cfs) per mile of tidal shoreline. The Penobscot, Kennebec, and Merrimack are the major rivers flowing into the ocean. Pollution from paper mills and other industries has been a major environmental problem, and the construction of mills and power dams has blocked anadromous fish spawning runs since the mid-1800's. Efforts to reduce pollution and to build fishways around dams have been effective in some rivers in recent years.

High salinities characterize coastal and estuarine waters. Some estuaries have characteristics of fjords. Nearshore salinities are commonly near 30 ppt, but exceed 32 ppt offshore.

Strong longshore currents are caused by tides and winds. Although currents transport some suspended clays and sand, turbidities are generally low in the nearshore area. Water temperatures range from 0°C (32°F) or less in winter to about 18°C (64°F) in summer. Summer water temperatures are higher in shallow embayments such as Cape Cod.

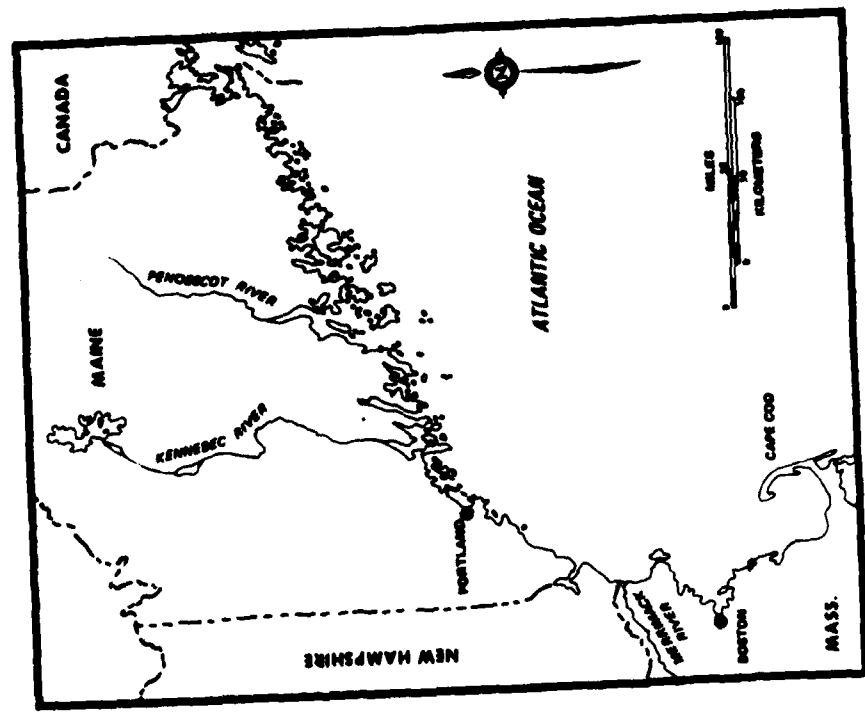
The primary nearshore commercial species are American lobster, hard clams, soft-shell clams, winter flounder, bay scallop, Atlantic herring, Atlantic cod, and Atlantic mackerel. Recreational species include the species listed above plus bluefish, striped bass, white perch, and Atlantic salmon. The important anadromous species are Atlantic salmon and American shad although alewives and smelt are caught in several rivers.



BIOGEOGRAPHIC COASTAL REGIONS OF CONTINENTAL UNITED STATES (ABOVE) AND THE NORTH ATLANTIC REGION (LEFT)



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**SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL FISHES AND
INVERTEBRATES (MID-ATLANTIC)**

Managed by

**National Coastal Ecosystems Team
Division of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior**

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PREFACE

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7. Pacific Northwest - Cape Mendocino to Canadian border

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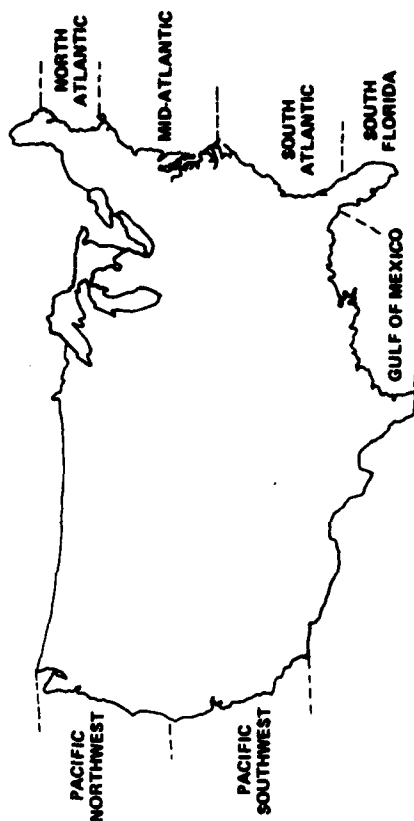
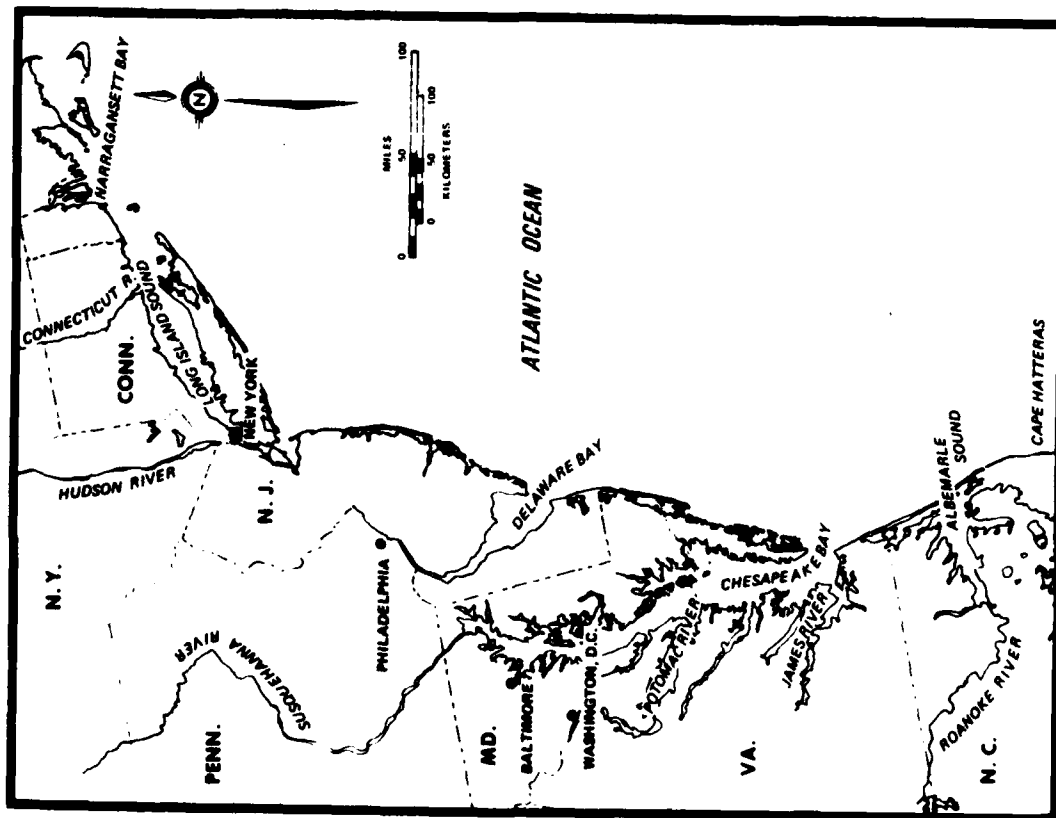
Among the biogeographic regions, the mid-Atlantic coastal region has the highest population density. Twenty-one million people lived in the coastal counties of this region in 1976 and, consequently, there have been extensive modifications of rivers and estuaries to support navigation and urban and industrial development. The region is characterized by several large estuaries, high river inflow with relatively low sediment loads, cool water temperatures, coastal marshes, and high fish production. The 18,503-km (11,498-mi) long tidal shoreline (see map) is mostly sand or marsh, but occasional rocky outcrops are present in northern areas.

The major rocks in the drainage basin are sedimentary limestones and sandstones, granites, volcanic deposits, and metamorphic rocks. The landscape is a mixture of forested mountains, low hills, rolling agricultural land, and a coastal plain. The primary rivers flowing are the Connecticut, Hudson, Delaware, Susquehanna, James, Potomac, and Roanoke (see map). The region has about 328,449 ha (811,597 acres) of coastal wetlands. Most are along the New Jersey coast (99,225 ha or 245,185 acres), in Delaware Bay (33,615 ha or 83,063 acres), and in Chesapeake Bay (171,720 ha or 424,320 acres).

The Continental Shelf is 80-160 km (50-100 mi) wide and slopes quite smoothly seaward. Barrier islands are common from New York to Cape Hatteras, and most are developed for human habitation. The major estuaries are Narragansett Bay, Long Island Sound, Delaware Bay, Chesapeake Bay, and Albemarle Sound. The Labrador Current has some effect on this coastal region, but the predominant longshore currents are largely controlled by tides and wind. Turbidities in nearshore marine waters are generally low except in or near estuaries when river inflow is high. Low dissolved oxygen concentrations are not a problem except in isolated sections of estuaries or in heavily polluted areas. The mean winter water temperature in the estuaries is about 2°C (36°F) and summer temperatures are about 24°C (75°F). Water temperatures are higher in Chesapeake Bay and Albemarle Sound. Estuarine areas with high river inflow, such as Chesapeake and Delaware Bays, have mean salinities of 13 ppt; but salinities in most of the region are in the 30- to 32-ppt range. The mean tide range for most of the region is 1.5 m (5 ft), but it is only about 0.6 m (2 ft) in Chesapeake Bay. Wind tides often govern the currents in Chesapeake Bay and Albemarle Sound.

