Estuarine Fish and Shellfish Species in U.S. Commercial and Recreational Fisheries:

Economic Value as an Incentive to Protect and Restore Estuarine Habitat

K. A. Lellis-Dibble, K. E. McGlynn, and T. E. Bigford

November 2008

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-F/SPO-90

Estuarine Fish and Shellfish Species in U.S. Commercial and Recreational Fisheries:

Economic Value as an Incentive to Protect and Restore Estuarine Habitat

K. A. Lellis-Dibble[1], K. E. McGlynn[2], and T. E. Bigford[3]

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Office of Habitat Conservation
Habitat Protection Division

November 2008

NOAA Technical Memorandum NMFS-F/SPO-90

U.S. Department of Commerce
Carlos M. Gutiérrez, Secretary

National Oceanic and Atmospheric Administration
Vice Admiral Conrad C. Lautenbacher, Jr., USN (Ret.)
Under Secretary for Oceans and Atmosphere

National Marine Fisheries Service
James W. Balsiger, Ph.D., Acting Assistant Administrator for Fisheries

---

[1] Current address: University of Rhode Island, Department of Natural Resources Sciences, Coastal Institute in Kingston, 1 Greenhouse Road, Kingston, RI 02881. Email: kimberlylellis@yahoo.com
[2] Current address: Habitat Ecological Consulting, 182 East 9th Street #12C, New York, NY 10128. Email: kemcglynn@gmail.com
[3] Current address: NOAA/National Marine Fisheries Service, Office of Habitat Conservation, 1315 East-West Highway, F/HP Room 14100, Silver Spring, MD 20910. Email: Thomas.bigford@noaa.gov

Suggested citation:

Lellis-Dibble, K. A., K. E. McGlynn, and T. E. Bigford. 2008. Estuarine Fish and Shellfish Species in U.S. Commercial and Recreational Fisheries: Economic Value as an Incentive to Protect and Restore Estuarine Habitat. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-90, 94 p.

A copy of this report may be obtained from:

Habitat Protection Division

NOAA/NMFS, Office of Habitat Conservation

1315 East-West Highway, Rm 14100

Silver Spring, MD 20910

Or online at:

http://www.nmfs.noaa.gov/habitat/habitatprotection/wetlands/index5.htm

ABSTRACT

Commercial and recreational fisheries generate billions of dollars each year for the U.S. economy. In 2006, 9.5 billion pounds of commercial catch was valued at $4.0 billion. This value is enhanced by the recreational fishing sector, whose 13 million recreational anglers caught 476 million fish in 2006, generating billions of dollars via small businesses such as tackle shops, restaurants, and hotels (Van Voorhees and Prichard 2007).

An analysis of U.S. commercial fishery landings from 2000 through 2004 indicates that estuarine species[1] comprised approximately 46% by weight and 68% by value of the commercial fish and shellfish landed nationwide. A similar analysis of U.S. recreational landings indicates that for the same time period estuarine species comprised approximately 80% of the fish harvested nationwide. Those numbers, which are likely to be conservative given trends described in the Discussion section below, support the importance of efforts by NOAA and others to protect and restore estuarine habitats that provide the ecological basis for the majority of our nation's commercial and recreational fisheries. Since many of the aquatic habitat types used by estuarine species may also be found outside estuaries, the value of species that use near shore and coastal wetland habitats is thought to be comparable to the value of estuary-using species to U.S. commercial landings and recreational harvest. NOAA uses that ecological connection and its legal mandates to focus its investment in protecting and restoring estuaries and coastal habitat. The agency's efforts yield positive returns in fish population health, higher harvest levels, and associated socioeconomic benefits to coastal communities.

[1] "Estuarine species" used in this report are finfish and shellfish that use estuaries during some stage of their life cycle. Estuaries are defined as zones where rivers and ocean waters mix to yield ecosystems with salinity ranges between oceanic and freshwater.

CONTENTS

INTRODUCTION

Estuaries are partially enclosed bodies of water where freshwater mixes with oceanic saltwater to produce a mixed salinity environment. They extend from the landward edge of saltwater or tidal influence seaward to the boundary between mixed-salinity and oceanic saltwater (Heinz Center 2002). There is a vast diversity of estuaries throughout the United States, with some characterized by low-elevation, marshy shorelines whose freshwater inflow is derived from dendritic tributary tidal streams (i.e., South Carolina and Georgia), to lagoons bounded by barrier islands (i.e., North Carolina and Florida), to drowned continental valleys and glacially carved areas restricted by the Coast Range mountains (i.e., California, Oregon, and Washington) (Nelson and Monaco 2000).

Estuaries contain diverse aquatic habitat types, including seagrass and kelp beds, shellfish beds and coral reefs, hard-bottom communities of sponges and outcrops, soft-bottom communities with mud and sand, rocky inter-tidal zones, fringing mangrove forests, and vegetated marshes/wetlands (Heinz Center 2002; Nelson and Monaco 2000). These are highly productive environments that provide important forage, spawning, refuge, and nursery habitat for commercial, recreational, and forage fish species during one or more of their life history stages (Able 2005; Chambers 1992; Nelson and Monaco 2000).

Vegetated marshes/wetlands are important estuarine habitat that stabilize shorelines, protect uplands against erosion, and improve water quality by filtering pollutants and trapping fine sediments. Those same habitats also provide food and cover

for fish, invertebrates, birds, mammals, amphibians, and others. The high productivity of wetlands also plays a role in the cycling of food and nutrients within estuaries and in nearby coastal areas (Thayer et al. 2005).

Although estuarine areas provide vital functions and services, including key habitat for economically and environmentally important species, their health is declining and continues to be at risk. The National Coastal Condition Report II (NCCR) (EPA 2004)—released by U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (FWS), and U.S. Geological Survey (USGS)—reports that the nation's estuarine resources are diminishing and continue to be threatened, receiving a "fair" rating on a scale of good, fair, and poor. Evaluation of sediment quality, water quality, benthic community condition, and coastal habitat loss indices as part of the NCCR II indicates that 28% of estuarine waters are impaired for aquatic life use.[1] According to this report, the overall national coastal habitat condition, based on long-term wetland loss rates, is poor.

The degraded and continued precarious state of the nation's estuarine and other coastal resources is related to a history of high human population density in the narrow fringe along the U.S. coastline, among other stressors. This trend is projected to continue in the foreseeable future. An estimated 53% of the current U.S. population lives in coastal counties. This translates to more than half of the nation's population living in 17% of the U.S. land area, excluding Alaska[2] (NOS 2004). To accommodate coastal

[1] Note: 0.1% of the 33,211 square miles of Alaskan coastal bays and estuaries have been surveyed. Therefore, the national statistic quoted (28%) for percent of estuarine water impairment would likely be altered if Alaskan lands were included in the NCCR II analysis.

[2] Note: 45,000 square miles of Alaska coastline is excluded from this NOS 2004 analysis. The statistic for U.S. land area (17%) would decrease if the analysis included Alaska, (i.e., ≥53% of the current U.S. population lives in an area less than 17% of the U.S. land area).

population growth during the past century, human activities such as land development, water control, and agriculture have resulted in rapid estuarine and other coastal habitat loss and degradation, with negative effects on aquatic species. For example, habitat degradation and overfishing have depressed landings of some commercial species of fish and shellfish. In Chesapeake Bay, between 1995 and 2005, the landings of menhaden fell from 320,000 tons to 176,000 tons; from 1990-2005, the landings of shad fell from 395 tons to 3.1 tons. In Atlantic coast estuaries, between 1985 and 2005, the landings of oysters, northern quahogs, soft shell clams, and bay scallops have declined by 87%, 49%, 52%, and 94%, respectively (Phelan, pers. comm. 2007).

Compounding the challenge of managing estuarine habitats is the parcity of scientific information about species and their habitats. In 1991, NOAA released the first national evaluation of coastal wetland distribution and aerial extent (Field et al. 1991). Unlike other national wetland trend reports, this evaluation defined *coastal wetlands* as wetlands in watersheds or drainage areas that surround estuarine waters, or within counties adjacent to marine waters. This expanded definition is important, particularly for evaluating estuarine health given linkages between the biological, physical, and hydrological components of freshwater wetlands (including streams and rivers) and saltwater wetlands in estuaries and coastal watersheds. Using this definition of coastal wetland, NOAA reported approximately 27.4 million acres of coastal wetlands in the continental United States,[3] which accounted for one-third of the nation's total wetlands at that time (Field et al. 1991). This analysis has not been updated to reflect recent changes.

[3] "Continental United States" excludes Hawaii and Alaska.

FWS' most recent status and trends report (Dahl 2006) reported promising news. For the first time in the study's history there was an overall net gain in U.S. wetland acreage. According to that report, between 1998 and 2004 the continental United States gained an additional 191,750 acres of wetlands. This is a notable turnaround from the tremendous annual wetland loss rate of 458,000 acres per year estimated between the mid-1950s and the mid-1970s (Dahl 2006). This overall increase would not have occurred without the large increase in open water ponds, many of them artificial.

In contrast to freshwater wetlands, estuarine and marine wetlands are still experiencing an annual average loss rate of approximately 4,740 acres, representing an increasingly large percentage of the last vestiges of this important habitat type. This decline is attributed to the natural and human-induced conversions of salt marsh to open water systems. Those losses from subsidence, dredging, and water control activities affect estuarine and coastal areas that serve as habitat for commercial, recreational, and forage species. Those estuarine habitats also provide ecosystem services such as shoreline stabilization and nutrient/toxin filtration; therefore, continued protection against their loss and degradation is important both ecologically and economically.

A new analysis of the 1998 to 2004 FWS data (Stedman and Dahl, 2008) shows that coastal wetlands (all wetlands in coastal watersheds, including marine, estuarine, and freshwater) experienced a net loss of 59,000 acres a year during that time period. A majority (82%) of the loss occurred in freshwater coastal wetlands. Freshwater coastal wetlands are important habitat for species that migrate between marine waters and fresh water, and are also important for the hydrologic and water quality services they perform for downstream estuarine and marine water bodies. Their loss has a direct effect on the

functions of estuarine and marine ecosystems, including support for commercial and recreational fisheries.

A previous National Marine Fisheries Service (NMFS) analysis, prepared in 1992 using fishery statistics from the 1980s, reported that estuarine species comprise a substantial portion of commercial and recreational landings by weight—an average of 75% nationally with a maximum of 98% in the Gulf of Mexico (Chambers 1992). Similar reports by other agencies and organizations note the importance of estuarine and wetland habitats in supporting commercial and recreational fish harvest. The National Research Council (1997) reported that 85% of commercially harvested fish depend on estuaries and nearshore habitats for at least one life stage. The NCCR II report (EPA 2004) indicates this value may be even higher - 95% of commercial fish and 85% of recreational fish use coastal wetlands and estuarine habitats. These numbers have been used to convey the importance of minimizing estuarine and coastal habitat loss and degradation, as well as the need to restore habitats degraded by human actions or natural events.

This paper builds on those earlier efforts by calculating the value of estuarine species using updated fishery landing statistics from 2000 to 2004. Estuarine percentages generated by NRC (1997) and EPA (2004) cannot be directly compared to figures generated in this report due to differing methodologies, data sources, and estuarine species (i.e., fish, shellfish, and other estuarine-using species used to calculate percentages). In addition, since Chambers' (1992) did not describe his methods, it is not possible to compare his percentages with this paper. To ease future analyses, our

evaluation of domestic landings use methods that use readily available data and can be replicated easily.

METHODS

This analysis: (1) developed a nationwide list of estuaries species by reviewing literature and consulting with NMFS scientists; (2) obtained commercial landings data and recreational harvest data for 2000 through 2004 from the NMFS Office of Science and Technology for fish and shellfish species on the national list (Appendix B); (3) calculated the national and regional percent[4] of commercial species landed (by weight and dollar value)[5] that use estuaries during any stage of their life cycle; and (4) calculated the national and regional percent[6] of recreational species harvested (by weight)[7] that use estuaries during any stage of their life cycle.

[4] National and regional estuarine percentages listed in this paper were calculated by taking the aggregate sum of estuarine commercial landings (by weight and value; see Appendix B for estuarine species used in this analysis) and estuarine recreational harvest (by weight) from 2000-2004, and then dividing the estuarine values by the aggregate sum of 2000-2004 nationwide and regional data for commercial landings and recreational harvest.

[5] *Commercial landings* are defined as quantities of fish and shellfish brought ashore and sold. Estuarine values in this paper are provided in pound weight and U.S. dollar value as collected and reported by the NMFS Office of Science and Technology. Pound weight are reported in terms of live or dressed weight. Crustacean landings are generally weighed when alive, although shrimp landings may be reported as dressed weight (heads-on, heads-off basis). Data for all mollusks are reported on a dressed, meat-weight basis (excludes shell weight). Dollar values refer to the ex-vessel price, which is the price paid to the harvester. Dollar values for 2000-2004 are reported as nominal values (current at the time of reporting), and have not been cost adjusted for inflation.

[6] See footnote 4.

[7] *Recreational harvest* is defined as any fish that is killed and brought back to the dock, combined with fish that are used for bait, released dead, or filleted. Harvest is reported in this paper in pound weight, as collected and reported by NMFS. Weight estimates are minimums and may not reflect the actual total weight harvested by the recreational fishing sector. Recreational harvest is reported in weight only because dollar value is not reported in the NMFS Marine Recreational Fishery Statistics Survey.

1. Estuarine Use Determination

A nationwide list of commercial and recreational species that use estuaries in any stage of their life cycle was developed during the first phase of this project. The list includes species identified in Fishery Management Plans (FMP), non-FMP commercial and recreational species, and forage species such as fish, mollusks, and crustaceans.[8] It is important to note that the species used to generate the statistics in this paper include both estuary-dependent and other estuary-using species (also referenced in scientific literature as "estuarine opportunists," "estuarine-related," or "estuarine-marine" species). An evaluation of the economic difference between obligate and facultative estuarine species is outside the scope of this study, mainly due to a lack of information regarding the degree to which many species use estuarine habitats (see Able 2005 for an in-depth discussion of estuary dependence and the associated information gaps).

Estuary use by commercial and recreational fish and shellfish was determined via two steps: (1) the authors reviewed information on species' relative abundance, density, distribution, preferred substrate, ideal temperature/depth,/salinity ranges, seasonality, and life history stage (e.g., eggs, larvae, juveniles, adults, and spawning adults) in which estuaries were used; (2) the authors used that information to prepare a preliminary nationwide list of species that use estuaries; and (3) NMFS scientists in Regional Offices and Fishery Science Centers commented on the preliminary list of estuarine species. Those comments were used to prepare a final nationwide list of estuarine species (Appendix B).

[8] Although the nationwide list of estuarine species is based on the best scientific information available to us, we recognize this list is not a comprehensive inventory of every estuary-using fish and shellfish species found in U.S. waters.

Documents Used to Determine Estuarine Use

Literature searches revealed many documents pertaining to commercial and recreational species' use of estuaries, including NOAA Estuarine Living Marine Resource (ELMR) program reports, NOAA Technical Memoranda and scientific reports, Essential Fish Habitat (EFH) designations in fishery management plans, environmental and living resource publications by other agencies, and peer-reviewed scientific literature.

NOAA ELMR program reports provide information on the presence, distribution, abundance, and life history characteristics of economically and ecologically important fish and invertebrate species in estuarine environments (Nelson and Monaco 2000). Regional data and life history summaries from that program include reports for the north Atlantic (Jury et al. 1994), mid-Atlantic (Stone et al. 1994), southeast (Nelson et al. 1991), Gulf of Mexico (Nelson et al. 1992; Pattillo et al. 1997), and the west coast (Emmett et al. 1991; Monaco et al. 1990).

NOAA Technical Memoranda (TM) are published by NMFS Regional and Headquarters Offices and Fishery Science Centers and are used for timely documentation and communication of preliminary results, interim reports, or more localized or special purpose information that may not have received formal outside peer reviews or detailed editing. NMFS Offices and Science Centers review the technical accuracy of information published in TMs.

EFH designations have been compiled by the eight regional fishery management councils and the NMFS Office of Sustainable Fisheries, with assistance from NMFS

Regional Offices and Fishery Science Centers and the three interstate marine fisheries commissions. EFH includes "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Information supporting EFH designations includes: literature searches; historical accounts; NMFS inshore and offshore trawl surveys; NMFS Marine Resources Monitoring, Assessment, and Prediction (MARMAP) ichthyoplankton surveys; exploratory trapping; transect dives; geospatial information; SEAMAP bottom mapping projects; and ELMR data.

Additional information sources included publications by other agencies and peer-reviewed scientific journal articles, reports, and books. For this analysis, 61 journal articles, reports, and books beyond those used for EFH designations were reviewed for species' use of estuaries.

After a thorough review of the aforementioned sources of information on estuarine habitat use, a preliminary nationwide list was drafted of finfish and shellfish species that use estuaries. The common and scientific names of the species on this list were then verified with the following American Fisheries Society publications: (1) *Common and Scientific Names of Fishes from the United States, Canada, and Mexico (6th ed.)* (Nelson et al. 2004); (2) *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks* (Turgeon et al. 1988); and (3) *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Decapod Crustaceans* (Williams et al. 1988).

Review of Nationwide Estuarine Species List by NMFS Regions and Science Centers

The second step in classifying a species as estuarine included a confirmation of the species' estuarine use by NMFS scientists in Regional Offices and Fishery Science Centers. Each reviewer examined the nationwide estuarine species list to determine: (1) whether any species on the list were not estuary users; and (2) whether any omitted species warranted estuarine status. Reviewer recommendations on estuarine status were then compiled and incorporated into the final nationwide estuarine species list (see Appendix B).

2. NMFS Commercial Landings Data and Recreational Harvest Data

NMFS and its predecessor agencies (U.S. Fish Commission and the Bureau of Commercial Fisheries) have collected fisheries landings data since 1880, with comprehensive surveys of species landed in each coastal state since 1951. NMFS currently compiles commercial landings data (by weight and value) and recreational harvest data (by weight) for fish and shellfish species caught in the U.S. Exclusive Economic Zone, in U.S. territorial seas, and by domestic vessels on the high seas. As described below, different methodologies are used to gather data—commercial data are collected at the dock when fish are landed, whereas recreational data are collected via two independent surveys.

Commercial Landings Data

Commercial fisheries data are collected at U.S. ports by NMFS regional staff by measuring the weight and quantity of fish and shellfish landed.[9] Weight, quantity, and ex-vessel value data are computed monthly and annually by gear type, distance from shore, state, sub-region, and nationwide. Those commercial data have been divided into the following regions: the north Atlantic including coastal states from Maine through Delaware; the Chesapeake including Maryland and Virginia (includes landings from the Chesapeake Bay and offshore waters of Maryland and Virginia); the south Atlantic including North Carolina through the east coast of Florida; the Gulf of Mexico including the coastal states from the west coast of Florida through Texas; the state of California; the Pacific northwest including Oregon and Washington; the state of Alaska; and the Hawaiian Islands region including only Hawaii.[10]

Commercial landings provided by NMFS included data for individual species (e.g., Atlantic cod, sockeye salmon, etc.) or group of species at the sub-phylum, class, order, family, or genus level (e.g., Crustacea, Bivalvia, Pleuronectiformes, Serranidae, Seriola, etc.). When landings data were provided by species grouping, it was not possible to determine which portion of the landings was attributed to estuarine species. The decision to include a species grouping toward the calculation of estuarine species in U.S. commercial landings was based on best professional judgment and an estimate of individual estuarine species in that particular grouping. The recalculation of estuarine

[9] In the northeastern Pacific, groundfish species caught and processed at sea aboard U.S. vessels are credited as landings to the state nearest the area of capture.

[10] Commercial and recreational fishing data from Pacific Island territories (other than Hawaii) were not available and therefore not included in the commercial or recreational analysis; data on Caribbean landings were available only for recreational species and therefore the Caribbean is not included in the commercial analysis.

species in commercial landings was performed using a "conservative" and "very conservative" selection from the NMFS commercial list, with a conservative selection containing fewer species groupings and the very conservative selection containing almost none. Reducing or omitting the larger species grouping had little effect on the nationwide percentages of estuarine species in commercial landings (reduction in 1% by weight and 3% by value), indicating that these larger taxonomic groupings make up only a small portion of the national estuarine landings. The accepted estuarine species used to calculate landings data were based on the conservative selection combined with finfish and shellfish species groupings (e.g., shrimp) primarily containing estuary users. Therefore, species groupings reported in commercial and recreational landings herein contain individual species (e.g., Pacific, Atlantic, and blueback herring) and species groupings (e.g., herrings), and are referred to by species grouping (e.g., herrings). See Appendix C for the specific species and species groupings used to calculate the nation's commercial estuarine percentages.

Recreational Harvest Data

Recreational fishing effort, catch, and participation data are collected by the NMFS Fisheries Statistics Division via the Marine Recreational Fishery Statistics Survey (MRFSS)[11], which consists of two independent yet complementary surveys: (1) a telephone survey of households; and (2) an intercept survey of anglers at fishing access sites. *Telephone surveys* of fishing and non-fishing households produce statistics on recreational fishing effort and participation. These statistics are based on questions asked

[11] Methodology used in the MRFSS can be found in Chapter 1: Survey Methodology, in the MRFSS Data User's Manual, available online at http://www.st.nmfs.gov/st1/recreational/pubs/data_users/index.html.

during telephone surveys pertaining to the number of trips made in the previous two months, dates on which those fishing trips were made, and locations fished.[12] *Intercept surveys* consist of on-site interviews with marine recreational anglers, in which catch, demographic, and avidity (trips per year) data are collected for three fishing modes: (1) party/charter boat; (2) private/rental boat; and (3) shore based (e.g., beaches, banks, and man-made structures such as docks). Information gathered during intercept surveys includes species, number, and weights and lengths of fish caught. Data from the telephone and intercept surveys are combined with U.S. Bureau of the Census data to produce estimates of catch, effort, and total participation in each mode and area of fishing activity in each state and sub-region.[13]

NMFS provided recreational fishing data[14] by regions: the north Atlantic including coastal states from Maine south to Connecticut; the mid-Atlantic from New York south to Virginia; the south Atlantic from North Carolina through the east coast of Florida; the Gulf of Mexico from the west coast of Florida through Louisiana; the

[12] Telephone surveys focus on households located in counties within 25 miles of an ocean coastline, including estuaries and bays. In the south Atlantic and Gulf of Mexico subregions during May through October, telephone surveys are extended to households located within 50 miles of the coast. In North Carolina, sampling effort is extended to 50 miles from the coast during November to April, and extended farther to 100 miles from the coastline during May through October. The extended telephone sampling effort in North Carolina is due to the high proportion of non-coastal anglers sampled in intercept surveys.

[13] In the south Atlantic and Gulf subregions the MRFSS has not collected catch data from headboats (i.e., "party boats"—large number of anglers (~100) taken out to fish) since 1985, so estimates for these subregions now only include charter boats (fewer anglers in a small boat, ~4–8 people). The Texas Department of Parks and Wildlife monitors marine recreational fishing via the Texas Marine Recreational Fishing Survey and has not contributed data to the national MRFSS database since 1985. In addition, on the Pacific coast, ocean boat trips during certain time periods and salmon trips are not sampled because they are surveyed through the state natural resource agencies. Alaska conducts its Sport Fish Statewide Harvest Survey and does not contribute data to the national MRFSS database, so this analysis does not include data from Alaska. Hawaii started contributing to the MRFSS in 2003, rendering an incomplete data set from 2000 to 2004, so the authors did not include Hawaiian data in their analysis.

[14] The MRFSS gathers information on recreational fish species harvested; recreational data are not collected for shellfish species such as oysters, clams, scallops, mussels, crabs, lobsters, and shrimp. Therefore, this paper reports on the weight of fish (*not* shellfish) harvested in the U.S. recreational fishing sector.

Caribbean including Puerto Rico; the state of California; and the Pacific northwest including Oregon and Washington (see Appendix D for the specific species and species groupings used to calculate the nation's recreational estuarine percentages).

3. Economic Analysis of Commercial and Recreational Species That Use Estuaries

The first phase of this project involved the development and verification of a nationwide estuarine species list (see Appendix B), and the second phase encompassed the compilation of 2000–2004 commercial landings data and recreational harvest data for those species on the nationwide estuarine species list. The third and fourth phases of this project involved the computation of national and regional statistics on the proportion of commercial species landed (by weight and dollar value) and recreational species harvested (by weight) that use estuaries for any stage during their life cycle (Tables 1, 2, and 4, and Figures 1-3). This paper also presents the national top 10 estuarine species in U.S. commercial and recreational fish and shellfish fisheries from 2000 to 2004 (Tables 3 and 5) and a breakdown of top estuarine commercial and recreational fish and shellfish in each region (Appendix A, Tables A-1 through A-14). The regional analysis for recreational data is presented as the top 10 estuarine species; the commercial analysis is also based on the top 10 species, but is limited to species that make up at least 1% by weight or dollar value of the total regional landings.

Taken together, these estuarine statistics provide a snapshot of estuarine importance to U.S. fisheries in terms as a proportion of total weight (commercial and recreational) and economic value (commercial) of fish that use estuaries for any stage of their life cycle.

RESULTS

1. Commercial Landings of Estuarine Species

Commercial fisheries landings data were obtained from NMFS for 2000 through 2004. Of the approximately 450 fish and shellfish species or species groupings landed during this time period, approximately 200 were identified as estuarine (see Appendix C) and used to determine the estuarine value of commercial fisheries.[15] Analysis indicates that from 2000 to 2004 estuarine species comprised approximately 46% by weight and 68% by value of the total U.S. commercial landings. Those years are thought to be representative of other time frames.

