Warmwater Marine Finfish in the Southern Tier States: Assessment of Historic Supply and its Implications for Aquaculture Commercialization

AAEC-305NP

VIRGINIA AGRICULTURAL EXPERIMENT STATION
VIRGINIA SEAFOOD AGRICULTURAL RESEARCH AND EXTENSION CENTER
VIRGINIA TECH

Warmwater Marine Finfish in the Southern Tier States: Assessment of Historic Supply and its Implications for Aquaculture Commercialization

October 2022

About the Project

The overall goal of this project is to develop scientifically sound information on the existing markets and marketing of warmwater marine finfish species identified as species of interest by USDA ARS in Southern tier states.

Authors

Carole R. Engle
Jonathan van Senten
Cristina Watkins

Acknowledgments

This work was supported by award number 58-0208-0-104 from the USDA Agricultural Research Service. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the Agricultural Research Service (ARS) or the United States Department of Agriculture (USDA).

VIRGINIA AGRICULTURAL EXPERIMENT STATION
VIRGINIA SEAFOOD AGRICULTURAL RESEARCH AND EXTENSION CENTER
VIRGINIA TECH

SEAMaR Seafood Economic Analysis & Marketing Research

About the Virginia Seafood AREC

The Virginia Seafood Agricultural Research and Extension Center provides education, scientific and technical guidance, support, and leadership to the commercial seafood and aquaculture industries throughout Virginia and the United States.

About SEAMaR

The Seafood Economic Analysis and Marketing Research (SEAMaR) program at VSAREC spans areas of business development, policy, marketing, and economics.

Virginia Seafood AREC
15 Rudd Lane
Hampton, VA 23669
757-727-4861
www.arec.vaes.vt.edu/arec/virginia-seafood

Table of Contents

List of Tables

List of Figures

Executive Summary

Aquaculture farming practices and technologies have expanded rapidly in recent years, particularly those for farming marine finfish. Global production of marine finfish has grown, both in total volume of production but also in the number of species farmed commercially. In the U.S., there has been little commercial production of marine species other than salmon and redfish. While there still are important production bottlenecks for some species, for many others, the key questions are related to the best ways to develop economically feasible farms and markets. This report is the first of a series that will begin to address the key economic questions related to economically feasible marine fish farming in the U.S. This report focuses on an analysis of the current supply of each of 20 marine finfish species selected for inclusion in this project. Subsequent reports will present results of surveys of consumers and distributors followed by estimates of production costs.

For the supply analysis, data were compiled on aquaculture production, commercial and recreational landings, and associated regulations. Since successful marketing strategies differ among products that are already well known to consumers and those that are not, the 20 species examined in this study were divided into one of four categories: 1) well-recognized in the U.S. market; 2) well-recognized in regional U.S. markets on the East and Gulf Coasts; 3) well-recognized in regional U.S. markets on the West Coast; and 4) largely unknown in U.S. markets.

The current commercial supply of each of these species is the sum of the commercial landings and the volume of imports into the U.S. With the exception of sablefish and Atlantic cod, the overall commercial supply of these species is quite low. The 96 million pounds of total commercial supply (commercial landings summed with imports) in 2019 of the 20 species considered in this project were only 17% of the total volume sold of farm-raised catfish in the U.S. Thus, the current effective market demand for these 20 species is low. From the perspective of aquaculture farming, several small/medium-scale farms would be sufficient to meet current demand for each of these species. Moreover, commercial landings for 17 of the 20 species exhibited declines; for some species the declines were a number of years ago, whereas the declines were more recent for other species.

The supply analysis further confirmed the high degree of variability of commercial landings. An important advantage of aquaculture is that it typically results in much greater consistency of sizes, volumes, and availability. Periods of declining supplies for a particular species may offer windows of opportunity for an aquaculture farm to gain a foothold in that market. With declining supplies, market price then often increases, potentially offering an opportunity to weather the early startup years and prepare for subsequent price declines as farmed supplies increase.

There are several important unknowns related to the economic feasibility of aquaculture farms for these species. Subsequent phases of this project are expected to provide insights into potential market price points and costs of production. A third unknown, however, is how quickly imports from other countries will emerge as important competitors. All successful businesses attract competition that increases supply and puts downward pressure on prices. Thus, business plans must be developed to prepare for the competition that comes as

a result of success market development. An additional unknown is the extent of substitutability by consumers among various marine species. If consumers readily substitute among various species of finfish, much of the competition will be on price. Successful farms would need to find ways to differentiate their product from other marine finfish generally to be able to sell at a higher price.

An interesting potential effect on the supply of these species is that of the recreational catch. Recreational landings were greater than commercial landings for 14 of the 20 species considered in this project. Only four of the species had commercial landings that were greater than recreational landings, and there were no recreational landings for two others. Recreational landings are unlikely to have a direct effect on overall demand for these species because anglers fish primarily for recreation. However, the extent to which anglers might wish to purchase the same species at a restaurant or supermarket does not appear to have been examined to any degree in the research literature. Given that the effect of recreational catch of these species is unknown, this analysis has assumed that recreational anglers are unlikely to wish to spend money on fish that they can catch on their own. However, there likely is an indirect effect of the recreational catch on demand for these species. Increasing volumes of recreational landings would be expected to increase awareness and perhaps positive perceptions of species caught recreationally. A second indirect effect would occur if lobbying efforts by anglers result in increased shares of catch quotas allocated to anglers, thereby decreasing allocations and landings from commercial fishing. Decreased commercial landings would decrease commercial supply of that species in the market.

Additional uncertainties exist for commercialization of these species. An important limitation to this study is the lack of readily available data on the volumes of imports of several of these specific species. For example, import data tends to aggregate a variety of species into categories such as “flounder,” “bass,” and “snapper.” Imported farmed volumes of these species will likely be a major source of competition for U.S. aquaculture farms, but farmers will be at a disadvantage without reliable data on those volumes of imports. Additional uncertainties exist with regard to regulatory issues and constraints, international trading conditions, and overall economic conditions both domestically and internationally.

In summary, current markets for these 20 species are quite small. Meeting the demand for most of these species with farmed product will mean producing and selling only low volumes initially. Low volumes are typically accompanied by higher costs. Thus, target markets will need to be upscale, high-end markets. A key to success likely will be developing the logistical capability to deliver extremely fresh product of consistent size on a very regular basis. Developing customer loyalty and a brand identify will also be important to prepare for the competition that will inevitably follow success of the business. Over time, it will be important to achieve economies of scale, but to do so will require creating new markets for the fish raised.

Specific marketing strategies will vary depending on whether the fish raised is one that is well known in the targeted markets or not. For well-known species, price competition with commercial supplies will be a factor in the early years. Developing a partnership with a specialty seafood distributor can often be helpful in working through decisions on positioning farmed supply in markets where the fish is well known. If the fish is not well known in the targeted market area, then new product introductory strategies will be

necessary. These often involve offering samples in restaurants and supermarkets, offering fish as a “Catch of the Day”, eliciting the assistance of a well-known local chef, or other innovative product introduction strategies.

Acronyms & Definitions

Federal Waters – Federal waters extend from where state waters end out to 200 nautical miles, except in cases where waters hit those of other countries such as in the Caribbean.

FL – Fork Length; measured from the tip of the jaw or snout to the center of the fork in the tail

Marine Fisheries Commissions & Councils
ASMFC – Atlantic States Marine Fisheries Commission
SAFMC – South Atlantic Fishery Management Council
MAFMC – Mid Atlantic Fishery Management Council
GOMFMC – Gulf of Mexico Fishery Management Council
NEFMC – New England Fishery Management Council
PFMC – Pacific Fishery Management Council
NPFMC – North Pacific Fishery Management Council
CFMC – Caribbean Fishery Management Council

Overfished – A stock having a population size that is too low and that jeopardizes the stock’s ability to produce its maximum sustainable yield (MSY) (NOAA, 2020a)

Overfishing – A stock having a harvest rate higher than the rate that produces its maximum sustainable yield (MSY) (NOAA, 2020a)

Product forms
Frozen fillet blocks - Frozen blocks of fish fillets
Fillets
Whole fillets – entire portion of the meat cut from the side of the fish
Belly fillets – the portion of a fish fillet closes to the belly region (as opposed to the top loin near the top of the fillet and the loin in the middle of the fillet)
Collar cuts – cut of fish from just behind the gills with rich meat

RMAs – Regulated Mesh Areas.

State Agencies Involved in Fisheries Management
ADCNR – Alabama Department of Conservation and Natural Resources
CDFW – California Department of Fish & Wildlife
CT DEEP – Connecticut Department of Energy & Environmental Protection
DDNREC – Delaware Department of Natural Resources & Environmental Control
FWC – Florida Fish and Wildlife Conservation Commission
GADNR – Georgia Department of Natural Resources
LDWF – Louisiana Department of Wildlife & Fisheries
MDNR – Maryland Department of Natural Resources
MDMR – Mississippi Department of Marine Resources

NYS DEC – New York State Department of Environmental Conservation
NCDMF – North Carolina Division of Marine Fisheries
ODFW – Oregon Department of Fish & Wildlife
SCDNR – South Carolina Department of Natural Resources
TPWD – Texas Parks & Wildlife Department
VMRC – Virginia Marine Resources Commission

State Waters – State waters extend out to three nautical miles on the Atlantic and Pacific coasts and extend out to nine nautical miles in the Gulf of Mexico.

TL – Total Length; measured from the most forward point of the head to the farthest tip of the tail with the tail compressed or squeezed **In Regulations section – all fish lengths are “total length” (TL) unless otherwise specified.

Introduction

Aquaculture has grown rapidly around the world, accounting for 52% of all fish produced for human consumption in 2018 (FAO 2020). While shellfish farming in marine waters has been an important component of aquaculture for centuries, finfish production has historically consisted primarily of freshwater species, with carp and tilapia being the major cultured finfish worldwide. The relatively recent exception is that of salmon raised in net pens that grew in importance to become the eighth most important finfish by aquaculture production by 2012, following seven freshwater finfishes (FAO 2020). Over the past several decades, interest in farming marine finfish has grown, and the rate of technological development of farming practices and methods for marine finfish has increased rapidly.

Globally, aquaculture has grown rapidly, at 5.3% annual growth from 2001 to 2018, accounting for 46% of global fish production in 2018 (FAO 2020). Marine finfish production contributed 13.4% of the global finfish production from aquaculture. Salmon is the major marine finfish species produced globally, ranking 9th in importance of the top aquaculture species (not just finfish). Moreover, global salmon production increased by 70% from 2010 to 2018. Of greater interest to this study is that the "other marine fish" category contributed 1.4% of the 2018 share of all finfish produced in aquaculture, with production volumes that increased by 64% from 2010 to 2018.

Research on marine finfish farming technologies has increased globally as well as in the U.S., resulting in a number of critical breakthroughs in larval feeding and hatchery methods for a wide range of species. For some species, sufficient technological information is available to support burgeoning commercial production of that species, whereas for other species, there are still important bottlenecks in the state of knowledge of efficient culture methods. For some species, it is biologically possible to grow the fish to market size, but the economic requirements for feasible production are not known. Thus, there are many questions about how to commercialize new, marine finfish farming technologies, even for those species for which there appears to be sufficient information for commercial production.

Published literature on the growth and development of several successful sectors of aquaculture have documented several salient points. For a number of species like U.S. catfish, efficient fingerling production practices were developed by stock enhancement programs decades before the first private growout ponds were built (Engle et al. 2021). The salmon, red drum, and tilapia foodfish sectors all followed long-term breeding and fingerling rearing success, often by state and federal hatcheries charged with enhancement of stocks of wild fish. Nevertheless, commercial sectors have not developed for all species for which efficient fingerling production methods have been established. While adoption of new technologies in aquaculture, as in agriculture, are triggered to some degree by technological breakthroughs (Kumar and Engle 2016), other factors also play critical roles as to whether and when new technologies are adopted by farmers (Kumar et al. 2018a; 2020a,b).

A series of economic and risk factors affect whether farmers will adopt new technologies or raise new species. Studies have shown that on-farm trials that demonstrate and verify performance of critical production parameters (i.e., growth, survival, yield, feed conversion ratio, time to market size) have been important for adoption (Kumar et al. 2018b). Production methods must also be shown to be sufficiently efficient to result in costs of production that

will allow the farmer to be competitive in seafood markets. The question is not only whether a type of fish can be grown to market size or not, but whether it can be grown at a cost that is less than market price received by the farm. Thus, market windows of opportunity and the overall marketing strategy selected by the farm business are critical in terms of the success of a farm raising any given species.

Marketing strategies for products depend upon the characteristics of the product. For example, a successful marketing strategy to raise and sell a species of marine fish that is well known in the markets to be targeted will necessarily be quite different from that needed to successfully develop a market for an unknown species of fish. For a well-known species, understanding the availability of supply and common price points will be critical to develop a strategy to compete effectively (on price and taste) with that current supply or find a way to differentiate it slightly from the current supply. However, if the species is not available and largely unknown to consumers in the targeted market, then the marketing strategy will need to focus on developing consumer awareness by providing samples for tasting and advertising that introduce new species. The market will then need to be built from that initial product introduction. There are models of U.S. aquaculture for each of the above situations in which enterprising farmers have developed successful marketing strategies and farms for species that were well known previously and for those that were not well known previously in the targeted market areas.

Economic feasibility, in its simplest form, entails comparison of the cost per pound of production with a realistic average market price ($/lb). Both costs of production and market prices vary across specific markets (geographic, demographic) and over time. Input costs and market price variations result from the various determinants of demand and supply. Thus, understanding both demand and supply for any new species is important information in the assessment of overall feasibility.

Commercial aquaculture production, including that of warmwater marine finfish (Engle et al. 2020), has been slower to develop in the U.S. as compared to other countries, despite the knowledge and suitable technologies in place to produce these species. While regulatory challenges have affected the development of offshore marine aquaculture in the U.S., there are other challenges affecting warmwater marine finfish that warrant further investigation. Readily accessible information on the size of markets, consumer preferences, and market opportunities for warmwater marine finfish species for U.S. aquaculture production are currently unavailable. Understanding the existing supply (and implications for price), major geographic markets, and preferences of consumers and supply chain distributors who handle these products are critical elements in successful business planning and business development. This report summarizes the supply of warmwater marine finfish species of interest in Southern tier states.

Seafood markets have developed historically based on the supply of the fish caught locally (Engle et al. 1990). As fishing, processing, and packaging have improved, seafood has become a major globally traded commodity. Yet, the demand for specific seafood species in some cases remains highly localized while, for others such as cod, salmon, and shrimp, demand has spread across the world.

A new aquaculture business seeking to supply U.S. markets with one of these species will need to identify a market window of opportunity to begin to penetrate markets that historically were created for and have been supplied largely by commercial landings. In more recent years, the increased volume of imports has contributed to the overall supply of seafood. Thus, the immediate competition for a new aquaculture venture are the fish supplied from commercial fishing and, increasingly, from imports. This project aims to develop a base of information on the historical and current supplies of selected marine finfish species entering U.S. markets.

Study Objectives

The overall goal of this project was to develop scientifically sound information on the existing markets of warmwater marine finfish species identified as species of interest by USDA ARS in Southern tier states (Table 1). Year 1 of the project focused on market information related to current supplies and the consumer/buyer preference determinants of demand. This information will allow for a better understanding of the scale of production required to satisfy current markets and identify potential opportunities for new market development for U.S. aquaculture production of warmwater marine finfish. Year 2 of this overall project will focus on costs of production for these same species. The focus of this project is on domestic, U.S. markets for these species.

Table 1. Species identified as those for which sufficient farming technology has been developed to consider for aquaculture production.