The mid-Atlantic region supports valuable commercial and sport fisheries. In 1978 the commercial catch of 403,000 metric tons (444,106 tons) of finfish and shellfish had a dockside value of \$207 million. The primary commercial species are the bay scallop, hard clam, surf clam, American oyster, blue crab, Atlantic croaker, Atlantic menhaden, flounder, bluefish, and American shad. The common sport species are bluefish, Atlantic croaker, spot, striped bass, weakfish, mackerel, flounder, and perch. The important anadromous species are striped bass and American shad. Alewives and blueback herring are caught in a few streams.

High population density and heavy industrial and commercial development along the coast have caused major environmental problems. For example, in the 1870's, oysters in Raritan Bay, New Jersey, were found to be unsuitable for human consumption due to pollution. Other major environmental problems are dredging of wetlands, excessive sedimentation, modification of river inflow, and habitat displacement (e.g., buildings and bulkheads).



BIOGEOGRAPHIC COASTAL REGIONS OF CONTINENTAL UNITED STATES (ABOVE) AND THE MID-ATLANTIC REGION (LEFT)

SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL FISHES AND
INVERTEBRATES (SOUTH ATLANTIC)

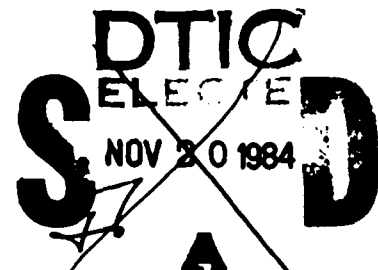
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PREFACE

Species Profiles are summaries of the life histories and environmental requirements of selected coastal fishes and invertebrates of commercial, recreational, or ecological significance. They were prepared through an Interagency Agreement between the Waterways Experiment Station of the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service. The Corps is developing estuarine water quality models and conducting studies to assess the environmental impacts of modifying estuarine circulation and transport processes. The Profiles will be used to relate life history and environmental requirements of species to coastal numerical water quality models and to assist in evaluating the environmental impacts of altering estuarine habitats. The data for the preparation of Species Profiles are taken from the published and unpublished literature.

For this program the marine coastline of the continental United States was divided into the following seven biogeographic regions. (see map):

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The Species Profiles are assembled in loose-leaf volumes by biogeographic region. → Forty species or species groups were selected in order of priority by offices of the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service for each biogeographic region. Some species are included in several volumes because of their wide distribution, but specific life requirements for each region are described. To assist users, a glossary and labeled diagrams of the external adult anatomy of a finfish, shrimp, clam, and crab follow this preface.

The South Atlantic coastal region is noted for large numbers of barrier islands, extensive coastal marshes, and estuaries (see map). Barrier islands, which border about 65% of the coastline, were formed during the Pleistocene and Holocene Periods, and have been modified extensively by littoral currents and sediment inflow from rivers. Coastal marshes developed ultimately from the heavy sediment inflow (est. 53 million metric tons/yr or 58 tons/yr) that partially filled in the estuaries between barrier islands and the mainland. Estuaries are both of the drowned river valley type and the bar-built type. The average annual river inflow in the region is $4,245 \text{ m}^3/\text{s}$ (150,000 cubic feet per second [cfs]). Diurnal tides are about 1.5 m (5 ft) range in most areas, but reach 2.4 m (8 ft) off the Georgia coast. In Pamlico Sound lunar tides are in the 0.3- to 0.6-m (1- to 2-ft) range, but wind tides are also important.

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**SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL FISHES AND
INVERTEBRATES (SOUTH FLORIDA)**

Managed by

National Coastal Ecosystems Team
Division of Biological Services
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The south Florida coastal region (see map) is subtropical and has coral reefs, large stands of mangroves and seagrasses, and fish and invertebrate species compositions not common elsewhere along the United States coast. The Continental Shelf is about 50 km (31 mi) wide at Cape Canaveral, but it gradually narrows, and the Continental Slope essentially adjoins the barrier islands from Palm Beach to Miami. The Continental Shelf widens slightly south of Miami, but then drops off rapidly south and east of the Florida Keys into the Straits of Florida, which is an abyssal ocean trench between Cuba and the United States. Florida Bay is a large embayment between the Keys and the mainland. The Continental Shelf on the west coast of Florida is about 170 km (106 mi) wide. Tampa Bay and Charlotte Harbor are the largest bays on the west coast of Florida.

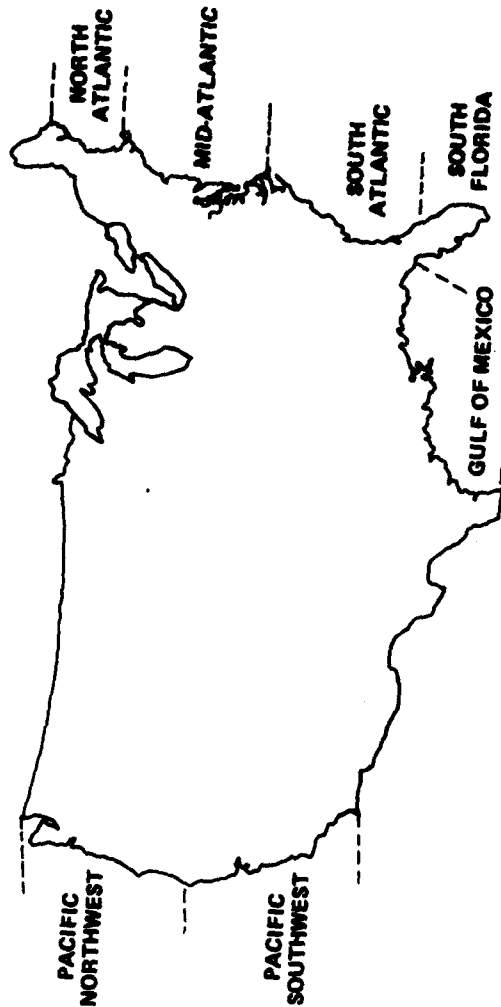
The primary ocean current influencing the Atlantic coast of Florida is the Gulf Stream, which leaves the Gulf of Mexico through the Straits of Florida and follows the Continental Shelf northward. It reaches nearshore of the barrier islands from Miami to Palm Beach and then moves gradually to about 56 km (35 mi) offshore at Cape Canaveral. Currents on the west Florida coast generally flow northward.

The mean winter air temperature is 21°C (70°F), and the mean summer temperature is 32°C (89°F). Annual precipitation averages about 122 cm (48 inches) and peaks in the summer and early fall. Sea-surface temperatures in winter range from 19°C (66°F) to 26°C (79°F) and in summer from 27° to 30°C (80° to 86°F). Sea-surface salinities are about 35 ppt, but reach 70 ppt in Florida Bay. Semidiurnal tides on the Atlantic coast average about 1 m (3 ft) whereas diurnal tides in the Gulf of Mexico average 0.3-0.6 m (1-2 ft). Sediment input from tributary streams and turbidities in the nearshore waters and estuaries are relatively low except where streams carry heavy loads of organic matter or as a result of tropical storms and hurricanes.

The drainage area of south Florida, which is relatively flat, has many shallow lakes, hardwood swamps, and marshes. Extreme southern Florida is dominated by the Everglades, which are shallow rivers flowing through grassy areas with hummocks of pines and shrubs. Cypress swamps dominate the western part of south Florida. Historically, surface waters drained southward through the Everglades to the Gulf of Florida or westward through cypress swamps to the Thousand Islands area. Extensive water diversion to support urban developments on the east coast and for agriculture has seriously reduced the southward flow. Because of reduced freshwater inflow, the Gulf of Florida has become hypersaline (up to 70 ppt), and abundance of many fish species and wading birds has declined as much as 50% from historical levels.

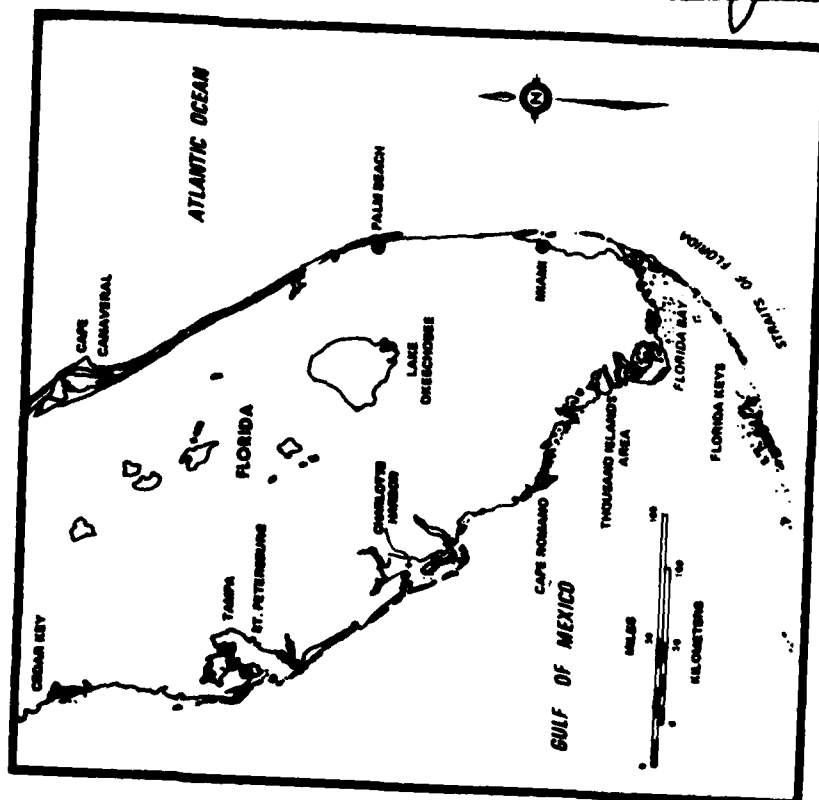
Coastal salt marshes and seagrass beds are common along the Atlantic coast between the barrier islands and the mainland. The coastal region from Miami around the tip of Florida inside the Keys to Cape Romano on the Gulf of Mexico includes vast stands of seagrasses and mangroves on the fringes of islands and the mainland. The Thousand Islands region on the southwest coast has the most extensive mangrove stands along the coast of the continental United States. The barrier island chain north of Cape Romano on the gulf coast extends north to Tampa. Stands of seagrasses and coastal marshes are apparent between the barrier islands and the mainland and along the mainland north of Tampa.