The percent of estuarine landings in fisheries varies by region, and is highest in the Chesapeake region (Maryland, Virginia, and Chesapeake Bay) where 98% of the commercial landings (by weight) are estuarine (Table 1). This is due to high landings of Atlantic menhaden and crabs. Table 1 lists the regional percentages of estuarine landings throughout the United States. According to these numbers, most of the fish and shellfish landed in the Chesapeake, Gulf of Mexico, north Atlantic, south Atlantic and Pacific northwest use estuaries for at least one stage of their life cycle. Additionally, a high percentage of the species landed in California use estuaries. The Hawaiian Islands and Alaska have a lower percent of estuarine species in their regional landings by both weight and dollar value.

[15] In addition to the ~450 species of fish and shellfish, U.S. commercial landings for 2000–2004 also included 20 species groupings excluded from this evaluation because they were not fish or shellfish. They included seaweeds, sponges, sea cucumbers, sea urchins, jellyfish, sandworms, starfish, echinoderms, etc.

Table 1. Commercial Estuarine Landings as Percent of Catch in Each Region and for Entire Nation (**by weight and value, rounded**), 2000–2004.

Estuarine Landings (**by weight**)		Estuarine Landings (**by value**)	
Chesapeake	98%	Chesapeake	97%
Gulf of Mexico	97%	Gulf of Mexico	93%
South Atlantic	87%	North Atlantic	83%
North Atlantic	77%	South Atlantic	83%
Pacific Northwest	76%	Pacific Northwest	73%
California	49%	California	50%
Alaska	15%	Alaska	32%
Hawaii	2%	Hawaii	3%
Nationwide	**46%**	**Nationwide**	**68%**

The rankings in Table 1 differ when considering the percent of regional contribution to total national estuarine landings. The Gulf of Mexico led the regional estuarine contribution (by weight) by providing 38% of all national estuarine pounds, and the north Atlantic region led the regional estuarine contribution (by value) with 32% of all national estuarine dollars from 2000–2004 (Table 2). Note the numbers in Table 2 reflect totals during a five year period, not an annual mean during any one year. These high percentages are due to the substantial Atlantic menhaden fishery, as well as shrimp, oyster, and crab fisheries (Table A-4, Appendix A). Table 2 and Figures 1 and 2 show regional contributions to total national estuarine landings.

Table 2. Regional Contribution to National Commercial Estuarine Landings (**by weight and value; rounded**), 2000–2004.

Region	2000–2004 Commercial Estuarine Landings (**weight in lbs**)	Percent of National Comm. Estuarine Landings	Region	2000–2004 Commercial Estuarine Landings (**value in $**)	Percent of National Comm. Estuarine Landings
Gulf of Mexico	7,964,226,642	38%	North Atlantic	$3,628,131,288	32%
Alaska	3,758,219,974	18%	Gulf of Mexico	$3,586,776,369	31%
North Atlantic	3,200,386,320	15%	Alaska	$1,521,265,608	13%
Chesapeake	2,579,111,548	12%	Chesapeake	$885,998,184	8%
Pacific Northwest	1,537,169,333	7%	Pacific Northwest	$838,634,606	7%
California	935,943,498	4%	South Atlantic	$719,410,846	6%
South Atlantic	897,741,014	4%	California	$298,298,123	3%
Hawaii	2,279,240	<1%	Hawaii	$8,909,821	<1%
Nationwide	20,875,077,569	100%	Nationwide	$11,487,424,845	**100%**

Figure 1. Regional Contribution to National Commercial Estuarine Landings (**by weight**), 2000–2004.

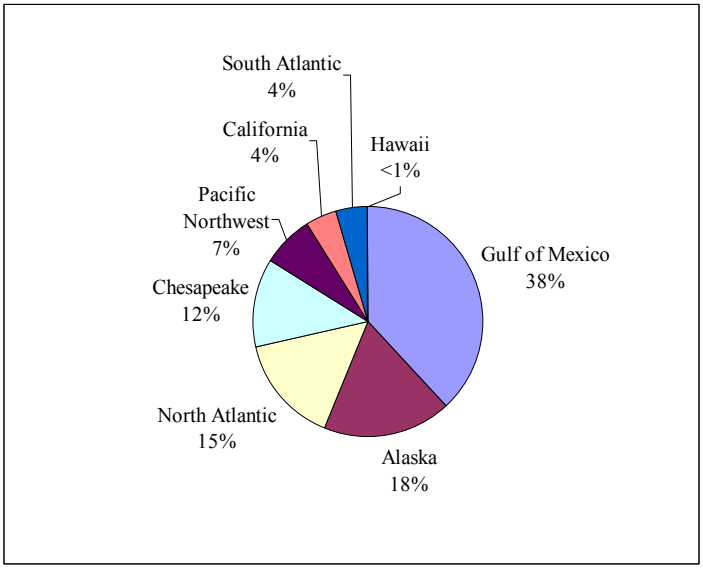
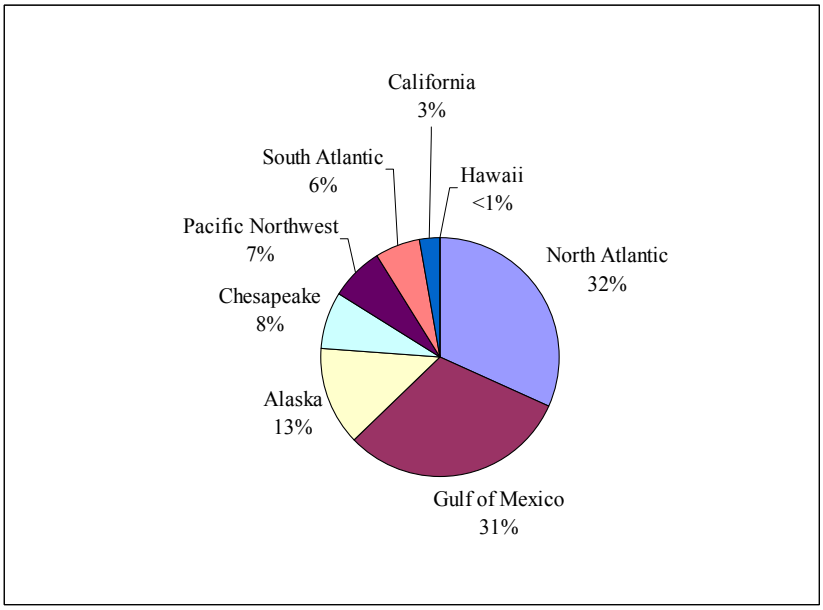


Figure 2. Regional Contribution to National Commercial Estuarine Landings (**by value**), 2000–2004.



Although approximately 200 commercial species or groups of species were identified as estuarine (see Appendix C), the majority of estuarine landings are generated by only a few species and species groups, notably Atlantic menhaden, salmon, shrimps,

crabs, and lobsters (Table 3). Atlantic menhaden contributes the most to national commercial pounds, comprising 18% of the nation's estuarine landings by weight, followed by salmon at 7% (Table 3). Shrimp is the estuarine species group that generated the highest percentage (15%) of commercial dollars from 2000–2004, followed by two other shellfish species groups, crabs at 11%, and lobsters at 10%. Table 3 lists the top 10 estuarine species landed by U.S. commercial fisheries according to weight and dollar value. This table is dominated by species groupings for shrimps, crabs, lobsters, salmon, scallops, clams, and herrings. Where NMFS data allow, the primary contributors for these groupings (e.g., brown and white shrimps for that category) are discussed in the regional results below.

Table 3. Top 10 Estuarine Fish and Shellfish in Commercial Landings (**by weight and value, rounded**), 2000–2004.

Rank	Top 10 Estuarine Species in U.S. Commercial Landings (**by weight**)	Percent of National Commercial Pounds	Top 10 Estuarine Species in U.S. Commercial Landings (**by dollar value**)	Percent of National Commercial Dollars
1	Atlantic menhaden, *Brevoortia tyrannus*	18%	Shrimps	15%
2	Salmon, *Oncorhynchus* spp.	7%	Crabs	11%
3	Shrimps	3%	Lobsters	10%
4	Crabs	3%	Salmon, *Oncorhynchus* spp.	7%
5	Herrings	3%	Scallops	6%
6	Pacific sardine, *Sardinops sagax*	2%	Clams	3%
7	Pacific hake (whiting), *Merluccius productus*	2%	Atlantic menhaden, *Brevoortia tyrannus*	3%
8	Lobsters	1%	Eastern oyster, *Crassostrea virginica*	2%
9	Spanish mackerel, *Scomberomorus maculatus*	1%	Pacific oyster, *Crassostrea gigas*	1%
10	Scallops	1%	Atlantic cod, *Gadus morhua*	1%

The *North Atlantic Region* landed approximately 4.1 billion pounds of fish and shellfish from 2000 to 2004, valued at more than $4.3 billion. Approximately 77% of these landed pounds, and 83% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). The north Atlantic region comprises 15% by weight and 32% by value of all national estuarine landings in the United States (Table 2; Figs. 1, 2). As listed in Table A-1 (Appendix A) the top estuarine species landed in the north Atlantic region by weight are Atlantic herring (22% of total north Atlantic commercial landings), American lobster (10%), and the mackerel group (7%). Atlantic mackerel was the primary contributor to the mackerel species grouping. Top estuarine species by value are American lobster (35%), scallops (18%), and clams (7%). Sea scallops are the primary contributor to the scallop species grouping, and quahogs and soft-shell clams are the primary contributors to the clam species grouping.

The *Chesapeake Region* (Maryland, Virginia, and Chesapeake Bay) landed approximately 2.6 billion pounds of fish and shellfish from 2000 to 2004, valued at more than $908 million. Approximately 98% of these landed pounds, and 97% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). The Chesapeake region comprises 12% by weight and 8% by value of all national estuarine landings in the United States (Table 2; Figs. 1, 2). As listed in Table A-2 (Appendix A), the top estuarine species landed in the Chesapeake region by weight are Atlantic menhaden (77% of total Chesapeake commercial landings), crabs (10%), and sea scallops (3%). The top Chesapeake estuarine species by value are sea scallops (34%), crabs (31%), and Atlantic menhaden (14%). Blue crab is the primary contributor to the Chesapeake crab species grouping in both weight and dollar value.

Profile: Atlantic Menhaden

(Brevoortia tyrannus)

Photo: NOAA Photo Library

Life History and Habitat Use

Estuaries are particularly important to species such as Atlantic menhaden, which are transported inshore as larvae and spend most of their early developmental stage in estuarine waters. The Chesapeake Bay, which is the largest estuary on the east coast of North America, provides an important nursery ground for filter-feeding juvenile menhaden. Larval and juvenile Atlantic menhaden enter estuaries such as the Chesapeake Bay to feed on rich supplies of plankton. After the species quadruples in size, they migrate south to North Carolina where they overwinter and become prey for species such as striped bass, bluefish, sea trout, Spanish mackerel, tuna, sharks, marine mammals, herons, egrets, ospreys, and eagles. Atlantic menhaden are considered a major forage species in estuarine and marine environments, and are known to use estuaries and nearshore marine habitats during their sub-adult and adult life history stages.

Commercial Landings

Atlantic menhaden was the #1 estuarine fish landed by weight from 2000–2004 in the United States commercial fishing industry, accounting for 18% (8.3 billion lbs) of the nation's total commercial landings over the five-year time span. This oily fish species is prized as bait or processed and used in: (1) protein meal; (2) paints; (3) crop fertilizer; and (4) food additives (ASMFC 2007).

Threats to Habitat

A robust menhaden population depends on healthy estuaries for survival from larval to adult. As coastal development, eutrophication, pollutant runoff, dead zones, overfishing, dredging/filling, and other environmental impacts affect habitat in Chesapeake Bay, the menhaden's population could become depressed, thereby affecting other populations that depend on this keystone species. Since Atlantic menhaden accounted for 77% of the Chesapeake region's commercial landings from 2000–2004, actions to protect and restore estuarine habitats are of utmost importance.

Example of NOAA Habitat Conservation Measures

Fisheries management in the Chesapeake Bay is currently transitioning from traditional single-species management to ecosystem-based fisheries management (including Atlantic menhaden). This shift is beneficial because it seeks to protect, enhance, and restore living resources, their habitats, and ecological relationships.

The *South Atlantic Region* landed approximately 1.0 billion pounds of fish and shellfish from 2000 to 2004, valued at more than $871 million. Approximately 87% of these landed pounds, and 83% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). The south Atlantic region comprises 4% by weight and 6% by value of all national estuarine landings in the United States (Table 2; Figs. 1, 2). As listed in Table A-3 (Appendix A), the top estuarine species landed in the south Atlantic region by weight are Atlantic menhaden (27% of total south Atlantic commercial landings), crabs (23%), and shrimps (11%). The top south Atlantic estuarine species by value are shrimps (28%), crabs (25%), and flatfish (6%). Like the Chesapeake region, blue crab is the primary contributor to the crab species grouping. Brown and white shrimp are the major contributors to the south Atlantic shrimp species grouping.

The *Gulf of Mexico Region* landed approximately 8.2 billion pounds of fish and shellfish from 2000 to 2004, valued at more than $3.8 billion. Approximately 97% of these landed pounds, and 93% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). The Gulf of Mexico is the largest contributor to the nation's estuarine landings (by weight), amounting to 38% of the estuarine weight and 31% of the economic revenue gained via estuarine fish landings (Table 2; Figs. 1, 2). As listed in Table A-4 (Appendix A), the top estuarine species landed in the Gulf of Mexico by weight are Atlantic menhaden (72%), shrimps (15%), and crabs (4%). The top Gulf of Mexico estuarine species by value are shrimps (58%), Atlantic menhaden (9%), and crabs (9%). Like the south Atlantic region, brown and white shrimp are the major contributors to the Gulf of Mexico shrimp group. Blue crab is the primary contributor to the crab species grouping, with additional numbers provided by Florida stone crabs.

Profile: Salmon

(*Oncorhynchus* spp.)

Photo: NMFS Southwest Regional Office (Chinook salmon)

Life History and Habitat Use

Freshwater streams and estuaries provide important habitat for salmon species such as Chinook, coho, chum, pink, and sockeye salmon. Salmon are an anadromous species that spend most of their adult lives in saltwater but must travel to their natal freshwater streams and rivers to spawn. Salmon depend on healthy spawning habitat containing gravel, cool water, and good water flow (oxygen supply). Fry and smolts spend up to 2 years in freshwater, after which they migrate downstream to estuaries. Estuaries and their associated wetland habitats provide vital nursery habitat, in which salmon may spend approximately 6 months feeding on terrestrial and aquatic insects, amphipods, crustaceans, and small fish. After leaving the estuary, salmon may live in the open ocean for up to 8 years before returning to their natal freshwater streams and rivers to spawn and complete their life cycle (PSMFC 2007).

Commercial Landings and Recreational Harvest

The salmon fishery is an important commercial, recreational, and subsistence fishery in California, the Pacific northwest, and Alaska. Nationwide, commercial landings of salmon generated $1.1 billion in economic revenue and was the #2 estuarine fish landed (by weight, 3.3 billion lbs) in the United States from 2000–2004. In Alaska, salmon accounts for 20% of the economic revenue generated in the commercial fishing industry (Table A-5). Salmon supports an important recreational fishery that generates millions of dollars in revenue for the Pacific states. Chinook salmon was the #1 fish harvested recreationally off California, accounting for 15% of the regions recreational harvest from 2000-2002. In the Pacific northwest, Chinook, coho, chum, and pink salmon accounted for 58% of the regions total recreational harvest from 2000 to 2002, with more than 20 million pounds harvested. Salmon is also a highly coveted subsistence species and many Native American tribes depend on a healthy salmon fishery for food and cultural needs.

Threats to Habitat

Human induced changes in habitat, such as altered freshwater flows due to dam construction and operations, lack of fish passage, pollutant runoff, high water temperatures, wetland destruction, poor forestry practices, and loss of stream cover have adversely affected salmon habitat in rivers and streams along the Pacific coast. Since salmon must migrate to native spawning habitat to reproduce and complete their life cycle, it is necessary for rivers to have adequate flow and fish passage structures around impediments (e.g., hydropower dams).

Example of NOAA Habitat Conservation Measures

As provided under the Federal Power Act, NMFS works with federal and state agencies during the hydropower licensing process to ensure migratory fish such as salmon have adequate passage around dams to reach their natal spawning habitat and to ensure the hydrology of the river is conducive to fish survival. NMFS issues mandatory Section 18 fishway prescriptions and Section 4(e) flow recommendations to achieve those results. Flow recommendations benefit migratory and estuarine species alike, because adequate freshwater flow will ensure aquatic habitat conditions remain tolerable to all species.

The state of *Alaska* landed approximately 25.2 billion pounds of fish and shellfish from 2000 to 2004, valued at more than $4.7 billion. Approximately 15% of these landed pounds, and 32% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). The state of Alaska comprises 18% by weight and 13% by value of all national estuarine landings in the United States (Table 2; Figs. 1, 2). As listed in Table A-5 (Appendix A), the top estuarine species landed in Alaska by weight are salmon (12% of Alaska's total commercial landings) and Pacific herring (1%). The top Alaskan estuarine species by value are salmon (20%), crabs (10%), and Pacific herring (1%). Sockeye and pink salmon are the top contributors to the salmon species group.

The state of *California* landed approximately 1.9 billion pounds of fish and shellfish from 2000 to 2004, valued at more than $594 million. Approximately 49% of these landed pounds, and 50% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). California comprises 4% by weight and 3% by value of all national estuarine landings in the United States (Table 2; Figs. 1, 2). As listed in Table A-6 (Appendix A), the top estuarine species landed in California by weight are Pacific sardine (28% of California's commercial landings), northern anchovy (5%), and chub mackerel (5%). The top Californian estuarine species by value are crabs (20%), Chinook salmon (9%), and the Pacific oyster (5%). Dungeness crab is the top contributor to the crab species group in California.

The *Pacific Northwest Region* landed approximately 2.0 billion pounds of fish and shellfish from 2000 to 2004, valued at more than $1.1 billion. Approximately 76% of these landed pounds, and 73% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). The Pacific northwest region comprises 7% by both weight and

dollar value of all national estuarine landings in the United States (Table 2; Figs. 1, 2). As listed in Table A-7 (Appendix A), the top estuarine species landed in the Pacific northwest region by weight are Pacific hake (36% of total regional commercial landings), Pacific sardine (17%), and crabs (9%). The top Pacific northwest estuarine species by value are crabs (30%), clams (15%), and oysters (12%). Dungeness crab is the top contributor to the crab species group in the Pacific northwest region. The Pacific geoduck clam and the manila clam are the top contributors to the estuarine clam species group. The Pacific oyster is the primary contributor to the estuarine oyster species group in the Pacific northwest region.

The *Hawaiian Islands Region* landed approximately 128 million pounds of fish and shellfish from 2000 to 2004, valued at more than $284 million. Approximately 2% of these landed pounds, and 3% of their dollar value, are attributed to estuarine fish and shellfish (Table 1). The Hawaiian Islands region comprises less than 1% by both weight and dollar value of all national estuarine landings in the United States (Table 2; Figs. 1, 2). Only one estuarine species group, the snappers, comprised more than 1% of the total regional catch. The snapper species group comprised approximately 1% by weight and 2% by value of the total regional Hawaiian commercial landings.

Profile: Shrimp

Photo: NOAA (in Graff and Middleton 2002)

Life History and Habitat Use
Brown, white, and pink shrimp are the most common species of shrimp found in southern estuaries (Nelson et al. 1991, 1992). Shrimp spawn in the open ocean and drift into estuaries and salt marshes, habitats critically needed by shrimp to grow, evade predators, and ensure survival during postlarval and juvenile life history stages. Juvenile shrimp eat detritus and algae that grow on marsh plants such as rooted vegetation, bottomland forests, marsh grasses, seagrass, and mangroves (Graff and Middleton 2002; NMFS, In prep.).

Commercial Landings
The commercial shrimp fishery generated the highest economic revenue from 2000 to 2004 (over $2.5 billion) when ranked against revenues generated by other estuary-using species. Commercial shrimp landings comprised 15% of the nation's commercial landings (by value—Table 3), with the south Atlantic, Gulf of Mexico, and California regions contributing the most to nationwide landings of shrimp.

Threats to Habitat
A major threat to shrimp habitat is loss of coastal wetlands, which provide shrimp with protective cover to reduce predation as well as increased resources for growth to maturity (Zimmerman et al. 2000). Another habitat threat for the species is hypoxic zone expansion in the Gulf of Mexico, which has been shown to decrease brown shrimp catch (O'Connor and Whitall 2007; Zimmerman and Nance 2001). Recently, NMFS scientists have reported that a 1-acre increase in hypoxia represents a decrease of 2 pounds of brown shrimp catch, while a 1-acre increase in nursery habitat can yield a gain in catch of 6 pounds of brown shrimp (Zimmerman et al. 2007).

Example of NOAA Habitat Conservation Measures
The NOAA Restoration Center is conducting large-scale habitat protection and restoration projects via the Coastal Wetlands Planning, Protection, and Restoration Act. These projects conserve marsh habitats that support shrimp and other NOAA trust resources. In addition, regional habitat conservation programs use regulatory and other tools to protect habitat from degradation and loss. Together, both habitat conservation approaches aim to increase estuarine habitats to support species such as shrimp.

Conservation Issue: Bycatch in the Commercial Shrimp Fishery
Throughout the United States, a major issue for NMFS is the unintentional capture of non-target species during fishing activities (i.e., "bycatch"), representing a major source of mortality within the ecosystem. For example, red snapper is not in itself an estuarine species, but it is caught unintentionally in large numbers by commercial shrimp fishermen. Non-target species removals adversely affect other fisheries (red snapper), but also affect ecosystem health by altering trophic food webs and ecosystem productivity. To help resolve this issue, NMFS is developing a National Bycatch Report that may be used to address such bycatch of non-target species.

2. Recreational Harvest of Estuarine Species

Recreational harvest data provided by NMFS for 2000–2004 were used to calculate the total U.S. and regional recreational fishing harvest of estuarine species. Of the approximately 600 species or species groupings on the nationwide estuarine species list (see Appendix B), NMFS provided recreational harvest data for approximately 250 (see Appendix D). Nationwide, the 2000–2004 recreational harvest totaled 1.2 billion pounds, with 958 million pounds coming from estuarine species. Analysis of these data indicates that from 2000 to 2004 estuarine species comprised approximately 80% of the fish harvested recreationally in the United States[16] (Table 4).

The proportion of estuarine species harvested recreationally is high in many regions, with *at least* 54% of species recreationally harvested in every region using estuarine habitat during at least one stage of their life cycle (with the sole exception of the Caribbean at 19%) (Table 4). Estuarine harvest varies among regions and is highest in the north Atlantic, where 98% of the recreational fish harvested are estuary users. This is likely due to the high landings of striped bass, Atlantic cod, and bluefish (Table A-8, Appendix A). The mid-Atlantic, Gulf of Mexico, and Pacific northwest regions' recreational harvest data from 2000–2004 also show a high proportion of estuary users (90%, 87%, and 74%, respectively—Table 4). The proportion of estuarine harvest in the south Atlantic region and in California ranges from 54–61%. The Caribbean region had the smallest proportion of harvest contributed by estuary users (19%–Table 4).

[16] The Marine Recreational Fishery Statistics Survey (MRFSS) does not collect recreational data for shellfish harvest (i.e., species such as oysters, clams, scallops, mussels, crabs, lobsters, and shrimp). This paper reports on the weight of fish (not shellfish) harvested in the U.S. recreational fishing sector. Since several of the top ten estuarine fish and shellfish in commercial landings were shellfish, the national recreational estuarine percentage would likely have been >80% if MRFSS reported data on both finfish and shellfish recreational harvest.