Common Name	Scientific Name
Almaco jack	*Seriola rivoliana*
Atlantic cod	*Gadus morhua*
Black drum	*Pogonias cromis*
Black sea bass	*Centropristis striata*
California flounder	*Paralichthys californicus*
California yellowtail	*Seriola lalandi (formerly S. dorsalis)*
Cobia	*Rachycentron canadum*
Florida pompano	*Trachinotus carolinus*
Greater amberjack	*Seriola dumerili*
Olive flounder	*Paralichthys olivaceus*
Red drum	*Sciaenops ocellatus*
Red snapper	*Lutjanus campechanus*
Sablefish	*Anoplopoma fimbria*
Southern flounder	*Paralichthys lethostigma*
Spotted seatrout	*Cynoscion nebulosus*
Spotted wolffish	*Anarhichas minor*
Striped bass	*Morone saxatilis*
Summer flounder	*Paralichthys dentatus*
Tripletail	*Lobotes surinamensis*
White sea bass	*Atractoscion nobilis*

Specifically, the project objectives are as follows:

1) Assess and summarize the current supply from wild capture, domestic aquaculture production, and international trade for the warmwater marine finfish species of interest as identified by the USDA ARS.

2) Assess and summarize consumer preferences for native and locally available warmwater marine finfish in Southern tier states, including those identified as species of interest by USDA ARS.

3) Assess and summarize wholesaler/distributor preferences and interest in aquaculture warmwater marine finfish in corresponding Southern tier states.

This report is a summary of findings for Objective 1 (Year 1), analysis of the supply of the 20 species of marine finfish identified as species of interest for commercialization. Other reports will be developed with results of the consumer preference survey (Objective 2; Year 1) and the wholesaler/distributor survey (Objective 3; Year 1).

Results of this supply analysis, when combined with consumer and wholesaler/distributor demand and Year 2 production cost information, are expected to provide a basis of information useful to prospective investors and entrepreneurs for these species.

Methodology

Data were gathered and summarized on the current supply of the 20 warmwater marine finfish species identified in Table 1. Data were compiled, where available, on aquaculture production, imports, commercial landings, and recreational landings.

Aquaculture data for U.S. production were collected from the 2018 Census of Aquaculture (USDA-NASS 2019) and globally from FAO (2021a). Additional data were collected through a literature search of major aquaculture science journals. Aquaculture production and marketing is regulated by a different set of federal, state, and local agencies and statutes. Regulations for specific species were summarized where available and relevant.

Import statistics from the NOAA foreign trade database were collected from U.S. Customs and Border Protection that receives data from importers submitting transactions using the international Harmonized Commodity Description and Coding System (HCDCS) (https://usitc.gov/harmonized_tariff_information). Typical categories for finfish imports included: fresh, fresh fillet, other fresh meat, frozen, frozen fillet, and frozen fillet blocks, although there are reports of some live fish imports, such as olive flounder from South Korea.

Landings statistics collected from the National Marine Fisheries Database provided summaries of annual domestic fishery landings in the 50 states by U.S. fishermen (NOAA, 2021a). Landings are reported in pounds of whole live weight. When fish are processed or gutted at sea, this weight is converted to whole live weight using standard conversion factors. Import volume data (annual) were collected from the NOAA Foreign Trade Database

(NOAA 2021a) and the NOAA Landings Database (NOAA 2021b). Additional data were collected from state-mandated fishery landing weigh-out reports from seafood dealers, federal logbooks of fishery catch and effort, and shipboard and portside interviews through state-federal partnerships. Given the substantial variability in commercial and recreational landings year-to-year, best-fit polynomial trendlines were developed for landings data for each fish species.

Seasonal availability of marine finfish affects demand in various ways. Species with restricted fishing seasons may offer market opportunities for aquaculture farms that can provide a consistent supply of fish to customers. To compare the seasonality of availability across species, fishing seasons for each species were categorized numerically, with 1 being the least restrictive (open year-round) to 5 the most restrictive (closed year-round). Level 2 seasonality includes species with seasons that are open year-round but have catch shares or quotas in place. Level 3 seasonality includes species that are closed part of the year with catch shares or quotas in place, and Level 4 includes species that are open only a few months per year.

Marine finfish seasons and catches are regulated federally, often through Marine Fisheries Councils, and by states. Regulations for commercial and recreational fisheries was obtained from the NOAA Fisheries websites for each species for which data were available, interstate management documents of marine fisheries councils and commissions (ASMFC 2002, 2011, 2018a,, 2019a,b, CDFG 2002, CFMC 1985, GOMFMC 1984, 2001, NCDEQ 2021a, NEFMC 1985, NPFMC 2020a,b, PFMC 2019, SAFMC 2020), and state agencies involved in fisheries management (ADCNR 2021, CDFW 2021a,b, CT DEEP 2021, DDNREC 2021, FWC 2021a,b,c, GADNR 2021, LDWF 2021a,b, MDNR 2021, MDMR 2021a,b, NYS DEC 2021, NCDEQ 2021a,b, ODFW 2021, SCDNR 2021, TPWD 2021, VMRC 2021).

Data in this report span up to the year 2019 and do not include information from the year 2020. The public health crisis created by the COVID-19 pandemic led to shutdowns, both temporary and permanent, of many businesses in the seafood industry including restaurants, wholesalers, commercial aquaculture producers, and others. Imports of many marine finfish as well as commercial and recreational landings were lower in 2020 than in typical years. As such, data from the year 2020 were omitted to avoid biases due to the severe disruptions caused by the pandemic (van Senten et al. 2020a; van Senten et al. 2021).

Results

The following section includes a summary of results with a synthesis of trends and important information for each species. Each of the 20 species were categorized into one of the following marketing strategies categories: 1) well-recognized in the U.S. market; 2) well-recognized in regional U.S. markets on the East and Gulf Coasts; 3) well-recognized in regional U.S. markets on the West Coast; and 4) largely unknown in U.S. markets. Information on aquaculture production and regulations, imports, commercial landings and regulations, and recreational landings and regulations, are summarized for each species with more detailed information included in the corresponding appendix for each species.

Overview

Aquaculture

The total value of aquaculture production in the U.S. in 2018 was $1.5 billion (USDA-NASS 2019). Of this total, the greatest category was that of foodfish sales that composed nearly half (47%) of the value of all aquaculture sales in the U.S. (Figure 1). Total sales of foodfish have increased from roughly $672 million in 2005 to $716 million in 2019. Of total foodfish sales, freshwater fish accounted for 84% of the value of U.S. foodfish production. Mollusks comprised the second largest sector and have shown rapid growth over time. There also has been some growth over time in the miscellaneous species category, some of which may include small numbers of farms raising marine finfish species.

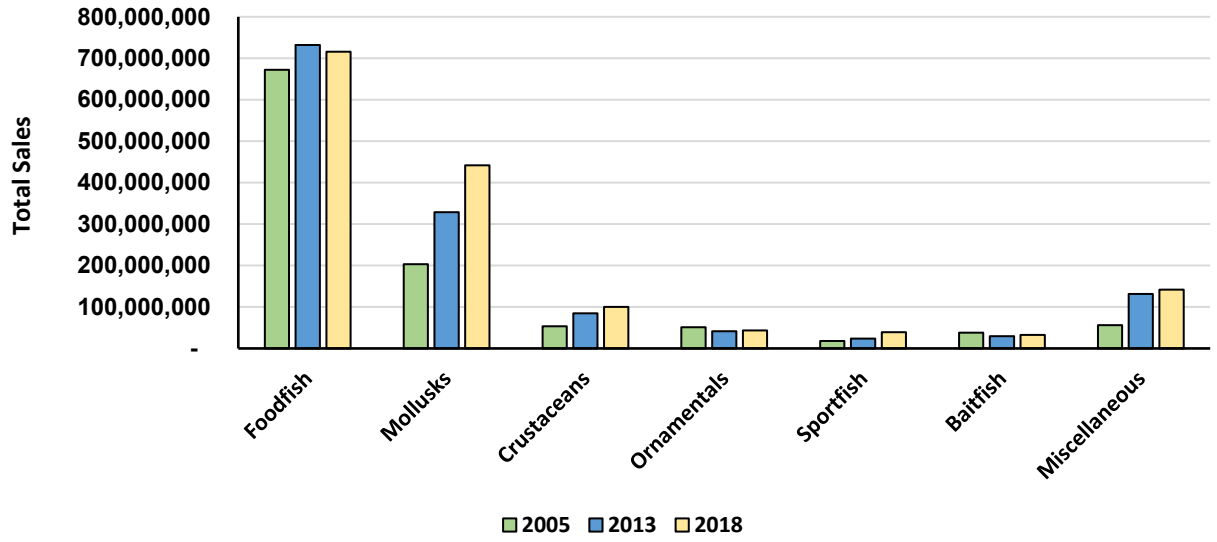

Figure 1. Sales ($) of foodfish farms in U.S. compared to other U.S. aquaculture sectors, 2005, 2013, and 2018. Sources: Census of Aquaculture, 2005, 2013, and 2018.

Catfish, by far the leading species raised in U.S. aquaculture generally and of foodfish sales, composed more than half (51%) of the value of all foodfish sales in the U.S. (Figure 2). The only marine finfish production of substantial volume in 2018 was that of salmon (for which the value could not be disaggregated from the total, given the small number of salmon farms in the U.S.) and red drum ($19 million). Red drum production in the U.S. has increased from 3.3 million lb in 2013 to 7.1 million lb in 2018, a 115% increase. Sales for red drum also increased, from $10.2 million to $19.5 million over the same time period, an increase of 91%. The 2005 Census of Aquaculture included three Pacific threadfin farms, but sales values were excluded for confidentiality purposes.

The “other foodfish” category in the U.S. Census of Aquaculture likely includes some production of a few farms that raise marine finfish on a relatively small scale. Species that

have been mentioned anecdotally as being farmed in the U.S. have included Florida pompano, kampachi, and flounder.

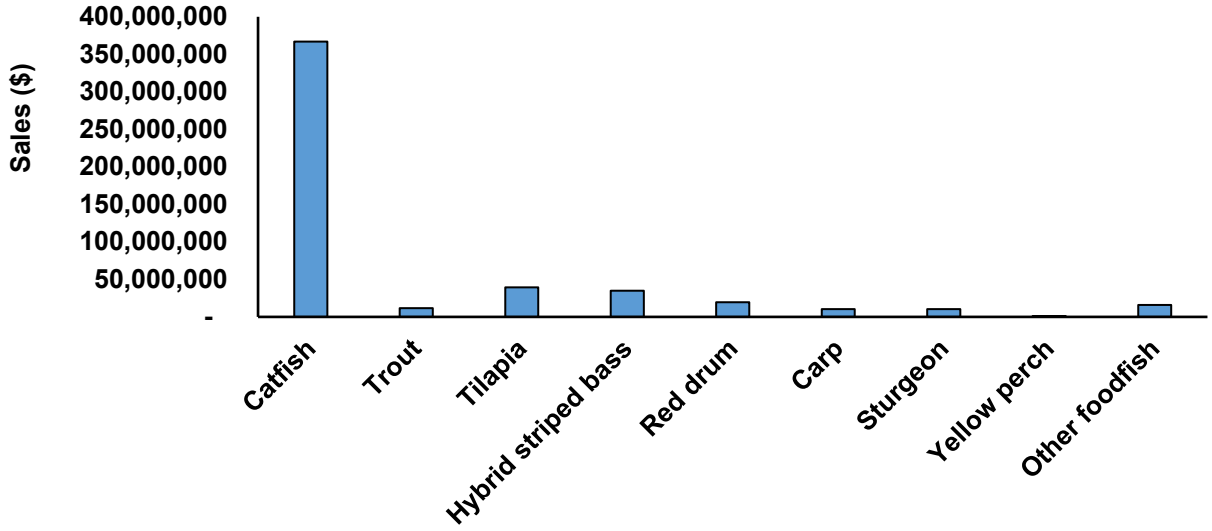

Figure 2. Sales of aquaculture foodfish by species, 2018. Note that several species, including flounder and salmon were produced in the U.S. but values were withheld for confidentiality purposes. SOURCE: Census of Aquaculture 2018 (USDA-NASS 2019).

The total number of aquaculture farms has declined over time, but nearly all of the decrease was in the smallest size category of aquaculture farms (with < $25,000 per year annual sales) (Figure 3). The number of farms in the largest size category (> $1 million per year annual sales) has increased at a small, steady rate over time.

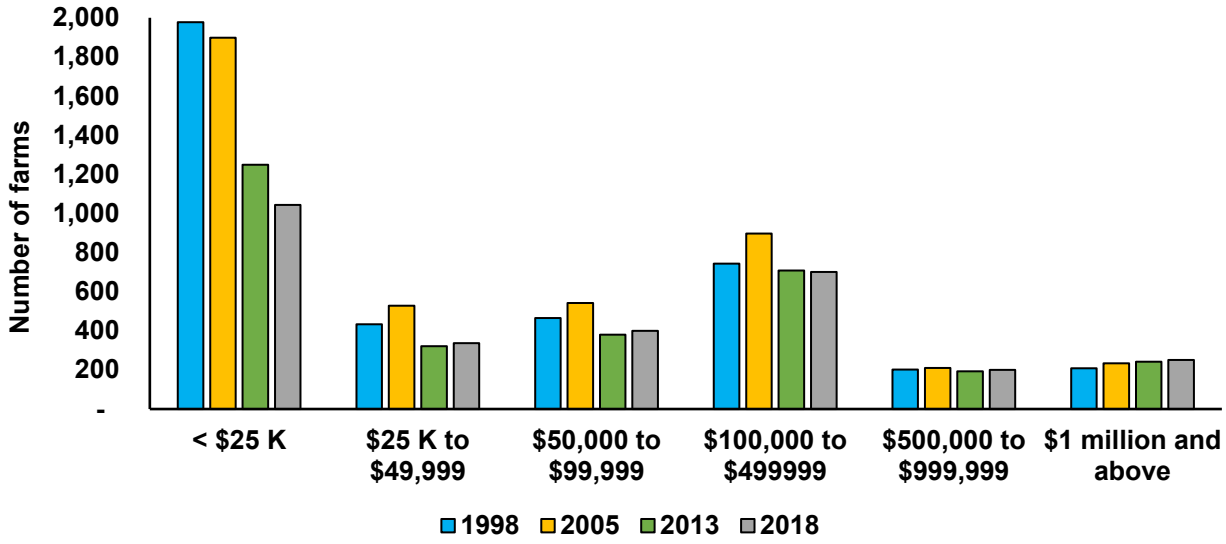

Figure 3. Farm size distribution of U.S. aquaculture by sales categories, 1998 to 2018. SOURCE: Census of Aquaculture 1998, 2005, 2018 (USDA-NASS 1999, 2006, 2014, 2019).

Aquaculture Regulations

Aquaculture production in the U.S. is regulated by state and federal agencies. More than 1,300 laws apply to U.S. aquaculture, and regulations can be categorized into environmental, food safety, legal and labor standards, interstate transport, fish health, and culture of commercially harvested species (Engle & Stone, 2013). Over 15 federal and dozens of state agencies as well as roughly 32 major federal statutes and regulations also regulate U.S. aquaculture. At the federal level, leading agencies include the Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), the Food and Drug administration (FDA) and the Animal Plant and Health Inspection Service (APHIS). State and local governments also regulate permitted and licensed aquaculture activities such as zoning, water use and discharge, species certifications, processing, and trade. For detailed information on aquaculture regulations in the U.S., see Engle and Stone (2013); van Senten & Engle (2017); van Senten et al. (2018); van Senten et al. (2018a,b); Engle et al. (2019); and van Senten et al. (2020b). These various studies have shown that the regulatory frameworks for U.S. aquaculture have generally constrained its growth through lengthy, multi-year delays in obtaining permits for aquaculture farming that have prevented businesses from expanding to meet growing demand for their products.

Aquaculture in marine and coastal areas faces even more challenging regulatory issues in the U.S. that originate from the complex jurisdictional issues. In some states in the U.S., the regulatory authority for local coastal water bodies can be with either local, county, state, or federal agencies, sometimes in various combinations of overlapping jurisdictions (van Senten et al. 2020b). In addition, many marine species with potential to be farmed are also game, or sportfish species. Laws to prohibit illegal catch and sale of gamefish and sportfish, when applied without modification, to farmed fish of the same species, constrain access to markets for farmed fish. In addition, there is no clear regulatory authority for offshore farming of marine finfish, and attempts to develop farms in marine waters have resulted in various legal challenges. Thus, the regulatory framework in the U.S. is one of the major constraints to increased farming of marine finfish in the U.S.

Import/Export of Seafood

The U.S. is a leading global importer of seafood. Imported seafood makes up approximately 90% of the seafood available for consumption in the U.S., and of this, estimates suggest roughly half of the imports are from aquaculture (NOAA, 2021c). The trade deficit for U.S. seafood was $16.8 billion in 2018 (NOAA, 2020b).