Important finfish and shellfish on the Atlantic coast include menhaden, bluefish, porgy, mullet, spotted seatrout, pompano, Atlantic croaker, spot, shrimps, crabs, oysters, and clams. Florida Bay and the mangrove swamps around the Thousand Islands area are important nursery areas for anchovy, pink shrimp, tarpon, snook, spotted seatrout, pompano, snapper, and red drum. Coral reefs along the gulf coast have many unique assemblages of reef fishes. The Florida west coast from Cape Romano to Cedar Key is noted for snappers, spotted seatrout, pompano, sea catfish, flounder, croaker, and snook.



BIOGEOGRAPHIC COASTAL REGIONS OF CONTINENTAL UNITED STATES (ABOVE) AND THE SOUTH FLORIDA REGION (LEFT)

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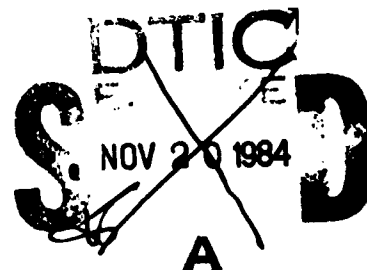


**SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL FISHES AND
INVERTEBRATES (GULF OF MEXICO)**

Managed by

**National Coastal Ecosystems Team
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Fish and Wildlife Service
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The Gulf of Mexico coastal region is a wide coastal plain of low relief, noted for large areas of estuarine habitat (see map). The dominant ecological influence is the inflow of the Mississippi River, which drains 3.4 million km² (1.3 million mi²) of the mid-continent of the United States. The annual sediment inflow into the Gulf of Mexico is estimated at 617 million metric tons (680 million tons), and the Mississippi Delta extends to the Continental Slope at its southernmost point. Sediment deposits have developed vast areas of coastal marshes along the Louisiana coast. Other major rivers flowing into the Gulf of Mexico and having sizable estuaries are the Apalachicola River in Florida, the Mobile River in Alabama, the Sabine River on the Louisiana-Texas border, and the Rio Grande, Trinity, and Colorado Rivers in Texas.

The Continental Shelf is over 273 km (170 mi) wide in the eastern Gulf of Mexico, but only 96 to 113 km (60 to 70 mi) wide off the Texas coast. The dominant incoming current to the Gulf of Mexico is the equatorial Atlantic Current, which enters the gulf south of Cuba and forms many gyres in the south and central sections of the gulf. Coastal currents flow generally northward along the Florida coast and westward along the northern gulf coast except near Panama City, Florida, where a gyre produces an easterly current. The Gulf Stream is the outflowing current from the Gulf of Mexico through the Straits of Florida.

The shallow northern gulf estuaries have soft substrates, and low to moderate (0.5-20 ppt) salinities because of high river inflow. Sea-surface salinities average 34-35 ppt in the central gulf, but average 36 ppt off south Texas and south Florida. The Laguna Madre, a hypersaline lagoon along the south Texas coast, has salinities exceeding 70 ppt in dry years.

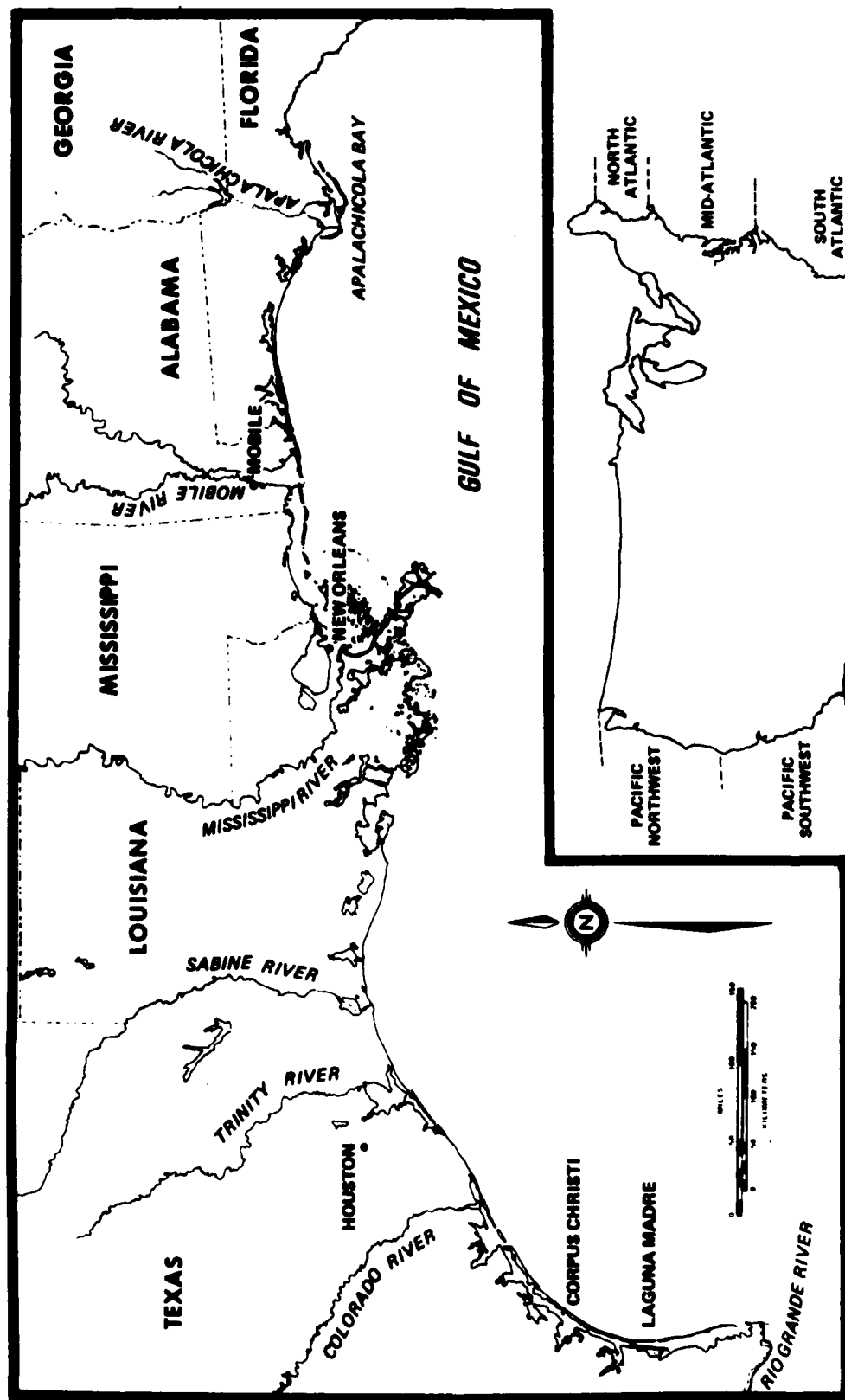
The climate of the Gulf of Mexico is subtropical and humid. Mean annual precipitation is 140 cm (55 inches) for most of the northern gulf, but it is much lower on the south Texas coast. Tropical storms and hurricanes commonly produce heavy rainfall for short periods. Summer water temperatures range from 25° to 30°C (77° to 86°F). In winter, minimum water temperatures range from about 13°C (55°F) in the northern gulf to 16°C (61°F) in south Texas. Diurnal tides are in the 0.3- to 0.6-m (1- to 2-ft) range in the region.

The gulf coast has an estimated 2.4 million ha (5.9 million acres) of estuaries, which is about 38% of the total for the continental United States. The 11 million ha (27 million acres) of salt and brackish marshes contribute 58% of the U.S. total.

Over 90% of the more valuable finfish and shellfish caught by commercial and sport fisherman in the Gulf of Mexico depend upon estuaries for some aspect of their life cycle. In 1980 about 30% of the U.S. commercial finfish and shellfish catch of 3.2 million tons was caught in the Gulf of Mexico. The most common species were gulf menhaden, Atlantic croaker, penaeid shrimp, blue crab, oyster, and spotted seatrout. Those most commonly taken by anglers are spot, croaker, spotted seatrout, catfishes, red drum, and mackerels.

10-10

A. For	
1. NAME	
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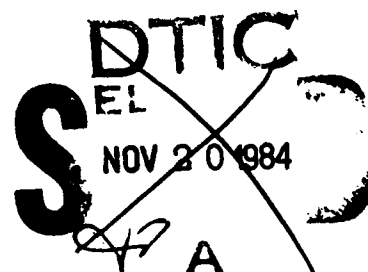
BIOGEOGRAPHIC COASTAL REGIONS OF CONTINENTAL UNITED STATES (BOTTOM INSERT) AND THE GULF OF MEXICO REGION

SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL FISHES AND
INVERTEBRATES (PACIFIC SOUTHWEST)

Managed by

National Coastal Ecosystems Team
Division of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior

This series is being jointly developed
and funded by the
U.S. Army Corps of Engineers
and
U.S. Fish and Wildlife Service



This document has been approved
for public release and sale; its
distribution is unlimited.