Table 4. Recreational Estuarine Harvest Compared to Total Recreational Harvest (all areas) in Each Region (**by weight in pounds**), 2000–2004.[17]

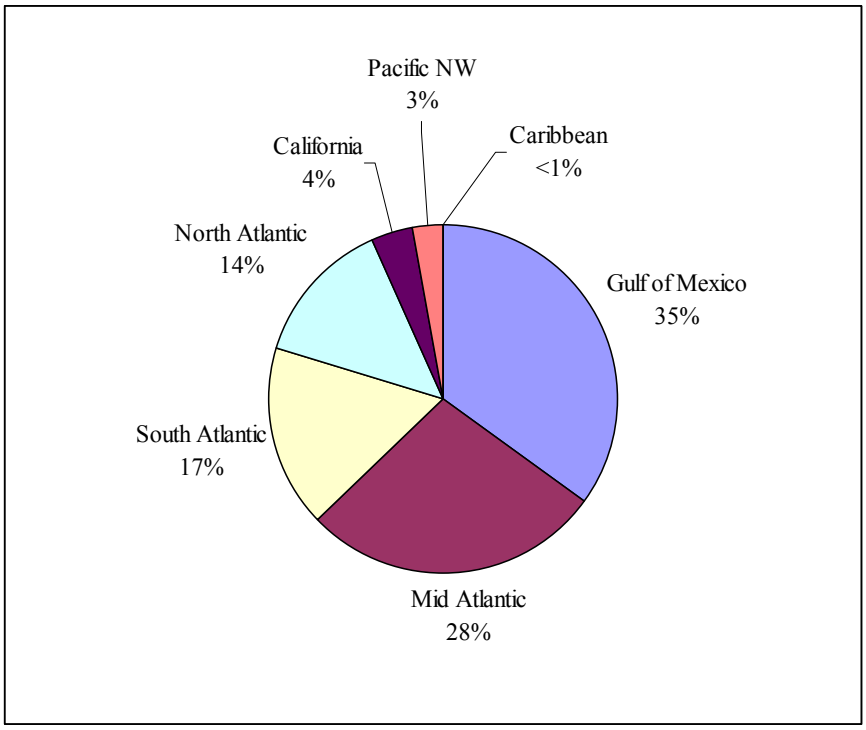
Region	Recreational Harvest (**weight in lbs**)	Estuarine Harvest (**weight in lbs**)	Percent of Recreational Harvest from Estuarine Species
North Atlantic	133,833,465	130,758,196	98%
Mid-Atlantic	297,378,386	266,259,991	90%
Gulf of Mexico	382,754,961	334,095,800	87%
Pacific Northwest	35,036,943	26,004,296	74%
South Atlantic	266,489,755	161,269,131	61%
California	68,967,595	37,393,196	54%
Caribbean	16,390,206	3,160,429	19%
Nationwide	**1,200,851,311**	**958,941,039**	**80%**

The Gulf of Mexico, mid-Atlantic, south Atlantic, and north Atlantic regions contribute the largest proportion of estuarine fish harvested recreationally (Figure 3). Of the total recreational harvest, the Gulf of Mexico contributes the highest proportion of estuarine fish, representing 35% of the nation's estuarine harvest (Figure 3). This is likely due to the large numbers of red drum, spotted seatrout, and sheepshead harvested recreationally in the Gulf of Mexico (Table A-11, Appendix A). Estuarine fish harvested in the mid-Atlantic region represent 28% of the nation's estuarine harvest (Figure 3), largely driven by the striped bass, summer flounder, and Atlantic croaker fisheries (Table A-9, Appendix A). The south Atlantic contributes 17% to the nationwide harvest of estuarine species, while the north Atlantic region contributes 14%. Overall, California, the Pacific northwest, and the Caribbean contribute the least to nationwide estuarine harvest, with a combined contribution of less than 8% (Figure 3). However, it is

[17] Alaska conducts its Sport Fish Statewide Harvest Survey and does not contribute data to the national MRFSS database, so this analysis does not include data from Alaska. Hawaii started contributing to the MRFSS in 2003, rendering an incomplete data set from 2000 to 2004, so the authors did not include Hawaiian data in their analysis.

important to note that we analyzed only 2000–2002 recreational data for California and the Pacific northwest, rather than data for the entire 2000–2004 time period (see footnote 18).[18]

Figure 3. Regional Contribution to National Recreational Estuarine Harvest (**by weight**), 2000–2004.



[18] Starting in 2003, California, Oregon, and Washington replaced the MRFSS with new surveys to collect better recreational fish assessment data. Since the survey design of MRFSS differs from that of individual surveys, the 2000–2002 data gathered via MRFSS are different than the data gathered in 2003 and 2004 by the individual states. Therefore, we analyzed only the 2000–2002 data collected via MRFSS methodology for California, Oregon, and Washington, and no data gathered via the individual surveys. Recreational estuarine harvest data (Table 4) will be minimally affected by the reduced data from the west coast because those numbers are computed by dividing estuarine harvest (over a number of years) by total harvest within the region. However, Figure 3 will be affected by the lack of 2003–2004 data for California, Oregon, and Washington. Harvest numbers are computed over a 5-year period and then divided by the total amount of pounds caught nationwide from recreational fish that use estuaries. The lack of data for 2003 and 2004 puts California and the Pacific northwest at a disadvantage compared to the other regions because the regional harvest numbers are deflated in relation to other regions (although the west coast states do not have high annual harvest rates). The data presented in Table 5 could also be affected by this lack of data—any west coast species harvested would change the other estuarine species' relative contribution toward national estuarine harvest. However, these changes are likely to be minimal given the small contribution California, Oregon, and Washington made in 2000, 2001, and 2002 toward national estuarine harvest.

The top ten estuarine fish harvested recreationally in the United States from 2000 to 2004 are displayed in Table 5. Striped bass, red drum, and spotted seatrout were the top three estuarine fish harvested recreationally nationally from 2000 to 2004, with striped bass accounting for 9% of the nation's recreational harvest, red drum 6%, and spotted seatrout 6% (Table 5).

Table 5. Top 10 Estuarine Species Harvested in the U.S. Recreational Fishing Sector as Percent of National Harvest (**by weight**), 2000–2004.

Rank	Species	Recreational Harvest (**weight in lbs**)	Percent of National **Recreational Harvest**	Primary Region (s) Harvested
1	Striped bass, *Morone saxatilis*	106,724,473	9%	NA, MA, SA
2	Red drum, *Sciaenops ocellatus*	73,943,599	6%	MA, SA, G
3	Spotted seatrout, *Cynoscion nebulosus*	67,778,187	6%	SA, G
4	Bluefish, *Pomatomus saltatrix*	65,971,560	5%	NA, MA, SA
5	Summer flounder, *Paralichthys dentatus*	58,851,827	5%	NA, MA
6	Atlantic croaker, *Micropogonias undulatus*	50,478,475	4%	MA, SA
7	King mackerel, *Scomberomorus cavalla*	38,718,710	3%	SA, G, C
8	Sheepshead, *Archosargus probatocephalus*	31,568,921	3%	SA, G
9	Scup, *Stenotomus chrysops*	26,219,770	2%	NA, MA
10	Atlantic cod, *Gadus morhua*	25,921,918	2%	NA

NA = North Atlantic; MA = Mid-Atlantic; SA = South Atlantic; G = Gulf of Mexico; C = Caribbean.

Profile: Red Drum

(*Sciaenops ocellatus*)

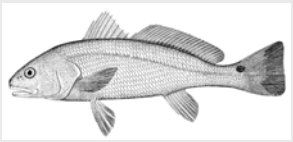


Photo: NOAA Photo Library

Life History and Habitat Use

Red drum is a commercially and recreationally important bottom-feeding species that uses mangrove wetlands, seagrasses, salt marshes, shallow tidal creeks, bays, and tidal flats: as nursery habitat; as refuge from predators; and as feeding grounds for crabs, shrimps, marine worms, and fish (ASMFC 2007; Graff and Middleton 2002). Juveniles use inshore habitats including tidal freshwater habitats, low-salinity reaches of estuaries, estuarine emergent vegetated wetlands (flooded salt marshes, brackish marsh and tidal creeks), mangrove fringe, seagrasses, oyster reefs, shell banks, and soft sediments. Sub-adults use backwater areas behind barrier islands, beaches, and tidal creeks and channels of southern estuaries. Nearshore areas close to inlets and passes are used during the spawning season (ASMFC 2007; NMFS, In prep.).

Commercial Landings and Recreational Harvest

This species is harvested recreationally in the Gulf of Mexico, mid-Atlantic, and south Atlantic regions and landed commercially in the Gulf of Mexico, Chesapeake, south Atlantic, and north Atlantic regions. The red drum recreational fishing industry harvested 73,943,599 pounds from 2000–2004, ranking this species #2 in the top 10 species harvested by the recreational fishing sector (Table 5). Red drum commercial landings in 2000–2004 were 798,386 pounds valued at $936,475.

Threats to Habitat

Threats to red drum habitat include coastal development, dredging, jetty construction, loss of estuarine wetlands, invasive species, pollutant discharges, and hydrologic modifications that alter freshwater flow into estuarine areas, among many others (ASMFC 2007).

Example of NOAA Habitat Conservation Measures

NMFS works with state and federal agencies to develop permit conditions that minimize or mitigate adverse impacts to fish habitat. In addition to recommending permit conditions, the agency also uses its mandates to protect habitats before threats materialize, address unavoidable impacts through restoration, and share information with the public via education and outreach activities.

The *North Atlantic Region's* recreational fishermen harvested 133,833,465 pounds of fish from 2000 to 2004, with 130,758,196 of these pounds (98%) attributed to species that use estuaries during at least one stage of their life cycle (Table 4). Recreational estuarine species harvested in the north Atlantic region accounted for 14% of the nation's estuarine recreational harvest from 2000 to 2004 (Figure 3). As shown in Table A-8 (Appendix A), striped bass, Atlantic cod, and bluefish were the top three estuarine species harvested in the north Atlantic region from 2000 to 2004, representing 60% of the region's recreational harvest. Striped bass accounted for 25% of the north Atlantic's recreational harvest, Atlantic cod represented 19%, and bluefish accounted for 16% of the harvest (Table A-8, Appendix A).

Mid-Atlantic Region recreational fishermen harvested 297,378,386 pounds from 2000 to 2004, with approximately 90% (266,259,991 lbs) from estuary-using fish (Table 4). From 2000 to 2004, 28% of the nation's estuarine recreational harvest came from the mid-Atlantic region (Figure 3). As shown in Table A-9 (Appendix A), striped bass, summer flounder, and Atlantic croaker were the top three estuarine species harvested recreationally in the mid-Atlantic region from 2000 to 2004, representing 52% of the region's recreational harvest. Striped bass accounted for 21% of the region's recreational harvest, summer flounder represented 16%, and Atlantic croaker accounted for 15% of the harvest (Table A-9, Appendix A).

The *South Atlantic Region's* recreational fishermen harvested 266,489,755 pounds of fish from 2000 to 2004, with approximately 61% (161,269,131 lbs) attributed to species using estuarine environments during at least one stage of their life cycle (Table 4). The south Atlantic region comprises 17% (by weight) of the total recreational

estuarine species harvested in the United States from 2000 to 2004 (Figure 3). King mackerel, striped bass, and bluefish were the top three estuarine species recreationally harvested in the south Atlantic region from 2000 to 2004, and when combined, represented 16% of the region's recreational harvest (Table A-10, Appendix A).

The largest proportion of the nation's recreational estuarine harvest is brought to shore in the *Gulf of Mexico region*. This region comprised 35% (by weight, 334,095,800 of the 958,941,039 pounds harvested) of the nation's recreational harvest of species having use of estuaries during their lifecycle (Table 4 and Figure 3). Within this region, approximately 87% of the harvest was composed of estuary-using species (Table 4). Red drum, spotted seatrout, and sheepshead were the top three estuarine species harvested recreationally in the Gulf of Mexico region from 2000 to 2004, contributing 39% to the region's recreational harvest (Table A-11, Appendix A).

Recreational fishermen in the *Caribbean* harvested 16,390,206 pounds of fish from 2000 to 2004, with approximately 19% of those fish (3,160,429 lbs) being estuary users (Table 4). The Caribbean region comprised <1% by weight of the total recreational estuarine species harvested and caught in the United States from 2000 to 2004 (Figure 3). The top three estuarine species harvested recreationally in the Caribbean region from 2000 to 2004 were the great barracuda, crevalle jack, and king mackerel, collectively representing 6% of the region's recreational harvest (Table A-12, Appendix A).

Profile: Striped Bass

(*Morone saxatilis*)

Photo: Duane Raver (in Graff and Middleton 2002)

Life History and Habitat Use

Striped bass are a migratory fish species whose Atlantic coast geographic range spans from Quebec south to Florida. Adult striped bass typically spend most of the time in coastal estuaries or in the ocean, but the species seasonally migrates north and south and ascends rivers to spawn in spring. Spawning occurs in freshwater near the heads of Atlantic coast estuaries or in major inland tributaries. Chesapeake Bay tributaries—as well as the Delaware, Hudson, and Roanoke Rivers—are principal spawning areas for striped bass along the Atlantic coast. Historically, Chesapeake Bay was the spawning ground for 90% of the Atlantic striped bass population (ASMFC 2007). Striped bass typically remain in coastal sounds and estuaries until they are 2 to 4 years old, when they commence their intercoastal migrations (ASMFC 2007). While in coastal estuaries, striped bass forage on small shrimp and other crustaceans, insects, worms, and fish such as Atlantic menhaden that live in salt marsh habitats (Graff and Middleton 2002).

Commercial Landings and Recreational Harvest

Striped bass support an important recreational fishery along the Atlantic coast that provides income for small businesses such as bait and tackle shops, restaurants, hotels, gas stations, boat rental shops, marinas, and many others. From 2000 to 2004, over 106 million pounds of striped bass were harvested by recreational fishermen, ranking this species #1 in the list of harvested recreational fish that use estuaries during their life cycles. The striped bass commercial fishery is also very important, with 2000–2004 landings weighing 33,159,964 pounds worth $59,046,462 in seafood markets. Considering commercial landings weighed less than one-third as much as the recreational harvest during this period, it is clear that small towns stand to gain significant business revenue from a healthy recreational striped bass fishery.

Threats to Habitat

Potential threats include the construction of dams, spillways, culverts, jetties, water withdrawal facilities, and hydropower facilities; thermal and toxic discharges into the environment; channelization and dredging; land use affecting estuaries and rivers (farming, logging, urbanization); release of aluminum and other metals into the water; and changes in pH levels, among many others.

Example of NOAA Habitat Conservation Measures

Fish habitat regulators address environmental impacts that adversely affect striped bass habitat via the consultative processes set forth under the Clean Water Act, Magnuson-Stevens Act, National Environmental Policy Act, and Fish and Wildlife Coordination Act. To assess the potential impacts of development projects, research on the habitat needs of migratory striped bass has been and will continue to be conducted by ASMFC and NMFS, among others. For example, an analysis of preferred striped bass wintering habitat has informed the Army Corps of Engineers (ACE) about potential impacts a proposed dredging project in North Carolina could have on the striped bass population, providing information ACE can use to make construction decisions.

Chinook salmon, barred sand bass, and California halibut were the top three estuarine species harvested recreationally off *California* from 2000 to 2002[19], representing 31% of the region's recreational harvest (Table A-13, Appendix A). Chinook salmon accounted for 15% of the region's recreational harvest, barred sand bass represented 9%, and California halibut accounted for 7% of the harvest (Table A-13, Appendix A). The region's recreational fishermen harvested 68,967,595 pounds of fish from 2000 to 2002, with 37,393,196 pounds (54%) attributed to species using estuarine environments during at least one stage of their life cycle (Table 4). California comprised 4% (by weight) of the nation's total recreational estuarine species harvest from 2000 to 2004[20] (Figure 3).

The *Pacific Northwest's* recreational fishermen harvested 35,036,943 pounds of fish from 2000 to 2002[21], with approximately 74% (26,004,296) of these harvested pounds coming from species that use estuaries (Table 4). The region comprised 3% by weight of the total recreational estuarine species harvested in the United States from 2000–2004[22] (Figure 3). Chinook and coho salmon and lingcod were the top three estuarine species harvested recreationally in the Pacific northwest region from 2000-2002, representing 56% of the region's recreational harvest. Chinook salmon accounted for 28% of the region's recreational harvest, coho represented 22%, and lingcod 6% of the harvest. Collectively, Chinook, coho, chum, and pink salmon accounted for 58% of the region's total recreational harvest from 2000 to 2002, with more than 20 million pounds of salmon harvested by recreational anglers (Table A-14, Appendix A).

---

[19] See footnote 18.
[20] See footnote 18.
[21] See footnote 18.
[22] See footnote 18.

Profile: Crab

Blue Crab
(*Callinectes sapidus*)

Dungeness Crab
(*Cancer magister*)

Photos: NOAA (in Graff and Middleton 2002)

Life History and Habitat Use

Crab species such as the blue crab use a variety of habitats during their life cycles, ranging from marshes to open-water estuaries. Juvenile blue crabs use wetlands and submerged aquatic vegetation (SAV) as nursery habitat, to forage for food, and for refuge from predation. Adult blue crabs use grassy shallow bays and wetland vegetation for protection from predation during molting, as well as for feeding on clams, dead fish, seaweed, and smaller crabs. After adult dungeness crab spawn in lower portions of estuaries, larvae are transported by tidal currents to wetland vegetation and SAV beds, which they use as nursery habitat (Graff and Middleton 2002).

Commercial Landings and Recreational Harvest

Crabs are revenue-generating species that are enjoyed throughout the United States; every region except Hawaii has at least one crab species in their top 10 commercial estuarine species landed (by value). Nationwide, crabs ranked #2 in the nation's top 10 estuarine species landed from 2000 to 2004 (by value), generating $1.8 billion for the U.S. economy. The top two contributors to the crab species grouping (by value) from 2000–2004 were: (1) blue crab, $766,301,043, and (2) dungeness crab, $488,609,220. Species such as the blue crab are also caught recreationally along the East coast, boosting local economies and serving as a cultural symbol.

Threats to Habitat

More than 70% of historic estuarine habitat used by dungeness crabs in the Pacific northwest and in California has been lost or degraded due to human activities such as hydraulic dredging, trawling, diking, filling, and pollution (NMFS, In prep.). Blue crab habitat such as wetland vegetation and SAV has been degraded throughout the nation, particularly in areas such as the Chesapeake Bay and Gulf of Mexico. Nutrient over-enrichment coupled with phytoplankton blooms can result in hypoxic conditions, in which a reduction of dissolved oxygen in the water column minimizes the biological productivity of these areas. Destructive fishing practices can also decrease food availability, thereby adversely affecting dungeness and blue crab populations.

Example of NOAA Habitat Conservation Measures

As an example of the agency's broader efforts, NOAA has been working with the Chesapeake Bay Program (CBP) and other federal, state, and private partners to improve blue crab habitat (e.g., SAV) in the Chesapeake Bay. CBP has adopted a goal to restore historic SAV beds to 185,000 acres in the Chesapeake Bay and its tidal tributaries by 2010. To achieve this goal, actions to protect existing SAV will be taken, water quality improvements will allow SAV to grow in new areas, and SAV transplants will restore historic beds. CBP and its partners have also developed a 'healthy bay goal' to decrease hypoxia and increase the bay's water quality. A reduction in nutrients and sediment flowing into the bay will result in a healthier bay capable of supporting a diverse ecosystem of plants and animals.

DISCUSSION

Interpreting These Data

These data reaffirm the strong dependence of the fishing industries and coastal communities on fish stocks that rely on estuarine habitats during some portion of their life cycle. The economic value of estuarine harvests should serve to urge society to protect and restore habitats that provide valuable services, including many beyond the fishing industries. When considering that value, and for the reasons noted below, it is important to note that these data are likely to under-represent the economic value of estuarine habitats to commercial and recreational fisheries:

- Recreational harvest could be under-represented where some catch might be outside existing surveys. While NMFS surveys are fairly complete for finfish from estuaries and the oceans along the Atlantic coast, the Gulf of Mexico, Hawaii, and Puerto Rico, invertebrates and anadromous fish in tidal rivers are generally not covered. There are also some coverage questions in Texas and the Pacific coast states, particularly Washington and Oregon, where some estuary and shore surveys have been suspended due to funding constraints. Also, MRFSS does not include recreational harvest of crabs, lobsters, bivalves or shrimp, which may be significant in some areas.
- Harvest weights and values analyzed herein include production from finfish and shellfish aquaculture for some states but not all. Culture operations depend on the same high-quality estuarine habitats as wild-caught fisheries.
- Ecological value from forage species, biomass exported from estuaries, and other secondary benefits of estuarine productivity add an economic value to estuaries.

The NMFS (pending assessment for 2005 or 2006) and US Fish and Wildlife Service (five-year intervals, most recently for 2006) have estimated the overall economic impact of recreational fisheries nationwide. Those studies may be adaptable to an evaluation of the estuarine-dependent component of the fishery.

- Similarly, value added by participants, services, and others connected to commercial and recreational fishing add billions of dollars but are not part of this analysis. Some species and associated commercial fisheries or angling opportunities could convey an intrinsic existence value such as is documented for national parks.
- Billions of eggs, larvae, and juveniles lost to entrainment, impingement, and other impacts are not easily converted into adult equivalents that would register as harvest in these analyses. And, even with precise conversions, the ecological loss of those early life stages to predators represents a significant loss to the estuarine and nearshore food cycle.
- Some major fisheries such as Alaskan walleye pollock have a minor estuarine connection but are not categorized as "estuarine" in this report. If pollock were considered estuarine users, 92% by weight (not 46%) and 88% by dollar value (not 68%) of the commercial fish and shellfish landed nationwide would be considered "estuarine," with major implications to our conclusions regarding the connection of harvest to habitat. Recreational statistics would not be affected since pollock are not harvested by anglers.
- These data are reported and analyzed by large geographic region. Finer analyses by state or smaller water body would be more useful to decision makers trying to

account for these economic values but such refinements are not feasible until harvest data are recorded on a comparable scale.

- These data also reflect fisheries from a narrow, five-year slice of our nation's fishing history. In past centuries, when coastal development encroached less into estuarine habitat and when fish stocks were more robust, harvests of many commercial and recreational fish may have been much higher in total and in comparison to the non-estuarine portion.
- Over time, it appears possible that the top producing fisheries have changed both by species and by estuarine dependence. Colonial dependence on nearshore species such as cod and riverine species such as shad gave way to offshore fisheries in the 1800s and then further shifts followed major offshore collapses in the late1900s. Those shifts would have a major effect on interpreting the numbers and trends in this report. The authors would estimate that estuarine dependence is lower now (given the state of estuarine habitat in the early 2000s) than in the past but further analysis would be needed.
- Looking to the future, with coastal wetland losses continuing at higher rates than other wetlands (see below in this section), future estuarine harvests could decline if habitat loss is manifested in decreased fish populations and lower harvests.
- Adverse impacts to estuarine habitat are often offset by regulatory requirements to mitigate. Habitat mitigation remains more "art" than "science" and requires years of patience while ecological services are restored. Those negatives could be moderated by using the economic values from this report to sharpen mitigation ratios. For example, for estuarine habitat known to be crucial for multiple species

supporting valuable fisheries, mitigation plans could request a higher ratio of mitigation:impact than for a project affecting habitat with less value.

Connections Between Estuarine and Coastal Habitats of the United States

These data offer glimpses of value beyond estuaries and to other coastal habitats. Estuaries are major habitats between freshwater and ocean systems; coastal habitats such as wetlands are key environments in coastal watersheds with direct, hydrologic connections to the sea. Values expressed in this report could be indicative of societal services provided by other shoreline habitats.

Estuaries and associated wetlands support various fish, shellfish, and bird species in parts or all of their life cycles (EPA 2004). Fish and shellfish may use the environments for shelter and food in a manner that is facultative (i.e., opportunistic) rather than obligate (i.e., dependent) (Able 2005). Many notable estuary-dependent or obligate species such as penaeid shrimps, Atlantic menhaden, and salmonids comprise a significant portion of U.S. commercial and recreational landings. Facultative species may be less significant economically but still essential to ecosystem health (i.e., spiny dogfish as predators) (ASMFC 2002). Alternatively, some fish and shellfish may never enter the estuary (i.e., highly migratory species such as bluefin tuna) but forage on species produced in estuarine environments (i.e., Atlantic herring, sand lance, bluefish, Atlantic mackerel, squid) (Chase 2002).

Estuarine habitats used by economically valuable, facultative, and obligate species include seagrasses and salt marsh vegetation that also provide a variety of ecological services to the ecosystem, including: primary production (providing food for

fish and wildlife); canopy structure (providing habitat, refuge, nursery, settlement, and support of fisheries); nutrient, contaminant, and sediment filtration and trapping; epibenthic and benthic production (supporting food webs); oxygen production; nutrient regeneration and recycling; organic matter accumulation (counteracting sea level rise and supporting fisheries); and shoreline erosion control by dampening waves and currents (EPA 2004; Short et al. 2000). Seagrasses, salt marsh, and other estuarine habitats are important for both the ecological services they provide and the economic benefit they bring by supporting commercially and recreationally important fish and shellfish species (Dawes et al. 2004).

Shrimp and crabs are two economically important species that use estuarine habitats during their life cycles (see shrimp and crab profiles on pages 25 and 35). Shrimp spawn in the open ocean and larvae eventually drift into estuaries and salt marshes, where they transform into juveniles as they eat detritus laden with food and algae growing on marsh plants (i.e., saltgrass, cordgrass, seagrass, mangroves, and rooted vegetation). Shrimp need these habitats for growth, evading predators, and survival during postlarval and juvenile life history stages.

Crabs also use seagrasses and salt marsh vegetation as habitat during their life cycle. Juvenile blue crabs use wetlands as nursery habitat and depend on marsh vegetation and seagrasses for food and refuge from predation. Adults use grassy shallow bays and wetland vegetation to escape predation during molting, as well as to feed on clams, dead fish, seaweed, and other crustaceans. The Dungeness crab also uses estuarine salt marshes and seagrass beds as nursery habitat. Dungeness crab larvae are transported by tidal currents from spawning grounds in lower portions of estuaries, shoreward to

areas with wetland vegetation. Wetland areas provide food and refuge essential for larvae to grow into juveniles and morph into adults.

Commercial species such as Atlantic menhaden and salmon are estuary users contributing the most to estuarine landings (by weight) in the United States (see Atlantic menhaden and salmon profiles, pages 20 and 22). Chesapeake Bay and other estuaries play an important role as nursery habitats for species such as Atlantic menhaden, which are transported as larvae into estuaries and spend most of their early developmental stage in estuarine waters.