For the species of interest in this study, species-specific import data were found only for: Atlantic cod, cobia, sablefish, and spotted wolffish. The NOAA Foreign Trade Database utilizes broad categories which aggregate data from several species into single groups. For example, the category of “Snapper” includes all species in the *Lutjanidae* family, “Flounder,” includes

all species of the *Pleuronectidae, Bothidae*, and *Citharidae* families, and "Seabass," includes fish in the Dicentrarchus genus only (thus, not including white or black sea bass or striped bass (Michael Liddel, personal communication). Best-fit trendlines were developed for imported quantities of Atlantic cod, wolffish, cobia, and sablefish and graphed.

Commercial and Recreational Landings

The 20 species considered in this analysis are characterized by very different volumes of U.S. commercial landings, ranging from less than 20,000 lb a year to nearly 40 million lb a year (Table 2). Sablefish commercial landings exceeded all others, with a 5-yr average of 37.4 million lb/year. Summer flounder followed, with 7.7. million pounds, red snapper (6 million lb), black drum (5.9 million lb), striped bass (5.4 million lb), Atlantic cod (4.6 million lb), black sea bass (3.1 million lb), and greater amberjack (1.2 million lb). The following species had 5-yr average volumes less than 500,000 pounds: California flounder, spotted seatrout, white sea bass, Florida pompano, cobia, red drum, almaco jack, southern flounder, California yellowtail, and tripletail. No U.S. commercial landings were reported for olive flounder or spotted wolffish.

Rankings based on 5-yr averages of recreational landings differed from those based on commercial landings. Striped bass had the greatest volume of recreational landings (34.1 million lb), and was followed by red drum (21.0 million lb), spotted seatrout (17.8 million lb), red snapper (14.7 million lb), summer flounder (13.4 million lb), black sea bass (10.1 million lb), black drum (9.4 million lb), cobia (5.2 million lb), greater amberjack (3.8 million lb), southern flounder (2.7 million lb), Florida pompano (2.7 million lb), Atlantic cod (2.3 million lb), California yellowtail (0.7 million lb), tripletail (0.6 million lb), almaco jack (0.4 million lb), California flounder (0.2 million lb), and sablefish (0.003 million lb). No recreational fishing landings were reported in the U.S. for either olive flounder or spotted wolffish.

Table 2. Commercial and recreational landings of warmwater marine finfish species ranked in order of average annual commercial landings for the 5-year period between 2015-2019.

Species	Commercial landings 5-year average (lb)	Recreational landings 5-year average (lb)
Sablefish	37,348,909	3,138
Summer flounder	7,702,048	13,411,468
Red snapper	5,983,275	14,712,919
Black drum	5,857,609	9,401,350
Striped bass	5,419,333	34,081,471
Atlantic cod	4,642,316	2,346,954
Black sea bass	3,121,638	10,083,669
Greater amberjack	1,245,171	3,780,234
Southern flounder	1,137,394	2,693,588
California flounder	455,810	249,053
Spotted seatrout	377,706	17,767,632
White sea bass	265,366	91,819

Florida pompano	250,424	2,653,920
Cobia	201,587	5,244,198
Red drum	191,491	21,041,734
Almaco jack	181,867	371,539
California yellowtail	55,715	706,444
Tripletail	18,798	622,278
Olive flounder	N/A	N/A
Spotted wolf fish	N/A	N/A

Source: NOAA Landings Database (NOAA 2021b).

Table 3 lists the states with the top three landings in 2019 for each of the species in this analysis. Most of these species are caught in the Atlantic Ocean or the Gulf of Mexico. Florida is the state with the most landings for six of these species including almaco jack, cobia, Florida pompano, greater amberjack, red snapper, and tripletail. Louisiana landed the most black drum; Mississippi had the most landings of red drum, and North Carolina of southern flounder and spotted sea trout. Four of the species are landed mostly in the northeast Atlantic, including Atlantic cod (Massachusetts), black sea bass (New Jersey), striped bass (Maryland), and summer flounder (Virginia). Four of the species are landed only on the west coast, with California the top state for three: California flounder, California yellowtail, and white sea bass. Alaska is the top landing state for sablefish. Landings were not recorded in any U.S. states for olive flounder or spotted wolffish.

Table 3. Top three states for commercial landings with percentage of overall commercial catch in 2019.

Species	State with most landings	State with second most landings	State with third most landings
Almaco jack	Florida (50%)	North Carolina (30%)	South Carolina (17%)
Atlantic cod	Massachusetts (91%)	New Hampshire (4.4%)	Maine (3.9%)
Black drum	Louisiana (59%)	Texas (33%)	Virginia (2%)
Black sea bass	New Jersey (19%)	Virginia (17%)	Massachusetts (14%)
California flounder	California (100%)	N/A	N/A
California yellowtail	California (100%)	N/A	N/A
Cobia	Florida (43%)	Virginia (28%)	North Carolina (16%)
Florida pompano	Florida (90%)	North Carolina (6%)	Louisiana (2%)
Greater amberjack	Florida (70%)	Alabama (8.2%)	South Carolina (7.8%)
Olive flounder	N/A	N/A	N/A
Red drum	Mississippi (51%)	North Carolina (47%)	Virginia (2%)
Red snapper	Florida (39%)	Texas (34%)	Louisiana (18%)
Sablefish	Alaska (71%)	Oregon (14%)	California (8%)
Southern flounder	North Carolina (90%)	Florida (10%)	N/A
Spotted seatrout	North Carolina (66%)	Virginia (24%)	Mississippi (6%)

Spotted wolf fish	N/A	N/A	N/A
Striped bass	Maryland (39%)	Virginia (31%)	Massachusetts (13%)
Summer flounder	Virginia (27%)	Rhode Island (24%)	New Jersey (23%)
Tripletail	Florida (67%)	North Carolina (13%)	Mississippi (12%)
White sea bass	California (100%)	N/A	N/A

Source: NOAA Landings Database (NOAA 2021b).

Table 4 shows the top three states for recreational landings for each of the 20 species under consideration in 2019. Florida is the top state for recreational landings of almaco jack, black drum, Florida pompano, greater amberjack, red snapper, southern flounder, spotted seatrout, and tripletail. The top state for recreational cobia landings is Virginia. Black sea bass and striped bass were landed mostly in New York, and summer flounder in New Jersey. California flounder, California yellowtail, and white sea bass are mostly caught recreationally in California, and sablefish in Oregon. Recreational landings were not recorded in any states for olive flounder or spotted wolffish.

Table 4. Top three states for recreational landings with percent share of total recreational catch in 2019.

Species	State with most landings	State with second most landings	State with third most landings
Almaco jack	Florida (93%)	North Carolina (4%)	Alabama (1%)
Atlantic cod	Connecticut (41%)	Rhode Island (22%)	New York (18%)
Black drum	Florida (40%)	Mississippi (23%)	South Carolina (14%)
Black sea bass	New York (33%)	Massachusetts (14%)	Rhode Island (13%)
California flounder	California (99%)	Oregon (<1%)	N/A
California yellowtail	California (99%)	Oregon (<1%)	N/A
Cobia	Virginia (41%)	Florida (36%)	Alabama (11%)
Florida pompano	Florida (76%)	North Carolina (18%)	South Carolina (5%)
Greater amberjack	Florida (81%)	Alabama (6%)	Louisiana (4%)
Olive flounder	N/A	N/A	N/A
Red drum	Louisiana (29%)	Florida (17%)	Mississippi (21%)
Red snapper	Florida (51%)	Alabama (39%)	Mississippi (7%)
Sablefish	Oregon (100%)	N/A	N/A
Southern flounder	Florida (66%)	North Carolina (11%)	Mississippi (8%)
Spotted seatrout	Florida (32%)	North Carolina (19%)	Louisiana (12%)
Spotted wolffish	N/A	N/A	N/A
Striped bass	New York (30%)	New Jersey (29%)	Maryland (14%)
Summer flounder	New Jersey (41%)	New York (31%)	Rhode Island (11%)
Tripletail	Florida (75.5%)	Alabama (12%)	Mississippi (6%)
White sea bass	California (100%)	N/A	N/A

Source: NOAA Landings Database (NOAA 2021b)

Species summaries

Well-recognized in the U.S. market

Atlantic cod (Gadhus morhua)

The Atlantic cod fishery was one of the world's largest fisheries for several centuries. The history of over-fishing had far-reaching effects in both the EU and the U.S. By the late 1980s, the cod fishery in Canada had collapsed, and the New England cod fishery in the U.S. followed closely behind.

Aquaculture. Atlantic cod has been farmed in a number of countries, including Canada, Denmark, the United Kingdom, Norway, Ireland, Iceland, the Faroe Islands, the Russian Federation, and the United States. Cod farming dates back to the 1980s and 1990s in these countries (Nardi et al. 2021). The impetus for cod farming initially was to produce juveniles for restocking programs to enhance the cod fishery, and a number of hatcheries were constructed during the 1980s and 1990s. Part of the impetus for farming cod for foodfish markets were the high cod prices in the 1990s following collapse of the fishery and the substantial decline in supply. Cod farms, however, also faced a series of technical problems in hatcheries in the early years that affected the supply of fingerlings for foodfish farms. The global economic crisis of 2008 was the final shock that resulted in the collapse of the farmed cod industry around the world. This collapse was exacerbated by a near doubling of landings of Pacific cod that replaced Atlantic cod in the marketplace. Increased landings from the Barents Sea from 2017 to 2019, along with increased imports of pangasius catfish from Asia replaced Atlantic cod sales in the EU and in the U.S. In 2019, farmed production of Atlantic cod was reported in Iceland and Norway, at less than 2 million pounds.

Aquaculture regulations. Atlantic cod farms in the U.S. were required to tag all fish produced in net pens, adding expense in terms of manpower.

Imports. The volume of imported Atlantic cod has generally declined since 1993 (Figure 4).

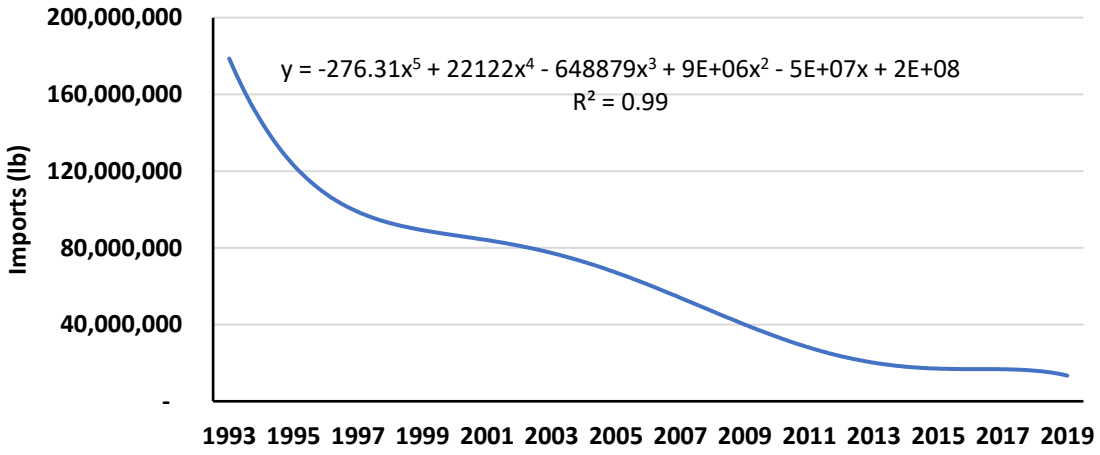

Figure 4. Trendline (fitted to a polynomial line, 5 order) of five-year average volumes of imported Atlantic cod. SOURCE: NOAA Foreign Trade Database (NOAA 2021a).

Commercial landings. In the U.S., commercial landings of Atlantic cod peaked in 1980 and subsequently declined to 2019 levels that were 1.9% of the 1980 peak (Figure 5). Landings declined from more than 75 million pounds in 1988 to just over 2 million pounds in 2019. It is of note that Pacific cod landings nearly doubled from 1988 to 2019. The top three states for commercial landings in 2019 were: Massachusetts (91%), New Hampshire (4.4%), and Maine (4%). Other states reporting commercial landings in 2019 included Connecticut, New York, and Rhode Island.

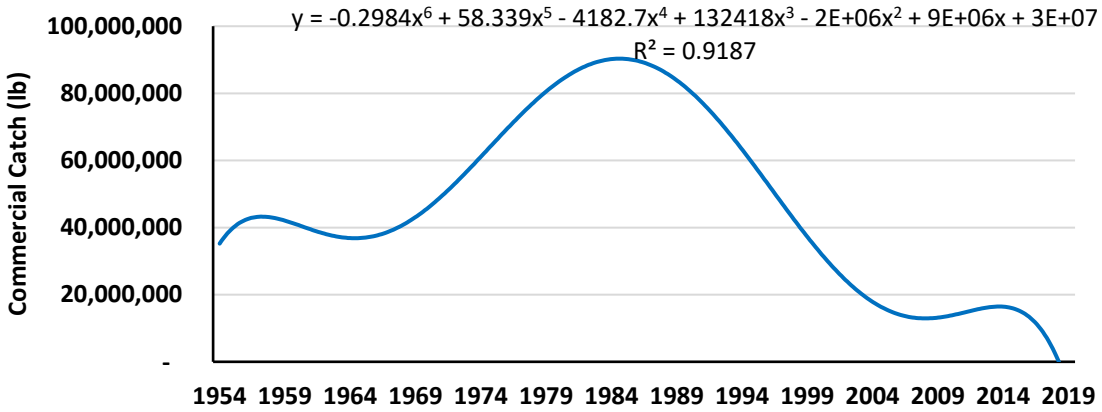

Figure 5. Trendline (fitted to a polynomial line, 6 order) for commercial Atlantic cod landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of Atlantic cod have declined from a peak in 1988 to very low levels in 2019 (Figure 6). The top three states for recreational landings of Atlantic cod in 2019 were Connecticut (41%), Rhode Island (22%), and New York (18%). Other states with recreational landings of Atlantic cod in 2019 included Maine, Massachusetts, New Hampshire, and New Jersey.

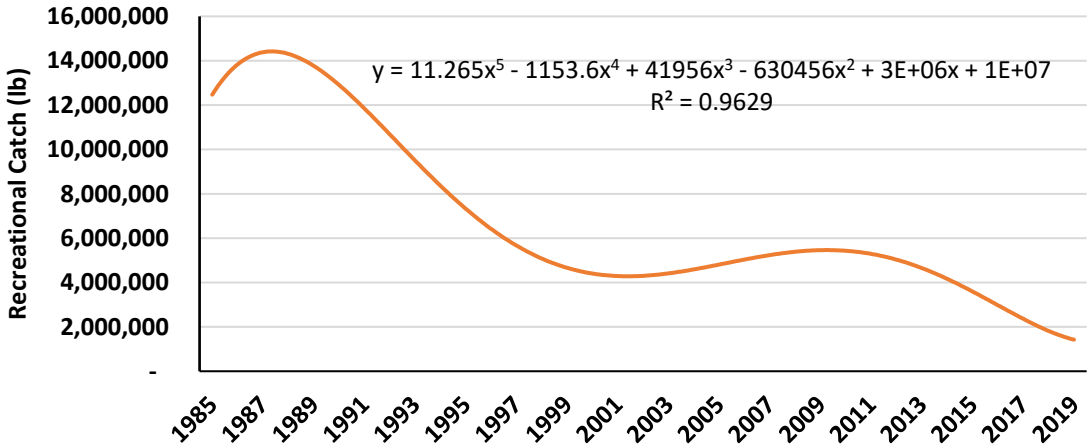

Figure 6. Trendline (fitted to a polynomial line, 5 order) for recreational Atlantic cod landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, commercial landings of Atlantic Cod in 2019 were 3.4 times greater than recreational landings of this species.