PREFACE

Species Profiles are summaries of the life histories and environmental requirements of selected coastal fishes and invertebrates of commercial, recreational, or ecological significance. They were prepared through an Interagency Agreement between the Waterways Experiment Station of the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service. The Corps is developing estuarine water quality models and conducting studies to assess the environmental impacts of modifying estuarine circulation and transport processes. The Profiles will be used to relate life history and environmental requirements of species to coastal numerical water quality models and to assist in evaluating the environmental impacts of altering estuarine habitats. The data for the preparation of Species Profiles are taken from the published and unpublished literature.

For this program the marine coastline of the continental United States was divided into the following seven biogeographic regions, (see map):

This series covers:

1. North Atlantic - Canadian border to Cape Cod, Massachusetts
2. Mid-Atlantic - Cape Cod to Cape Hatteras, North Carolina
3. South Atlantic - Cape Hatteras to Cape Canaveral, Florida
4. South Florida - Cape Canaveral to Cedar Key on the Gulf of Mexico
5. Gulf of Mexico - Cedar Key to U.S.-Mexico border
6. Pacific Southwest - U.S.-Mexico border to Cape Mendocino, California
7. Pacific Northwest - Cape Mendocino to Canadian border

The Species Profiles are assembled in loose-leaf volumes by biogeographic region. Forty species or species groups were selected in order of priority by offices of the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service for each biogeographic region. Some species are included in several volumes because of their wide distribution, but specific life requirements for each region are described. To assist users, a glossary and labeled diagrams of the external adult anatomy of a finfish, shrimp, clam, and crab follow this preface.

The Pacific Southwest coastal region is characterized by rocky bluffs interspersed with sandy beaches and small inlets for most of its length. The exception is the large estuarine system associated with San Francisco Bay. Except for the Sacramento and San Joaquin Rivers draining into San Francisco Bay, the coastal watersheds are generally small and have steep gradients. The Continental Shelf is narrow and drops off precipitously except off San Francisco Bay, where sediments have built a crescent-shaped shelf up to 64 km (40 mi) wide.

The normal tidal range averages about 1.5 m (5 ft), and ocean currents are complex. The offshore south-flowing California Current and the inshore

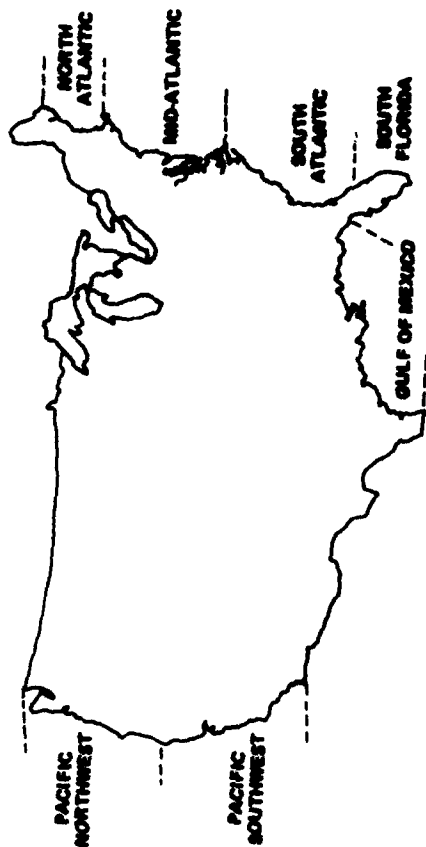
north-flowing Davidson Current are prominent in winter. In summer, the Davidson Current is interrupted by upwelling and the California Current is the only longshore current. Sea-surface salinities average about 33.5 ppt, but increase when the Davidson Current is strong.

Sea-surface water temperatures increase from north to south. In summer the minimums range from 10° to 15°C (50° to 59°F), and maximums from 17° to 22°C (63° to 72°F). In winter the minimums range from 8° to 12°C (46° to 54°F), and the maximums from 13° to 18°C (55° to 64°F).

Coastal watersheds south of San Luis Obispo Bay are largely vegetated with chaparral. Northern watersheds are forested with conifers and oaks. The coastal climate north of San Francisco Bay is characterized by mild to cool temperatures and moderate humidity controlled by oceanic winds and air masses. The central California coastal climate is Mediterranean-like, characterized by low humidity, mild dry summers, and cool wet winters. The southern California coastal area has warm dry summers and cool moist winters, often with sporadically heavy rainfall. Precipitation is primarily rain except for snow at high elevations. Average runoff is high (over 102 cm [40 inches]) near Cape Mendocino, less than 13 cm (5 inches) just north of San Francisco, and as low as 2.5 cm (1 inch) and even less in southern California.

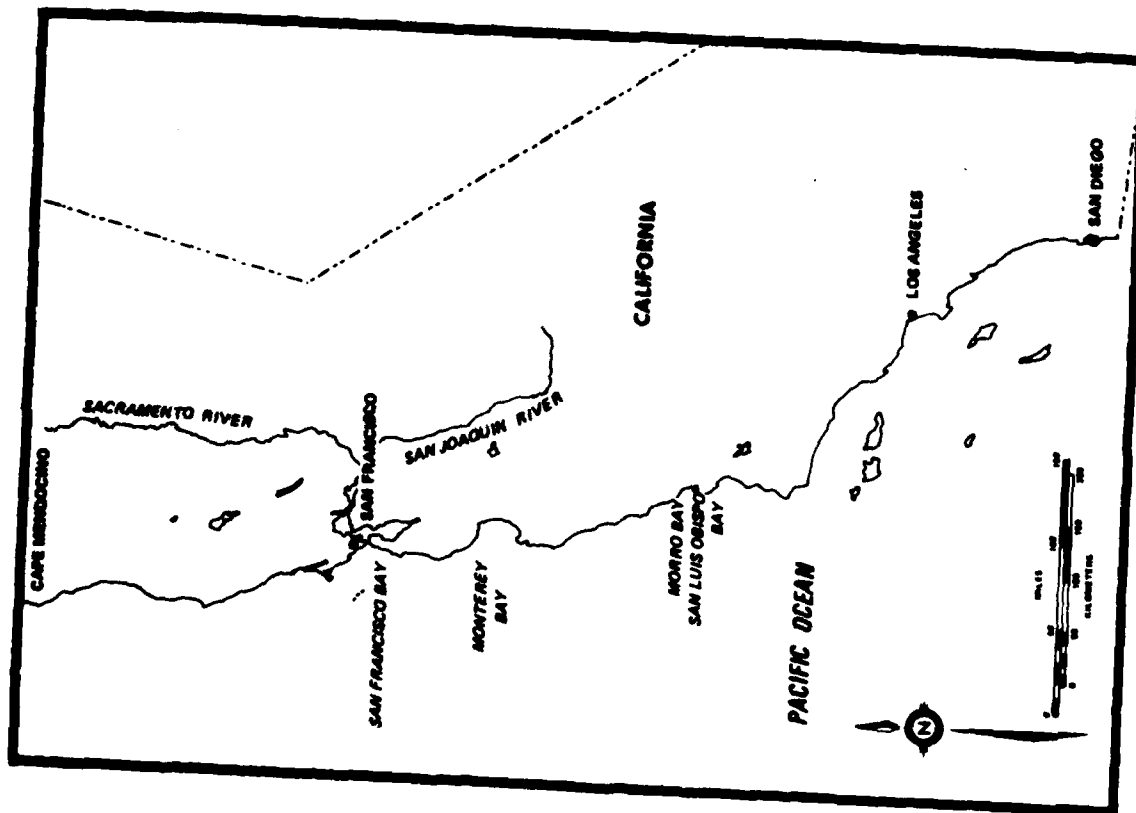
Small estuaries are located in San Diego Bay, San Luis Obispo Bay, Morro Bay, and Monterey Bay. The only large estuary extends from San Francisco Bay to the delta of the Sacramento and San Joaquin Rivers. The coastline is noted for its rugged cliffs and headlands and wind-swept trees. Large kelp beds in inshore areas are unique to this region; they furnish food and cover for many fish and invertebrate species and for the sea otter in some areas.

The most important anadromous fish species are chinook and coho salmon, steelhead, striped bass, American shad, and sturgeon. Valuable inshore species are anchovy, flounder, Pacific herring, abalone, crab, oyster, shrimp, rock fish, and mackerel.



BIOGEOGRAPHIC COASTAL REGIONS OF CONTINENTAL UNITED STATES (ABOVE) AND THE PACIFIC SOUTHWEST REGION (LEFT)

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SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL
REQUIREMENTS OF COASTAL FISHES AND
INVERTEBRATES (PACIFIC NORTHWEST)

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The Pacific Northwest coastal region (see map) is noted for its mountainous forested shoreline, its high rainfall, and its coastal diversity. Coastal mountains south of the Columbia River parallel the ocean. There are many rivers contained in relatively small drainage basins. The only significant indentations of the coastline are in Humboldt Bay, California, and Coos Bay, Oregon. The Columbia River drains much of Washington, Oregon, Idaho, and parts of Canada. It has a large estuary, but it lacks shallow-water habitat common to most Atlantic coast estuaries.