Salmon are anadromous species that travel through estuaries to sea as juveniles and return as adults to their natal streams and rivers to spawn. After spawning, fry and smolts may spend up to 6 months in estuarine waters. Estuaries and their associated wetland habitats provide vital nursery habitat in which salmon feed and find refuge from predators. Salmon then leave the estuarine environment for the open ocean returning several years later as they migrate through the estuary to their natal spawning grounds in rivers and streams (PSMFC 2007). NMFS dedicates significant effort in its Endangered Species Act programs to salmon listed in New England and the west coast. Atlantic and Pacific salmonids on their way to sea or returning to spawn rely heavily on estuarine habitats that are strongly influenced by human activities. For the reasons stated above, NMFS dedicates significant effort in its Endangered Species Act programs to salmon listed in New England and the west coast.

Striped bass and red drum are highly valued by recreational fishermen (see profiles, pages 30 and 33). Striped bass are a migratory fish that typically spends most of its life cycle in coastal estuaries or in coastal ocean waters, while seasonally migrating

north and south and ascending rivers to spawn in spring. Nursery habitats for red drum include coastal marshes, shallow tidal creeks, bays, tidal flats and impoundments, and seagrass beds (ASMFC 2007). Juvenile red drum use a variety of inshore habitats, including tidal freshwater habitats, low-salinity reaches of estuaries, estuarine emergent vegetated wetlands, mangrove fringe, seagrasses, oyster reefs, shell banks, and soft sediments. Sub-adults use backwater areas behind barrier islands, beaches, and in tidal creeks and channels of southern estuaries (ASMFC 2007; NMFS, In prep.).

Factors Adversely Affecting Estuarine Habitat in the United States

Wetland Vegetation Loss

The six species or species groupings mentioned above and in the profiles exemplify highly valued species dependent on estuaries. Those same species represent the largest commercial landings (by weight and dollar value) and recreational harvest (by weight) of all estuary-using species. The top species (Atlantic menhaden, salmon, shrimps, crabs, red drum, and striped bass) use estuarine wetland vegetation as nursery habitat, shelter/refuge from predators, and/or feeding. Wetlands throughout the United States continue to be affected by human activities, including coastal development, transportation, agriculture, hydropower dam construction/operation, flood control, agriculture, waste disposal, shipping, and oil/gas development, as well as by natural processes such as hurricanes, floods, droughts, sea-level rise, and sediment compaction (EPA 2004). Those indicators foretell a troubling trend with implications to estuaries, the fish dependent on estuarine habitat, and coastal economics linked to commercial and recreational fisheries.

The first status and trends report on wetlands estimated that between the mid-1950s and the mid-1970s the United States was losing about 458,000 wetland acres per year (Frayer et al. 1983). A re-evaluation from the mid-1970s to the mid-1980s revealed the rate of wetlands loss had declined, but annual loss of wetlands remained significant and still measured approximately 290,000 acres (Dahl and Johnson 1991). In a third report in 2000, the U.S. Fish and Wildlife Service (FWS) reported the net loss had decreased to 58,500 acres per year from 1986 to 1997 (Dahl 2000). The decrease has been attributed to more strict regulatory actions taken by the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and states under the Clean Water Act and habitat conservation efforts such as the U.S. Department of Agriculture's "Swampbuster" program (EPA 2004).

In 2006, FWS published a report indicating that wetland protection, restoration, and creation efforts had combined for a net gain of wetlands nationally for the first time. Gains of 191,750 wetland acres from 1998 to 2004 represented an average annual net gain of 32,000 acres (Dahl 2006). A deeper analysis revealed how gains of 700,000 acres of open water ponds, land set-asides, agricultural conservation programs, retirement programs, disincentives for wetland drainage, education programs, federal and state wetland management programs, and wetland restoration and creation programs involving partners on conservation lands offset losses from continued development pressures (Dahl 2006). There was also a significant message when separating coastal and in-land wetlands. While the in-land data revealed a net gain, data for coastal wetlands showed a net loss as witnessed in past decades.

A significant trend emerges when coastal and inland wetlands are evaluated separately. While the data revealed a net gain for inland wetlands, coastal wetlands showed a net loss of 59,000 acres per year during that time period (Stedman and Dahl, 2008). This loss rate is equiavent to the loss over the entire lower 48 states during the previous study period of 1986-1997. Clearly, while wetlands loss in inland areas is declining (or being offset by gains), wetland loss in coastal areas is accelerating.

The FWS 1998–2004 data revealed that estuarine intertidal emergent wetlands (salt and brackish water marsh habitats) continue to decline. In 2004, approximately 5.3 million acres of marine and estuarine wetlands remained in the contiguous coastal states (Dahl 2006). From 1998 to 2004, estuarine emergent wetlands declined by 5,540 acres per year, with a total loss of 0.9% during the 6-year period. This rate of salt marsh wetland loss is consistent with the 1986–1997 rate of estuarine wetland loss reported in the previous FWS study. While small when viewed out of context, the continued loss of coastal wetlands adds stress to valued habitats supporting harvested species. The 2006 report attributed the loss of estuarine and marine wetlands to the conversion of emergent salt marsh to open saltwater systems. Activities contributing to this loss in salt marsh habitat include water control, commercial and recreational boat traffic, and dredging (Dahl 2006), as well as sea-level rise due to warming ocean temperatures (Nicholls et al. 2007).

However, the greatest amount of recent coastal wetland loss is occurring in freshwater wetlands (Stedman and Dahl, 2008). Freshwater shrub wetlands experienced the greatest loss, followed by freshwater marshes and freshwater forested wetlands. Coastal areas continue to experience enormous development pressures that affect those

habitats in estuaries and other coastal areas. Previous studies (Brady and Goebel, 2002) have shown that 66% of the wetland loss in coastal counties was due to development (as compared to 41% in inland counties). Freshwater wetlands are important components of coastal and estuarine ecosystems, supplying nutrients, floodwater control, and habitat for migrating species such as alewife, herring, and salmon. The loss of freshwater coastal wetlands has a direct adverse effect on the quality of estuarine and marine ecosystems.

Salmon offer distinct challenges as the only species listed under the Endangered Species Act (ESA) yet harvested by commercial or recreational fisheries. Most of those fisheries are heavily regulated to conserve remaining populations. Human activities in watersheds supporting salmon are also scrutinized through the ESA section 7 consultation process since development pressures often compromise hydrology, water quality, sedimentation rates, and other key determinants of estuarine habitat quality.

In the lower 48 states, 30% of all coastal marshes, 45% of intertidal coastal marshes, and 14% of coastal wetlands (marshes, forests, and mangroves) are found in Louisiana. Louisiana has lost more than 1.22 million acres of coastal wetlands during the past 70 years. Louisiana experiences approximately 90% of all coastal wetland loss in the contiguous coastal states, with an estimated 448,000 additional wetland acres projected to be lost in the next 50 years based on conservative estimates for sea-level change. Wetland loss is caused in part by the lost sediment transfer between rivers and the coastline resulting from the construction and maintenance of dams, levees, and navigation projects. Louisiana's coast was formed by sediments from the Mississippi River, which are now mostly shunted past wetlands by human manipulations for flood control, navigation, and hydropower development. Sediment delivery from the

Mississippi River to coastal Louisiana has been reduced 67%, resulting in major subsidence and coastal wetland loss in the Gulf of Mexico (EPA 2004). The U.S. Army Corps of Engineers announced an effort in 2007 to open sediment delivery channels along the Mississippi, hoping to nourish those disappearing wetlands and dampen those trends.

In addition to fish habitat benefits provided by wetlands and the economic benefits to fishermen and their communities, these habitats provide ecological services such as: filtration and processing of industrial, residential, and agricultural wastes; shoreline erosion control; coastal storm buffers; flood control; and many others (EPA 2004). In 2006, U.S. consumers spent approximately $69.5 billion for fish products (Van Voorhees and Prichard 2007), supporting more than 1 million jobs that involve catching, processing, and/or selling fish and shellfish (EPA 2004; presumed similar in 2006). Considering the ecological and economic importance of wetland habitats to fishers and society, the continued loss of salt marsh wetlands from natural and anthropogenic causes could have troubling implications for our nation's economy and environment.

Wetland protection and restoration must continue to be a national priority. Resources should be directed toward protecting and restoring important wetland habitats in estuaries and elsewhere along the coast. By doing so, the United States will not only enhance fish and shellfish habitat but also gain additional ecological services provided by wetlands, shellfish beds, and other estuarine habitats.

Hypoxia and Eutrophication

According to the National Coastal Condition Report (NCCR II) (EPA 2004), the overall condition of estuaries in the United States is rated as "fair" on a scale of poor, fair, and good. Nationwide, coastal habitat is rated "poor" and water quality is rated "fair." Those habitats and their NCCR II grades are interconnected. A healthy water column is just as important as healthy wetland and submerged aquatic vegetation habitat for fish and shellfish. NCCR II reported that 60% of the nation's estuarine waters are moderately to highly degraded. Degraded water quality variables include increased chlorophyll *a* concentration, decreased dissolved oxygen (DO) concentration, increased nutrient concentration, and reduced water clarity.

Increased nutrient levels an fuel an increase in phytoplankton production, as indicated by increased levels of chlorophyll *a* in the water column. Overproduction of microscopic algae can cause problems because, after algae blooms, the cells die and sink to the substrate. Microbes use oxygen to decompose decaying algae, thereby lowering the DO content of the water column. Low DO degrades habitat, forcing finfish and shellfish to vacate an area to find adequate oxygen levels. These hypoxic zones are often referred to as "dead zones" because plant and animal species cannot live in these areas and the sedentary species (i.e., clams) or other species that do not vacate the area can die from lack of oxygen in the water column (EPA 2004).

In the northern Gulf of Mexico, nutrient loading from the Mississippi River results in an annual loss of habitat due to hypoxic conditions (EPA 2004). Each spring and summer, hypoxic "dead" zones develop in the region with DO levels below 2 mg/L, minimizing benthic and pelagic habitat used by aquatic organisms. Some years, these

hypoxic zones extend west from the mouth of the Mississippi River past the Texas border. From 1985 to 1992, the region averaged 3,205 square miles of habitat affected by hypoxia, and from 1993 to 2001 averaged 16,178 square miles (EPA 2004). The incidence of such dead zones nationwide has increased dramatically in recent decades, becoming a common occurrence with significant impacts extending into estuaries and affecting species dependent on estuarine habitats.

A nationwide assessment of coastal hypoxia and eutrophication in coastal waters was conducted by the National Science and Technology Council, Committee on Environment and Natural Resources (CENR 2003). The assessment showed that more than half of U.S. estuaries experience hypoxia during some part of the year, and the duration and frequency of these events have increased in recent decades. Hypoxia is now an issue in commercially and recreationally important areas such as the Gulf of Mexico, Chesapeake Bay, and Puget Sound (CENR 2003).

Habitat loss caused by wetland destruction in the Gulf of Mexico, combined with the increasing aerial extent of the "dead zone," has the potential to adversely affect commercially and recreationally important species such as shrimp and red drum. Shrimp were the top revenue-generating, commercial estuarine species in the United States from 2000 to 2004, with 88% ($2.2 billion) of the landings from the Gulf of Mexico. Red drum was the second highest recreational estuarine species harvested in the United States from 2000 to 2004, with approximately 74 million pounds harvested by anglers, which fueled local economies via the support of bait and tackle shops, restaurants, hotels, gas stations, and other local businesses.

Shrimp and red drum represent a small portion of species with major importance to the nation's economy. The much larger assemblage described in this report depend on healthy estuarine ecosystems with good water quality and intact wetland habitats. For that reason, NOAA protects, restores, enhances, and creates ecologically important and well functioning estuarine habitats that support our nation's fisheries, buffer the shorelines from degradation, create ecologically and economically resilient coastal communities, and provide societal services such as filtration of industrial, residential, and agricultural wastes from the land.

Other Factors Degrading Estuarine Habitat

Estuarine losses of wetland and water column habitats, whether from development or hypoxia, are not the only factors degrading benthic and pelagic estuarine health in the United States. Estuaries and the species therein have been adversely affected by pipeline installation, pier construction, noise, channel dredging, warming ocean waters due to climate change, siltation/pollutant runoff from terrestrial areas, fishing practices, chemical spills, fish and shellfish disease, invasive species, noxious phytoplankton blooms, vessel traffic, and more. The cumulative impacts on estuaries and aquatic flora and fauna caused by these stressors are large, and demand additional resources to protect and restore habitats critically needed by our nation's commercial and recreational fish species.

Actions to Conserve Fish Habitat

Federal, state, local, and tribal governments and non-governmental organizations spanning from industry sectors to local environmental often work together to conserve fish habitat. Collaboration and partnering are crucial ingredients for setting habitat conservation priorities and for combining and leveraging limited resources to maximize habitat gains. NMFS is currently supplementing its traditional regulatory work with proactive, cooperative efforts to protect habitats as well as identify products, tools, and partners to address priority habitat threats more efficiently than by individual projects or expensive restoration. Success will hinge on careful use of all available tools, but some new opportunities could be particularly effective.

One partnership, the National Fish Habitat Action Plan (NFHAP), has assembled more than 450 federal, state, local, and tribal agencies; non-governmental organizations; nonprofit foundations; and others to protect, restore, and enhance the nation's fish and aquatic communities through partnerships that foster fish habitat conservation in a voluntary, non-regulatory manner. NFHAP aims to leverage federal and privately raised funds, strategically focus resources, set habitat conservation priorities, improve coordination, and support efforts to improve fish habitat throughout the nation. Regional fish habitat partnerships established under the NFHAP umbrella could be an excellent approach to collaborative research, analysis, and management, as is occurring for migratory waterfowl under the program that served as the NFHAP model. NMFS is one federal partner in NFHAP, working with the Association of Fish and Wildlife Agencies, the states, and others.

In addition to supporting non-regulatory approaches such as NFHAP, NMFS has several other roles in conserving estuaries and other coastal habitats. The agency has traditionally provided technical advice to other agencies and the public on thousands of individual proposed actions that could negatively affect living marine resources. NMFS often recommends ways to avoid, minimize, and mitigate adverse effects of a proposed project via the Essential Fish Habitat consultation process set forth under the Magnuson-Stevens Act (MSA) of 1996. In addition, NMFS provides conservation recommendations to the Army Corps of Engineers who may issue permit conditions under section 404 of the Clean Water Act requiring the developer to reduce adverse effects of their project. Recommendations can include making a proposed project smaller, moving it away from estuarine habitats, timing some activities to avoid migrating fish populations, or compensating for the loss of wetland habitat by restoring nearby habitat. Initially under the Clean Water Act and Fish and Wildlife Coordination Act but now under the MSA, this consultative role has helped to inform agencies and educate the public about acceptable activities along our nation's coasts. Environmental pressures remain, but the agency sees fewer non-water-dependent projects and more carefully designed projects than in years past.

In addition to protecting habitat via regulatory and nonregulatory activities, NMFS also restores coastal wetlands via several other programs. The Damage Assessment, Remediation, and Restoration Program assesses injuries to natural resources and habitats (e.g., oil spills and ship groundings in or near coastal wetland habitats), seeks financial damages for those injuries, implements restoration activities to rebuild those natural resources, and monitors restoration progress. The Community-based Restoration

Program provides grants to communities to restore wetlands and other aquatic habitats (e.g., oyster reefs) at the local level. NMFS actively participates in the protection and restoration of coastal Louisiana's wetlands under the Coastal Wetlands Planning, Protection, and Restoration Act. In 2007, NMFS added the Open Rivers Initiative to its portfolio, with a focus on rivers supporting diadromous species. Those rivers are the hydrological life blood of downstream estuaries, and play a direct role in the health of many fish stocks. NMFS conducts estuarie research and investigates topics such as the importance of wetlands to fish, the success of coastal restoration projects, trends in coastal wetland loss, and the effects of development on coastal wetlands and their watersheds. NMFS is involved in public outreach and actively disseminates information on the consequences of wetland habitat loss as well as the ecological and economic value of healthy estuarine environments.

CONCLUSIONS

In 1992, NMFS published an analysis of the economic importance of estuaries to commercial and recreational fish and shellfish, reporting that estuarine species comprise as much as 75% of the nation's commercial and recreational landings (Chambers 1992). Although the results of the 1992 analysis and the current 2000–2004 analysis cannot be directly compared (because the methods, data, and estuarine species differ between the two reports), this report offers comparable conclusions that estuaries are important both economically and ecologically. From 2000 to 2004, estuarine species comprised

approximately 46% by weight and 68% by value of the commercial fish and shellfish landed and approximately 80% of the recreational fish harvested nationwide.

The values reported in this document underscore the importance of healthy estuarine ecosystems to the nation's fisheries and to the economy. It is important to note that the estimates of estuarine value referenced here are not the economic worth of estuaries or all estuarine species. Rather, the estimates are the weight in pounds and dollar value of estuarine species landed/harvested via commercial and recreational fishing. A full economic and environmental valuation of estuarine species would likely reveal a greater total value if it was expanded to include habitat functions and services such as: supporting trophic food webs, fauna, and other habitat components; enhancing recreational use through boating, fishing, tourism, restaurants, etc.; and intrinsic value of the species' existence individually and as part of a greater ecosystem. Until these estuarine attributes are realistically addressed, the value of estuarine and coastal habitats are, at best, undervalued.

ACKNOWLEDGMENTS

The authors would like to thank Kevin Bailey, Stephen K. Brown, Bryant Chesney, Gordon Colvin, Jim Ditty, Meghan Donahue, Virginia Fay, Dan Farrow, Bob Hoffman, Scott Johnson, Mark Monaco, Patricia Montanio, Bruce Mundy, Jeff Napp, Julie Nygard, John Olson, Derek Orner, Frances Pflieger, Beth Phelan, Art Rios, Mike Sigler, George Silva, Tom Sminkey, Susan-Marie Stedman, John Stein, Andy Strelcheck, Dave Sutherland, Bob Walker, Brittany White, and Matt Wilson for their time and effort

to review this technical memorandum. The authors also thank the Habitat Committee of the Atlantic States Marine Fisheries Commission for their many suggestions on how best to interpret these data. Nerie Canasa provided valued assistance in final design and lay out. Finally, we would like to thank our colleagues in the NMFS Office of Habitat Conservation, whose patience, dedication, and encouragement provided us with the impetus to finish this report.

REFERENCES

Able, K.W. 2005. A re-examination of fish estuarine dependence: Evidence for connectivity between estuarine and ocean habitats. *Est., Coast. and Shelf Sci.* 64: 5–17.

Abookire, A.A., J.F. Piatt, and M.D. Robards. 2000. Nearshore fish distributions in an Alaskan estuary in relation to stratification, temperature, and salinity. *Est., Coast. and Shelf Sci.* 51: 45–59.

Akin, S., K.O. Winemiller, and F.P. Gelwick. 2003. Seasonal and spatial variations in fish and macrocrustacean assemblage structure in Mad Island Marsh estuary, Texas. *Est., Coast. and Shelf Sci.* 57: 269–282.

Allen, L.G., T.E. Hovey, M.S. Love, and J.T.W. Smith. 1995. The life history of the spotted sand bass (Paralabrax maculatofasciatus) within the Southern California Bight. *CalCOFI Rep.* 36:193–203.

Allen, L.G. 1982. Seasonal abundance, composition, and productivity of the littoral fish assemblage in upper Newport Bay, California. *Fish. Bull*. 80(4): 769–790.

Allen, L.G. 1990. Fishes of bay, estuary, and harbor habitats in Southern California: A prospectus and predictions regarding Ballona Wetlands restoration. Consultation for Maquire Thomas Partners, April 1990.

Allen, L.G., and M.H. Horn. 1975. Abundance, diversity and seasonality of fishes in Colorado Lagoon, Alamitos Bay, California. *Est. and Coast. Mar. Sci.* 3: 371–380.

Atlantic States Marine Fisheries Commission (ASMFC). 2002. Interstate Fishery Management Plan for Spiny Dogfish. Fishery Management Report No. 40, November 2002.

Atlantic States Marine Fisheries Commission (ASMFC). 2007. ASMFC species profiles, habitat fact sheets, stock status information. Available: http://www.asmfc.org/.

Ayvazian, S.G., L.A. Deegan, and J.T. Finn. 1992. Comparison of habitat use by estuarine fish assemblages in the Acadian and Virginian zoogeographic provinces. *Estuaries* 15(3): 368–383.

Benson, L.K., and J.M. Fitzsimons. 2002. Life history of the Hawaiian fish *Kuhlia sandvicensis* as inferred from daily growth rings of otoliths. *Env. Biol. Fish.* 65: 131–137.

Bottom, D.L., and K.K. Jones. 1990. Species composition, distribution, and invertebrate prey of fish assemblages in the Columbia River Estuary. *Prog. Oceanog.* 25: 243–270.

Bozeman, E.L. Jr., and J.M. Dean. 1980. The abundance of estuarine larval and juvenile fish in a South Carolina intertidal creek. *Estuaries* 3(2): 89–97.

Brady, S.J. and Goebel, J.J. 2002. Geographical Distribution of Wetland Changes in the U.S., 1992-1997. Paper presented at the 5th Wetlands Workshop, Atlantic City, New Jersey, October 21-24.

Caribbean Fishery Management Council (CFMC). 2004. Final Environmental Impact Statement for the Generic Essential Fish Habitat Amendment to: Spiny Lobster Fishery Management Plan, Reef Fish Fishery Management Plan, Coral Fishery Management Plan for the U.S. Caribbean.

Chambers, J.R. 1992. Coastal degradation and fish population losses. Pages 45–51 *in* Stroud, ed. Stemming the tide of coastal fish habitat loss. National Coalition for Marine Conservation, Inc., Leesburg, VA.

Chase, B.C. 2002. Differences in diet of Atlantic bluefin tuna (Thunnus thynnus) at five seasonal feeding grounds on the New England continental shelf. *Fish. Bull.* 100: 168–180. Available: http://fishbull.noaa.gov/1002/02chasef.pdf.

Committee on Environment and Natural Resources (CENR). 2003. An Assessment of Coastal Hypoxia and Eutrophication in U.S. Waters. National Science and Technology Council, Washington, D.C. Available: http://www.oceanservice.noaa.gov/outreach/pdfs/coastalhypoxia.pdf.

Cowan, J.H. Jr., and R.S. Birdsong. 1985. Seasonal occurrence of larval and juvenile fishes in a Virginia Atlantic Coast estuary with emphasis on drums (Family Sciaenidae). 1985. *Estuaries* 8(1): 48–59.

Dahl, T.E. 2000. Status and trends of wetlands in the conterminous United States 1986 to 1997. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C.

Dahl, T.E. 2006. Status and trends of wetlands in the conterminous United States 1998 to 2004. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C.

Dahl, T.E., and C.E. Johnson. 1991. Status and trends of wetlands in the conterminous United States, mid-1970's to mid-1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Dawes, C.J., R.C. Phillips, and G. Morrison. 2004. Seagrass communities of the gulf coast of Florida: status and ecology. Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute and the Tampa Bay Estuary Program, St. Petersburg, Florida.

Derickson, W.K., and K.S. Price Jr. 1973. The fishes of the shore zone of Rehoboth and Indian River Bays, Delaware. *Trans. Amer. Fish. Soc.* 3: 552–562.

Ellis, R.H. 1999. Tillamook Bay: fish use of the estuary. 1999 Monitoring Report prepared for the Tillamook Bay National Estuary Project and Tillamook County Cooperative Partnership, Garibaldi, Oregon.

Emmett, R.L., S.L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in West Coast estuaries, Volume II: Species life history summaries. ELMR Rep. No. 8. NOAA/NOS SEA Division, Rockville, Maryland.

Environmental Protection Agency (EPA). 2004. National Coastal Condition Report II. EPA-620/R-03/002. Office of Research and Development and Office of Water, Washington, D.C.

Field, D.W., A.J. Reyer, P.V. Genovese, and B.D. Shearer. 1991. Coastal wetlands of the United States: an accounting of a valuable national resource. National Oceanic and Atmospheric Administration and U.S. Fish and Wildlife Service, Washington, D.C.

Frayer, W.E., T.J. Monahan, D.C. Bowden, and F.A. Graybill. 1983. Status and trends of wetlands and deepwater habitats in the conterminous United States, 1950's to 1970's. Colorado State University, Fort Collins, Colorado.

Graff, L., and J. Middleton. 2002. Wetlands and fish: catch the link. Office of Habitat Conservation, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

Gulf of Mexico Fishery Management Council (GMFMC). 2005. Final Amendment Number 13 to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico, U.S. Waters with Environmental Assessment, Regulatory Impact Review, and Regulatory Flexibility Analysis. Tampa, Florida.

Gulf of Mexico Fishery Management Council (GMFMC). 2004. Final Environmental Impact Statement for the Generic Essential Habitat Amendment to the following fishery management plans of the Gulf of Mexico (GOM): Shrimp Fishery of the GOM, Red Drum Fishery of the GOM, Reef Fish Fishery of the GOM, Stone Crab Fishery of the GOM, Coral and Coral Reef Fishery of the GOM, Spiny Lobster Fishery of the GOM and South Atlantic, Coastal Migratory Pelagic Resources of the GOM and South Atlantic. Tampa, Florida.

Gulf of Mexico Fishery Management Council (GMFMC). 1998. Generic Amendment for Addressing Essential Fish Habitat Requirements in the following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the GOM, Red Drum Fishery of the GOM, Reef Fish Fishery of the GOM, Coastal Migratory Pelagic Resources (Mackerels) in the GOM and South Atlantic, Stone Crab Fishery in the GOM, Spiny Lobster in the GOM and South Atlantic, Coral and Coral Reefs of the GOM. Tampa, Florida.