Market summary. Atlantic cod is a well-known marine finfish throughout the U.S. The majority of the Atlantic cod supplied currently is from imported wild-caught cod, estimated at a volume of 16 million pounds in 2019. Historically, Atlantic cod has been positioned as a lower-priced fish, reflective of its historically high volumes and associated lower prices (Nardi et al. 2021). The exception is that of "organic cod" produced and sold in Ireland. Farmed cod will be more expensive, and development of a new market for a high-valued product will be necessary for cod farming to expand. Farmed cod farmers will need to differentiate their fish from the current, lower-priced imported product. Re-positioning a species of fish as a higher-priced product in the market requires a continuous and consistent marketing effort over time.

Striped bass (Morone saxatilis)

Striped bass range on the East Coast from Canada to Florida (Andersen et al. 2021) with commercial and recreational fisheries that date back to pre-colonial times. The striped bass fishery collapsed in the 1980s, and a moratorium was declared in 1989. By 1995, stocks had fully recovered. The striped bass fishery is principally a recreational fishery that accounts for 60% to 70% of the total catch, with 30% to 40% of the total catch from commercial landings. While total landings increased from 1.5 million kg to 2.7 million kg in 2002, by 2019, the fisheries was once again declared to be overfished and closed from Oregon inlet to the South Carolina state line (Seafood Watch: Striped Bass 2020).

Aquaculture. Culture of striped bass began in the 1970s, but has not yet evolved into a farmed industry. Globally, there has been little farmed production of striped bass. Earliest reported farm production was 6,614 pounds annually in 2005 and 2006 in Mexico, with no further reports of production until 2014. From 2014 to 2019, volumes of farmed striped bass have ranged from approximately 450,000 lb a year to 1 million lb a year (FAO 2021a). Most of the production in 2019 was in Mexico with some minimal production in Palestine. In North America, there is one farm in Mexico that raises striped bass in floating net pens (Seafood Watch: Striped Bass 2020). Production from this farm was 1.2 million pounds in 2018, all of which were exported to the U.S. While striped bass are not native to the Pacific Ocean, they were introduced to California in the 1880s and stocked by the California Department of Fish and Wildlife until 2000. Striped bass have been raised experimentally in RAS, reaching 1.36 kg in 18 months and 2.27 kg in 24 months.

Hybrid striped bass (*Morone chrysops* x *Morone saxatilis*), a cross between white and striped bass, have been farmed commercially since the 1980s collapse of the wild Chesapeake Bay striped bass fishery. Hybrid striped bass, however, are sold as a different product, at a smaller size of 0.7 to 0.9 kg, with reported prices of $8.45 to $9.25/kg (Andersen et al. 2021).

Aquaculture regulations. In California, farmed hybrid striped bass must be either tagged or packaged according to regulations to ensure that fish were not caught from the wild. It is

likely that similar requirements would be enacted for farmed striped bass in California and other states. State laws on marine gamefish have constrained aquaculture of various marine fish species.

Commercial landings. Striped bass commercial landings appear to exhibit a nearly 20-year cycle (Figure 7). The trough of the previous cycle led to a surge in prices that opened market opportunities for hybrid striped bass farms to gain a foothold in markets. The most recent peak in 2010 was substantially lower than the previous peak in 1973. The top three states for commercial landings of striped bass in 2019 were: Maryland (39%), Virginia (31%), and Massachusetts (13%). Additional landings were reported in North Carolina, Connecticut, Delaware, New York, and Rhode Island.

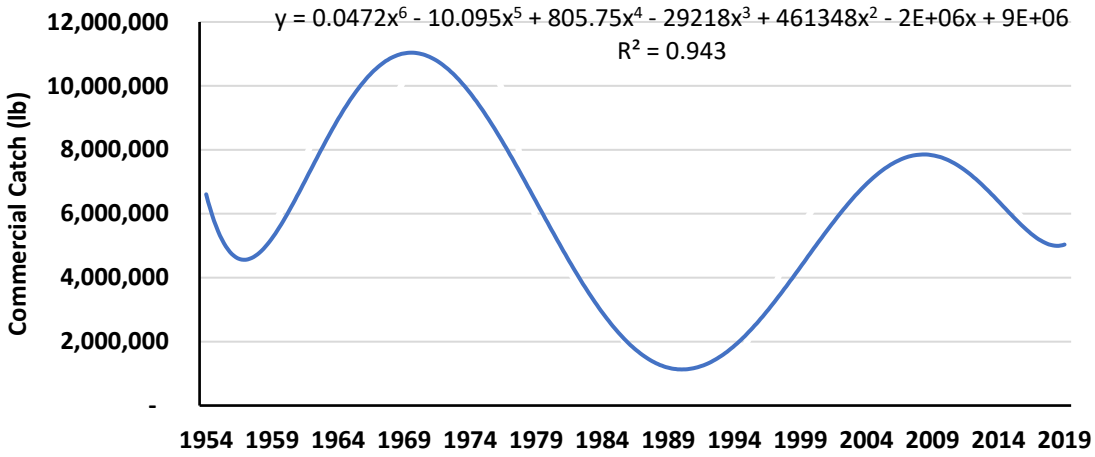

Figure 7. Trendline (fitted to a polynomial line, 6 order) for commercial striped bass landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of striped bass increased steadily from the late 1980s to their peak in 2013 and have since declined (Figure 8). Recreational landings in 2019 were 37% of those in 2013. The top three states for recreational landings in 2019 were: New York (30%), New Jersey (29%), Maryland (14%), Massachusetts (12%), and Rhode Island (10%). Additional landings were reported in: Connecticut, Delaware, Georgia, Louisiana, New Hampshire, North Carolina, and Virginia.

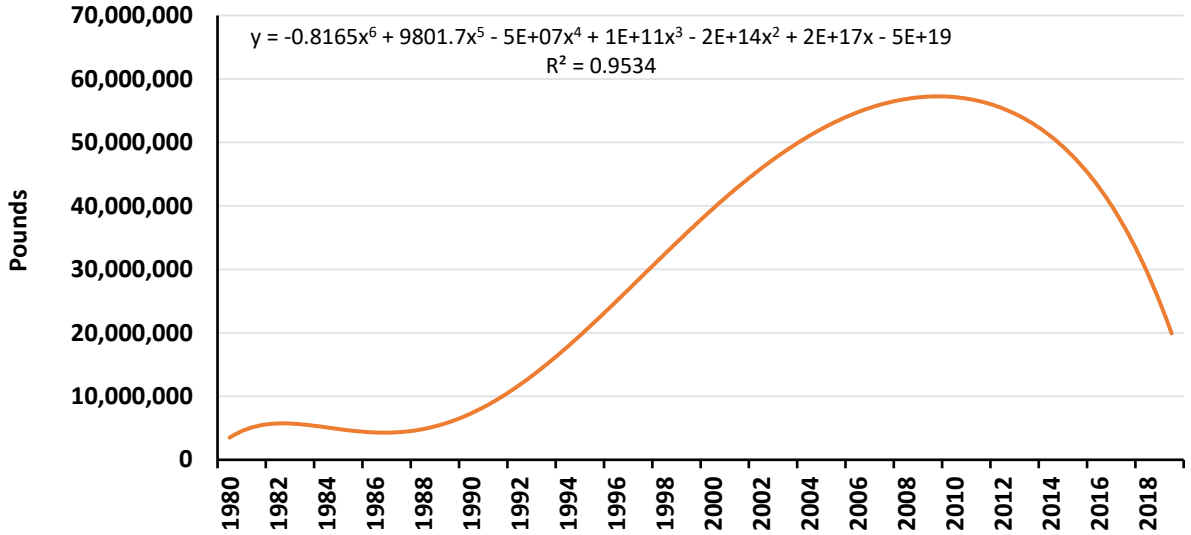

Figure 8. Trendline (fitted to a polynomial line, 3 order) for recreational striped bass landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings of striped bass were the greatest of all the species considered for this report. Moreover, recreational landings were 5.3 times greater than those of commercial landings in 2019 for striped bass.

Market summary. Striped bass is a well-known species throughout the U.S. Its status as overfished will likely reduce overall supplies that may provide opportunities either for increased sales of hybrid striped bass or of striped bass. The typical size differential between hybrid and striped bass may offer the opportunity for both to increase sales to meet demand. Wild-caught striped bass are purchased fresh or frozen and in either whole or filleted forms. Available seasonally in markets, striped bass have been reported to sell for $6.50 to $10.14/kg (Andersen et al. 2021).

Well-recognized in regional U.S. markets on East and Gulf Coasts

Almaco jack (Seriola rivoliana) (East Coast)

Almaco jack is a game fish in the jack family. They are found in the western Atlantic from North Carolina to Argentina and are common in the Gulf of Mexico. Their wide distribution in the Atlantic Ocean has resulted in recognition in regional U.S. markets on the East and Gulf Coasts.

Aquaculture. While global production of the genus *Seriola* spp. has averaged approximately 331 million lb/yr (Seafood Watch: Farmed Almaco Jack 2020), there is only one producer reported, growing almaco jack in offshore cages in Hawaii. Total annual production from this farm has averaged approximately 882,000 pounds.

Aquaculture regulations. Several states in the S.E. U.S. prohibit the sale of gamefish, which may impact the sale of almaco jack from future farms.

Import/export data on almaco jack. No import or export data were found on almaco jack.

Commercial landings. Commercial landings of almaco jack peaked in 2019, with landings 1.6 times greater than the previous peak in 2016 (Figure 9). The top three states for commercial landings of almaco jack were Florida (50%), North Carolina (30%), and South Carolina (17%), with additional landings in Alabama, Louisiana, and Texas.

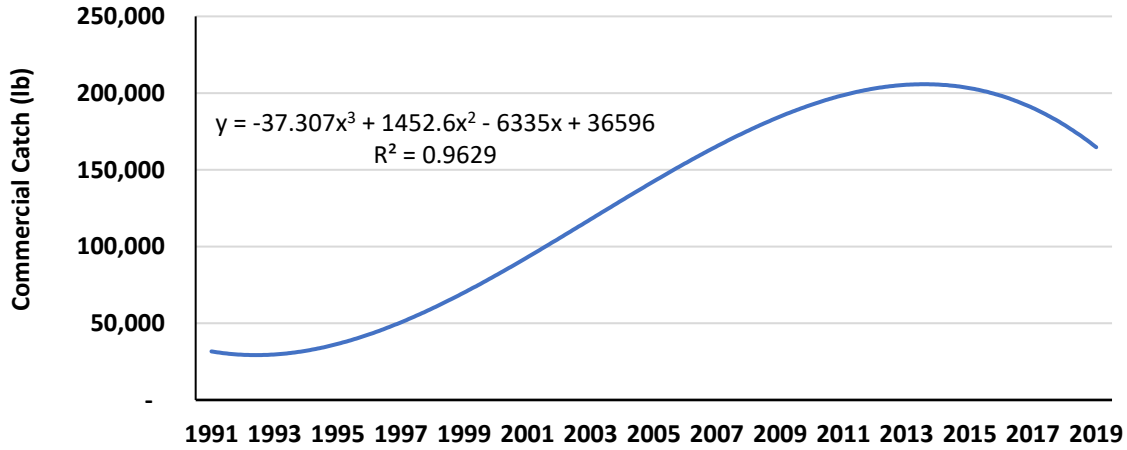

Figure 9. Trendline (fitted to a polynomial line, 3 order) for commercial almaco jack landings, 1991 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings of almaco jack have shown a generally increasing trend since the first data were available in 1985, with the greatest recorded levels in 2019 (Figure 10). The major states for recreational landings of almaco jack were Florida (93%), North Carolina (4%), and Alabama (1%), with additional southern-state landings in Georgia, Louisiana, Mississippi, South Carolina, and Virginia.

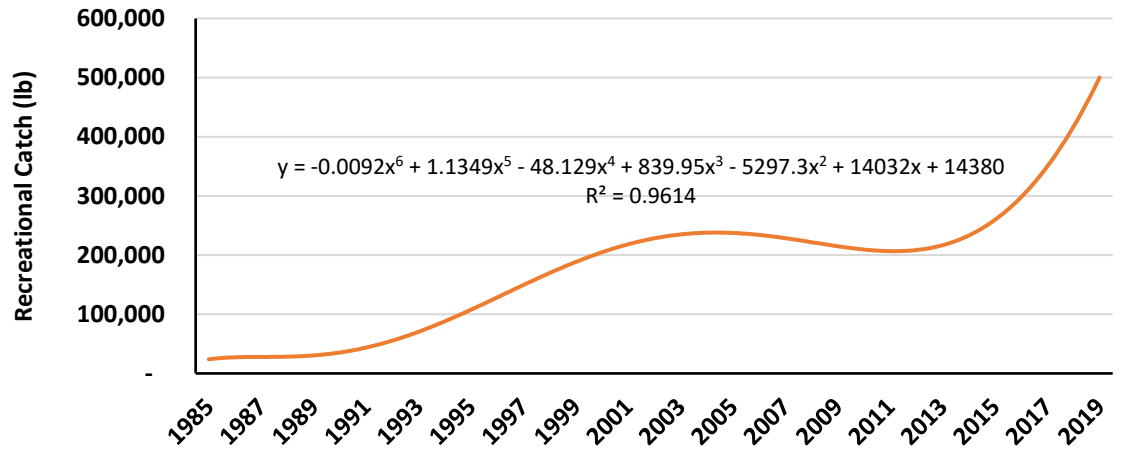

Figure 10. Trendline (fitted to a polynomial line, 6 order) for recreational almaco jack landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of almaco jack were 4.6 times greater in 2019 than were commercial landings.

Marketing summary. Almaco jack is reasonably well-known over a wide range. It is being farmed on a relatively small scale for aquaculture farms. The one farm in production has successfully developed markets and has branded their product as "Hawaiian Kanpachi." Branding is a strategy used to differentiate products and command a higher-price in markets. Product forms sold of almaco jack include whole fish, collar cuts, and whole or belly fillets.

Black drum (Pogonias cromis) (Gulf Coast)

Black drum is a relatively well-known fish on the East and Gulf Coasts with a range that extends from Nova Scotia to Florida and the Gulf of Mexico.

Aquaculture. No reports have been found of culture of black drum. Nevertheless, its similarities to red drum may suggest it as a potential culture species.

Aquaculture regulations. As a gamefish, farmed black drum likely would be subjected to regulations similar to those for red drum. Regulations related to the sale of marine gamefish have constrained marine finfish farming and may affect sales of farmed black drum.

Import/exports of black drum. No data on imports or exports of black drum were found, but some volume of black drum has been reported to be sold to Mexico (Leard et al. 1993).

Commercial landings. Black drum commercial landings reached a peak in 1987, but have remained fairly stable at slightly lower levels since (Figure 11). The top three states for commercial landings in 2019 were: Louisiana (59%), Texas (33%), and Virginia (2%). Additional commercial landings were from Alabama, Delaware, Florida, Maryland, Mississippi, New Jersey, New York, North Carolina, and Texas. Black drum is not considered overfished in the Gulf of Mexico, although it had been overfished in Louisiana in the 1980s (Seafood Watch: Black Drum 2018).

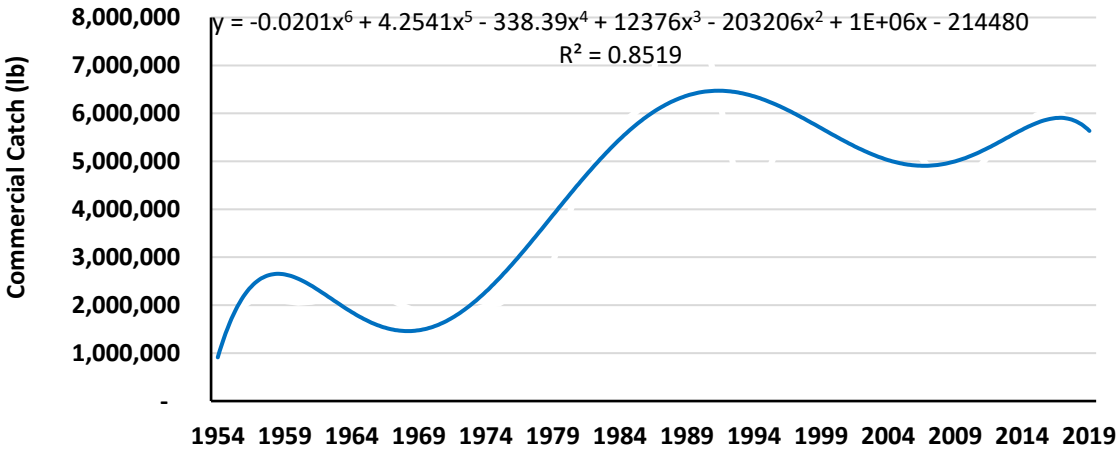

Figure 11. Trendline (fitted to a polynomial line, 6 order) for commercial black drum landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of black drum increased throughout the 1990s, reaching a peak in 2013 (Figure 12). Recreational landings from 2014 to 2019 appear to be entering a cyclical trough. The top three states for recreational landings of black drum in 2019 were: Florida (40%), Mississippi (23%), and South Carolina (14%). Additional recreational landings were reported in Alabama, Georgia, Louisiana, New Jersey, North Carolina, South Carolina, and Virginia.