North of the Columbia River low coastal flats have been formed largely by erosion of sedimentary deposits in the coastal mountains. Important estuaries

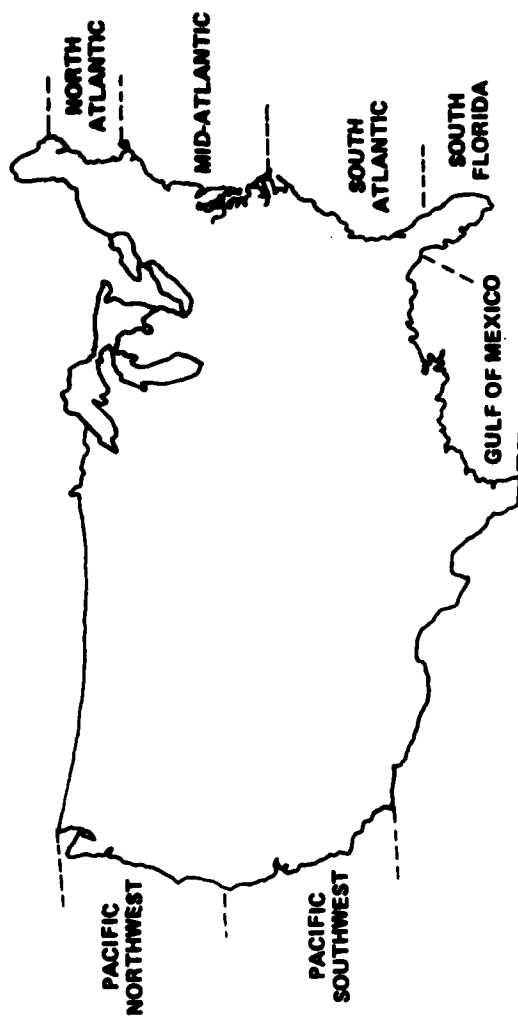
in this area are Willapa Bay and Grays Harbor, but the major embayment in the region is Puget Sound on the United States-Canada border. Puget Sound was sculptured by glaciers and is highly diverse because of its many channels, islands, coastal marshes, and tributary streams.

In the Pacific Northwest region, the Continental Shelf is 16 to 64 km (10 to 40 mi) wide except at the Canadian border, where it is 96 km (60 mi) wide. The tidal range is 1.8-2.7 m (6-9 ft), and the major tidal force is directed north-northeast or nearly parallel to the coast. The inshore ocean currents generally flow northward in winter and southward in summer. In winter the south-flowing California Current flows seaward of the north-flowing Davidson Current. In summer the Davidson Current becomes obliterated by upwellings and the California Current is the only longshore current.

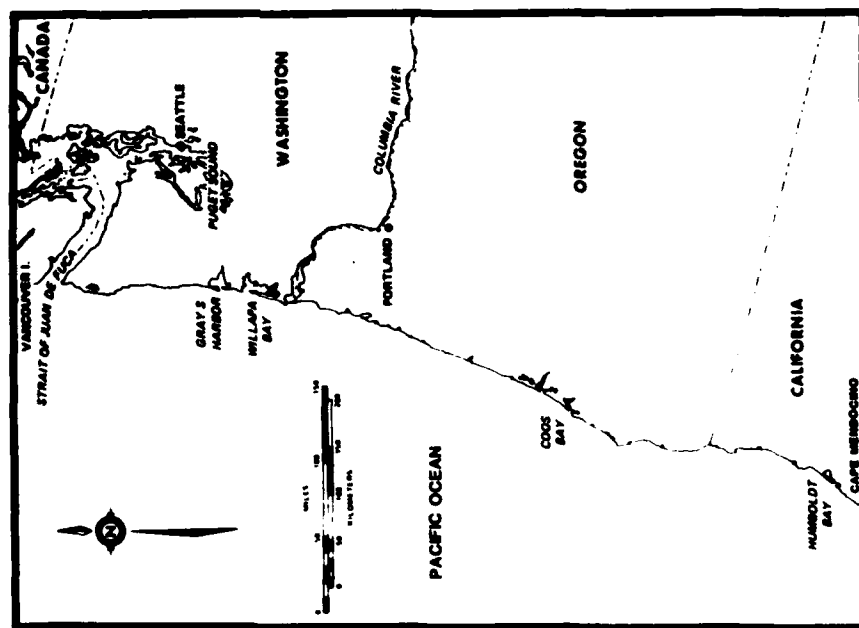
Sea-surface salinities generally average 32-33 ppt in winter and 33-34 ppt in summer and fall. Salinities at the mouth of the Columbia River reach 31 ppt during spring runoff. Average minimum sea-surface water temperatures in winter range from 5° to 8°C (41° to 46°F), and maximums are about 12° to 13°C (54° to 55°F). In summer the minimum water temperature is 10°C (50°F) and the maximum about 18°C (64°F).

The climate of the region is controlled by oceanic winds and air masses and is characterized by high precipitation, cloudy weather, and fog. Annual precipitation along the open coast averages 180 to 200 cm (71 to 79 inches), but is generally lower in the south. It ranges from 101 cm (40 inches) at Humboldt Bay to nearly 635 cm (250 inches) at the crest of the Olympic Peninsula mountains in the north. The region has wet winters and dry summers.

The coastal watersheds are temperate rain and fog forests of Sitka spruce, western hemlock, western red cedar, maple, alder, Douglas fir, and, in limited areas, coast redwood, and Port Orford cedar. The important sport and commercial fishes are the Pacific salmon (chinook, coho, sockeye, and chum), steelhead, searun cutthroat trout, and flounder. Major shellfish are dungeness crab, clams, and oysters.



BIOGEOGRAPHIC COASTAL REGIONS OF CONTINENTAL UNITED STATES (ABOVE) AND THE NORTHWEST PACIFIC REGION (LEFT)



GLOSSARY¹

abyssal - Refers to the deeper portions of the oceans.

acclimatization - Adjustment of an organism to a new environment or stimulant.

adductor - Muscle or muscles attached to both valves of a bivalve mollusk.

adipose fin - Small fleshy second dorsal fin lacking rays or spines on salmon, trout, and catfish.

advection - Movement of a mass of water, usually in a horizontal plane.

aerobic - Organisms requiring free oxygen; usually applied to bacteria.

age group - Age of a fish in years, based upon a designated birthday on 1 January. Fish in their first year of life (hatched from 1 January to 31 December) are designated as age group 0; fish in their second year of life are designated as age group 1; fish in ensuing years are aged accordingly.

alevin - Newly hatched salmon with yolk sac.

allochthonous - Organic and inorganic material originating in another habitat.

ammocoete - Larval stage of the lamprey.

anadromous - Refers to species that spawn and hatch in freshwater streams and lakes but that usually spend most of their life at sea.

anaerobic - Organisms able to live in the absence of free oxygen; usually applied to bacteria.

annulus - Annual ring or mark on a scale, bone, fin ray, otolith, or shell used for aging fish or shellfish and estimating growth.

antennae - Paired preoral feelers. In Crustacea the first smaller pair are called antennules.

antennules - First pair of feelers in Crustacea.

autochthonous - Organisms or material originating within a habitat.

¹Modified from Ecology, Utilization, and Management of Marine Fisheries by George A. Rounsefell, 1975, The C. V. Mosby Company, St. Louis, Missouri, with permission from the publisher.

autotrophic - Applies to plants that can produce organic matter from inorganic matter in the presence of carbon dioxide, water, and light; see photosynthesis.

bacteria - Small unicellular organisms 1 to 5 μ in size, usually with a cellulose cell wall.

barbel - Fleshy, often elongated, projection(s) below the lower jaw, under the snout, or around the mouth (e.g., catfish, cod, sturgeon).

benthic - Pertaining to the bottom of a body of water.

berried - Refers to female crustaceans carrying mass of fertilized eggs.

bioassay - Determination of the effect of varying concentrations of a substance or of varying physical conditions or stresses on living organisms by testing these materials or conditions under standardized conditions.

biochemical oxygen demand (BOD) - Decrease in oxygen content, measured in milligrams per liter of water, while held in the dark at a certain temperature over a designated period of time.

biocoenosis - An ecological community.

biological indicators - Organisms that by their presence or absence tend to indicate environmental conditions.

biomass - 1. The total wet weight of all living organisms in a unit of area or volume in a specified volume of water. 2. Total weight of a particular organism. 3. Total particulate organic matter by area or volume.

biota - All fauna and flora.

bivalve - Mollusk with a paired shell usually connected by a hinge that permits the two valves to open and close.

boat - Fishing craft of less than 5 tons net capacity.

brackish - Water that is slightly salty, usually <7-15 parts per thousand of sodium chloride.

branchiostegals - Bony rays supporting the branchiostegal membrane that encloses the gill chamber of a fish.

brood year - Year in which all of the fish of a particular age were spawned.

byssus - Horny threadlike structure in mussels and some other mollusks attaching them to the substrate.

carapace - Exoskeletal fold or plate covering the head and thorax. In decapod crustaceans (e.g., shrimp and crabs) it is fastened along the back, but its sides are free and cover the gills, which are between the body and the carapace.

carrying capacity - Maximum weight of a species or combination of species or total biomass that a particular body of water can support over a given period of time.

catadromous - Refers to species that spawn in the sea but spend most of their life in freshwater lakes and streams.

chela (pl. chelae) - An appendage and pincer, common among crustaceans.

chemical oxygen demand (COD) - Measurement of oxygen decrease due to chemical action over a designated time period. Determined by incubation similar to method for measuring biochemical oxygen demand.

chitin - Substance that forms the skeleton of crustaceans.

chlorion - Outer membrane of fish egg.

chlorophyll - Green substance in living cells usually necessary for photosynthesis.

circuli - Fine, usually concentric, lines on a fish scale. On most scales the "annulus" is formed when the spacings between circuli become narrower.

cleithrum - Bone supporting the pectoral fins in fishes.

compensation point - Depth at which light is just sufficient for the oxygen produced by organisms in photosynthesis to equal the oxygen they utilize in respiration.