Haedrich, R.L. and S.O. Haedrich. 1974. A seasonal survey of the fishes in the Mystic River, a polluted estuary in downtown Boston, Massachusetts. 1974. *Est. and Coast. Mar. Sci.* 2: 59–73.

Haertel, L., and C. Osterberg. 1966. Ecology of zooplankton, benthos and fishes in the Columbia River Estuary. *Ecology* 48(3): 459–472.

Hagan, S.M., and K.W. Able. 2003. Seasonal changes of the pelagic fish assemblage in a temperate estuary. *Est., Coast. And Shelf Sci*. 56: 15–29.

Heck, K.L., Jr., K.W. Able, M.P. Fahay, and C.T. Roman. 1989. Fishes and decapod crustaceans of Cape Cod eelgrass meadows: Species composition, seasonal abundance patterns and comparison with unvegetated substrates. *Estuaries* 12(2): 59–65.

H. John Heinz III Center for Science, Economics and the Environment (Heinz Center). 2002. The state of the nation's ecosystems: measuring the lands, waters, and living resources of the United States. Cambridge University Press, New York.

Hoff, J.G., and R.M. Ibara. 1977. Factors affecting the seasonal abundance, composition, and diversity of fishes in a southeastern New England estuary. *Est. and Coast. Mar. Sci.* 5: 665–678.

Horn, M.H. 1980. Diel and seasonal variation in abundance and diversity of shallow-water fish populations in Morro Bay, California. *Fish. Bull*. 78(3): 759–770.

Hughes, J.E., L.A. Deegan, J.C. Wyda, M.J. Weaver, and A. Wright. 2002. The effects of eelgrass habitat loss on estuarine fish communities of southern New England. *Estuaries* 25(2): 235–249.

Hurst, T.P., K.A. McKown, and D.O. Conover. 2004. Interannual and long-term variation in the nearshore fish community of the mesohaline Hudson River Estuary. *Estuaries* 27(4): 659–669.

Johnson, S.W., A. Darcie Neff, and J.F. Thedinga. 2005. An atlas on the distribution and habitat of common fishes in shallow nearshore waters of Southeastern Alaska. NOAA Tech. Memo. NMFS-AFSC-157.

Jones, K.K., C.A. Simenstad, D.L. Higley, and D.L. Bottom. 1990. Community structure, distribution, and standing stock of benthos, epibenthos, and plankton in the Columbia River estuary. *Prog. Oceanog.* 25: 211–241.

Jung, S., and E.D. Houde. 2003. Spatial and temporal variabilities of pelagic fish community structure and distribution in Chesapeake Bay, USA. *Est., Coast. and Shelf Sci.* 58: 335–351.

Jury, S.H., J.D. Field, S.L. Stone, D.M. Nelson, and M.E. Monaco. 1994. Distribution and abundance of fishes and invertebrates in North Atlantic estuaries. ELMR Rep. No. 13. NOAA/NOS SEA Division, Silver Spring, Maryland.

Keller, A.A., G. Klein-MacPhee, and J. St. Onge Burns. 1999. Abundance and distribution of ichthyoplankton in Narragansett Bay, Rhode Island, 1989–1990. *Estuaries* 22(1):149–163.

Kneib, R.T., and S.L. Wagner. 1994. Nekton use of vegetated marsh habitats at different stages of tidal inundation. *Mar. Ecol. Prog. Ser.* 106: 227–238.

Lazzari, M.A., S. Sherman, and J.K. Kanwit. 2003. Nursery use of shallow habitats by epibenthic fishes in Maine nearshore waters. *Est., Coast. and Shelf Sci.* 56: 73–84.

Lazzari, M.A. and B. Tupper. 2002. Importance of shallow water habitats for demersal fishes and decapod crustaceans in Penobscot Bay, Maine. *Env. Biol. Fishes* 63: 57–66.

Leet, W.S., C.M. Dewees, R. Klingbiel, and E.J. Larson (eds.). 2001. California's living marine resources: a status report. ANR Publ. SG01-11. Calif. Dep. Fish Game and Univ. Calif. Agric. Nat. Res.

Ley, J.A., C.C. McIvor, and C.L. Montague. 1999. Fishes in mangrove prop-root habitats of northeastern Florida Bay: distinct assemblages across an estuarine gradient. *Est., Coast. and Shelf Sci.* 48: 701–723.

Lippson, A.J. (ed). 1985. The Chesapeake Bay in Maryland: an atlas of natural resources. The John Hopkins University Press, Baltimore.

Livingston, R.J. 1976. Diurnal and seasonal fluctuations of organisms in a North Florida estuary. *Est. and Coast. Mar. Sci.* 4: 373–400.

Mattila, J., G. Chaplin, M.R. Eilers, K.L. Heck, Jr., J.P. O'Neal, and J.F. Valentine. 1999. Spatial and diurnal distribution of invertebrate and fish fauna of a *Zostera marina* bed and nearby unvegetated sediments in Damariscotta River, Maine (USA). *J. Sea Res.* 41: 321–332.

McCain, B. 2003. Essential Fish Habitat: West Coast Groundfish. Draft Revised Appendix. Prepared Initially in June, 1998 by EFH Core Team for West Coast Groundfish. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Mecklenburg, C.W., T. A. Mecklenburg, and L. K. Thorsteinson. 2002. Fishes of Alaska. Am. Fish. Soc., Bethesda, MD.

Mid-Atlantic Fishery Management Council (MAFMC). 1998. Amendment 8 to the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan.

Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC). 2002. Amendment 13 to the Summer Flounder, Scup, and Black Seabass Fishery Management Plan, Volume 1.

Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC). 1998. Amendment 1 to the Bluefish Fishery Management Plan.

Mid-Atlantic Fishery Management Council (MAFMC) and New England Fishery Management Council (NEFMC). 1999. Spiny Dogfish Fishery Management Plan.

Monaco, M.E., T.A. Lowery, and R.L. Emmett. 1992. Assemblages of U.S. West Coast estuaries based on the distribution of fishes. *J. Biogeography* 19: 251–267.

Monaco, M.E., D.M. Nelson, R.L. Emmett, and S.A. Hinton. 1990. Distribution and abundance of fishes and invertebrates in West Coast estuaries, Volume I : Data summaries. ELMR Rep. No. 4. NOAA/NOS SEA Division, Silver Spring, MD.

Murdy, E., R. Birdsong, and J. Musick. 1997. Fishes of the Chesapeake. Smithsonian Institution.

National Marine Fisheries Service (NMFS). 2004. Annual Report to Congress on the Status of U.S. Fisheries – 2003. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service (NMFS). 1998a. Essential Fish Habitat: New Marine Fish Habitat Conservation Mandate for Federal Agencies. A Primer for Federal Agencies. National Marine Fisheries Service, Habitat Conservation Division, Northeast Regional Office. Available: http://www.nero.noaa.gov/hcd/finprim.pdf.

National Marine Fisheries Service (NMFS). 1998b. Essential Fish Habitat: New Marine Fish Habitat Conservation Mandate for Federal Agencies. A Primer for Federal Agencies. National Marine Fisheries Service, Habitat Conservation Division, Southwest Regional Office. Available: http://swr.nmfs.noaa.gov/hcd/efhprim.htm.

National Marine Fisheries Service (NMFS). 2005. Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska. National Marine Fisheries Service, Alaska Region. Juneau, Alaska.

National Marine Fisheries Service (NMFS). Office of Science and Technology, Marine Recreational Fishery Statistics Survey (MRFSS) Data User's Manual. Available: http://www.st.nmfs.gov/st1/recreational/pubs/data_users/index.html.

National Marine Fisheries Service (NMFS). In Prep. Our Living Oceans: The Status of Habitats of U.S. Living Marine Resources, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-75.

National Ocean Service (NOS). 2004. Population Trends Along the Coastal United States: 1980 – 2008. Coastal Trends Report Series. Management and Budget Office, Special Projects.

National Research Council (NRC). 1997. Striking a Balance: Improving Stewardship of Marine Areas. National Academy Press, Washington, DC.

Nelson, D.M., and M.E. Monaco. 2000. National Overview and Evolution of NOAA's Estuarine Living Marine Resources (ELMR) Program. NOAA Tech. Memo. NOS NCCOS CCMA 144. Silver Spring, MD: NOAA, NOS, Center for Coastal Monitoring and Assessment.

Nelson, D.M., M.E. Monaco, C.D. Williams, T.E. Czapla, M.E. Pattillo, L.C. Clements, L.R. Settle, and E.A. Irlandi. 1991. Distribution and abundance of fishes and invertebrates in southeast estuaries. ELMR Rep. No. 9. NOAA/NOS SEA Division, Rockville, MD.

Nelson, D.M. (ed.), M.E. Monaco, C.D. Williams, T.E. Czapla, M.E. Pattillo, L.C. Clements, L.R. Settle, and E.A. Irlandi. 1992. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Volume I: Data summaries. ELMR Rep. No. 10. NOAA/NOS SEA Division, Rockville, MD.

Nelson, J.S., E.J. Crossman, H. Espinosa-Pérez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. 6th edition. American Fisheries Society, Special Publication 29, Bethesda, Maryland.

New England Fishery Management Council (NEFMC). 2005a. Atlantic Herring Fishery Management Plan (draft Amendment 1). Newburyport, Massachusetts.

New England Fishery Management Council (NEFMC). 1988. Atlantic Salmon Fishery Management Plan. Newburyport, Massachusetts.

New England Fishery Management Council (NEFMC). 2003a. Atlantic Sea Scallop Fishery Management Plan. Newburyport, Massachusetts.

New England Fishery Management Council (NEFMC). 2002. Deep Sea Red Crab Fishery Management Plan. Newburyport, Massachusetts.

New England Fishery Management Council (NEFMC). 1998. Final Amendment #11 to the Northeast Multispecies Fishery Management Plan, Amendment #9 to the Atlantic Sea Scallop Fishery Management Plan, Amendment #1 to the Monkfish Fishery Management

Plan, Amendment #1 to the Atlantic Salmon Fishery Management Plan, and Components of the proposed Atlantic Herring Fishery Management Plan for Essential Fish Habitat (EFH Omnibus Amendment). Newburyport, Massachusetts.
New England Fishery Management Council (NEFMC). 2003b. Northeast Multispecies Fishery Management Plan. Newburyport, Massachusetts.

New England Fishery Management Council (NEFMC). 2003c. Northeast Skate Complex Fishery Management Plan. Newburyport, Massachusetts.

Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden, and C.D. Woodroffe. 2007. Coastal systems and low-lying areas. In: *Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (Eds.). Cambridge University Press, Cambridge, UK, 315-356.

Northeast Regional Office Habitat Conservation Division. Guide to Essential Fish Habitat Descriptions in the Northeastern United States. Available: http://www.nero.noaa.gov/hcd/list.htm

North Pacific Fishery Management Council (NPFMC). 1998. Fishery Management Plan for Bering Sea and Aleutian Islands King and Tanner Crabs. Anchorage, Alaska.

North Pacific Fishery Management Council (NPFMC). 2005a. Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area. Anchorage, Alaska.

North Pacific Fishery Management Council (NPFMC). 2005b. Fishery Management Plan for Groundfish of the Gulf of Alaska. Anchorage, Alaska.

North Pacific Fishery Management Council (NPFMC). 1990. Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska. Anchorage, Alaska.

North Pacific Fishery Management Council (NPFMC). 2004. Fishery Management Plan for the Scallop Fishery off Alaska. Anchorage, Alaska.

O'Connor, T. and D. Whitall. 2007. Linking hypoxia to shrimp catch in the northern Gulf of Mexico. *Mar. Poll. Bull.* 54(4): 460-63.

Olsen, S., D. Robadue, and V. Lee. 1980. An Interpretive Atlas of Narragansett Bay. Coastal Resources Center, University of Rhode Island Marine Bulletin 40.

Pacific Fishery Management Council (PFMC). 2005a. Coastal Pelagic Species Fishery Management Plan. Portland, Oregon.

Pacific Fishery Management Council (PFMC). 2004. Pacific Coast Groundfish Fishery Management Plan. Portland, Oregon.

Pacific Fishery Management Council (PFMC). 2005b. Pacific Coast Groundfish Fishery Management Plan: Essential Fish Habitat Designation and Minimization of Adverse Impacts. Draft Environmental Impact Statement. Prepared by the National Marine Fisheries Service Northwest Region, Seattle, Washington.

Pacific Fishery Management Council (PFMC). 2003. Pacific Coast Salmon Fishery Management Plan. Portland, Oregon.

Pacific States Marine Fisheries Commission (PSMFC). 2007. Anadromous Fish Life History Profiles. Available: http://www.psmfc.org/habitat/edu_anad_table.html

Packer, D.B. (ed.). 1999-2005. Essential Fish Habitat Species Source Documents. NOAA Technical Memorandum NMFS-NE Series.

NMFS-NE-123: American Plaice, *Hippoglossoides platessoides*, Life History and Habitat Characteristics. By: D.L. Johnson, P.L. Berrien, W.W. Morse, and J.J. Vitaliano. 1999.

NMFS-NE-124: Atlantic Cod, *Gadus morhua*, Life History and Habitat Characteristics. By: M.P. Fahay, P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999.

NMFS-NE-125: Atlantic Halibut, *Hippoglossus hippoglossus*, Life History and Habitat Characteristics. By: L.M. Cargnelli, S.J. Griesbach, and W.W. Morse. 1999.

NMFS-NE-128: Haddock, *Melanogrammus aeglefinus*, Life History and Habitat Characteristics. By: L.M. Cargnelli, S.J. Griesbach, P.L. Berrien, W.W. Morse, and D.L. Johnson. 1999.

NMFS-NE-129: Ocean Pout, *Macrozoarces americanus*, Life History and Habitat Characteristics. By: F.W. Steimle, W.W. Morse, P.L. Berrien, D.L. Johnson, and C.A. Zetlin. 1999.

NMFS-NE-130: Offshore Hake, *Merluccius albidus*, Life History and Habitat Characteristics. By: S. Chang, P.L. Berrien, D.L. Johnson, and C.A. Zetlin. 1999.

NMFS-NE-131: Pollock, *Pollachius virens*, Life History and Habitat Characteristics. By: L.M. Cargnelli, S.J. Griesbach, D.B. Packer, P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999.

NMFS-NE-132: Redfish, *Sebastes* sp., Life History and Habitat Characteristics. By: R.A. Pikanowski, W.W. Morse, P.L. Berrien, D.L. Johnson, and D.G. McMillan. 1999.

NMFS-NE-133: Red Hake, *Urophycis chuss*, Life History and Habitat Characteristics. By: F.W. Steimle, W.W. Morse, P.L. Berrien, and D.L. Johnson. 1999.

NMFS-NE-136: White Hake, *Urophycis tenuis*, Life History and Habitat Characteristics. By: S. Chang, W.W. Morse, and P.L. Berrien. 1999.

NMFS-NE-137: Windowpane, *Scophthalmus aquosus*, Life History and Habitat Characteristics. By: S. Chang, P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999.

NMFS-NE-138: Winter Flounder, *Pseudopleuronectes americanus*, Life History and Habitat Characteristics. By: J.J. Pereira[1], R. Goldberg, J.J. Ziskowski, P.L. Berrien, W.W. Morse, and D.L. Johnson. 1999.

NMFS-NE-139: Witch Flounder, *Glyptocephalus cynoglossus*, Life History and Habitat Characteristics. By: L.M. Cargnelli, S.J. Griesbach, D.B. Packer, P.L. Berrien, W.W. Morse, and D.L. Johnson. 1999.

NMFS-NE-140: Yellowtail Flounder, *Limanda ferruginea*, Life History and Habitat Characteristics. By: Donna L. Johnson, Wallace W. Morse, Peter L. Berrien, and Joseph J. Vitaliano. 1999.

NMFS-NE-163: Red Deepsea Crab, *Chaceon (Geryon) quinquedens*, Life History and Habitat Characteristics. By: F.W. Steimle, C.A. Zetlin, and S. Chang. 2002.

NMFS-NE-173: Barndoor Skate, *Dipturus laevis*, Life History and Habitat Characteristics By: D.B. Packer, C.A. Zetlin, and J.J. Vitaliano. 2003.

NMFS-NE-174: Clearnose Skate, *Raja eglanteria*, Life History and Habitat Characteristics. By: D.B. Packer, C.A. Zetlin, and J.J. Vitaliano. 2003.

NMFS-NE-175: Little Skate, *Leucoraja erinacea*, Life History and Habitat Characteristics. By: D.B. Packer, C.A. Zetlin, and J.J. Vitaliano. 2003.

NMFS-NE-176: Rosette Skate, *Leucoraja garmani virginica*, Life History and Habitat Characteristics. By: D.B. Packer, C.A. Zetlin, and J.J. Vitaliano. 2003.

NMFS-NE-177: Smooth Skate, *Malacoraja senta*, Life History and Habitat Characteristics. By: D.B. Packer, C.A. Zetlin, and J.J. Vitaliano. 2003.

NMFS-NE-178: Thorny Skate, *Amblyraja radiata*, Life History and Habitat Characteristics. By: D.B. Packer, C.A. Zetlin, and J.J. Vitaliano. 2003.

NMFS-NE-179: Winter Skate, *Leucoraja ocellata*, Life History and Habitat Characteristics. By: D.B. Packer, C.A. Zetlin, and J.J. Vitaliano. 2003.

NMFS-NE-186: Silver Hake, *Merluccius bilinearis*, Life History and Habitat Characteristics. By: M.C. Lock and D.B. Packer. 2004.

NMFS-NE-189: Sea Scallop, *Placopecten magellanicus*, Life History and Habitat Characteristics. By: D.R. Hart and A.S. Chute. 2004.

NMFS-NE-192: Atlantic Herring, *Clupea harengus*, Life History and Habitat Characteristics. By: D.K. Stevenson and M.L. Scott. 2005.

Paperno, R., K.J. Mille, and E. Kadison. 2001. Patterns in species composition of fish and selected invertebrate assemblages in estuarine subregions near Ponce de Leon Inlet, Florida. *Est., Coast. and Shelf Sci.* 52: 117–130.

Paperno, R. and R.B. Brodie. 2004. Effects of environmental variables upon the spatial and temporal structure of a fish community in a small, freshwater tributary of the Indian River Lagoon, Florida. *Est., Coast. and Shelf Sci.* 61: 229–241.

Pattillo, M.E., T.E. Czapla, D.M. Nelson, and M.E. Monaco. 1997. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Volume II: Species life history summaries. ELMR Rep. No. 11. NOAA/NOS SEA Division, Silver Spring, MD.

Pearcy, W.G., and S.S. Myers. 1974. Larval fishes of Yaquina Bay, Oregon: A nursery ground for marine fishes? *Fish. Bull.* 72(1): 201–213.

Pearcy, W.G. and S.W. Richards. 1962. Distribution and ecology of fishes of the Mystic River Estuary, Connecticut. *Ecology* 43(2): 248–259.

Phelan, B. 2007. Chief, Behavior Ecology Branch, National Marine Fisheries Service, Northeast Fisheries Science Center, Highlands, NJ. Personal communication via memorandum dated July 2, 2007.

Pinnix, W.D., T.A. Shaw, K.C. Acker, and N.J. Hetrick. 2005. Fish communities in eelgrass, oyster culture, and mudflat habitats of North Humboldt Bay, California. U.S. Fish and Wildlife Service Final Report. August 2005. Arcata Fisheries Technical Report Number TR2005-02.

Rakocinski, C.F., J. Lyczkowski-Shultz, and S.L. Richardson. 1996. Ichthyoplankton assemblage structure in Mississippi Sound as revealed by canonical correspondence analysis. *Est., Coast. and Shelf Sci.* 43: 237–257.

Recksiek, C.W. and J.D. McCleave. 1973. Distribution of pelagic fishes in the Sheepscot River-Back River Estuary, Wiscasset, Maine. *Trans. Amer. Fish. Soc.* 3: 541–551.

Robards, M.D., J.F. Piatt, A.B. Kettle, and A.A. Abookire. 1999. Temporal and geographic variation in fish communities of lower Cook Inlet, Alaska. *Fish. Bull.* 97(4): 962–977.

Rountree, R.A., and K.W. Able. 1992. Fauna of polyhaline subtidal marsh creeks in southern New Jersey: Composition, abundance, and biomass. *Estuaries* 15(2): 171–185.

Rountree, R.A., and K.W. Able. 1993. Diel variation in decapod crustacean and fish assemblages in New Jersey polyhaline marsh creeks. *Est., Coast. and Shelf Sci.* 37: 181–201.

Rozas, L.P. and C.T. Hackney. 1984. Use of oligohaline marshes by fishes and macrofaunal crustaceans in North Carolina. *Estuaries* 7(3): 213–224.

Rozas, L.P. and T.J. Minello. 1998. Nekton use of salt marsh, seagrass, and nonvegetated habitats in a south Texas (USA) estuary. *Bull. Mar. Sci.* 63(3): 481–501.

Sheridan, P.F. 1992. Comparative habitat utilization by estuarine macrofauna within the mangrove ecosystem of Rookery Bay, Florida. *Bull. Mar. Sci.* 50(1): 21–39.

Short, F.T., D.M. Burdick, C.A. Short, R.C. Davis, and P.A. Morgan. 2000. Developing success criteria for restored eelgrass, salt marsh, and mud flat habitats. *Ecol. Engineering* 15: 239–252.

Sogard, S.M., G.V.N. Powell, and J.G. Holmquist. 1989. Utilization by fishes of shallow, seagrass-covered banks in Florida Bay: 2. Diel and tidal patterns. Env. Biol. Fish. 24(2): 81–92.

South Atlantic Fishery Management Council (SAFMC). 2000. Final Amendment 12 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. Charleston, South Carolina.

South Atlantic Fishery Management Council (SAFMC). 1998. Final Habitat Plan for the South Atlantic Region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. Charleston, South Carolina.

South Atlantic Fishery Management Council (SAFMC). 2003. Fishery Management Plan for the Dolphin and Wahoo Fishery of the Atlantic. Charleston, South Carolina.

Stedman, S.M., and Dahl, T.E. 2008. Coastal Watersheds of the eastern United States: Status and Trends of Wetlands. (In press at *National Wetland Newsletter* by Environmental Law Institute).

Stone, S.L., T.A. Lowery, J.D. Field, S.H. Jury, D.M. Nelson, M.E. Monaco, C.D. Williams, and L.A. Andreasen. 1994. Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. ELMR Rep. No. 12. NOAA/NOS SEA Division, Silver Spring, MD. 280 p.

Subrahmanyam, C.B., and C.L. Coultas. 1980. Studies on the animal communities in two north Florida salt marshes. Part III: Seasonal fluctuations of fish and macroinvertebrates. *Bull. Mar. Sci.* 30(4): 790–818.

Szedlmayer, S.T., and K.W. Able. 1996. Patterns of seasonal availability and habitat use by fishes and decapod crustaceans in a southern New Jersey estuary. *Estuaries* 19(3): 697–709.

Thayer, G.W., T.A. McTigue, R.J. Salz, D.H. Merkey, F.M. Burrows, and P.F. Gayaldo, (eds.). 2005. Science-Based Restoration Monitoring of Coastal Habitats, Volume Two: Tools for Monitoring Coastal Habitats. NOAA Coastal Ocean Program Decision Analysis Series No. 23. NOAA National Centers for Coastal Ocean Science, Silver Spring, MD. 628 pp. plus appendices.

Tremain, D.M., and D.H. Adams. 1995. Seasonal variations in species diversity, abundance, and composition of fish communities in the northern Indian River Lagoon, Florida. *Bull. Mar. Sci.* 57(1): 171–192.

Turgeon, D.D., A.E. Bogan, E.V. Coan, W.K. Emerson, W.G. Lyons, W.L. Pratt, C.F.E. Roper, A. Scheltema, F.G. Thompson, and J.D. Williams. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. American Fisheries Society, Special Publication 16, Bethesda, Maryland.

Van Voorhees, D. 2007. Fisheries of the United States, 2005. Current Fishery Statistics No. 2005. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics Division, Silver Spring, Maryland.

Van Voorhees, D. and E.S. Pritchard (ed.). 2003. Fisheries of the United States, 2002. Current Fishery Statistics No. 2002. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics and Economics Division, Silver Spring, Maryland.

Van Voorhees, D. and E.S. Pritchard (ed.). 2004. Fisheries of the United States, 2003. Current Fishery Statistics No. 2003. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics Division, Silver Spring, Maryland.

Van Voorhees, D. and E.S. Pritchard (ed.). 2005. Fisheries of the United States, 2004. Current Fishery Statistics No. 2004. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics Division, Silver Spring, Maryland.

Van Voorhees, D. and E.S. Pritchard (ed.). 2007. Fisheries of the United States, 2006. Current Fishery Statistics No. 2006. National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics Division, Silver Spring, Maryland.
Wagner, C.M. 1999. Expression of the estuarine species minimum in littoral fish assemblages of the lower Chesapeake Bay tributaries. *Estuaries* 22(2A): 304–312.

Weinstein, M.P. 1979. Shallow marsh habitats as primary nurseries for fishes and shellfish, Cape Fear River, North Carolina. *Fish. Bull.* 77(2): 339–357.

Weinstein, M.P. and H.A. Brooks. 1983. Comparative ecology of nekton residing in a tidal creek and adjacent seagrass meadow: community composition and structure. *Mar. Ecol. Prog. Ser.* 12: 15–27.

Western Pacific Fishery Management Council (WPFMC). 2005a. Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region: 2004 Annual Report. Honolulu, Hawai'i.