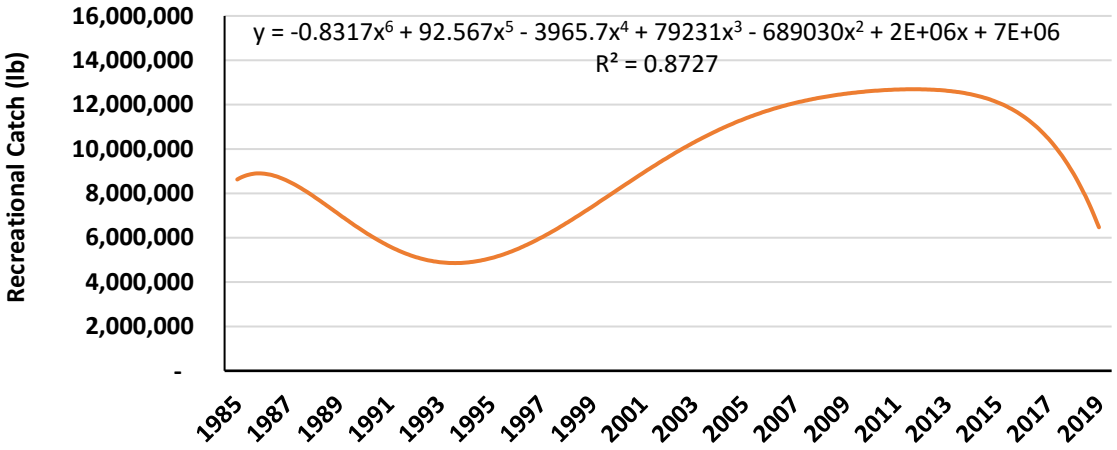

Figure 12. Trendline (fitted to a polynomial line, 6 order) for recreational black drum landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

In 2019, recreational landings of black drum were 20% greater than the commercial landings.

Market summary. The U.S. is the main market for black drum (Leard et al. 1993). Product forms sold include fresh whole gutted fish, collar cuts, fresh whole or belly fillets, frozen headed and gutted fish, and frozen fillets.

Black sea bass (Centropristis striata) (East Coast)

Black sea bass is a regionally known fish on the East Coast, with a range that extends from Maine to the Florida Keys. Black sea bass are fished commercially and recreationally on the Atlantic Coast.

Aquaculture. There is some farmed production of limited volumes of black sea bass in the U.S. Black sea bass fingerlings are available from the University of North Carolina at Wilmington for farms to raise in growout RAS. Nevertheless, farmed black sea bass compete in the market with wild-caught black sea bass. Black sea bass farmers target smaller markets with very fresh product.

Aquaculture regulations. Several states in the southern U.S. either prohibit or have severely restrictive regulations on the sale of gamefish, which may affect sales of black sea bass. In North Carolina, for example, marine finfish such as black sea bass are regulated by the Division of Marine Fisheries of the North Carolina Department of Environment and Natural Resources, not the Department of Agriculture, as are trout, hybrid striped bass, and catfish. Natural resource agencies frequently have less understanding of farming practices than do agriculture agencies, often resulting in greater regulatory conflicts.

Commercial landings. Commercial landings of black sea bass show a substantial decline from 1954 to the mid-1970s, followed by relatively stable landings since (Figure 13). The top three major states for commercial landings of black sea bass are: New Jersey (19%), Virginia (17%), and Massachusetts (14%). Additional commercial landings were reported in: Connecticut, Delaware, Florida, Maryland, New York, North Carolina, South Carolina, and Rhode Island. Black sea bass is sustainably managed, with 2018 commercial quotas of 3.53 million pounds and recreational quotas of 3.66 million pounds.

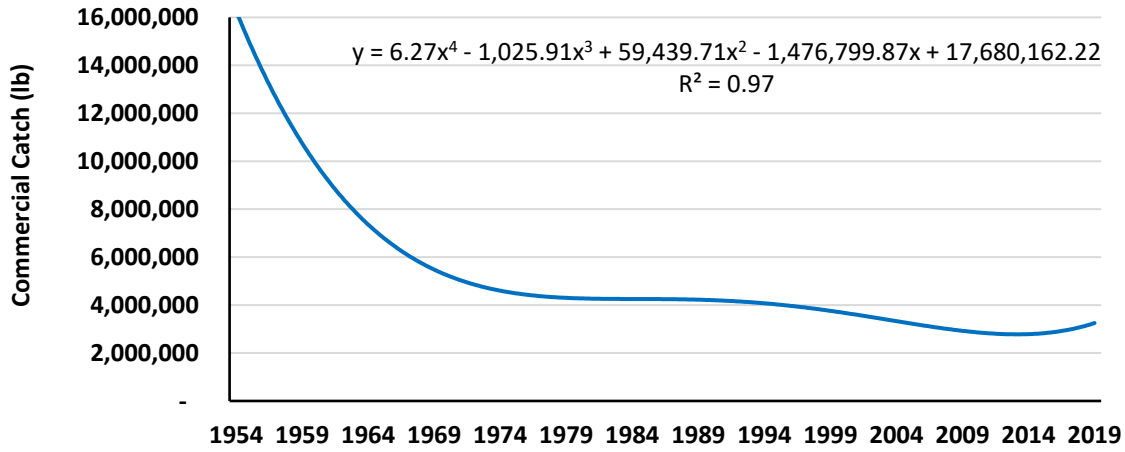

Figure 13. Trendline (fitted to a polynomial line, 4 order) for commercial black sea bass landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Data for recreational landings of black sea bass were available only from 1985 on and show a slight decline through 2006 followed by an increase that in 2019 was more than double the 2006 landings (Figure 14). The top three major states for

recreational landings of black sea bass in 2019 were: New York (33%), Massachusetts (14%), and Rhode Island (13%). Other states with recreational landings in 2019 include: Alabama, Connecticut, Delaware, Florida, Georgia, Maryland, New Jersey, North Carolina, South Carolina, and Virginia.

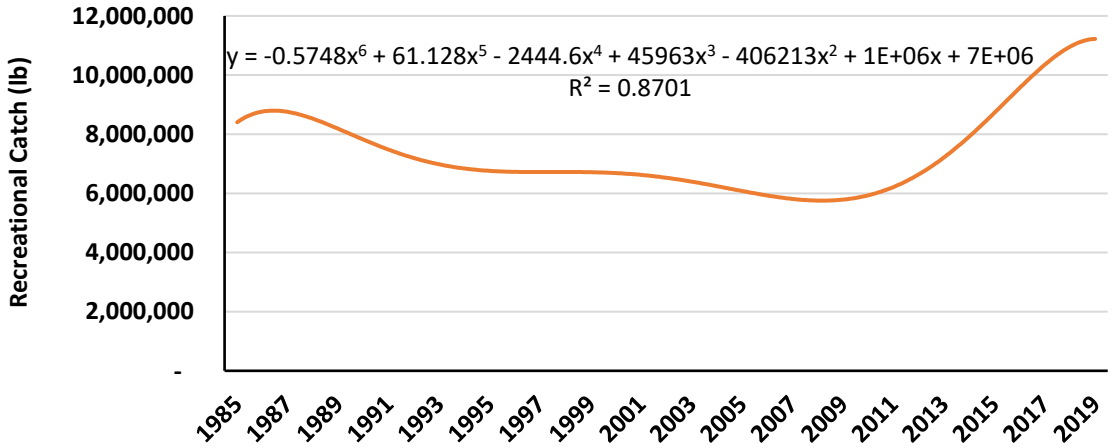

Figure 14. Trendline (fitted to a polynomial line, 6 order) for recreational black sea bass landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, 2019 recreational landings of black sea bass were 2.5 times greater than 2019 commercial landings.

Market summary. Commercial landings of sea bass are well below historical highs. The previous demand for black sea bass likely is being met by other seafood substitutes, but the extent to which latent demand from earlier years exists is not known. Niche markets have been developed for black sea bass and are reported to include cities in North Carolina, New York City, Philadelphia, Atlanta, and San Francisco (Watanabe et al. 2021). Black sea bass is considered to be similar to Pacific grouper and is sold into sushi and sashimi markets (Dumas and Wilde 2009; Wilde 2008). From a size of 1.25 lb and larger, black sea bass sell at premium prices in live markets or as whole-on-ice product. Smaller black sea bass (0.5 to 1 lb) bring prices of $2 to $3.50/lb, and $4 to $6.50/lb for 1 to 2 lb fish, and $7 to $8/lb for jumbo fish > 2 lb. Sales to live markets (through wholesalers), however, require weekly deliveries, consistently of 6,500 lb per haul.

Cobia (Rachycentrum canadum) (East Coast)

Cobia are regionally known on the Atlantic Coast of the U.S. and the Gulf of Mexico, although its distribution is global. Cobia, however, is better known as a recreational, than a commercially caught fish.

Aquaculture. Cobia have been farmed in many countries in cages, ponds, and RAS around the world for the last three decades. From its beginnings in the late 1990s, cobia farming expanded in the 2000s (Seafood Watch: Panama Net Pens). In 2013, 94.6 million pounds were produced, mostly in the Asia-Pacific region. In Panama, 1.1 million pounds were produced in 2012, that grew to 3.3 million pounds in 2014 for export to the U.S. (Nadkarni 2013). At one

point, 18 different countries reported farmed production of cobia (including Taiwan, China, Vietnam, Australia, U.S./Puerto Rico, Dominican Republic, Martinique, Bahamas, Cuba, Mexico, Belize, Panama, Columbia, Ecuador, Chile, Denmark, Saudi Arabia) (Benetti et al. 2021).

By 2020, however, the majority of cobia farms, and hatcheries were no longer in production. Most of the commercial failures occurred in near-shore coastal areas, in land-based ponds and RAS in the Americas. Cobia is difficult to raise in locations other than offshore, where there is high dissolved oxygen, strong currents, and greater depths (Benetti et al. 2021). In the Americas, the only large operating cobia farm is in Panama, located in an exposed, high-energy, offshore location with submerged offshore cages (Benetti et al. 2021). The global production of 106.2 million pounds in 2019 was mostly produced in net pens in China, with additional production in Viet Nam, Taiwan, and Panama.

Import/export of cobia. Cobia import volumes showed an increasing trend from 2012 (the first year that import data were available) up to a peak in about 2017, followed by a downward trend in the latter part of the decade (Figure 15). In 2012, the U.S. imported 1.1 million pounds of cobia from Columbia and Panama (Seafood Watch Cobia US 2014). In 2013, the US exported 82,000 pounds to South Korea and 64,000 pounds in 2013 to South Korea. These values include farmed fish from Panama.

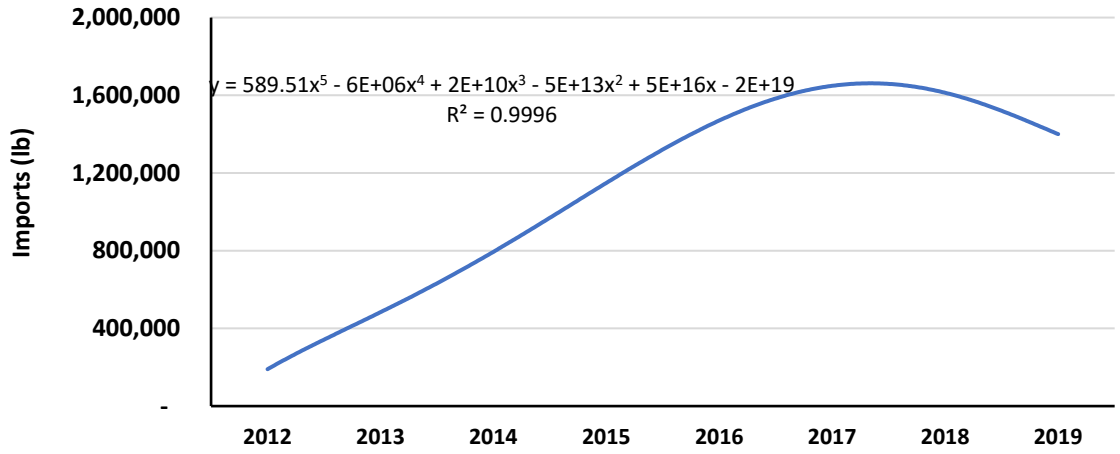

Figure 15. Trendline (fitted to a polynomial line, 5 order) of five-year averages for cobia imports. SOURCE: NOAA Foreign Trade Database (NOAA 2021a).

Commercial landings. Cobia is distributed globally. In the U.S., it is a retained, not a targeted species in the Atlantic and Gulf of Mexico (Seafood Watch: Cobia US. 2014). There are two stocks of cobia, one in the Atlantic, the other in the Gulf. Cobia is neither overfished or undergoing overfishing. The overall catch is 29.5 million pounds worldwide, of which 189,000 pounds is in the US Atlantic and 83,000 pounds in the Gulf of Mexico (FAO 2021a).

Commercial landings of cobia peaked in 1996 and have generally declined since then (Figure 16). By 2019, landings had declined by 68% of their commercial peak in 1996. The top three states for commercial landings of cobia in 2019 were: Florida (43%), Virginia (28%), and North

Carolina (16%), with additional landings reported in Alabama, Louisiana, New Jersey, New York, Rhode Island, South Carolina, and Texas.

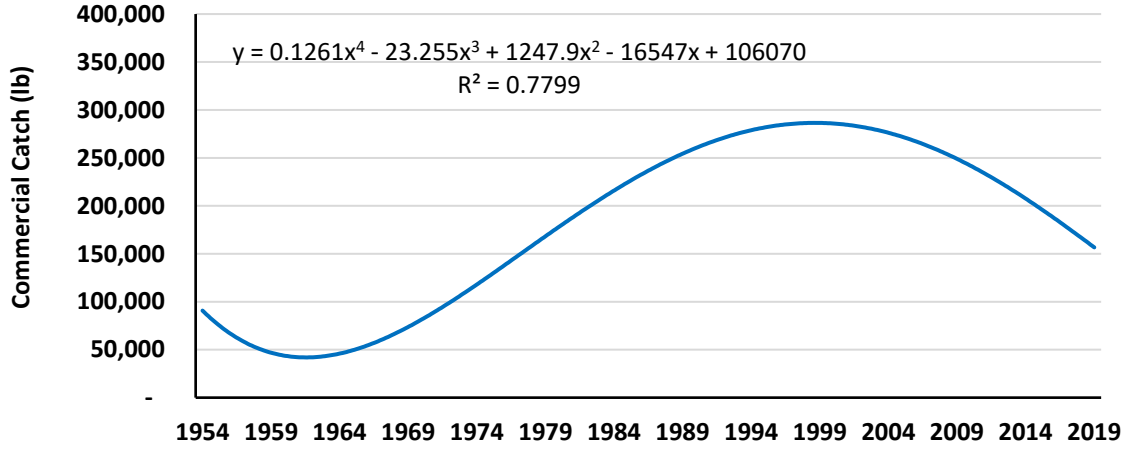

Figure 16. Trendline (fitted to a polynomial line, 4 order) for commercial cobia landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Cobia are targeted by recreational anglers. Data on recreational landings of cobia were available only from 1985 on. Recreational landings of cobia have remained relatively stable from the late 1990s through 2019 (Figure 17). The top three states for recreational landings of cobia in 2019 were: Virginia (41%), Florida (36%), and Alabama (11%). Additional recreational landings were reported in Georgia, Louisiana, Mississippi, North Carolina, and South Carolina.