competition - Interaction between organisms for food, shelter, and space that could limit the abundance of one or both groups. Interspecific competition is between species; intraspecific competition is between individuals of the same species.

continental shelf - Submerged edge of a continent (or island) to where it begins a steep descent. As shallow as 20 m (coral shelves) or as deep as 500 m (portions of the sea).

continental slope - Steep slope seaward of the edge of the continental shelf.

convergence - Imaginary line along which two surface currents meet; one or both water masses may sink.

coral shelf - Continental or island shelf of coral usually ending at about 20 m, the maximum depth for shelf-building corals.

crystalline style - Gelatinous rod used for digestion in oysters and other bivalves and certain snails.

ctenoid scale - Teleost (bony) fish scale with small sharp spines or ctenii on the posterior margin.

culling - Sorting and discarding unwanted organisms in the catch while at sea.

cultch - Shells or other material, spread over oyster grounds, on which oyster larvae can attach and develop into spat.

curvilinear relation - Results when changes in a variable that are associated with changes in another variable differ significantly from a straight line.

cycloid scale - Teleost (bony) fish scale with smooth edges and surfaces.

cyclonic eddy - Surface eddy (usually wind-driven) that rotates counterclockwise in the northern hemisphere and clockwise in the southern hemisphere.

deciduous - Refers to plant and animal parts that are easily or periodically shed; e.g., some fish scales.

demersal - Benthic; dwelling on or close to the bottom.

density-dependent - Describes predators whose abundance is largely controlled by the level of abundance of a certain species or type of prey.

dentary - Bone, usually carrying teeth, forming anterior portion of each lower jaw.

depuration (purification) - Elimination or substantial reduction of harmful quantities of pathogenic bacteria from live shellfish.

detritus - Finely divided organic material from animal and plant remains.

diatom - Unicellular plant enclosed in a siliceous frustule (two-valved shell). Diatoms are important components of the plankton.

diel - Pertains to a 24-hour period.

dimorphism - Marked differences between the sexes of an organism in size, color, or form. May refer to any differences in form.

dinoflagellates - Unicellular plants of the class Flagellata (or Mastigophora), some of which produce powerful toxins causing the dreaded red tides and paralytic shellfish poisoning.

divergence - Imaginary line along which two surface currents flow apart.

drill - Gastropod that feeds on oysters and other mollusks by making a hole in their shell with its radula.

ecdysis - Molt in which the chitinous exoskeleton is shed.

ecosystem - More or less self-sustaining biological area, e.g., a salt marsh or, in a larger sense, an estuary and the adjacent continental shelf that support an array of organisms dependent on the estuary at some life stage.

eelgrass - Seed-producing bladelike marine grass that lives in shallow coastal waters and estuaries.

elver - Early stage of American eel that are caught in estuaries or while ascending streams to reach nursery grounds.

embedded scales - Fish scales completely enveloped in skin.

endemic - Native to the locality.

epibenthic - Benthic marine species living on the surface of the bottom.

epifauna - Benthic animals that live on the surface of substrate.

epilimnion - Portion of a freshwater body lying above the thermocline.

escapement - Portion of a run of anadromous fish that escape capture either in the sea or the stream while on a migration to the spawning area.

estuary - Protected body of water in which the salinity fluctuates and departs significantly from the adjacent sea or ocean due to dilution from freshwater runoff. Most estuaries have a lower salinity (positive estuary). Some have a higher salinity (negative estuary) because of excessive evaporation.

euryhaline - Tolerant of wide changes in salinity; characteristic of estuarine species and certain stages in the life history of other species.

eutrophic - Applied chiefly to lakes relatively rich in nutrients.

fecundity - The number of ova in an organism or the size and number of ova in relation to the length or weight of the mature female.

fjord - Semienclosed coastal body of water formed by glacial erosion in young mountains; typically deep, usually long and narrow, with deep shores and often with a sill.

flocculation - Process whereby mineral and organic substances are carried into an estuary by a stream to form aggregates.

food web - Pattern by which energy (food) is transferred from one trophic level to another.

foot - Muscular part of the body of mollusks modified for clinging, creeping, digging, or swimming (as in squid). In some bivalve mollusks the foot is restricted to larvae.

forage fishes - Small fishes that are prey for larger fishes.

fork length - Length of a fish from the end of the snout to the fork in the tail fin.

fry - Newly hatched fish; usually refers to fish <25 mm long.

gear selectivity - A tendency of certain types of fishing gear or methods to catch fish of certain species, size, or sex.

gill arch - One of the bony supports for attachment of gill rakers and gill membranes.

gill rakers - Bony protuberances on anterior edge of the gill arches; normally short in predator fishes, but long and slender in fishes that eat plankton.

glaciated shelf - Continental shelf once occupied by glaciers; characterized by uneven bottom, moraines, and very large rubble.

gonad - Term denoting both ovaries and testes.

gravid fish - Fish with mature gonads.

grilse - Precocious salmon or anadromous trout (usually a male) that has matured at a much smaller size, and usually at a younger age, than most adult fish.

groundfish - Term for fish living on or near the bottom and usually caught by trawl.

gutted - Fish from which the contents of the body cavity have been removed.

gyre - Large oceanic eddy.

hermaphrodite - Individual with both male and female functional organs. It may or may not be self-fertilizing.

heterotroph - Organism requiring organic material for metabolic synthesis or nourishment.

hinge - Articulation between the two shells (valves) of a bivalve mollusk held together by a horny ligament.

hydrography - Study of the physical and chemical attributes of a body of water.

ichthyology - Study of the classification and systematic relationships of fishes.

indigenous - Species native to an area.

industrial fish - Fish used for pet or fur farm food, bait, fish meal, fish oil, or other industrial products.

infauna - Organisms that live in a benthic substrate.

intertidal - Zone or area of the shore between high and low tide.

isohaline - Contour of equal salinity.

isotherm - Contour of equal temperature.

juvenile - Immature organism that resembles an adult.

kelt - Mature Atlantic salmon that has spawned and has not yet recovered its weight or silvery color; sometimes called "black" salmon.

kype - Hooked prolongation of the upper jaw that develops in male salmon shortly before spawning.

labial palps - Sensory appendages surrounding the mouths; in bivalves the palps aid in sorting particles of food and detritus trapped in the mucus secreted by the gills.

larva (pl. larvae) - Early life stage of animal that is usually unlike that of the adult.

lateral line - Row of modified scales, sometimes with branches, along the side and sometimes extending onto the head of fish. The lateral line has a sensory function.

LD₅₀ - See mean lethal dose.

live weight - Weight of entire organism, including all organs, gills, head, shell, and skeleton.

mariculture - Commercial rearing of marine organisms.

maxillary - Upper jawbone of fishes, sometimes toothed, comprising the whole jaw or only the posterior part.

mean lethal dose (LD₅₀) - Dose of toxic substance that on the average kills 50% or more of the animals in a specified time.

megaloys - Last larval stage in crabs.

meristic - Pertains to segmentation of the body. Properly limited to such characters as fin rays and vertebral numbers, which are related to the number of body segments.

meroplankton - Organisms occurring in the plankton during early life stages before becoming benthic or nektonic.

micron - One-thousandth of a millimeter; usually designated by μ .

milt - Semen of fish.

morphometric - Describes body characteristics based on measurement of body proportions.

myomere - Muscle segment.

nannoplankton - Small plankton forms, about 5 to 60 μ , such as smaller diatoms, dinoflagellates, coccolithophores, protozoans, and bacteria.

natural mortality - Death of organisms from any causes other than fishing, usually expressed as an annual rate.

nekton - Actively swimming organisms.

neritic - Nearshore coastal waters, often applied to all waters over the Continental Shelf.

nutrients - Usually refers to dissolved nitrates, phosphates, silicates, and trace elements necessary for the growth of phytoplankton.

oceanic - Waters beyond the Continental Shelf.

omnivore - Animal that eats plants and animals.

operculum (opercle) - Flap of bone covering the gills of the higher fishes.

otolith - Earstone; aggregations of calcium carbonate contained in the semi-circular canals on each side of the head in fish.

out-migration - Seasonal migration of fish from a stream into a lake or sea.

overfishing - Fishing with such a high intensity on all or on selected portions of a population that the population cannot annually replace the biomass taken by fishing.

oviparous - Producing eggs that develop and hatch outside the female.

paralytic shellfish poisoning - A toxic disease caused by eating contaminated mollusk tissue.

parr - Young salmon and trout in freshwater before smolting or reaching the migratory stage.

pelagic - In the water column.

pH - Hydrogen-ion concentration used as a measure of water acidity.

phenotype - Morphologic aspect of an organism apart from its genetic properties.

pheromone - Chemical substance produced by an animal to attract the same or other species.

photoperiodism - Regulation of body functions in accordance with the frequency and duration of light.

photosynthesis - Process whereby plants produce organic matter from carbon dioxide, water, and sunlight.

photosynthetic zone - Surface waters where light is sufficient for photosynthesis.

phytoplankton - Diatoms, dinoflagellates, and other plants living in open water and capable of photosynthesis.

piscivorous - Fish-eating; applied to predators subsisting chiefly on fishes.

plankton - Living organisms in the water column, usually free-floating.

pleopods - Abdominal appendages in Crustacea anterior to the last appendages (which are part of the tail fan or uropods); used for swimming, carrying eggs, or gas exchange.

population - Stock or race of a species that exists as a biological or generic unit.

postlarvae - Life stage following the larval stage.

predator - Animal that consumes other animals.

primary productivity - Rate of formation of organic carbon by photosynthesis.

productivity - Yield, either in the general sense of harvest of marine organisms or in the more specialized usage of the annual production of the basic food substance, plankton, in any particular body of water.