Western Pacific Fishery Management Council (WPFMC). 2004. EFH/HAPC Designations for Fishery Management Units Covered Under the Bottomfish, Crustacean, Pelagic, Precious Corals and Coral Reef Ecosystem Fishery Management Plans. Honolulu, Hawaii.

Western Pacific Fishery Management Council (WPFMC). 2001. Final Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region. Volume III: Essential Fish Habitat for Management Unit Species.

Western Pacific Fishery Management Council (WPFMC). 2005b. Pelagic Fisheries of the Western Pacific Region: 2004 Annual Report. Honolulu, Hawaii.

Western Pacific Fishery Management Council (WPFMC). 2005c. Western Pacific Bottomfish and Seamount Groundfish Fishery Management Plan. Honolulu, Hawaii.

Western Pacific Fishery Management Council (WPFMC). 1995. Western Pacific Crustaceans Fishery Management Plan. Honolulu, Hawaii.

Western Pacific Fishery Management Council (WPFMC). 2003. Western Pacific Pelagics Fishery Management Plan. Honolulu, Hawaii.

Western Pacific Fishery Management Council (WPFMC). 2005d. Western Pacific Precious Corals Fishery Management Plan. Honolulu, Hawaii.

Williams, A.B., L.G. Abele, D.L. Felder, H.H. Hobbs, Jr., R.B. Manning, P.A. McLaughlin, and I. Perez Farfante. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. American Fisheries Society, Special Publication 17, Bethesda, Maryland.

Yoklavich, M.M., G.M. Cailliet, J.P. Barry, D.A. Ambrose, and B.S. Antrim. 1991. Temporal and spatial patterns in abundance and diversity of fish assemblages in Elkhorn Slough, California. *Estuaries* 14(4): 465–480.

Yoklavich, M.M., M. Stevenson, and G.M. Cailliet. 1992. Seasonal and spatial patterns of ichthyoplankton abundance in Elkhorn Slough, California. *Est., Coast. and Shelf Sci.* 34: 109–126.

Zimmerman, R.J. and T.J. Minello. 1984. Densities of *Penaeus aztecus*, *Penaeus* setiferus, and other natant macrofauna in a Texas salt marsh. *Estuaries* 7(4A): 421–433.

Zimmerman, R. J., T. J. Minello, and L. P. Rozas. 2000. Salt marsh linkages to productivity of penaeid shrimps and blue crabs in the northern Gulf of Mexico. Pages 293-314 in M. P. Weinstein and D. A. Kreeger, editors. Concepts and controversies in tidal marsh ecology. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Zimmerman, R.J. and L.M. Nance. 2001. Effects of hypoxia on the shrimp fishery of Louisiana and Texas. Pages 293-310 in N.N. Rabalais and R.E. Turner, editors. Coastal Hypoxia: Consequences for Living Resources and Ecosystems. American Geophysical Union, Washington, DC.

Zimmerman, R.J., J. Nance, and R. Hart. 2007. Correlative Relationship of Annual Brown Shrimp Catch to Nursery and Hypoxia Areas in the Northwestern Gulf of Mexico. A presentation/abstract given at the "Ecological Impacts of Hypoxia on Living Resources Workshop," convened by NMFS, Bay St. Louis, Mississippi, March 26-27, 2007.

Appendix A: Regional Estuarine Commercial Landings and Recreational Harvest, 2000-2004.

Note: Percent values stated in the tables below are based on total regional catch (i.e., estuarine plus non-estuarine landings).

Table A-1. Top Commercial Estuarine Species in the *North Atlantic Region*, and the Species' Proportion of Regional Commercial Landings, 2000–2004.

Rank	Species	Commercial Landings **by Weight in Pounds**	Percent of Species in Total North Atlantic Commercial Landings	Species	Commercial Landings **by Dollar**	Percent of Species in Total North Atlantic Commercial Landings
1	Atlantic herring, *Clupea harengus*	893,400,666	22%	American lobster, *Homarus americanus*	$1,506,329,372	35%
2	American lobster, *Homarus americanus*	401,073,843	10%	Scallops	$777,128,945	18%
3	Mackerel	273,257,340	7%	Clams	$283,202,629	7%
4	Flatfish	206,858,066	5%	Flatfish	$233,276,319	5%
5	Scallops	175,380,329	4%	Atlantic cod, *Gadus morhua*	$138,483,283	3%
6	Hakes	161,892,345	4%	Crabs	$97,957,868	2%
7	Skates, Rajidae	153,958,516	4%	Longfinned squid, *Loligo pealeii*	$97,048,583	2%
8	Longfinned squid, *Loligo pealeii*	142,843,071	3%	Haddock, *Melanogrammus aeglefinus*	$80,558,224	2%
9	Crabs	141,280,374	3%	Hakes	$76,166,683	2%
10	Atlantic cod, *Gadus morhua*	126,921,685	3%	Atlantic herring, *Clupea harengus*	$61,087,525	1%

Table A-2. Top Commercial Estuarine Species in the *Chesapeake Region (Maryland, Virginia, Chesapeake Bay)*, and the Species' Proportion of Regional Commercial Landings, 2000–2004.

Rank	Species	Commercial Landings **by Weight in Pounds**	Percent of Species in Total Chesapeake Commercial Landings	Species	Commercial Landings **by Dollar**	Percent of Species in Total Chesapeake Commercial Landings
1	Atlantic menhaden, *Brevoortia* spp.	2,014,789,393	77%	Sea scallops, *Placopecten magellanicus*	$305,056,625	34%
2	Crabs	271,961,143	10%	Crabs	$284,412,031	31%
3	Sea scallops, *Placopecten magellanicus*	75,358,794	3%	Atlantic menhaden, *Brevoortia* spp.	$124,090,681	14%
4	Atlantic croaker, *Micropogonias undulatus*	67,271,119	3%	Clams	$44,057,740	5%
5	Clams	47,333,987	2%	Striped bass, *Morone saxatillis*	$33,266,508	4%
6				Atlantic croaker, *Micropogonias undulatus*	$21,458,950	2%
7				Flatfish	$21,348,414	2%
8				Eastern oyster, *Crassostrea virginica*	$15,866,136	2%
9				Spot, *Leiostomus xanthurus*	$9,165,347	1%

Table A-3. Top Commercial Estuarine Species in the *South Atlantic Region*, and the Species' Proportion of Regional Commercial Landings, 2000–2004.

Rank	Estuarine Species	Commercial Landings **by Weight in Pounds**	Percent of Species in Total South Atlantic Commercial Landings	Estuarine Species	Commercial Landings **by Dollar**	Percent of Species in Total South Atlantic Commercial Landings
1	Atlantic menhaden, *Brevoortia* spp.	281,310,175	27%	Shrimps	$242,424,198	28%
2	Crabs	238,174,969	23%	Crabs	$217,839,145	25%
3	Shrimps	111,078,085	11%	Flatfish	$56,032,220	6%
4	Atlantic croaker, *Micropogonias undulatus*	58,847,005	6%	Clams	$34,734,401	4%
5	Flatfish	34,433,725	3%	Mackerels	$32,241,612	4%
6	Mackerels	28,963,451	3%	Atlantic croaker, *Micropogonias undulatus*	$15,848,278	2%
7	Mullets	18,661,141	2%	Eastern oyster, *Crassostrea virginica*	$11,712,989	1%
8	Bluefish	17,567,745	2%	Groupers	$11,185,308	1%
9	Sharks	16,747,978	2%	Caribbean spiny lobster, *Panulirus argus*	$10,863,870	1%
10	Shads	15,438,802	1%	Atlantic menhaden, *Brevoortia* spp.	$10,603,354	1%

Table A-4. Top Commercial Estuarine Species in the *Gulf of Mexico Region*, and the Species' Proportion of Regional Commercial Landings, 2000–2004.

Rank	Estuarine Species	Commercial Landings **by Weight in Pounds**	Percent of Species in Total Gulf of Mexico Commercial Landings	Estuarine Species	Commercial Landings **by Dollar**	Percent of Species in Total Gulf of Mexico Commercial Landings
1	Atlantic menhaden, *Brevoortia* spp.	5,927,791,398	72%	Shrimps	$2,234,807,705	58%
2	Shrimps	1,245,882,147	15%	Atlantic menhaden, *Brevoortia* spp.	$345,964,149	9%
3	Crabs	344,988,171	4%	Crabs	$343,724,125	9%
4	Eastern oyster, *Crassostrea virginica*	127,561,567	2%	Eastern oyster, *Crassostrea virginica*	$278,713,663	7%
5				Groupers	$106,386,804	3%
6				Caribbean spiny lobster, *Panulirus argus*	$96,858,643	3%
7				Mullets	$47,846,496	1%

Table A-5. Top Commercial Estuarine Species in *Alaska*, and the Species' Proportion of Regional Commercial Landings, 2000–2004.

Rank	Estuarine Species	Commercial Landings **by Weight in Pounds**	Percent of Species in Total Alaska Commercial Landings	Estuarine Species	Commercial Landings **by Dollar**	Percent of Species in Total Alaska Commercial Landings
1	Salmon, *Oncorhynchus* spp.	3,144,546,334	12%	Salmon, *Oncorhynchus* spp.	$958,486,013	20%
2	Pacific herring, *Clupea pallasii*	362,448,750	1%	Crabs	$462,638,794	10%
3				Pacific herring, *Clupea pallasii*	$51,772,685	1%

Table A-6. Top Commercial Estuarine Species in *California*, and the Species' Proportion of Regional Commercial Landings, 2000–2004.

Rank	Estuarine Species	Commercial Landings **by Weight in Pounds**	Percent of Species in Total California Commercial Landings	Estuarine Species	Commercial Landings **by Dollar**	Percent of Species in Total California Commercial Landings
1	Pacific sardine, *Sardinops sagax*	535,008,038	28%	Crabs	$120,224,812	20%
2	Northern anchovy, *Engraulis mordax*	97,310,175	5%	Chinook salmon, *Oncorhynchus tshawytscha*	$52,520,082	9%
3	Chub mackerel, *Scomber japonicus*	87,683,144	5%	Pacific oyster, *Crassostrea gigas*	$28,337,861	5%
4	Crabs	70,878,570	4%	Pacific sardine, *Sardinops sagax*	$24,428,578	4%
5	Pacific hake, *Merluccius productus*	36,184,816	2%	Spot shrimp, *Pandalus platyceros*	$14,705,798	2%
6	Pacific herring, *Clupea pallasii*	28,770,499	2%	California halibut, *Paralichthys californicus*	$13,597,509	2%
7	Chinook salmon, *Oncorhynchus tshawytscha*	28,740,843	2%	Pacific herring, *Clupea pallasii*	$9,247,143	2%
8	Jack mackerel, *Trachurus symmetricus*	15,611,861	1%	Chub mackerel, *Scomber japonicus*	$5,694,296	1%
9				Northern anchovy, *Engraulis mordax*	$4,335,008	1%
10				Cabezon, *Scorpaenichthys marmoratus*	$3,253,557	1%

Table A-7. Top Commercial Estuarine Species in the *Pacific Northwest Region*, and the Species' Proportion of Regional Commercial Landings, 2000–2004.

Rank	Estuarine Species	Commercial Landings **by Weight in Pounds**	Percent of Species in Total Pacific Northwest Commercial Landings	Estuarine Species	Commercial Landings **by Dollar**	Percent of Species in Total Pacific Northwest Commercial Landings
1	Pacific hake (whiting), *Merluccius productus*	738,037,664	36%	Crabs	$341,905,683	30%
2	Pacific sardine, *Sardinops sagax*	350,629,447	17%	Clams	$172,204,993	15%
3	Crabs	191,481,027	9%	Oysters	$134,372,842	12%
4	Salmon, *Oncorhynchus spp.*	140,789,328	7%	Salmon, *Oncorhynchus spp.*	$96,816,408	8%
5	Oysters	47,495,680	2%	Pacific hake (whiting), *Merluccius productus*	$29,001,033	3%
6	Clams	14,216,479	1%	Pacific sardine, *Sardinops sagax*	$19,927,498	2%
7	English sole, *Pleuronectes vetulus*	10,616,544	1%	Blue mussel, *Mytilus edulis*	$16,941,173	1%
8				Penaeid shrimp	$9,170,896	1%

Note: The Hawaiian Islands region does not have a table listing the top commercial estuarine species and their proportion of regional landings. Only one species group (snappers) comprised more than 1% of total regional landings. The snapper species group comprised approximately 1% by weight and 2% by dollar value of the total regional Hawaiian commercial landings.

Table A-8. Top 10 Estuarine Species Recreationally Harvested, *North Atlantic Region*, 2000–2004.

Rank	Species	Recreational Harvest **by weight in pounds**	Percent of **Regional Recreational Harvest**
1	Striped bass, *Morone saxatilis*	33,139,976	25%
2	Atlantic cod, *Gadus morhua*	25,921,409	19%
3	Bluefish, *Pomatomus saltatrix*	21,407,821	16%
4	Scup, *Stenotomus chrysops*	13,718,374	10%
5	Atlantic mackerel, *Scomber scombrus*	11,579,824	9%
6	Summer flounder, *Paralichthys dentatus*	10,148,820	8%
7	Tautog, *Tautoga onitis*	5,130,690	4%
8	Pollock, *Pollachius virens*	3,768,276	3%
9	Haddock, *Melanogrammus aeglefinus*	1,954,409	1%
10	Black sea bass, *Centropristis striata*	1,686,562	1%

Table A-9. Top 10 Estuarine Species Recreationally Harvested, *Mid-Atlantic Region*, 2000–2004.

Rank	Species	Recreational Harvest **by weight in pounds**	Percent of **Regional Recreational Harvest**
1	Striped bass, *Morone saxatilis*	62,694,918	21%
2	Summer flounder, *Paralichthys dentatus*	47,005,992	16%
3	Atlantic croaker, *Micropogonias undulatus*	45,227,481	15%
4	Bluefish, *Pomatomus saltatrix*	32,946,909	11%
5	Black sea bass, *Centropristis striata*	14,957,201	5%
6	Tautog, *Tautoga onitis*	12,523,494	4%
7	Scup, *Stenotomus chrysops*	12,499,022	4%
8	Weakfish, *Cynoscion regalis*	9,504,524	3%
9	Spot, *Leiostomus xanthurus*	8,062,665	3%
10	Winter flounder, *Pleuronectes americanus*	4,519,664	2%

Table A-10. Top 10 Estuarine Species Recreationally Harvested, *South Atlantic Region*, 2000–2004.

Rank	Species	Recreational Harvest **by weight in pounds**	Percent of **Regional Recreational Harvest**
1	King mackerel, *Scomberomorus cavalla*	24,507,215	9%
2	Striped bass, *Morone saxatilis*	9,638,872	4%
3	Bluefish, *Pomatomus saltatrix*	9,190,779	3%
4	Spanish mackerel, *Scomberomorus maculatus*	8,660,415	3%
5	Spot, *Leiostomus xanthurus*	8,629,993	3%
6	Sheepshead, *Archosargus probatocephalus*	8,359,797	3%
7	Red drum, *Sciaenops ocellatus*	6,865,989	3%
8	Spotted seatrout, *Cynoscion nebulosus*	6,432,834	2%
9	Southern kingfish, *Menticirrhus americanus*	6,227,888	2%
10	Black drum, *Pogonias cromis*	5,765,700	2%

Table A-11. Top 10 Estuarine Species Recreationally Harvested, *Gulf of Mexico Region*, 2000–2004.

Rank	Species	Recreational Harvest **by weight in pounds**	Percent of **Regional Recreational Harvest**
1	Red drum, *Sciaenops ocellatus*	66,669,935	17%
2	Spotted seatrout, *Cynoscion nebulosus*	60,738,352	16%
3	Sheepshead, *Archosargus probatocephalus*	23,034,894	6%
4	Gag grouper, *Mycteroperca microlepis*	20,312,030	5%
5	Spanish mackerel, *Scomberomorus maculatus*	15,255,132	4%
6	Black drum, *Pogonias cromis*	14,059,012	4%
7	King mackerel, *Scomberomorus cavalla*	13,846,739	4%
8	Pinfish, *Lagodon rhomboides*	10,686,977	3%
9	Red grouper, *Epinephelus morio*	9,956,168	3%
10	White grunt, *Haemulon plumieri*	9,597,316	3%

Table A-12. Top 10 Estuarine Species Recreationally Harvested, *Caribbean Region*, 2000–2004.

Rank	Species	Recreational Harvest **by weight in pounds**	Percent of **Regional Recreational Harvest**
1	Great barracuda, *Sphyraena barracuda*	486,407	3%
2	Crevalle jack, *Caranx hippos*	279,259	2%
3	King mackerel, *Scomberomorus cavalla*	229,373	1%
4	Mutton snapper, *Lutjanus analis*	218,692	1%
5	Yellowtail snapper, *Ocyurus chrysurus*	175,554	1%
6	Common snook, *Centropomus undecimalis*	166,501	1%
7	Red hind, *Epinephelus guttatus*	165,261	1%
8	Lane snapper, *Lutjanus synagris*	163,517	1%
9	Tripletail, *Lobotes surinamensis*	163,037	1%
10	Blue runner, *Caranx crysos*	105,702	<1%

Table A-13. Top 10 Estuarine Species Recreationally Harvested, *California*, 2000–2002.

Rank	Species	Recreational Harvest **by weight in pounds**	Percent of **Regional Recreational Harvest**
1	Chinook salmon, *Oncorhynchus tshawytscha*	10,614,047	15%
2	Barred sand bass, *Paralabrax nebulifer*	5,874,388	9%
3	California halibut, *Paralichthys californicus*	4,797,558	7%
4	Lingcod, *Ophiodon elongatus*	2,509,265	4%
5	Pacific chub mackerel, *Scomber japonicus*	2,456,656	4%
6	Kelp bass, *Paralabrax clathratus*	2,300,158	3%
7	White sea bass, *Atractoscion nobilis*	1,500,992	2%
8	Striped bass, *Morone saxatilis*	1,243,996	2%
9	Pacific sand dab, *Citharichthys sordidus*	1,106,409	2%
10	California scorpionfish, *Scorpaena guttata*	882,504	1%

Table A-14. Top Ten Estuarine Species Recreationally Harvested, *Pacific Northwest Region*, 2000–2002.

Rank	Species	Recreational Harvest **by weight in pounds**	Percent of **Regional Recreational Harvest**
1	Chinook salmon, *Oncorhynchus tshawytscha*	9,705,085	28%
2	Coho salmon, *Oncorhynchus kisutch*	7,701,774	22%
3	Lingcod, *Ophiodon elongatus*	2,001,383	6%
4	Chum salmon, *Oncorhynchus keta*	1,647,932	5%
5	Pink salmon, *Oncorhynchus gorbuscha*	1,132,957	3%
6	White sturgeon, *Acipenser transmontanus*	891,373	3%
7	Surf smelt, *Hypomesus pretiosus*	677,262	2%
8	Kelp greenling, *Hexagrammos decagrammus*	470,135	1%
9	Cabezon, *Scorpaenichthys marmoratus*	380,637	1%
10	Atlantic herring, *Clupea harengus*	374,023	1%

Appendix B: Nationwide List of Species that Use Estuaries for Any Stage of Their Lifecycle.

Common Name	Scientific Name	Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*	Capelin	*Mallotus villosus*
Amberjack	*Seriola sp.*	Carp, common	*Cyprinus carpio*
Amberjack, greater	*Seriola dumerili*	Catfish, blue	*Ictalurus furcatus*
Anchovies	*Engraulidae*	Catfish, channel	*Ictalurus punctatus*
Anchovy, bay	*Anchoa mitchilli*	Catfish, gafftopsail	*Bagre marinus*
Anchovy, deepbody	*Anchoa compressa*	Catfish, hardhead	*Arius felis*
Anchovy, northern	*Engraulis mordax*	Catfish, white	*Ameiurus catus*
Anchovy, slough	*Anchoa delicatissima*	Chubsucker, creek	*Erimyzon oblongus*
Anchovy, striped	*Anchoa hepsetus*	Chubsucker, lake	*Erimyzon sucetta*
Angelfish, gray	*Pomacanthus arcuatus*	Cisco, Arctic	*Coregonus autumnalis*
Arctic char	*Salvelinus alpinus*	Cisco, least	*Coregonus sardinella*
Barracuda, great	*Sphyraena barracuda*	Clam, Atlantic middleneck	*Mercenaria sp.*
Barracudas	*Spyraenidae*	Clam, Atlantic rangia	*Rangia cuneata*
Bass, kelp	*Paralabrax clathratus*	Clam, Atlantic topneck	*Mercenaria sp.*
Bass, largemouth	*Micropterus salmoides*	Clam, banded chione	*Chione californiensis*
Bass, rock	*Ambloplites rupestris*	Clam, butter	*Saxidomus gigantea*
Bass, smallmouth	*Micropterus dolomieu*	Clam, button	*Mercenaria species*
Bass, striped	*Morone saxatilis*	Clam, California jacknife	*Tagelus californianus*
Beaugregory	*Stegastes leucostictus*	Clam, frilled venus	*Chione undatella*
Bigmouth buffalo	*Ictiobus cyprinellus*	Clam, horseneck gaper	*Tresus capax*
Blenny, feather	*Hypsoblennius hentz*	Clam, manila	*Corbicula manilensis*
Blenny, Florida	*Chasmodes saburrae*	Clam, Pacific gaper	*Tresus nuttallii*
Blenny, freckled	*Hypsoblennius ionthas*	Clam, Pacific geoduck	*Panopea abrupta*
Blenny, Gossamer	*Omobranchus ferox*	Clam, Pacific littleneck	*Protothaca staminea*
Blenny, highfin	*Lupinoblennius nicholsi*	Clam, Pacific manila	*Tapes philippinarum*
Blenny, striped	*Chasmodes bosquianus*	Clam, Pacific razor	*Siliqua patula*
Blenny, tasseled	*Parablennius thysanius*	Clam, quahog	*Mercenaria mercenaria*
Bluefish	*Pomatomus saltatrix*	Clam, razor	*Siliqua sp.*
Bluegill	*Lepomis macrochirus*	Clam, rough-sided littleneck	*Protothaca laciniata*
Bonefish	*Albula vulpes*	Clam, smooth venus	*Chione fluctifraga*
Bonefish, longjaw	*Albula forsteri*	Clam, softshell	*Mya arenaria*
Bonefish, roundjaw	*Albula glossodonta*	Clam, Texas hard	*Mercenaria mercenaria texana*
Bream, sea	*Archosargus rhomboidalis*	Clam, thin-shelled littleneck	*Protothaca tenerrima*
Bullhead, black	*Ameiurus melas*	Clam, Washington	*Saxidomus nuttalli*
Bullhead, brown	*Ameiurus nebulosus*	Clams or bivalves	*Bivalvia*
Bullhead, yellow	*Ameiurus natalis*	Clingfish, kelp	*Rimicola muscarum*
Bumper, Atlantic	*Chloroscombrus chrysurus*	Cobia	*Rachycentrum canadum*
Burrfish, striped	*Chilomycterus schoepfi*	Cockle, nuttall	*Clinocardium nuttallii*
Butterfish	*Peprilus sp.*	Cockscomb, high	*Anoplarchus purpurescens*
Butterfish, Atlantic	*Peprilus triacanthus*	Cod, Arctic	*Boreogadus saida*
Butterfish, Gulf	*Peprilus burti*	Cod, Atlantic	*Gadus morhua*
Butterflyfish, banded	*Chaetodon striatus*	Corbina	*Menticirrhus undulatus*
Butterflyfish, foureye	*Chaetodon capistratus*	Cowfish, scrawled	*Acanthostracion quadricornis*
Butterflyfish, spotfin	*Chaetodon ocellatus*	Crab, Atlantic rock	*Cancer irroratus*
Cabezon	*Scorpaenichthys marmoratus*	Crab, blue	*Calliectes sapidus*