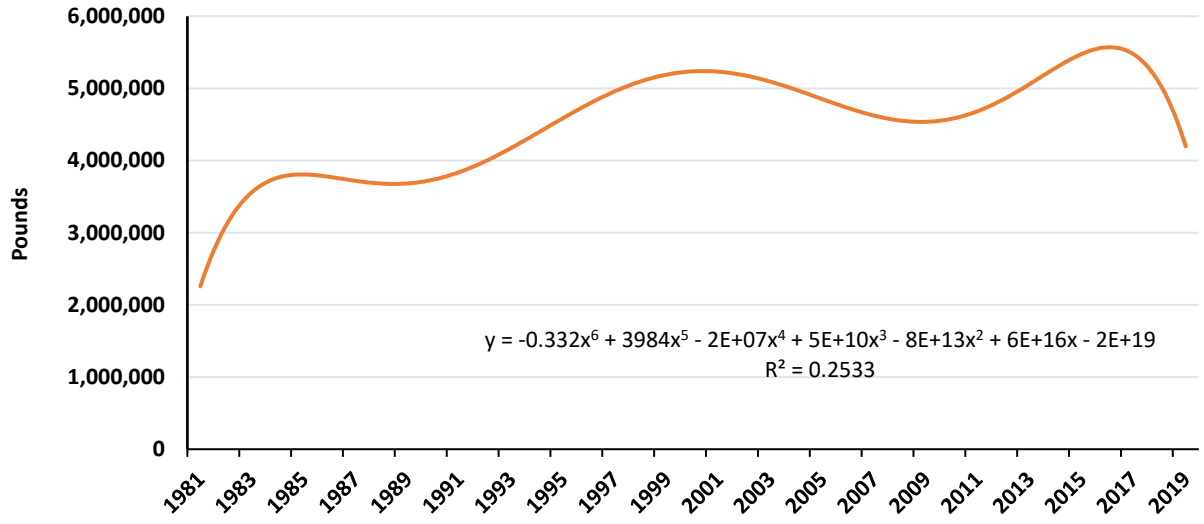

Figure 17. Trendline (fitted to a polynomial line, 6 order) for recreational cobia landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of cobia in 2019 were more than 31 times greater than commercial landings.

Market summary. Most of the cobia production in Panama is exported to the U.S. (Nadkarni 2013). Product forms include whole gutted, headed and gutted, filleted, fresh and frozen. Fresh product is the largest share of the market.

Florida pompano (Trachinotus carolinus) (East & Gulf Coasts)

Florida pompano is a marine finfish in the jack family with a wide distribution in the Atlantic Ocean from Massachusetts to Brazil. Prized by both commercial and recreational fishermen (Weirich et al. 2021), Florida pompano command a high price per pound (Seafood Watch: Wild Pompano). Landings exhibit an overall declining trend (Seafood Watch: Wild Pompano 2014).

Aquaculture. Research on aquaculture of pompano dates back to the 1950s (Weirich et al. 2021). Total global production of "pompano" (this FAO category includes species other than Florida pompano), was just over 370 million pounds in 2019 (FAO 2021a). Pompano have been raised mostly in RAS, but have also been raised in net pens and cages. At one point, up to 1.7 million pounds of Florida pompano were raised in the Bahamas, the Dominican Republic, and in Panama. Production in the Bahamas ceased in 2017, following damage from hurricanes, but pompano raised in net pens from Panama continue to be imported into the U.S. Florida pompano have been shown to grow to 1.5 lb in 275 days. In the U.S., there is a RAS, a pond-based operation, and a breeding/juvenile production facility in Florida. Global farmed production of Florida pompano was 1.4 million pounds in 2019, primarily in Panama (FAO 2021a).

Aquaculture regulations. Several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of farm-raised Florida pompano.

Import/export of Florida pompano. Florida pompano is imported to the U.S. from Mexico, Brazil, and the Dominican Republic, but wild-caught and farmed imports are not differentiated (Weirich et al. 2021). Other pompanos (Trachinotus spp.) are imported from China, Thailand, Vietnam, and Australia, with prices ranging from $3.17 to $8.16/lb (average of $4.99/lb) and wholesale fillets selling for $9.52/kg (range of $6.35 to $14.06/lb) (NOAA 2021a).

Commercial landings. The commercial harvest of Florida pompano is small and unpredictable. Commercial landings have generally declined from their peak in 1968 of 1.7 million lb to 405,720 lb in 2019 (Figure 18). The top three major states for commercial landings of Florida pompano in 2019 were: Florida (90%), North Carolina (6%), and Louisiana (2%). Additional commercial landings were reported in Alabama, Texas, and Virginia.

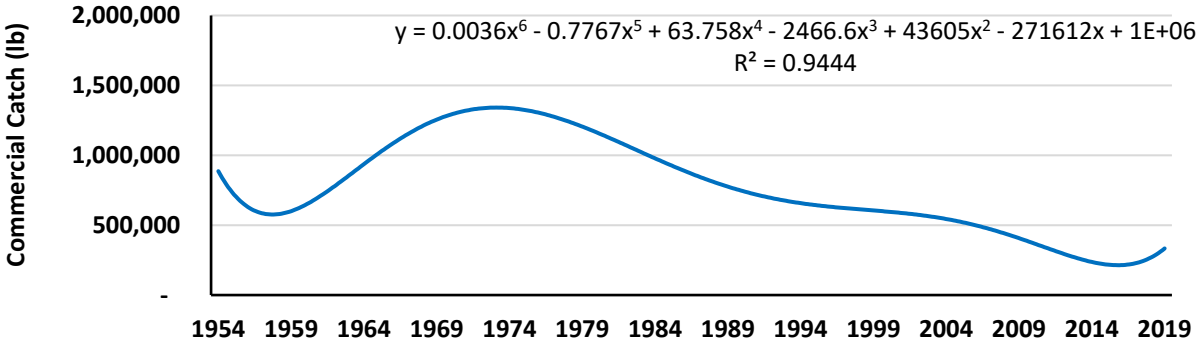

Figure 18. Trendline (fitted to a polynomial line, 6 order) for commercial Florida pompano landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of Florida pompano peaked in 2004 followed by a generally declining trend. Recreational landings in 2019 were more than double those in 2018, appearing in Figure 19 as an increasing trend in recent years. The top three major states for recreational landings of Florida pompano in 2019 were: Florida (76%), North Carolina (18%), and South Carolina (5%). Additional recreational landings were reported in Alabama, Georgia, Louisiana, Mississippi, and Virginia.

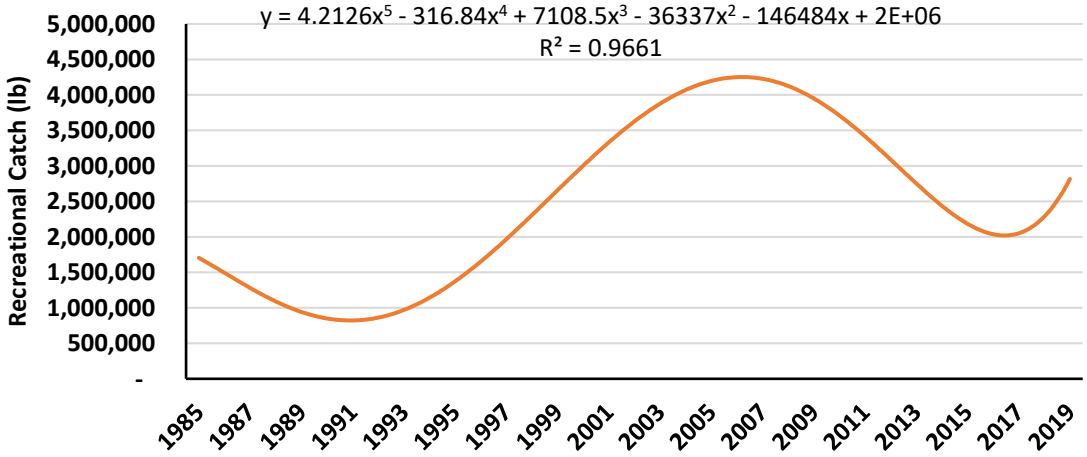

Figure 19. Trendline (fitted to a polynomial line, 5 order) for recreational Florida pompano landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of Florida Pompano were more than 10 times greater than commercial landings in 2019.

Market summary. Florida pompano is valued in the N.E. United States, Florida, and Louisiana, mostly as a whole fish and fillets, with fresh, not frozen, preferred. Often sold as a whole, gutted fish, Florida pompano is the basis for an iconic New Orleans dish, “pompano en papillote,” and is a prominent menu item at high-end restaurants on the East Coast and on the Gulf of Mexico (Weirich et al. 2021). Florida pompano often is prepared in whole form, either grilled or baked.

Greater amberjack (Seriola dumerili) (East Coast)

Greater amberjack, of the jack family, is regionally well-recognized on the Atlantic Coast and the Gulf of Mexico. While categorized as overfished in the Gulf of Mexico, it is considered to be abundant in the Southeast Atlantic (Seafood Watch: Greater Amberjack 2017).

Aquaculture. Global farmed production of greater amberjack has been reported in FAO data from 1985, at levels that have ranged from several thousand pounds a year to several hundred thousand pounds a year. Greater amberjack are farmed primarily in net pens. The greatest volume of farmed production of greater amberjack in 2019 was in the United Arab Emirates, followed by Greece and Spain (2021a). There is no commercial production of greater amberjack in the U.S., although there is on-going research on farming methods for greater amberjack in the U.S.

Aquaculture regulations. Some states in the Southeast U.S. prohibit the sale of gamefish which may affect sales of greater amberjack.

Import/export of greater amberjack. No data were found on imports or exports of greater amberjack.

Commercial landings. Data on commercial landings of greater amberjack were available only from 1992 on (Figure 20). More than two-thirds of the commercial greater amberjack catch is from the Gulf of Mexico, with the rest from the South Atlantic. Commercial landings of 2.7 million pounds in 1992 declined by approximately 70% to 0.8 million pounds in 2019. Although still considered to be abundant in the Southeast Atlantic, greater amberjack are considered to be overfished in the Gulf of Mexico.

The top three states for commercial landings of greater amberjack are: Florida (70%), Alabama (8%), and South Carolina (8%). Additional landings have been reported in Louisiana, North Carolina, and Texas.

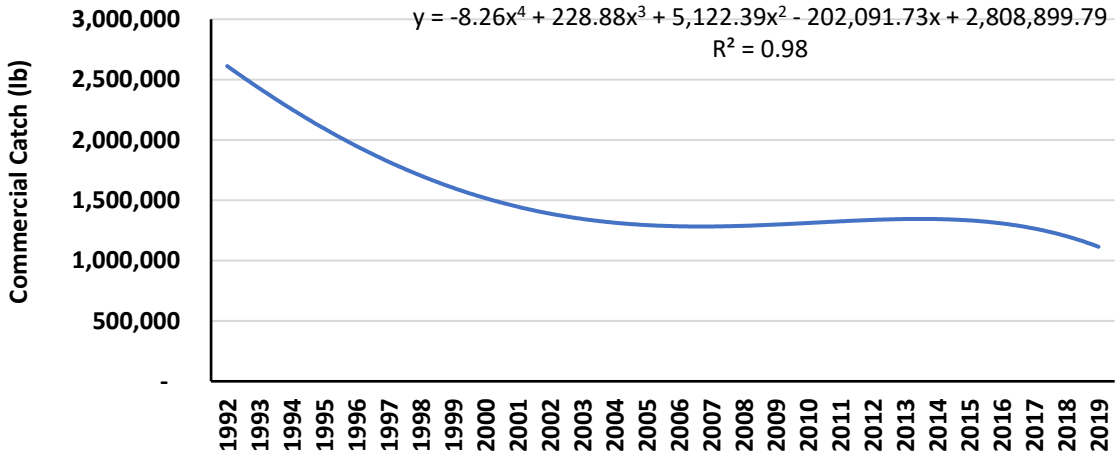

Figure 20. Trendline (fitted to a polynomial line, 4 order) for commercial greater amberjack landings, 1992 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of greater amberjack were substantially greater in the late 1980s than in the 2000's (Figure 21), averaging 2.1 million lb/year from 2006 to 2015 (NMFS 2016). The 2019 recreational landings were 12% of those in 1987. The top three states for recreational landings in 2019 were: Florida (81%), Alabama (6%), and Louisiana (4%). Additional landings were reported in Georgia, Mississippi, North Carolina, and South Carolina.

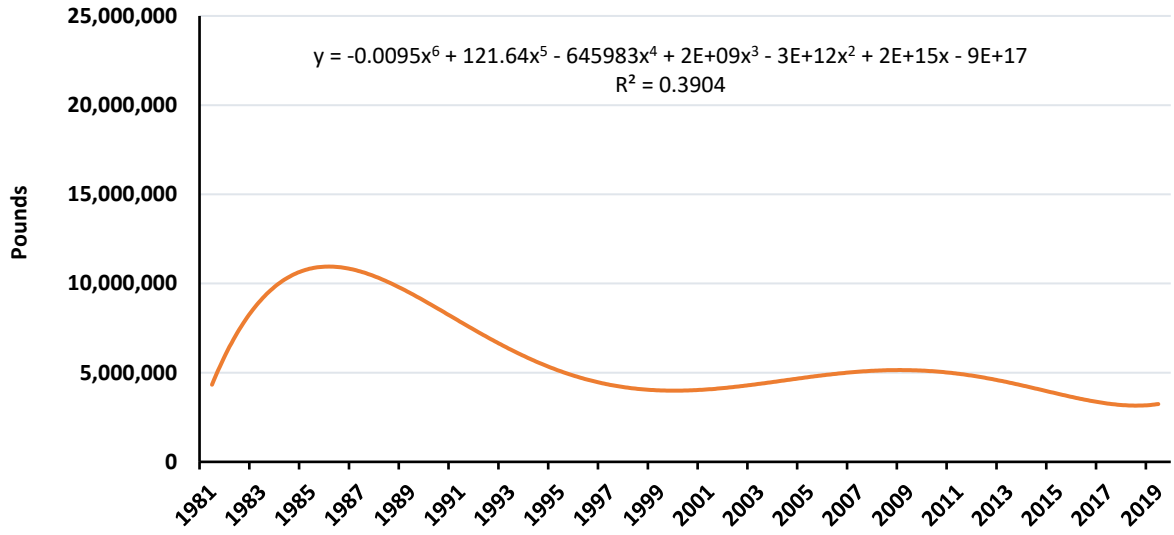

Figure 21. Trendline (fitted to a polynomial line, 6 order) for recreational greater amberjack landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of greater amberjack were nearly three times greater than commercial landings in 2019.

Market summary. Greater amberjack is a regionally well recognized fish. While it is best known as a recreational species, there is a commercial catch of approximately 1 million pounds a year with which farmed production will need to compete. If commercial harvests continue to decline, market windows of opportunity may appear that may present opportunities for sales of farmed greater amberjack. Greater amberjack has been sold fresh (whole or filleted), frozen, and smoked (filleted) in the U.S. (Berry and Burch 1978; Diversified Communications 2009).

Red drum (Sciaenops ocellatus) (Gulf Coast)

Red drum, commonly known as redfish in the U.S., is a marine species in the drum family. Commercial and recreational harvests on the Atlantic Coast and Gulf of Mexico have declined over time, while farmed production has increased.

Aquaculture. Aquaculture production of red drum began in the 1970s with the goal of enhancing wild stocks and supplementing the declining supply (Seafood Watch: Red Drum 2016). Red drum farming has become a global aquaculture industry with total global farmed production of 170 million pounds in 2019 (FAO 2021a). The top countries for farmed red drum production in 2019 were China, followed by the U.S., Mauritius, Israel, Martinique, and

Guadalupe (FAO 2021a). Red drum are raised primarily in earthen ponds, although there had been some production in cages in the past.

In the U.S., there were two red drum farms in 2005 (USDA-NASS 2005). By 2018, the number of red drum farms had increased to 12 farms, with reported production of 7.2 million pounds and a value of $19.5 million (USDA-NASS 2018). Next to salmon, red drum is the second largest marine finfish sector of aquaculture in the U.S.