protandrous - Describes change of sex in an organism.

pseudofeces - False feces; waste material not taken into the digestive tract; applies especially to mollusks that entrap their food on a continuing exuded band of mucus.

quasicatadromous - Species spawning in high salinity water, the young of which return to the lower salinity of the estuarine nursery grounds, e.g., blue crab, mullet, and menhaden.

race - Denotes subspecific differences, often of an isolated population.

recruit - Young fish that has just become available (vulnerable) to the fishing gear.

redd - Nest dug in a gravel bottom by salmonid fish. It may contain two or more egg pits.

reduction - Manufacturing process whereby whole or discarded portions of marine organisms are converted into such products as meal, oil, and solubles.

relative abundance - Measure or index of the size of a population in any particular year in relation to other years without reference to actual numbers or biomass.

reproduction curve - Curve of the numbers of adults in a population in successive years as the dependent variable y plotted against the numbers of their parents as the independent variable x .

reproductive potential - Potential number of a species that will attain maturity from the spawning of each adult.

rheotactic - Moving toward (positive) or against (negative) the current in a stream.

ripe - Fish in a physiological state for spawning.

river shelf - Continental Shelf, usually with a smooth bottom, off the mouth of a major river.

run - Assemblage of fish that ascend a river, usually to spawn, or to return to the ocean.

sac fry - Larval fish with yolk sac.

salt wedge - Layer or wedge of higher salinity water moving along the bottom toward the head of an estuary.

school - More or less compact group of individuals acting in concert. Many species of schooling fish are rarely found alone; some fish form dense schools at certain seasons or periods for spawning or migration but scatter at other times.

sediments - Bottom deposits.

sessile - Attached to the substrate, e.g., oysters or mussels, or feebly motile, e.g., most clams.

significance - Term reserved for the evaluation of a rigorous statistical test. When the probability of the occurrence of a particular event is only 1 in 20 or less ($P = 0.05$), the probability of its nonoccurrence is termed significant. When the probability is 1 in 100 or less ($P = 0.01$), it is termed highly significant.

sill - Shallow entrance to an enclosed body of deeper water.

siphon - Tube to bring in water, food, and oxygen (inhalant siphon) or to expel water and excretory products (exhalant siphon); pertains largely to clams.

smolt - Young anadromous salmon in which the scales have become silvery, hiding the underlying markings. The life stage in which young salmon migrate to the sea.

spat - Young oyster that has settled on a substrate.

spent - Applies to a fish that has recently spawned.

sponge (of Crustacea) - Mass of fertilized eggs carried by a female crustacean that adheres to the abdomen and swimmerets. Females with large-sized attached eggs, e.g., lobster, are usually called "berried."

standard length - Length of fish from front of snout to end of last vertebra.

standing crop - Total quantity at a given time of any species or of the total biomass in any body of water.

stenohaline - Lacking in ability to withstand large changes in salinity.

substrate - Materials comprising the bottom.

subtidal - Waters below the low tide level; usually refers to below the mean low tide.

supersaturation - Condition in which water contains over 100% of any or all atmospheric gases that it could hold at the ambient temperature and pressure while in equilibrium with the atmosphere.

taxon (pl. taxa) - Any of the formal groups to which living organisms are assigned, e.g., family, order, or genus.

territoriality - Defense of a particular area against encroachment by other animals.

thermocline - Zone of water with a steep temperature gradient separating upper and lower layers of well-mixed water; also called discontinuity layer.

thermohaline - Shifts in water masses induced by density changes generated by variations in water temperature and salinity.

thigmotropic - Pertains to an organism attracted to any solid body.

tidal pool - Pool of entrapped water left by the receding tide.

tidal prism - The volume of water between high and low tide levels in a partially enclosed body of water.

total length - Length of fish from front of snout to end of caudal fin when pressed together to attain maximum length.

trace elements - Chemical elements necessary in miniscule amounts to sustain life.

trochophore - Early larval stage of a bivalve.

trophic levels - Strata in a food web. Algae are in the primary trophic (food) level; herbivores are in the first consumer level; carnivores are at a higher trophic level.

tychoplankton - Forms of the littoral (shoreline) community occurring accidentally in the plankton, e.g., sessile diatoms broken off by turbulent water.

umbo - Peaked small portion of the adult bivalve shell near the hinge that represents the shell of the spat.

upwelling - Vertical movement of deep water to the surface.

urostyle - Fused vertebrae that support the caudal peduncle (see anatomical illustration) in fish.

veliger - Free-swimming larval mollusk after development of the velum, a foot, and a shell.

velum - Retractable bilobed rim with a preoral circlet of cilia in the veliger larvae of mollusks.

vessel - Fishing craft of more than 5 net tons capacity.

viscosity - Property of a liquid that presents a resistance to flow.

water column - Vertical column of water extending from the surface to the bottom.

year class - Year in which fish hatched from egg. Year classes are designated by year, e.g., 1980 year class.

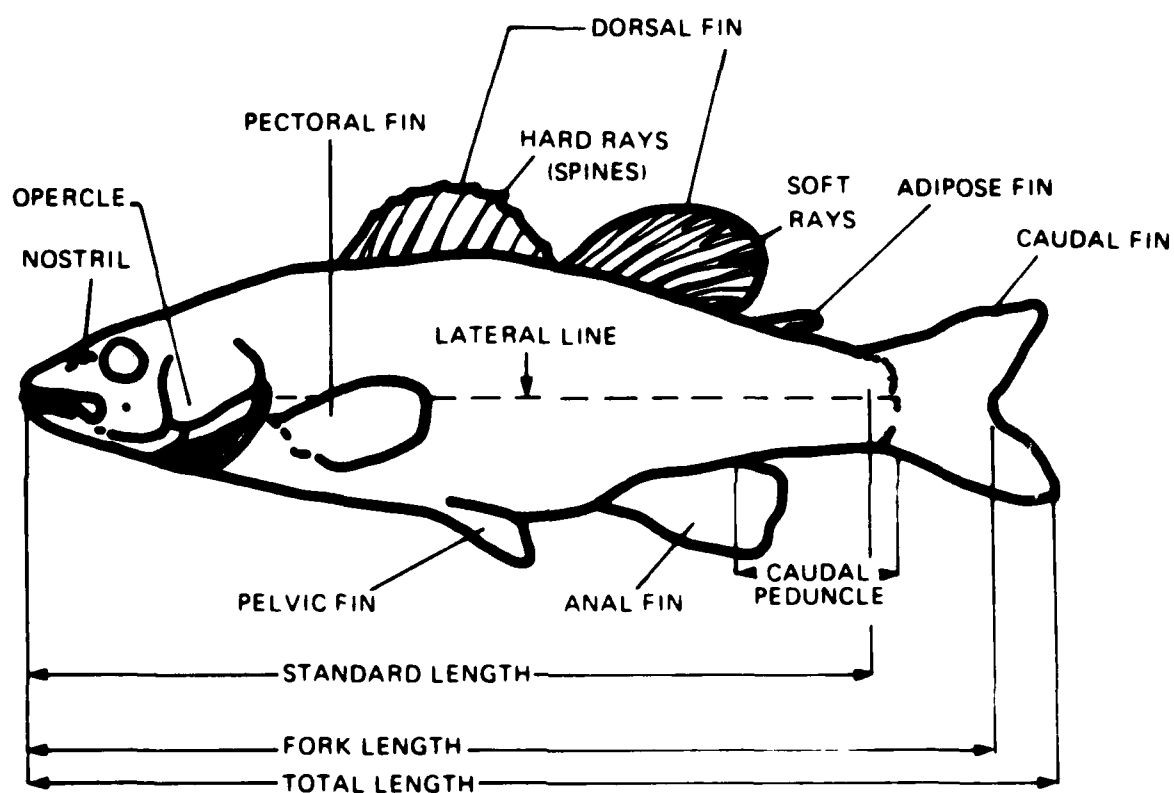
yield - Annual harvest of fish or shellfish. May be used for other time periods.

yolk sac - Membranous sac with yolk attached to a recently hatched fish that furnishes food until the fish begins feeding.