Common Name	Scientific Name	Common Name	Scientific Name
Crab, blue king	*Paralithodes platypus*	Eel, speckled worm	*Myrophis punctatus*
Crab, broadback mud	*Eurytium limosum*	Eel, whip	*Bascanichthys scuticaris*
Crab, cancer	*Cancer sp.*	Eulachon	*Thaleichthys pacificus*
Crab, dungeness	*Cancer magister*	Filefish, orange	*Aluterus schoepfi*
Crab, Florida stone	*Menippe mercenaria*	Filefish, planehead	*Monacanthus hispidus*
Crab, green	*Carcinus maenas*	Flagtail, Hawaiian	*Kuhlia sandvicensis; Kuhlia xenura*
Crab, green porcelain	*Petrolisthes armatus*	Flatfish	*Pleuronectiformes*
Crab, Gulf stone	*Menippe adina*	Flounder, fourspot	*Paralichthys oblongus*
Crab, hairy hermit	*Pagurus hirsutiusculus*	Flounder, fringed	*Etropus crossotus*
Crab, hermit	*Paguroidea*	Flounder, gray	*Etropus rimosus*
Crab, horseshoe	*Limulus polyphemus*	Flounder, Gulf	*Paralichthys albigutta*
Crab, jonah	*Cancer borealis*	Flounder, ocellated	*Ancylopsetta quadrocellata*
Crab, kelp	*Majidae*	Flounder, Pacific sanddab	*Citharichthys sordidus*
Crab, mangrove tree	*Aratus pisonii*	Flounder, smallmouth	*Etropus microstomus*
Crab, Pacific rock	*Cancer antennarius*	Flounder, smooth	*Pleuronectes putnami*
Crab, red king	*Paralithodes camtschaticus*	Flounder, southern (fluke)	*Paralichthys lethostigma*
Crab, red rock	*Cancer productus*	Flounder, speckled sanddab	*Citharichthys stigmaeus*
Crab, snow/tanner	*Chionoecetes sp.*	Flounder, starry	*Platichthys stellatus*
Crab, spider	*Majidae*	Flounder, summer	*Paralichthys dentatus*
Crab, tanner	*Chionoecetes bairdi*	Flounder, windowpane	*Scophthalmus aquosus*
Crab, triangle tanner	*Chionoecetes angulatus*	Flounder, winter	*Pleuronectes americanus*
Crabs	*Decapoda*	Flounder, yellowtail	*Pleuronectes ferrugineus*
Crappie, black	*Pomoxis nigromaculatus*	Flounders, righteye	*Pleuronectidae*
Crappie, white	*Pomoxis annularis*	Gag	*Mycteroperca microlepis*
Croaker, Atlantic	*Micropogonias undulatus*	Gar, longnose	*Lepisosteus osseus*
Croaker, white	*Genyonemus lineatus*	Gar, spotted	*Lepisosteus oculatus*
Croaker, yellowfin	*Umbrina roncador*	Goatfish, spotted	*Pseudupeneus maculatus*
Cunner	*Tautogolabrus adspersus*	Goatfish, yellow	*Mulloidichthys martinicus*
Cusk-eel, crested	*Ophiodon josephi*	Goby, arrow	*Clevelandia ios*
Cusk-eel, striped	*Ophiodon marginatum*	Goby, bay	*Lepidogobius lepidus*
Cutlassfish, Atlantic	*Trichiurus lepturus*	Goby, blackeye	*Rhinogobiops nicholsii*
Damselfish, bicolor	*Stegastes partitus*	Goby, cheekspot	*Ilypnus gilberti*
Damselfish, yellowtail	*Microspathodon chrysurus*	Goby, clown	*Microgobius gulosus*
Darter, tessellated	*Etheostoma olmstedi*	Goby, code	*Gobiosoma robustum*
Doctorfish	*Acanthurus chirurgus*	Goby, darter	*Gobionellus boleosoma*
Dolly Varden	*Salvelinus malma*	Goby, freshwater	*Ctenogobius shufeldti*
Dragonet, spotted	*Diplogrammus pauciradiatus*	Goby, frillfin	*Bathygobius soporator*
Drum, banded	*Larimus fasciatus*	Goby, green	*Microgobius thalassinus*
Drum, black	*Pogonias cromis*	Goby, highfin	*Gobionellus oceanicus*
Drum, freshwater	*Aplodinotus grunniens*	Goby, lyre	*Evorthodus lyricus*
Drum, red	*Sciaenops ocellatus*	Goby, naked	*Gobiosoma bosc*
Drum, star	*Stellifer lanceolatus*	Goby, ragged	*Bollmannia communis*
Eel, American	*Anguilla rostrata*	Goby, seaboard	*Gobiosoma ginsburgi*
Eel, pikeconger	*Nettastomatidae*	Goby, shadow	*Quietula y-cauda*
Eel, ridged	*Neoconger mucronatus*	Goby, tidewater	*Eucyclogobius newberryi*
Eel, shrimp	*Ophichthus gomesii*	Goby, violet	*Gobioides broussonetii*

Common Name	Scientific Name	Common Name	Scientific Name
Goby, yellowfin	*Acanthogobius flavimanus*	Hogchoker	*Trinectes maculatus*
Goldfish	*Carassius auratus*	Hogfish	*Lachnolaimus maximus*
Graysby	*Epinephelus cruentatus*	Hogfish, Spanish	*Bodianus rufus*
Greenling, kelp	*Hexagrammos decagrammus*	Jack, bar	*Caranx ruber*
Greenling, masked	*Hexagrammos octogrammus*	Jack, crevalle	*Caranx hippos*
Greenling, painted	*Oxylebius pictus*	Jack, horse-eye	*Caranx latus*
Greenling, rock	*Hexagrammos lagocephalus*	Jack, yellow	*Caranx bartholomaei*
Greenling, whitespotted	*Hexagrammos stelleri*	Jacks	*Carangidae*
Greenlings	*Hexagrammidae*	Jacksmelt	*Atherinopsis californiensis*
Grouper, black	*Mycteroperca bonaci*	Killifish, banded	*Fundulus diaphanus*
Grouper, goliath	*Epinephelus itajara*	Killifish, bayou	*Fundulus pulvereus*
Grouper, Nassau	*Epinephelus striatus*	Killifish, California	*Fundulus parvipinnis*
Grouper, red	*Epinephelus morio*	Killifish, diamond	*Adinia xenica*
Grouper, yellowfin	*Mycteroperca venenosa*	Killifish, goldspotted	*Floridichthys carpio*
Groupers	*Serranidae*	Killifish, gulf	*Fundulus grandis*
Grubby	*Myoxocephalus aenaeus*	Killifish, longnose	*Fundulus similis*
Grunt, bluestriped	*Haemulon sciurus*	Killifish, marsh	*Fundulus confluentus*
Grunt, French	*Haemulon flavolineatum*	Killifish, rainwater	*Lucania parva*
Grunt, white	*Haemulon plumieri*	Killifish, spotfin	*Fundulus luciae*
Grunts	*Haemulidae*	Killifish, striped	*Fundulus majalis*
Gunnel, crescent	*Pholis laeta*	Kingfish, Gulf	*Menticirrhus littoralis*
Gunnel, penpoint	*Apodichthys flavidus*	Kingfish, northern	*Menticirrhus saxatilis*
Gunnel, red	*Pholis schultzi*	Kingfish, southern	*Menticirrhus americanus*
Gunnel, rock	*Pholis gunnellus*	Ladyfish	*Elops saurus*
Gunnel, rockweed	*Apodichthys fucorum*	Lamprey, Pacific	*Lampetra tridentata*
Gunnel, saddleback	*Pholis ornata*	Launces	*Ammodytes sp.*
Haddock	*Melanogrammus aeglefinus*	Leatherjack	*Oligoplites saurus*
Hake, Pacific (whiting)	*Merluccius productus*	Limia, Cuban	*Limia vittata*
Hake, red	*Urophycis chuss*	Lingcod	*Ophiodon elongatus*
Hake, silver	*Merluccius bilinearis*	Lizardfish, inshore	*Synodus foetens*
Hake, southern	*Urophycis floridana*	Lobster, American	*Homarus americanus*
Hake, spotted	*Urophycis regia*	Lobster, spiny	*Panulirus argus*
Hake, white	*Urophycis tenuis*	Lord, brown Irish	*Hemilepidotus spinosus*
Halfbeak	*Hemiramphidae*	Lord, red Irish	*Hemilepidotus hemilepidotus*
Halibut, Atlantic	*Hippoglossus hippoglossus*	Lumpsucker, Pacific spiny	*Eumicrotremus orbis*
Halibut, California	*Paralichthys californicus*	Mackerel, Atlantic	*Scomber scombrus*
Harvestfish	*Peprilus alepidotus*	Mackerel, jack	*Trachurus symmetricus*
Helmet, flame	*Cassis flammea*	Mackerel, king	*Scomberomorus cavalla*
Herring, Atlantic	*Clupea harengus*	Mackerel, Pacific chub	*Scomber japonicus*
Herring, Atlantic thread	*Opisthonema oglinum*	Mackerel, Spanish	*Scomberomorus maculatus*
Herring, blueback	*Alosa aestivalis*	Margate	*Haemulon album*
Herring, dwarf	*Jenkinsia lamprotaenia*	Menhaden, Atlantic	*Brevoortia tyrannus*
Herring, Pacific	*Clupea pallasii*	Menhaden, finescale	*Brevoortia gunteri*
Herring, round	*Etrumeus teres*	Menhaden, Gulf	*Brevoortia patronus*
Herrings	*Clupeidae*	Menhaden, yellowfin	*Brevoortia smithi*
High-hat	*Pareques acuminatus*	Midshipman, plainfin	*Porichthys notatus*
Hind, red	*Epinephelus guttatus*	Midshipman, Atlantic	*Porichthys plectrodon*

Common Name	Scientific Name	Common Name	Scientific Name
Midshipman, specklefin	*Porichthys myriaster*	Pholids	*Pholidae*
Milkfish	*Chanos chanos*	Pickerel, chain	*Esox niger*
Minnow, bluntnose	*Pimephales notatus*	Pickerel, redfin	*Esox americanus americanus*
Minnow, fathead	*Pimephales promelas*	Pigfish	*Orthopristis chrysoptera*
Minnow, pugnose	*Opsopoeodus emiliae*	Pinfish	*Lagodon rhomboides*
Minnow, sheepshead	*Cyprinodon variegatus*	Pinfish, spottail	*Diplodus holbrooki*
Minnow, silvery	*Hybognathus sp.*	Pipefish	*Syngnathidae*
Mojarra, flagfin	*Eucinostomus melanopterus*	Pipefish, bay	*Syngnathus leptorhynchus*
Mojarra, mottled	*Eucinostomus lefroyi*	Pipefish, chain	*Syngnathus louisianae*
Mojarra, spotfin	*Eucinostomus argenteus*	Pipefish, dusky	*Syngnathus floridae*
Mojarra, striped	*Diapterus plumieri*	Pipefish, Gulf	*Syngnathus scovelli*
Mojarras	*Gerreidae*	Pipefish, northern	*Syngnathus fuscus*
Molly miller	*Scartella cristata*	Pipefish, sargassum	*Syngnathus pelagicus*
Monos	*Monodactylidae*	Pipefish, Texas	*Syngnathus affinis*
Moonfish, Atlantic	*Selene setapinnis*	Plaice, American	*Hippoglossoides platessoides*
Mosquitofish, eastern	*Gambusia holbrooki*	Poacher, northern spearnose	*Agonopsis vulsa*
Mosquitofish, western	*Gambusia affinis*	Poacher, pricklebreast	*Stellerina xyosterna*
Mudsucker, longjaw	*Gillichthys mirabilis*	Poacher, sturgeon	*Podothecus accipenserinus*
Mullet, striped	*Mugil cephalus*	Poacher, tubenose	*Pallasina barbata*
Mullet, white	*Mugil curema*	Poacher, warty	*Chesnonia verrucosa*
Mullets	*Mugilidae*	Pollock	*Pollachius virens*
Mummichog	*Fundulus heteroclitus*	Pompano, African	*Alectis ciliaris*
Mussel, blue	*Mytilus edulis*	Pompano, Florida	*Trachinotus carolinus*
Needlefish, Atlantic	*Strongylura marina*	Pompano, Irish	*Diapterus auratus*
Needlefish, redfin	*Strongylura notata*	Porcupinefish	*Diodon hystrix*
Opaleye	*Girella nigricans*	Porgy, grass	*Calamus arctifrons*
Oyster, eastern	*Crassotrea virginica*	Porgy, littlehead	*Calamus proridens*
Oyster, European flat	*Ostrea edulis*	Porgy, whitebone	*Calamus leucosteus*
Oyster, Olympia	*Ostreola conchaphila*	Porkfish	*Anisotremus virginicus*
Oyster, Pacific	*Crassostrea gigas*	Pout, eel	*Lycodes sp.*
Parrotfish, rainbow	*Scarus guacamaia*	Pout, ocean	*Zoarces americanus*
Parrotfish, redtail	*Sparisoma chrysopterum*	Prickleback, rock	*Xiphister mucosus*
Parrotfish, stoplight	*Sparisoma viride*	Prickleback, snake	*Lumpenus sagitta*
Parrotfish, striped	*Scarus iseri*	Puffer, least	*Sphoeroides parvus*
Perch, black	*Embiotoca jacksoni*	Puffer, northern	*Sphoeroides maculatus*
Perch, dwarf	*Micrometrus minimus*	Puffer, sharpnose	*Canthigaster rostrata*
Perch, kelp	*Brachyistius frenatus*	Puffer, southern	*Sphoeroides nephelus*
Perch, pile	*Rhacochilus vacca*	Puffers	*Tetraodontidae/Sphoeroides*
Perch, shiner	*Cymatogaster aggregata*	Pumpkinseed	*Lepomis gibbosus*
Perch, silver	*Bairdiella chrysoura*	Queenfish	*Seriphus politus*
Perch, tule	*Hysterocarpus traski*	Quillback	*Carpiodes cyprinus*
Perch, white	*Morone americana*	Rabbitfishes	*Siganidae*
Perch, yellow	*Perca flavescens*	Ratfish, spotted	*Hydrolagus colliei*
Periwinkle, marsh	*Littorina irrorata*	Ray, bat	*Myliobatis californica*
Permit	*Trachinotus falcatus*	Ray, cownose	*Rhinoptera bonasus*

Common Name	Scientific Name	Common Name	Scientific Name
Ray, spotted eagle	*Aetobatus narinari*	Sculpin, ribbed	*Triglops pingelii*
Redhorse, shorthead	*Moxostoma macrolepidotum*	Sculpin, sailfin	*Nautichthys oculofasciatus*
Rockfish, brown	*Sebastes auriculatus*	Sculpin, sharpnose	*Clinocottus acuticeps*
Rockfish, grass	*Sebastes rastrelliger*	Sculpin, shorthorn	*Myoxocephalus scorpius*
Ronquil, Alaskan	*Bathymaster caeruleofasciatus*	Sculpin, silverspotted	*Blepsias cirrhosus*
Ronquil, northern	*Ronquilus jordani*	Sculpin, smoothhead	*Artedius lateralis*
Runner, blue	*Caranx crysos*	Sculpin, tadpole	*Psychrolutes paradoxus*
Sailfin molly	*Poecilia latipinna*	Sculpin, tidepool	*Oligocottus maculosus*
Sailors choice	*Haemulon parra*	Sculpins	*Cottidae*
Salmon, Atlantic	*Salmo salar*	Scup	*Stenotomus chrysops*
Salmon, Chinook	*Oncorhynchus tshawytscha*	Sea bass, black	*Centropristis striata*
Salmon, chum	*Oncorhynchus keta*	Sea bass, white	*Atractoscion nobilis*
Salmon, coho	*Oncorhynchus kisutch*	Sea raven	*Hemitripterus americanus*
Salmon, pink	*Oncorhynchus gorbuscha*	Sea urchin, green	*Strongylocentrotus droehbachiensis*
Salmon, sockeye	*Oncorhynchus nerka*	Seahorse, dwarf	*Hippocampus zosterae*
Sand bass, barred	*Paralabrax nebulifer*	Seahorse, lined	*Hippocampus erectus*
Sand bass, spotted	*Paralabrax maculatofasciatus*	Seahorses	*Syngnathidae*
Sand lance, American	*Ammodytes americanus*	Seaperch, striped	*Embiotoca lateralis*
Sand lance, Pacific	*Ammodytes hexapterus*	Seaperch, white	*Phanerodon furcatus*
Sandfish, Pacific	*Trichodon trichodon*	Searobin, bighead	*Prionotus tribulus*
Sardine, Pacific	*Sardinops sagax*	Searobin, northern	*Prionotus carolinus*
Sardine, scaled	*Harengula jaguana*	Searobin, spotted	*Prionotus punctatus*
Sardines	*Clupeidae*	Searobin, striped	*Prionotus evolans*
Sawfish	*Pristis species*	Seatrout, sand	*Cynoscion arenarius*
Scad, yellowtail	*Atule mate*	Seatrout, spotted	*Cynoscion nebulosus*
Scallop, bay	*Argopecten irradians*	Sergeant major	*Abudefduf saxatilis*
Scallop, sea	*Placopecten magellanicus*	Shad, Alabama	*Alosa alabamae*
Schoolmaster	*Lutjanus apodus*	Shad, American	*Alosa sapidissima*
Scorpionfish, California	*Scorpaena guttata*	Shad, gizzard	*Dorosoma cepedianum*
Scorpionfish, spotted	*Scorpaena plumieri*	Shad, hickory	*Alosa mediocris*
Sculpin, antlered	*Enophrys diceraus*	Shad, threadfin	*Dorosoma petenense*
Sculpin, Arctic	*Myoxocephalus scorpioides*	Shanny, Arctic	*Stichaeus punctatus*
Sculpin, armorhead	*Gymnocanthus galeatus*	Shark, Atlantic angel	*Squatina dumerili*
Sculpin, buffalo	*Enophrys bison*	Shark, Atlantic sharpnose	*Rhizoprionodon terraenovae*
Sculpin, crested	*Blepsias bilobus*	Shark, blacknose	*Carcharhinus acronotus*
Sculpin, fluffy	*Oligocottus snyderi*	Shark, blacktip	*Carcharhinus limbatus*
Sculpin, frog	*Myoxocephalus stelleri*	Shark, bonnethead	*Sphyrna tiburo*
Sculpin, great	*Myoxocephalus polyacanthocephalus*	Shark, brown smoothhound	*Mustelus henlei*
Sculpin, leister	*Enophrys lucasi*	Shark, bull	*Carcharhinus leucas*
Sculpin, longhorn	*Myoxocephalus octodecemspinosus*	Shark, dusky	*Carcharhinus obscurus*
Sculpin, manacled	*Synchirus gilli*	Shark, finetooth	*Carcharhinus isodon*
Sculpin, northern	*Icelinus borealis*	Shark, gray smoothhound	*Mustelus californicus*
Sculpin, Pacific staghorn	*Leptocottus armatus*	Shark, lemon	*Negaprion brevirostris*
Sculpin, padded	*Artedius fenestralis*	Shark, leopard	*Triakis semifasciata*
Sculpin, prickly	*Cottus asper*	Shark, nurse	*Ginglymostoma cirratum*

Common Name	Scientific Name	Common Name	Scientific Name
Shark, sand tiger	*Carcharias taurus*	Skate, clearnose	*Raja eglanteria*
Shark, sandbar	*Carcharhinus plumbeus*	Skate, little	*Leucoraja erinacea*
Shark, scalloped hammerhead	*Sphyrna lewini*	Skate, longnose	*Raja rhina*
Shark, smalltail	*Carcharhinus porosus*	Skate, winter	*Leucoraja ocellata*
Shark, smooth dogfish	*Mustelus canis*	Skates	*Rajidae*
Shark, soupfin	*Galeorhinus galeus*	Skilletfish	*Gobiesox strumosus*
Shark, spinner	*Carcharhinus brevipinna*	Sleeper, bigmouth	*Gobiomorus dormitor*
Shark, spiny dogfish	*Squalus acanthias*	Sleeper, emerald	*Erotelis smaragdus*
Sharks, pelagic	*Carcharinidae,/Sphyrnidae*	Sleeper, fat	*Dormitator maculatus*
Sheepshead	*Archosargus probatocephalus*	Smelt, delta	*Hypomesus transpacificus*
Shiner, blacknose	*Notropis heterolepis*	Smelt, longfin	*Spirinchus thaleichthys*
Shiner, golden	*Notemigonus crysoleucas*	Smelt, night	*Spirinchus starksi*
Shiner, satinfin	*Cyprinella analostana*	Smelt, rainbow	*Osmerus mordax*
Shiner, spottail	*Notropis husonius*	Smelt, surf	*Hypomesus pretiosus*
Shrimp, banded snapping	*Alpheus armillatus*	Smelt, wakasagi	*Hypomesus nipponensis*
Shrimp, bay	*Crangon franciscorum*	Smelt, whitebait	*Allosmerus elongatus*
Shrimp, bigclaw snapping	*Alpheus heterochaelis*	Smelts	*Osmeridae*
Shrimp, blacktailed bay	*Crangon nigricauda*	Snailfish, kelp	*Liparis tunicatus*
Shrimp, blue mud	*Upogebia pugettensis*	Snailfish, ringtail	*Liparis rutteri*
Shrimp, brackish grass	*Palaemonetes intermedius*	Snailfish, showy	*Liparis pulchellus*
Shrimp, brown	*Farfantepenaeus aztecus*	Snailfish, slimy	*Liparis mucosus*
Shrimp, coonstripe	*Pandalus hypsinotus*	Snailfish, slipskin	*Liparis fucensis*
Shrimp, daggerblade grass	*Palaemonetes pugio*	Snailfish, tidepool	*Liparis florae*
Shrimp, ghost	*Callianassidae*	Snapper, cubera	*Lutjanus cyanopterus*
Shrimp, green snapping	*Alpheus normanni*	Snapper, dog	*Lutjanus jocu*
Shrimp, mantis	*Stomatopoda*	Snapper, gray	*Lutjanus griseus*
Shrimp, marsh grass	*Palaemonetes vulgaris*	Snapper, lane	*Lutjanus synagris*
Shrimp, northern	*Pandalus borealis*	Snapper, mahogany	*Lutjanus mahogoni*
Shrimp, penaeid	*Penaeidae*	Snapper, mutton	*Lutjanus analis*
Shrimp, pink	*Farfantepenaeus duorarum*	Snapper, yellowtail	*Ocyurus chrysurus*
Shrimp, riverine grass	*Palaemonetes paludosus*	Snappers	*Lutjanidae*
Shrimp, roughback	*Trachypenaeus similis*	Snook, common	*Centropomus undecimalis*
Shrimp, roughneck	*Trachypenaeus constrictus*	Soapfish, greater	*Rypticus saponaceus*
Shrimp, sevenspine bay	*Crangon septemspinosa*	Sole, English	*Pleuronectes vetulus / Parophrys vetulus (PFMC)*
Shrimp, snapping	*Alpheidae*	Sole, lined	*Achirus lineatus*
Shrimp, spot	*Pandalus platyceros*	Spadefish, Atlantic	*Chaetodipterus faber*
Shrimp, white	*Litopenaeus setiferus*	Spadefishes	*Ephippidae*
Silver Jenny	*Eucinostomus gula*	Spot	*Leiostomus xanthurus*
Silverside, Atlantic	*Menidia menidia*	Sprats	*Clupeidae*
Silverside, hardhead	*Atherinomorus stipes*	Squid, bay	*Lolliguncula brevis*
Silverside, inland	*Menidia beryllina*	Squid, long-finned	*Loligo pealeii*
Silverside, rough	*Membras martinica*	Squirrelfish, longspine	*Holocentrus rufus*
Silverside, tidewater	*Menidia peninsulae*	Stargazer, northern	*Astroscopus guttatus*
Silversides	*Atherinidae/Menidia sp.*	Stargazer, southern	*Astroscopus y-graecum*
Skate, big	*Raja binoculata*	Stickleback, four-spine	*Apeltes quadracus*
Skate, California	*Raja inornata*	Stickleback, nine-spine	*Pungitius pungitius*

Common Name	Scientific Name	Common Name	Scientific Name
Stickleback, three-spine	*Gasterosteus aculeatus*	Timucu	*Strongylura timucu*
Stingray, Atlantic	*Dasyatis sabina*	Toadfish, Gulf	*Opsanus beta*
Stingray, round	*Urobatis halleri*	Toadfish, oyster	*Opsanus tau*
Stingray, southern	*Dasyatis americana*	Toadfishes	*Batrachoididae*
Sturgeon, Atlantic	*Acipenser oxyrhynchus*	Tomcod, Atlantic	*Microgadus tomcod*
Sturgeon, green	*Acipenser medirostris*	Tomcod, Pacific	*Microgadus proximus*
Sturgeon, lake	*Acipenser fulvescens*	Tomtate	*Haemulon aurolineatum*
Sturgeon, shortnose	*Acipenser brevirostrum*	Tonguefish, blackcheek	*Symphurus plagiusa*
Sturgeon, white	*Acipenser transmontanus*	Tonguefish, California	*Symphurus atricauda*
Sturgeons	*Acipenseridae*	Topminnow, saltmarsh	*Fundulus jenkinsi*
Sucker, Sacramento	*Catostomus occidentalis*	Topsmelt	*Atherinops affinis*
Sunfish, green	*Lepomis cyanellus*	Trevally, black	*Caranx lugubris*
Sunfish, redbreast	*Lepomis auritus*	Trevally, bluefin	*Caranx melampygus*
Sunfish, warmouth	*Lepomis gulosus*	Trevally, giant	*Caranx ignobilis*
Surfperch, barred	*Amphistichus argenteus*	Trevally, thick-lipped	*Pseudocaranx dentex*
Surfperch, redtail	*Amphistichus rhodoterus*	Tripletail	*Lobotes surinamensis*
Surfperch, silver	*Hyperprosopon ellipticum*	Trout, cutthroat	*Oncorhynchus clarki*
Surfperch, spotfin	*Hyperprosopon anale*	Trout, steelhead (rainbow)	*Oncorhynchus mykiss*
Surfperch, walleye	*Hyperprosopon argeneum*	Trunkfish	*Lactophrys trigonus*
Surfperches	*Embiotocidae*	Trunkfish, spotted	*Lactophrys bicaudalis*
Surgeon, ocean	*Acanthurus bahianus*	Tube-snout	*Aulorhynchus flavidus*
Tang, blue	*Acanthurus coeruleus*	Turbot, diamond	*Hypsopsetta guttulata*
Tarpon	*Megalops atlanticus*	Turbot, spotted	*Pleuronichthys ritteri*
Tautog	*Tautoga onitis*	Waspfish	*Tetrarogidae*
Terrapin	*Terrapin sp.*	Weakfish	*Cynoscion regalis*
Threadfin, Atlantic	*Polydactylus octonemus*	Whiff, bay	*Citharichthys spilopterus*
Threadfin, Pacific	*Polydactylus sexfilis*	Wolf-eel	*Anarrhichthys ocellatus*
Threadfins	*Polynemidae*	Wrasse, bluehead	*Thalassoma bifasciatum*
Tilapia, blackchin	*Sarotherodon melanotheron*	Wrasse, yellowhead	*Halichoeres garnoti*

Appendix C: Estuarine Species or Species Groupings in U.S. Commercial Landings, 2000–2004.