Aquaculture regulations: As a gamefish, farmed red drum is regulated in their home state of Texas through strict reporting requirements for each fish sold. Not only are U.S. farms required to report sales of individual fish, but buyers must also report information on each fish purchased within 24 hours of receipt of deliveries. Such a reporting burden has restricted sales of red drum to those restaurants willing to comply with reporting requirements.

Import/export of red drum. No import/export data were found for red drum.

Commercial landings. Commercial landings of red drum peaked in 1986 at 14.4 million pounds, followed by a substantial decline (Figure 22). Commercial landings of red drum in 2019 were 92% lower (120,572 pounds) than those of the peak in 1986. The top three states for commercial landings of red drum in 2019 were: Mississippi (51%), North Carolina (47%), and Virginia (2%). No commercial landings were reported in other states.

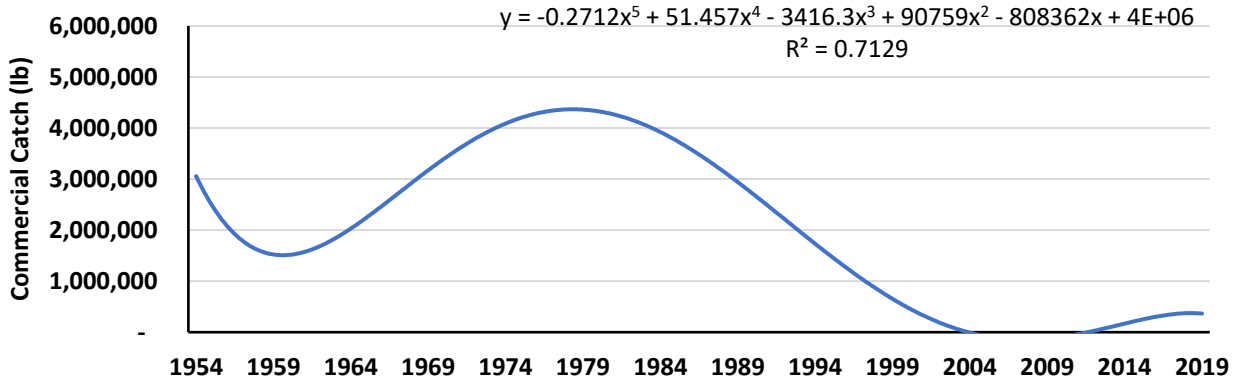

Figure 22. Trendline (fitted to a polynomial line, 5 order) for commercial red drum landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Red drum is a popular sport and foodfish, especially in the Gulf of Mexico. Recreational landings of red drum peaked in 2013 at 42.7 million pounds, following more than a decade of relatively stable landings (Figure 23). In 2019, recreational landings were 71% lower (at 12.4 million pounds) than those of the 2013 peak landings. The major states for recreational landings in 2019 were: Louisiana (29%), Florida (17%), and Mississippi (21%), with additional landings in Alabama, Georgia, North Carolina, South Carolina, and Virginia.

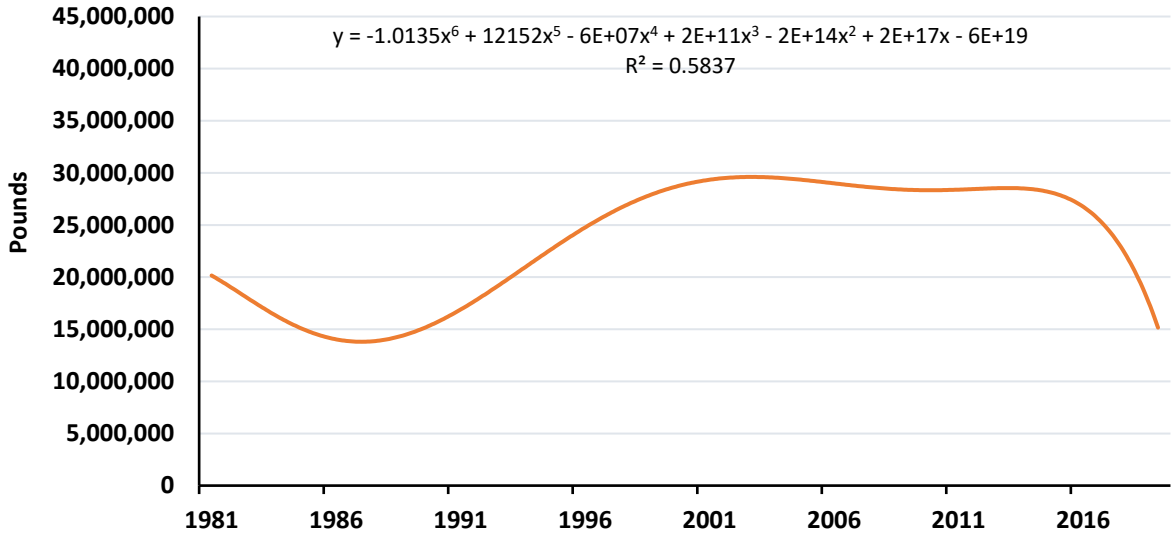

Figure 23. Trendline (fitted to a polynomial line, 6 order) for recreational red drum landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of red drum were more than 100 times greater than commercial landings in 2019 and have exceeded commercial landings since 1987.

Market summary. Farmed production of red drum in the U.S. has expanded rapidly, exceeding commercial harvests, since 2005. Recreational harvests, while still substantial, have declined. U.S. red drum farmed production has been able to successfully capture a portion of the markets and developed into a cluster of successful farms. The principal market for red drum produced in other countries is the U.S., and red drum are imported from Taiwan and China (U.S. FDA 2016). More recently, imports of red drum from a net-pen farm in Mauritius have entered the U.S. market. Red drum are sold as fresh and frozen fillets in both whole and gutted forms. Red drum has been characterized as a "high price" fish (Sumaila et al. 2007).

Red snapper (Lutjanus campechanus) (Gulf Coast)

Red snapper is a regionally well-known fish in the Southeast U.S. and the Gulf of Mexico. While the South Atlantic Stock is considered overfished, the Gulf of Mexico stock is not (NOAA 2020a). Both stocks are rebuilding and have fishery management plans to regulate commercial and recreational harvests.

Aquaculture. Global aquaculture statistics do not separate out individual snapper species, and report production volumes for "snapper" as a group (FAO 2021a). The total world farmed production of fish labeled as "snapper" was 19.7 million pounds in 2019, up from 235,894 pounds in 1987 (FAO 2021a). Red snapper have been raised in research studies in flow-through systems, RAS, and in-pond raceways (Miranda et al. 2021). Fish were reported to reach a pound in about nine months from hatching. Beaver Street Fisheries, a seafood distributor, has reported raising red snapper to market size in a little more than a year in flow-through tanks in the Bahamas.

Import/export of red snapper. No import or export data specific to red snapper were found. The NOAA Foreign Trade Database utilizes a single category titled "Snapper (Lutjanidae spp)," which includes all species in the *Lutjanidae* family. Import information for the aggregated snapper category is available in Appendix U.

Commercial landings. Commercial landings of red snapper reached a peak of 14 million pounds in 1967, followed by a decline through the early 1990s to a relatively stable level (Figure 24). The data appear to show an increasing trend of landings through 2019. The top three states in terms of commercial landings of red snapper in 2019 were: Florida (39%), Texas (34%), and Louisiana (18%). Additional commercial landings were recorded in Alabama, Mississippi, North Carolina, and South Carolina.

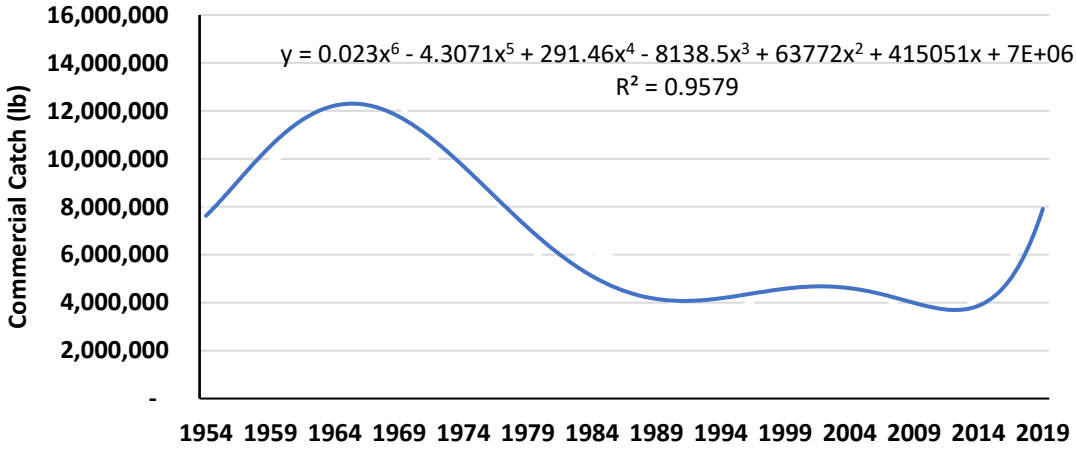

Figure 24. Trendline (fitted to a polynomial line, 6 order) for commercial red snapper landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of red snapper exhibit a roughly 10-year cycle (Figure 25). The 2017 peak of 19.5 million lb, however, is approximately 3 million pounds (approximately one-third) greater than the previous peak. The top three states for recreational landings of red snapper in 2019 were: Florida (51%), Alabama (39%), and Mississippi (7%). Additional recreational landings were reported in Georgia, Louisiana, and South Carolina.

Recreational landings of red snapper were nearly double those of commercial landings in 2019.

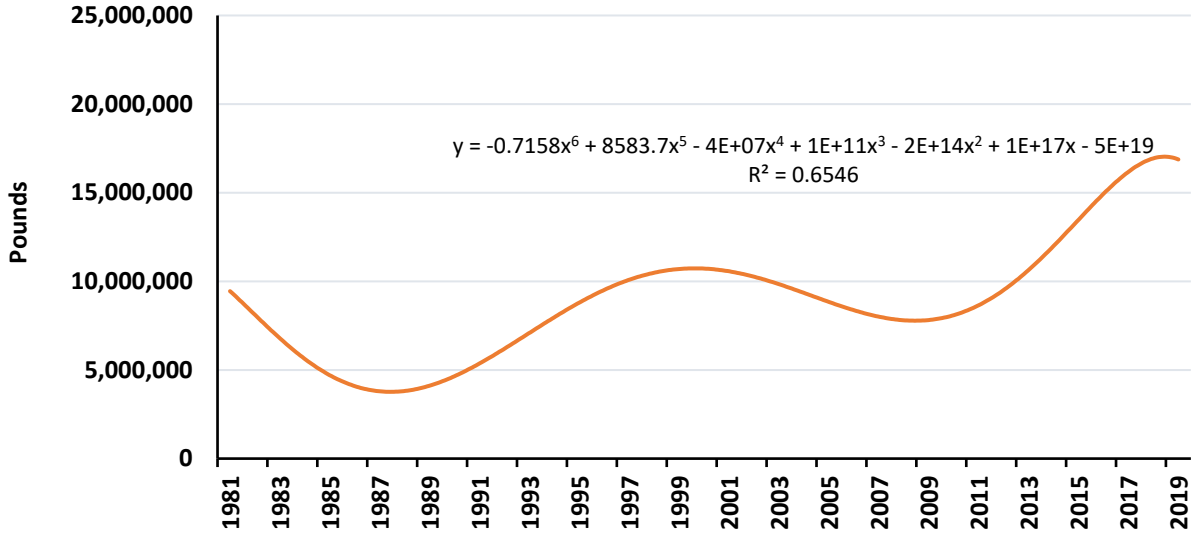

Figure 25. Trendline (fitted to a polynomial line, 6 order) for recreational red snapper landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Market summary of red snapper. Large volumes of fish labeled as "snapper" are imported into the U.S. in both fresh and frozen forms.

Southern flounder (Paralichthys lethostigma) (East Coast)

Southern flounder is a well-known species on the Atlantic Cost of the U.S. and the Gulf of Mexico. Southern flounder is a popular gamefish with high commercial value.

Aquaculture. Globally, there were 33,000 pounds of generic flatfish farmed in 2019, a nearly four-fold increase over the 2015 production of 8,820 pounds (FAO 2021). The FAO data do not report farmed flatfish or flounder production by species. The 2013 and 2018 Censuses of Aquaculture (USDA 2014; 2019) indicated that there was some farmed production of flounder in the U.S. in Florida, Missouri, and Nebraska, but did not specify the species or provide production volumes for confidentiality reasons.

Import/export of southern flounder. Little data were found on imports of specific species of "flounder", but large volumes of un-specified species of flounder are imported into the U.S., mostly as frozen product. Total imported volumes of frozen flounder products in 2019 were 21.9 million lb.

Commercial landings. Commercial landings of southern flounder peaked in 1994, followed by a substantial decline to a level in 2019 of 102,592 lb, that was 98% less than the 1994 peak of 4.9 million pounds (Figure 26). By state, data on commercial landings were found for only two states in 2019: North Carolina (90%) and Florida (10%).

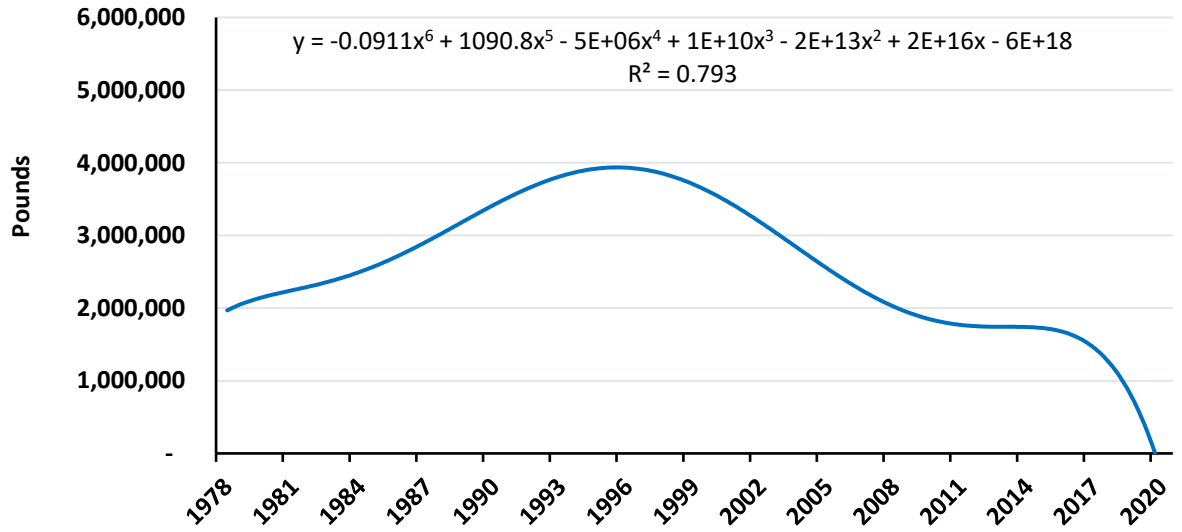

Figure 26. Trendline (fitted to a polynomial line, 4 order) for commercial southern flounder landings, 1978 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of southern flounder have been relatively stable through about 2013, but subsequently exhibit an approximately 40% decline from 2013 to 2019 landings of 3.5 million pounds (Figure 27). The major states with recreational landings in 2019 were Florida (66%), North Carolina (11%), and Mississippi (8%) with additional landings in Alabama, Georgia, Louisiana, South Carolina, and Virginia.