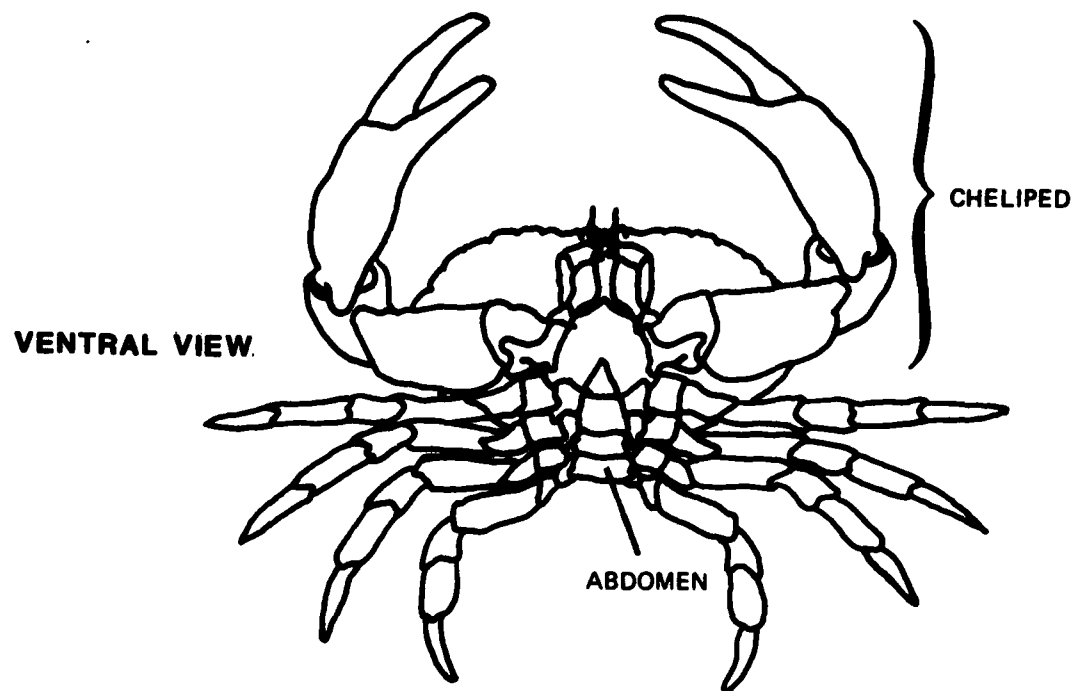
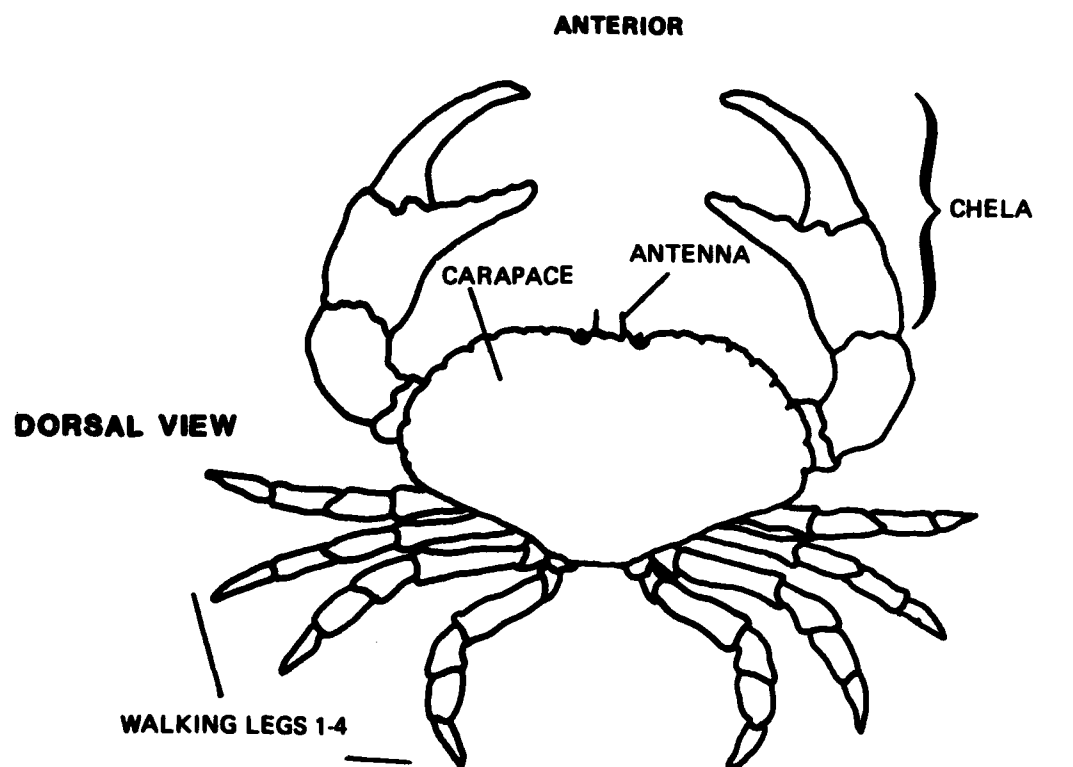
zoea - Larval stage in some crustaceans. The eggs hatch into zoea larvae in crabs, but zoea are the third free-swimming larval stage in penaeid shrimp (Family Penaeidae) and in mysids (Order Mysidacea).

zooplankton - Faunal components of the plankton, including small crustaceans such as copepods, ostracods, euphausiids, and amphipods; the jellyfishes and siphonophores; worms; mollusks such as pteropods and heteropods; and egg and larval stages of the majority of benthic and nektonic animals.

GENERAL ANATOMY OF FISH, CRAB, SHRIMP, AND CLAM

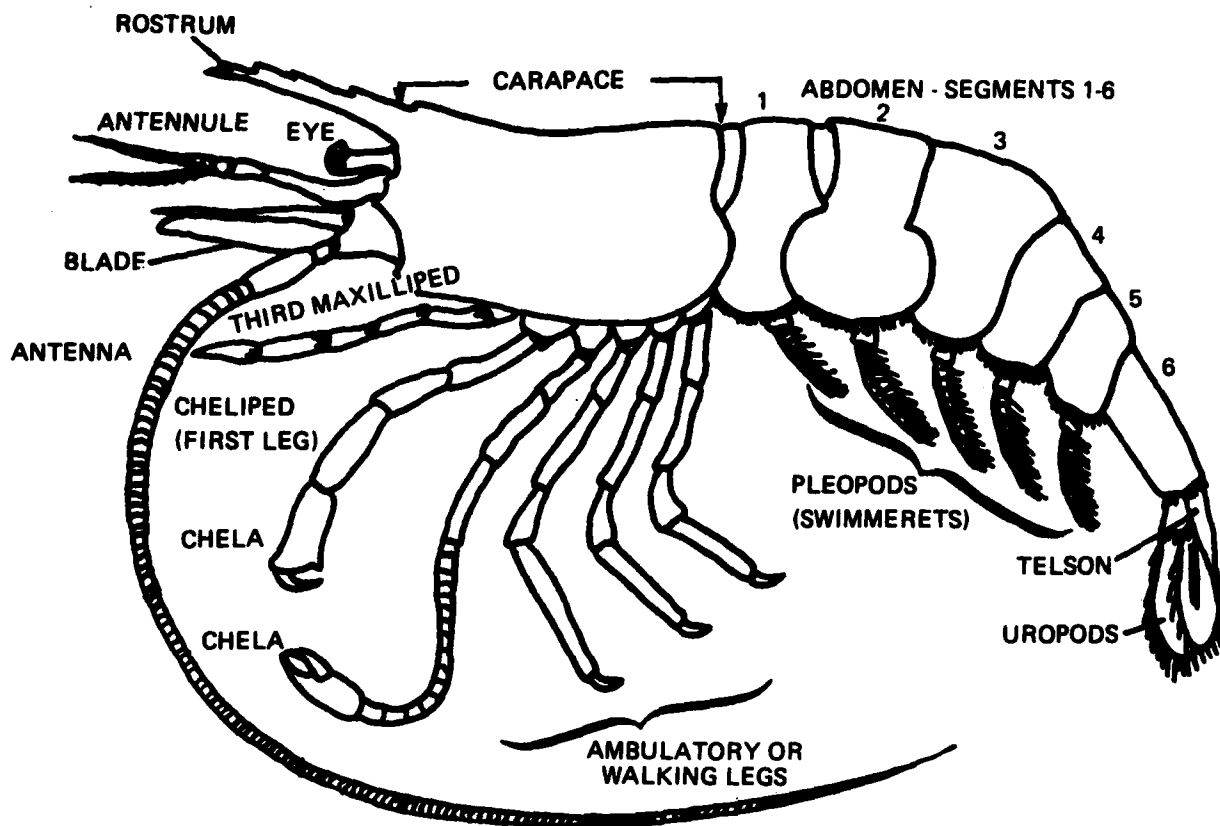


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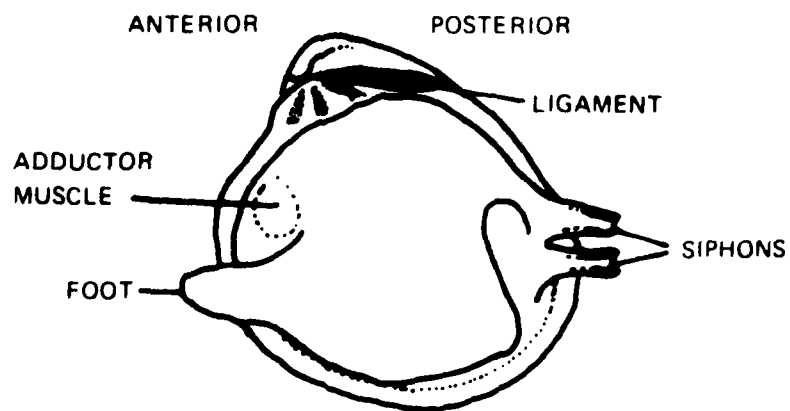
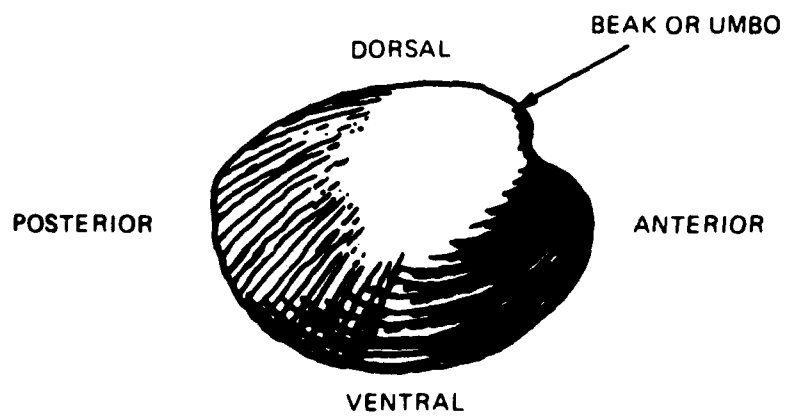


POSTERIOR

CRAB



SHRIMP



CLAM

END

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