Common Name	Scientific Name	Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*	Drum, black	*Pogonias cromis*
Amberjack	*Seriola sp.*	Drum, freshwater	*Aplodinotus grunniens*
Amberjack, greater	*Seriola dumerili*	Drum, red	*Sciaenops ocellatus*
Anchovies	*Engraulidae*	Eel, american	*Anguilla rostrata*
Anchovy, northern	*Engraulis mordax*	Flatfish	*Pleuronectiformes*
Barracudas	*Sphyraenidae*	Flounder, flukes	*Paralichthys*
Bass, striped	*Morone saxatilis*	Flounder, Pacific, sanddab	*Citharichthys*
Bluefish	*Pomatomus saltatrix*	Flounder, starry	*Platichthys stellatus*
Butterfish	*Peprilus sp.*	Flounder, summer	*Paralichthys dentatus*
Cabezon	*Scorpaenichthys marmoratus*	Flounder, windowpane	*Scophthalmus aquosus*
Carp, common	*Cyprinus carpio*	Flounder, winter	*Pleuronectes americanus*
Catfish, blue	*Ictalurus furcatus*	Flounder, yellowtail	*Pleuronectes ferrugineus*
Catfish, channel	*Ictalurus punctatus*	Flounders, righteye	*Pleuronectidae*
Clam, butter	*Saxidomus giganteus*	Gag	*Mycteroperca microlepis*
Clam, California jackknife	*Ensis myrae*	Graysby	*Epinephelus cruentatus*
Clam, manila	*Corbicula manilensis*	Grouper, black	*Mycteroperca bonaci*
Clam, Pacific geoduck	*Panopea abrupta*	Grouper, red	*Epinephelus morio*
Clam, Pacific littleneck	*Protothaca staminea*	Grouper, yellowfin	*Mycteroperca venenosa*
Clam, Pacific razor	*Siliqua patula*	Grouper, yellowmouth	*Mycteroperca interstitialis*
Clam, Pacific, gaper	*Tresus*	Groupers	*Serranidae*
Clam, quahog	*Mercenaria*	Grunt, white	*Haemulon plumieri*
Clam, softshell	*Mya arenaria*	Grunts	*Haemulidae*
Clams or bivalves	*Bivalvia*	Haddock	*Melanogrammus aeglefinus*
Cobia	*Rachycentron canadum*	Hake, Atlantic, red/white	*Urophycis*
Cockle, nuttall	*Clinocardium nuttallii*	Hake, Pacific (whiting)	*Merluccius productus*
Cod, Atlantic	*Gadus morhua*	Hake, red	*Urophycis chuss*
Crab, Atlantic rock	*Cancer irroratus*	Hake, silver	*Merluccius bilinearis*
Crab, blue	*Callinectes sapidus*	Hake, white	*Urophycis tenuis*
Crab, cancer	*Cancer*	Halibut, Atlantic	*Hippoglossus hippoglossus*
Crab, dungeness	*Cancer magister*	Halibut, California	*Paralichthys californicus*
Crab, Florida stone	*Menippe mercenaria*	Harvestfish	*Peprilus alepidotus*
Crab, green	*Carcinus maenas*	Herring, Atlantic	*Clupea harengus*
Crab, horseshoe	*Limulus polyphemus*	Herring, Atlantic thread	*Opisthonema oglinum*
Crab, jonah	*Cancer borealis*	Herring, blueback	*Alosa aestivalis*
Crab, king	*Paralithodes*	Herring, Pacific	*Clupea pallasii*
Crab, red rock	*Cancer productus*	Herring, round	*Etrumeus teres*
Crab, snow/tanner	*Chionoecetes sp.*	Herrings	*Clupeidae*
Crab, southern tanner	*Chionoecetes bairdi*	Hind, red	*Epinephelus guttatus*
Crab, spider	*Majidae*	Hogfish	*Lachnolaimus maximus*
Crabs	*Decapoda*	Jack mackerel	*Trachurus symmetricus*
Crappie	*Pomoxis*	Jacks	*Carangidae*
Croaker, Atlantic	*Micropogonias undulatus*	Jack, bar	*Caranx ruber*
Croaker, Pacific white	*Genyonemus lineatus*	Jack, crevalle	*Caranx hippos*
Cunner	*Tautogolabrus adspersus*	Jack, horse-eye	*Caranx latus*
Cutlassfish, Atlantic	*Trichiurus lepturus*	King whiting	*Menticirrhus*

Common Name	Scientific Name	Common Name	Scientific Name
Ladyfish	*Elops saurus*	Salmon, coho	*Oncorhynchus kisutch*
Launces	*Ammodytes*	Salmon, Pacific	*Oncorhynchus*
Lingcod	*Ophiodon elongatus*	Salmon, pink	*Oncorhynchus gorbuscha*
Lobster, American	*Homarus americanus*	Salmon, sockeye	*Oncorhynchus nerka*
Lobster, Caribbean spiny	*Panulirus argus*	Sanddab, Pacific	*Citharichthys sordidus*
Mackerel (scomber)	*Scomber*	Sardine, Pacific	*Sardinops sagax*
Mackerel, Atlantic	*Scomber scombrus*	Scallop, bay	*Argopecten irradians*
Mackerel, chub	*Scomber japonicus*	Scallop, sea	*Placopecten magellanicus*
Mackerel, king	*Scomberomorus cavalla*	Scorpionfish, spotted	*Scorpaena plumieri*
Mackerel, king and cero	*Scomberomorus*	Sculpins	*Cottidae*
Mackerel, Spanish	*Scomberomorus maculatus*	Scup	*Stenotomus chrysops*
Mantis shrimps	*Stomatopoda*	Scups or porgies	*Sparidae*
Margate	*Haemulon album*	Sea bass, black	*Centropristis striata*
Menhaden, Atlantic	*Brevoortia* sp.	Sea raven	*Hemitripterus americanus*
Mojarras	*Gerreidae*	Seabass, white	*Atractoscion nobilis*
Moonfish, Atlantic	*Selene setapinnis*	Seatrout, sand	*Cynoscion arenarius*
Mullet, striped (liza)	*Mugil cephalus*	Seatrout, spotted	*Cynoscion nebulosus*
Mullet, white	*Mugil curema*	Shad, American	*Alosa sapidissima*
Mullets	*Mugilidae*	Shad, gizzard	*Dorosoma cepedianum*
Mummichog	*Fundulus heteroclitus*	Shad, hickory	*Alosa mediocris*
Mussel, blue	*Mytilus edulis*	Shark, Atlantic angel	*Squatina dumeril*
Needlefish, Atlantic	*Strongylura marina*	Shark, Atlantic sharpnose	*Rhizoprionodon terraenovae*
Oyster, eastern	*Crassostrea virginica*	Shark, blacknose	*Carcharhinus acronotus*
Oyster, European flat	*Ostrea edulis*	Shark, blacktip	*Carcharhinus limbatus*
Oyster, Olympia	*Ostrea conchaphila*	Shark, bonnethead	*Sphyrna tiburo*
Oyster, Pacific	*Crassostrea gigas*	Shark, bull	*Carcharhinus leucas*
Penaeid shrimp	*Penaeidae*	Shark, dogfish	*Squalidae*
Perch, white	*Morone americana*	Shark, dusky	*Carcharhinus obscurus*
Perch, yellow	*Perca flavescens*	Shark, finetooth	*Carcharhinus isodon*
Permit	*Trachinotus falcatus*	Shark, lemon	*Negaprion brevirostris*
Pigfish	*Orthopristis chrysoptera*	Shark, leopard	*Triakis semifasciata*
Pinfish	*Lagodon rhomboides*	Shark, nurse	*Ginglymostoma cirratum*
Pinfish, spottail	*Diplodus holbrooki*	Shark, sand tiger	*Odontaspis taurus*
Plaice, American	*Hippoglossoides platessoides*	Shark, sandbar	*Carcharhinus plumbeus*
Pollock	*Pollachius virens*	Shark, smooth dogfish	*Mustelus canis*
Pompano, African	*Alectis ciliaris*	Shark, soupfin	*Galeorhinus zyopterus*
Pompano, Florida	*Trachinotus carolinus*	Shark, spiny dogfish	*Squalus acanthias*
Porgy, whitebone	*Calamus leucosteus*	Sheepshead	*Archosargus probatocephalus*
Pout, ocean	*Macrozoarces americanus*	Shellfish	*Crustacea*
Puffers	*Tetraodontidae*	Shrimp, blue mud	*Upogebia pugettensis*
Puffers	*Sphoeroides*	Shrimp, brown	*Farfantepenaeus aztecus*
Queenfish	*Seriphus politus*	Shrimp, ghost	*Callianassidae*
Ratfish spotted	*Hydrolagus colliei*	Shrimp, marine, other	*Decapoda, Dendrobranchiata*
Rays	*Rajiformes*	Shrimp, penaeid	*Penaeidae*
Rockfish, brown	*Sebastes auriculatus*	Shrimp, pink	*Farfantepenaeus duorarum*
Rockfish, grass	*Sebastes rastrelliger*	Shrimp, spot	*Pandalus platyceros*
Runner, blue	*Caranx crysos*	Shrimp, white	*Litopenaeus setiferus*
Salmon, Chinook	*Oncorhynchus tshawytscha*	Shrimp, Atlantic & Gulf, roughneck	*Trachypenaeus*
Salmon, chum	*Oncorhynchus keta*	Silversides	*Atherinidae*

Common Name	Scientific Name	Common Name	Scientific Name
Skate, big	*Raja binoculata*	Spot	*Leiostomus xanthurus*
Skates	*Rajidae*	Squid, longfin	*Loligo pealeii*
Smelt, eulachon	*Thaleichthys pacificus*	Sturgeon, green	*Acipenser medirostris*
Smelt, rainbow	*Osmerus mordax*	Sturgeon, white	*Acipenser transmontanus*
Smelts	*Osmeridae*	Sturgeons	*Acipenseridae*
Snappers	*Lutjanidae*	Surfperches	*Embiotocidae*
Snapper, cubera	*Lutjanus cyanopterus*	Tarpon	*Megalops atlanticus*
Snapper, dog	*Lutjanus jocu*	Tautog	*Tautoga onitis*
Snapper, gray	*Lutjanus griseus*	Threadfins	*Polynemidae*
Snapper, lane	*Lutjanus synagris*	Toadfishes	*Batrachoididae*
Snapper, mahogany	*Lutjanus mahogoni*	Tomcod, Pacific	*Microgadus proximus*
Snapper, mutton	*Lutjanus analis*	Tripletail	*Lobotes surinamensis*
Snapper, schoolmaster	*Lutjanus apodus*	Trout, rainbow	*Oncorhynchus mykiss*
Snapper, yellowtail	*Ocyurus chrysurus*	Weakfish	*Cynoscion regalis*
Sole, english	*Pleuronectes vetulus*	Wolf-eel	*Anarrhichthys ocellatus*
Spadefishes	*Ephippidae*		

Appendix D: Estuarine Species in U.S. Recreational Harvest, 2000–2004.

Common Name	Scientific name	Common Name	Scientific name
Alewife	*Alosa pseudoharengus*	Drum, red	*Sciaenops ocellatus*
Amberjack, greater	*Seriola dumerili*	Drum, star	*Stellifer lanceolatus*
Anchovy, deepbody	*Anchoa compressa*	Eel, American	*Anguilla rostrata*
Anchovy, northern	*Engraulis mordax*	Eel, shrimp	*Ophichthus gomesii*
Anchovy, striped	*Anchoa hepsetus*	Filefish, orange	*Aluterus schoepfi*
Angelfish, gray	*Pomacanthus arcuatus*	Filefish, planehead	*Monacanthus hispidus*
Barracuda, great	*Sphyraena barracuda*	Flounder, fourspot	*Paralichthys oblongus*
Bass, barred sand	*Paralabrax nebulifer*	Flounder, Gulf	*Paralichthys albigutta*
Bass, black sea	*Centropristis striata*	Flounder, ocellated	*Ancylopsetta quadrocellata*
Bass, kelp	*Paralabrax clathratus*	Flounder, southern	*Paralichthys lethostigma*
Bass, smallmouth	*Micropterus dolomieu*	Flounder, starry	*Platichthys stellatus*
Bass, spotted sand	*Paralabrax maculatofasciatus*	Flounder, summer	*Paralichthys dentatus*
Bass, striped	*Morone saxatilis*	Flounder, windowpane	*Scophthalmus aquosus*
Bass, white sea	*Atractoscion nobilis*	Flounder, winter	*Pleuronectes americanus*
Blue runner	*Caranx crysos*	Flounder, yellowtail	*Pleuronectes ferrugineus*
Bluefish	*Pomatomus saltatrix*	Gar, longnose	*Lepisosteus osseus*
Bluegill	*Lepomis macrochirus*	Gar, spotted	*Lepisosteus oculatus*
Bonefish	*Albula vulpes*	Goatfish, yellow	*Mulloidichthys martinicus*
Bream, sea	*Archosargus rhomboidalis*	Graysby	*Epinephelus cruentatus*
Bullhead, brown	*Ameiurus nebulosus*	Greenling, kelp	*Hexagrammos decagrammus*
Bullhead, yellow	*Ameiurus natalis*	Greenling, painted	*Oxylebius pictus*
Bumper, Atlantic	*Chloroscombrus chrysurus*	Greenling, rock	*Hexagrammos lagocephalus*
Burrfish, striped	*Chilomycterus schoepfi*	Greenling, whitespotted	*Hexagrammos stelleri*
Cabezon	*Scorpaenichthys marmoratus*	Grouper, goliath	*Epinephelus itajara*
Carp, common	*Cyprinus carpio*	Grouper, black	*Mycteroperca bonaci*
Catfish, blue	*Ictalurus furcatus*	Grouper, gag	*Mycteroperca microlepis*
Catfish, channel	*Ictalurus punctatus*	Grouper, Nassau	*Epinephelus striatus*
Catfish, gafftopsail	*Bagre marinus*	Grouper, red	*Epinephelus morio*
Catfish, hardhead	*Arius felis*	Grouper, yellowfin	*Mycteroperca venenosa*
Catfish, white	*Ameiurus catus*	Grunt, bluestriped	*Haemulon sciurus*
Cobia	*Rachycentrum canadum*	Grunt, French	*Haemulon flavolineatum*
Cod, Atlantic	*Gadus morhua*	Grunt, white	*Haemulon plumieri*
Corbina	*Menticirrhus undulatus*	Haddock	*Melanogrammus aeglefinus*
Cowfish, scrawled	*Acanthostracion quadricornis*	Hake, Pacific	*Merluccius productus*
Crappie, black	*Pomoxis nigromaculatus*	Hake, red	*Urophycis chuss*
Croaker, Atlantic	*Micropogonias undulatus*	Hake, silver	*Merluccius bilinearis*
Croaker, white	*Genyonemus lineatus*	Hake, southern	*Urophycis floridana*
Croaker, yellowfin	*Umbrina roncador*	Hake, spotted	*Urophycis regia*
Cunner	*Tautogolabrus adspersus*	Hake, white	*Urophycis tenuis*
Cutlassfish, Atlantic	*Trichiurus lepturus*	Halibut, California	*Paralichthys californicus*
Doctorfish	*Acanthurus chirurgus*	Herring, Atlantic	*Clupea harengus*
Drum, banded	*Larimus fasciatus*	Herring, Atlantic thread	*Opisthonema oglinum*
Drum, black	*Pogonias cromis*	Herring, blueback	*Alosa aestivalis*
Drum, freshwater	*Aplodinotus grunniens*	Hind, red	*Epinephelus guttatus*

Common Name	Scientific name	Common Name	Scientific name
Hogfish	*Lachnolaimus maximus*	Perch, yellow	*Perca flavescens*
Hogfish, Spanish	*Bodianus rufus*	Permit	*Trachinotus falcatus*
Jack, bar	*Caranx ruber*	Pigfish	*Orthopristis chrysoptera*
Jack, crevalle	*Caranx hippos*	Pinfish	*Lagodon rhomboides*
Jack, horse-eye	*Caranx latus*	Pinfish, spottail	*Diplodus holbrooki*
Jack, yellow	*Caranx bartholomaei*	Pollock	*Pollachius virens*
Jacksmelt	*Atherinopsis californiensis*	Pompano, African	*Alectis ciliaris*
Killifish, striped	*Fundulus majalis*	Pompano, Florida	*Trachinotus carolinus*
Kingfish, Gulf	*Menticirrhus littoralis*	Pompano, Irish	*Diapterus auratus*
Kingfish, northern	*Menticirrhus saxatilis*	Porcupinefish	*Diodon hystrix*
Kingfish, southern	*Menticirrhus americanus*	Porgy, grass	*Calamus arctifrons*
Ladyfish	*Elops saurus*	Porgy, littlehead	*Calamus proridens*
Leatherjack	*Oligoplites saurus*	Porgy, whitebone	*Calamus leucosteus*
Lingcod	*Ophiodon elongatus*	Porkfish	*Anisotremus virginicus*
Lizardfish, inshore	*Synodus foetens*	Pout, ocean	*Zoarces americanus*
Lord, red Irish	*Hemilepidotus hemilepidotus*	Prickleback, rock	*Xiphister mucosus*
Mackerel, Atlantic	*Scomber scombrus*	Puffer, least	*Sphoeroides parvus*
Mackerel, jack	*Trachurus symmetricus*	Puffer, northern	*Sphoeroides maculatus*
Mackerel, king	*Scomberomorus cavalla*	Puffer, southern	*Sphoeroides nephelus*
Mackerel, Pacific chub	*Scomber japonicus*	Pumpkinseed	*Lepomis gibbosus*
Mackerel, Spanish	*Scomberomorus maculatus*	Queenfish	*Seriphus politus*
Margate	*Haemulon album*	Raven, sea	*Hemitripterus americanus*
Menhaden, Atlantic	*Brevoortia tyrannus*	Ray, bat	*Myliobatis californica*
Menhaden, Gulf	*Brevoortia patronus*	Ray, cownose	*Rhinoptera bonasus*
Menhaden, yellowfin	*Brevoortia smithi*	Ray, spotted eagle	*Aetobatus narinari*
Midshipman, plainfin	*Porichthys notatus*	Rockfish, brown	*Sebastes auriculatus*
Midshipman, specklefin	*Porichthys myriaster*	Rockfish, grass	*Sebastes rastrelliger*
Minnow, sheepshead	*Cyprinodon variegatus*	Sailors choice	*Haemulon parra*
Mojarra, flagfin	*Eucinostomus melanopterus*	Salmon, Atlantic	*Salmo salar*
Mojarra, mottled	*Eucinostomus lefroyi*	Salmon, Chinook	*Oncorhynchus tshawytscha*
Mojarra, spotfin	*Eucinostomus argenteus*	Salmon, chum	*Oncorhynchus keta*
Mojarra, striped	*Diapterus plumieri*	Salmon, coho	*Oncorhynchus kisutch*
Moonfish	*Selene sp.*	Salmon, pink	*Oncorhynchus gorbuscha*
Mullet, striped	*Mugil cephalus*	Salmon, sockeye	*Oncorhynchus nerka*
Mullet, white	*Mugil curema*	Sand dab, Pacific	*Citharichthys sordidus*
Needlefish, Atlantic	*Strongylura marina*	Sand dab, speckled	*Citharichthys stigmaeus*
Opaleye	*Girella nigricans*	Sardine, Pacific	*Sardinops sagax*
Parrotfish, rainbow	*Scarus guacamaia*	Sardine, scaled	*Harengula jaguana*
Parrotfish, redtail	*Sparisoma chrysopterum*	Schoolmaster	*Lutjanus apodus*
Parrotfish, stoplight	*Sparisoma viride*	Scorpionfish, California	*Scorpaena guttata*
Parrotfish, striped	*Scarus iseri*	Scorpionfish, spotted	*Scorpaena plumieri*
Perch, black	*Embiotoca jacksoni*	Sculpin, buffalo	*Enophrys bison*
Perch, pile	*Rhacochilus vacca*	Sculpin, great	*Myoxocephalus polyacanthocephalus*
Perch, shiner	*Cymatogaster aggregata*	Sculpin, Pacific staghorn	*Leptocottus armatus*
Perch, silver	*Bairdiella chrysoura*	Sculpin, shorthorn	*Myoxocephalus scorpius*
Perch, white	*Morone americana*	Scup	*Stenotomus chrysops*

Common Name	Scientific name	Common Name	Scientific name
Seaperch, striped	*Embiotoca lateralis*	Snapper, yellowtail	*Ocyurus chrysurus*
Seaperch, white	*Phanerodon furcatus*	Snook, common	*Centropomus undecimalis*
Searobin, bighead	*Prionotus tribulus*	Soapfish, greater	*Rypticus saponaceus*
Searobin, northern	*Prionotus carolinus*	Sole, English	*Pleuronectes vetulus / Parophrys vetulus (PFMC)*
Searobin, striped	*Prionotus evolans*	Spadefish, Atlantic	*Chaetodipterus faber*
Seatrout, sand	*Cynoscion arenarius*	Spot	*Leiostomus xanthurus*
Seatrout, spotted	*Cynoscion nebulosus*	Squirrelfish, longspine	*Holocentrus rufus*
Sergeant major	*Abudefduf saxatilis*	Stargazer, northern	*Astroscopus guttatus*
Shad, American	*Alosa sapidissima*	Stargazer, southern	*Astroscopus y-graecum*
Shad, gizzard	*Dorosoma cepedianum*	Stingray, Atlantic	*Dasyatis sabina*
Shad, hickory	*Alosa mediocris*	Stingray, round	*Urobatis halleri*
Shark, Atlantic sharpnose	*Rhizoprionodon terraenovae*	Stingray, southern	*Dasyatis americana*
Shark, blacknose	*Carcharhinus acronotus*	Sturgeon, green	*Acipenser medirostris*
Shark, blacktip	*Carcharhinus limbatus*	Sturgeon, white	*Acipenser transmontanus*
Shark, bonnethead	*Sphyrna tiburo*	Sunfish, redbreast	*Lepomis auritus*
Shark, brown smoothhound	*Mustelus henlei*	Surfperch, barred	*Amphistichus argenteus*
Shark, bull	*Carcharhinus leucas*	Surfperch, redtail	*Amphistichus rhodoterus*
Shark, dusky	*Carcharhinus obscurus*	Surfperch, silver	*Hyperprosopon ellipticum*
Shark, finetooth	*Carcharhinus isodon*	Surfperch, spotfin	*Hyperprosopon anale*
Shark, gray smoothhound	*Mustelus californicus*	Surfperch, walleye	*Hyperprosopon argeneum*
Shark, lemon	*Negaprion brevirostris*	Surgeon, ocean	*Acanthurus bahianus*
Shark, leopard	*Triakis semifasciata*	Tang, blue	*Acanthurus coeruleus*
Shark, nurse	*Ginglymostoma cirratum*	Tarpon	*Megalops atlanticus*
Shark, sandbar	*Carcharhinus plumbeus*	Tautog	*Tautoga onitis*
Shark, scalloped hammerhead	*Sphyrna lewini*	Threadfin, Atlantic	*Polydactylus octonemus*
Shark, smalltail	*Carcharhinus porosus*	Timucu	*Strongylura timucu*
Shark, smooth dogfish	*Mustelus canis*	Toadfish, Gulf	*Opsanus beta*
Shark, soupfin	*Galeorhinus galeus*	Toadfish, oyster	*Opsanus tau*
Shark, spinner	*Carcharhinus brevipinna*	Tomcod, Atlantic	*Microgadus tomcod*
Shark, spiny dogfish	*Squalus acanthias*	Tomcod, Pacific	*Microgadus proximus*
Sheepshead	*Archosargus probatocephalus*	Tomtate	*Haemulon aurolineatum*
Silverside, rough	*Membras martinica*	Topsmelt	*Atherinops affinis*
Skate, big	*Raja binoculata*	Trevally, black	*Caranx lugubris*
Skate, California	*Raja inornata*	Tripletail	*Lobotes surinamensis*
Skate, clearnose	*Raja eglanteria*	Trout, cutthroat	*Oncorhynchus clarki*
Skate, little	*Leucoraja erinacea*	Trout, steelhead	*Oncorhynchus mykiss*
Skate, winter	*Leucoraja ocellata*	Trunkfish	*Lactophrys trigonus*
Smelt, rainbow	*Osmerus mordax*	Trunkfish, spotted	*Lactophrys bicaudalis*
Smelt, surf	*Hypomesus pretiosus*	Tube-snout	*Aulorhynchus flavidus*
Snapper, cubera	*Lutjanus cyanopterus*	Turbot, diamond	*Hypsopsetta guttulata*
Snapper, dog	*Lutjanus jocu*	Warmouth	*Lepomis gulosus*
Snapper, gray	*Lutjanus griseus*	Weakfish	*Cynoscion regalis*
Snapper, lane	*Lutjanus synagris*	Whiff, bay	*Citharichthys spilopterus*
Snapper, mahogany	*Lutjanus mahogoni*	Wolf-eel	*Anarrhichthys ocellatus*
Snapper, mutton	*Lutjanus analis*		

**Note: 2000–2004 recreational harvest data not available for shellfish species such as oysters, clams, scallops, mussels, crabs, lobsters, and shrimp.