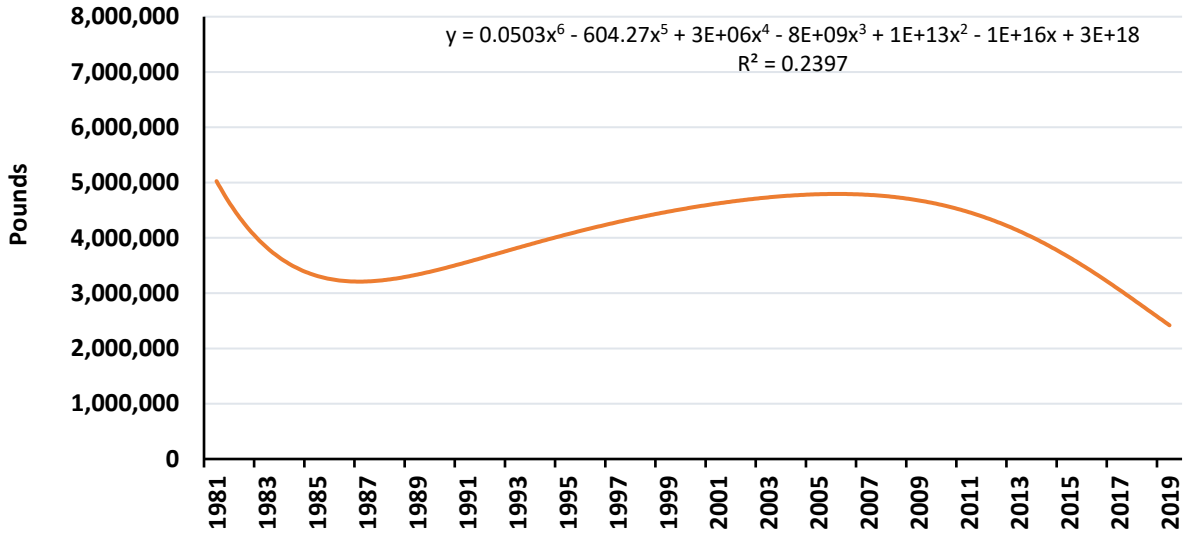

Figure 27. Trendline (fitted to a polynomial line, 6 order) for recreational southern flounder landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of southern flounder were more than 33 times greater than commercial landings.

Market summary. Those developing farms to raise southern or other species of flounder will likely need to differentiate their product from the frozen flounder imports, totaling 21.9 million pounds in 2019. There are anecdotal reports of consumers not willing to pay as much for certain species of flounder than others in specific local markets, but there may also be some more widespread substitutability, particularly with respect to imported frozen flounder, in which competition is largely price-based. Product forms of southern flounder sold in the U.S. include whole fish and fillets, with most fish sold fresh (GSMFC 2015).

Spotted seatrout (Cynoscion nebulosus) (Gulf Coast)

Spotted seatrout, also known as speckled trout, is a well-known gamefish along the Southeastern Coast of the U.S. from Maryland to Florida and on the Gulf of Mexico.

Aquaculture. Spotted seatrout fingerlings have been raised for a number of years in ponds for stock enhancement purposes. Culture techniques for spotted seatrout were adapted from those developed for red drum (Blaylock et al. 2021). Mississippi, Texas, and South Carolina have initiated aquaculture-based stock enhancement programs (Blaylock et al. 2021. By 2018, 80 million 25 to 30-day old seatrout had been produced through aquaculture for stock enhancement. Research on tank production of market-sized spotted seatrout showed that 1.1 lb spotted seatrout can be produced in 10 months (Blaylock et al. 2021). No data were found on farmed production of spotted seatrout elsewhere in the world.

Import/export of spotted seatrout. No data were found of imports or exports of spotted seatrout.

Commercial landings. The commercial supply of spotted seatrout is seasonal and variable (Blaylock et al. 2021). Commercial landings of spotted seatrout have declined fairly steadily from their peak of 8.8 million pounds in 1973 to 1999, thereafter leveling off at levels 7% (570,879 lb) of the volumes in their peak years (Figure 28). The top three states for commercial landing in 2019 were: North Carolina (66%), Virginia (24%), and Mississippi (6%). Additional landings were reported in Alabama and Louisiana.

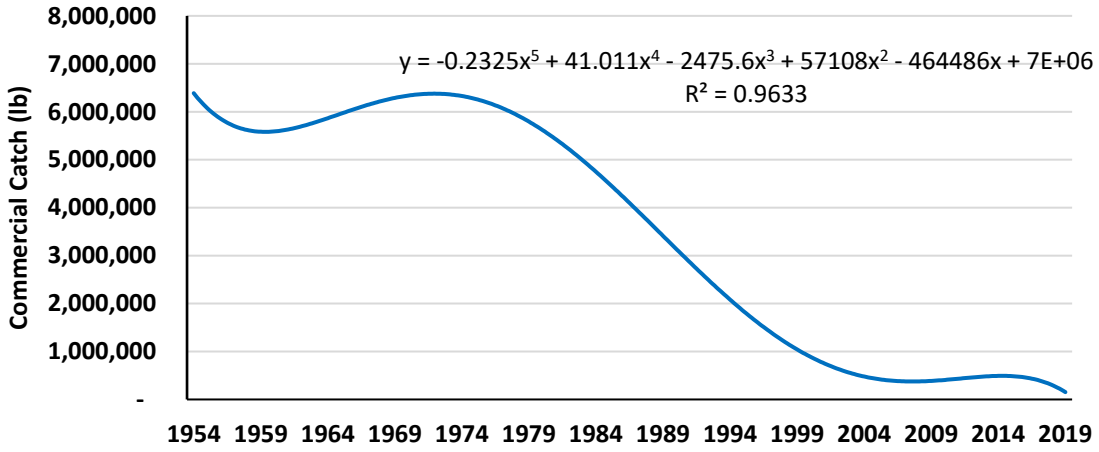

Figure 28. Trendline (fitted to a polynomial line, 5 order) for commercial spotted seatrout landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Spotted seatrout is a popular recreational fish in the Gulf of Mexico, reported to be among the top five marine fish harvested recreationally in the U.S. (Blaylock et al. 2021). The Texas saltwater fishery alone generated $2 billion per year in economic impact. Overall landings have risen fivefold since the early 1990s (Blaylock et al. 2021). The importance of the recreational fishery has resulted in a shift over time from commercial to recreational fisheries, with 98% of the spotted seatrout harvest currently in the recreational fishery (NMFS 2020).

However, recreational landings of spotted seatrout peaked in 2012 and have declined sharply since then to 2019 levels (15.2 million lb) that were 36% of their 2012 peak volumes (Figure 29). The top three states for recreational landings were: Florida (32%), North Carolina (19%), and Louisiana (12%). Additional landings were reported in Alabama, Georgia, Louisiana, Mississippi, South Carolina, and Virginia.

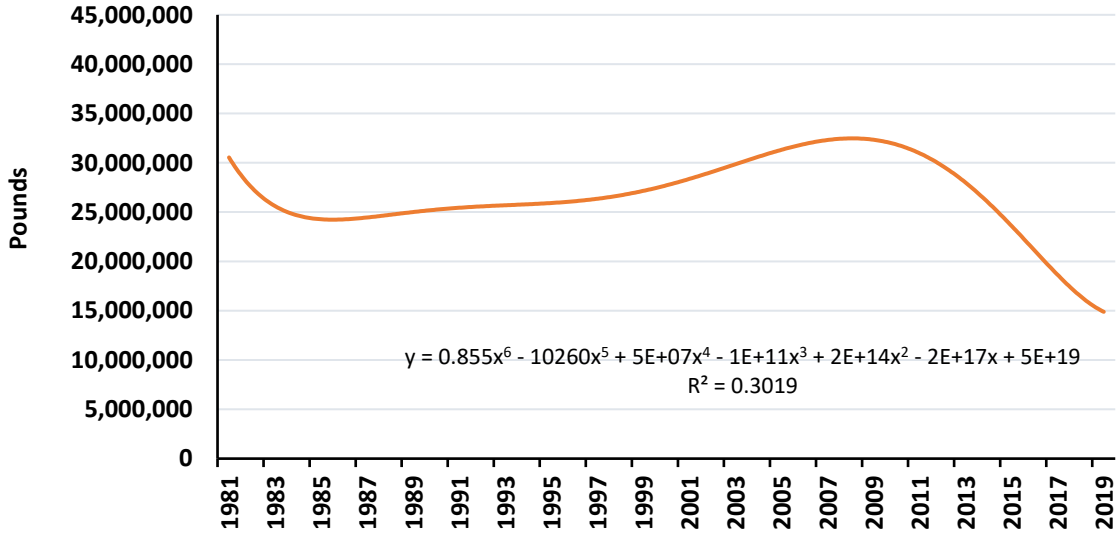

Figure 29. Trendline (fitted to a polynomial line, 6 order) for recreational spotted seatrout landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings in 2019 were 27 times greater than commercial landings.

Market summary. Seatrout is important in the cuisine of the northern Gulf Coast (Blaylock et al. 2021). Regional restaurants and fishmongers have been filling the gap from the decreased commercial supply (resulting from increased catch share allocated to recreational fishing), with other imported, farmed species that are available consistently (Blaylock et al. 2021).

Summer flounder (Paralichthys dentatus) (East Coast)

Summer flounder is a well-recognized and sought-after fish on the Atlantic Coast, found from Maine to Florida.

Aquaculture. Globally, there were approximately 33,000 pounds of generic flatfish farmed in 2019, a nearly four-fold increase over the 2015 production of 8,000 pounds (FAO 2021a). The FAO data do not report farmed flatfish or flounder production by species.

The 2013 and 2018 Censuses of Aquaculture (USDA 2014; 2019) indicated that there was some farmed production of flounder in the U.S. in Florida, Missouri, and Nebraska, but did not specify the species or provide production volumes for confidentiality reasons.

Import/export of southern flounder. Little data were found on imports of specific species of "flounder", but large volumes of un-specified species of flounder are imported into the U.S., mostly as frozen product. Total imported volumes of frozen flounder products in 2019 were 21.9 million lb.

Commercial landings. Summer flounder is caught only in the U.S. It is not currently overfished nor is overfishing occurring (Seafood Watch: Summer Flounder 2019). Commercial landings of summer flounder peaked in the mid-1980s (Figure 30). While commercial landings have exhibited fluctuations of more than 15 million lb over cycles, there was no clear upwards or downwards trend of commercial landings through 2013. The 2013 peak was much lower than the 1979 peak of 39.9 million pounds followed by subsequent declines to 7.0 million pounds in 2019.

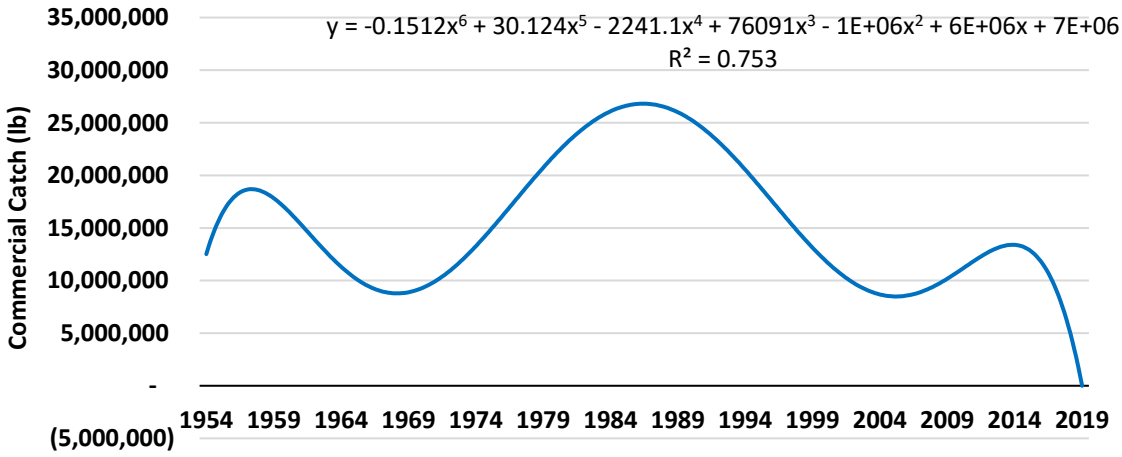

Figure 30. Trendline (fitted to a polynomial line, 6 order) for commercial summer flounder landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

The top three states for commercial summer flounder landings in 2019 were: Virginia (27%), Rhode Island (24%), and New Jersey (23%). Additional commercial landings were reported in Connecticut, Delaware, Florida, Maryland, Massachusetts, and New York.

Recreational landings. Recreational landings data for summer flounder were available only from 1985 on and demonstrated a roughly 10-year cycle (Figure 31) and entered a declining period from 2016. The top three states for recreational landings of summer flounder were: New Jersey (41%), followed by New York (31%), and Rhode Island (11%). Additional recreational landings were reported in Connecticut, Delaware, Florida, Georgia, Maryland, Massachusetts, New Jersey, North Carolina, South Carolina, and Virginia.

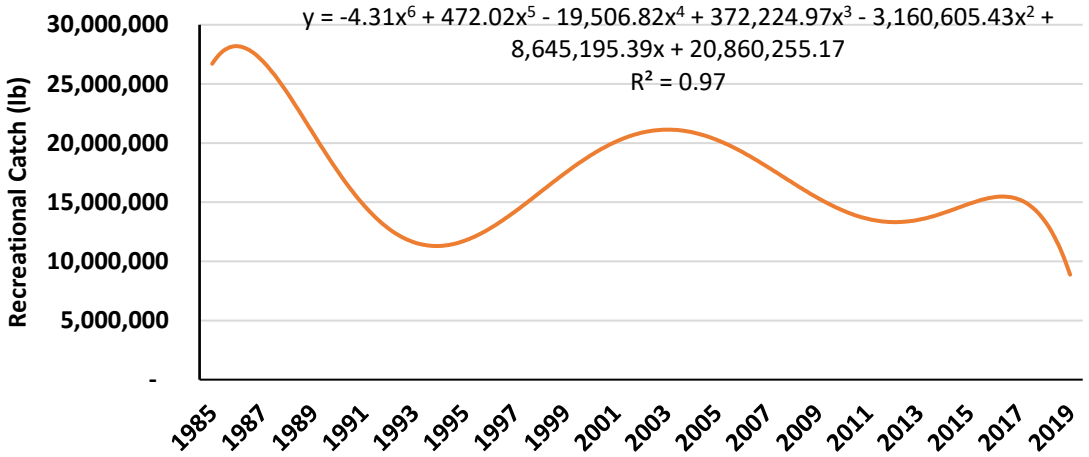

Figure 31. Trendline (fitted to a polynomial line, 6 order) for recreational summer flounder landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings of summer flounder were slightly greater than commercial landings in 2019.

Market summary. Those developing farms to raise summer or other species of flounder will likely need to differentiate their product from the frozen flounder imports, totaling 21.9 million in 2019. There are anecdotal reports of consumers not willing to pay as much for certain species of flounder than others in specific local markets, but there may also be some more widespread substitutability, particularly with respect to imported frozen flounder, in which competition is largely price-based. Product forms include: fresh, frozen, whole or as fillets. Summer flounder is commonly used in raw preparations for sushi or sashimi (Froese and Pauly 2014; NOAA Fish Watch 2014).

Well-recognized on regional U.S. markets on West Coast

California flounder (Paralichthys californicus) (West Coast)

California flounder, also known as California halibut, is the largest flounder and supports important commercial and recreational fisheries along the Pacific Coast in California and Oregon. California flounder are well known on the Pacific Coast from both the commercial and recreational fisheries (Stuart et al. 2021).

Aquaculture. Initial interest in farming California flounder was for stock enhancement purposes. While research studies have been conducted on California flounder, there is no known commercial farm production of California flounder. Most research studies have focused on broodstock, spawning, larval culture, and juvenile production. For growout, some limited trials have been conducted in flow-through raceways (Stuart et al. 2021). There are no data reported by FAO (2021a) on farmed production of California flounder globally.

Import/export of California flounder. Cortez flounder from Mexico are mostly sold into domestic markets in Mexico, but some are exported to the U.S. (DOF 2010; BC 2015). The volume of imports from Mexico is not known because exports from Mexico are classified as "flatfish." In 2015, 33,075 pounds of "unspecified halibut were imported from Mexico (NMFS 2016).

Commercial landings. Worldwide, the only locations of California flounder are off the coast of California. Production has decreased over time, with commercial catches peaking in the 1910s and 1940s (Seafood Watch: Flounder 2020). The southern California stocks were considered to be of moderate concern, based on the southern California stock being at 14% of the unexploited bass in 2011, whereas the Central California stock was at 122% of unexploited biomass and of low concern (Seafood Watch: California Flounder 2020). One-third of the commercial landings were in southern California in 2019. Commercial landings of California flounder peaked in 1999, declined rapidly until 2012 to levels of 29% of the 1999 levels, and then nearly doubled by 2019 (Figure 32). All commercial landings of California flounder in 2019 were in California.

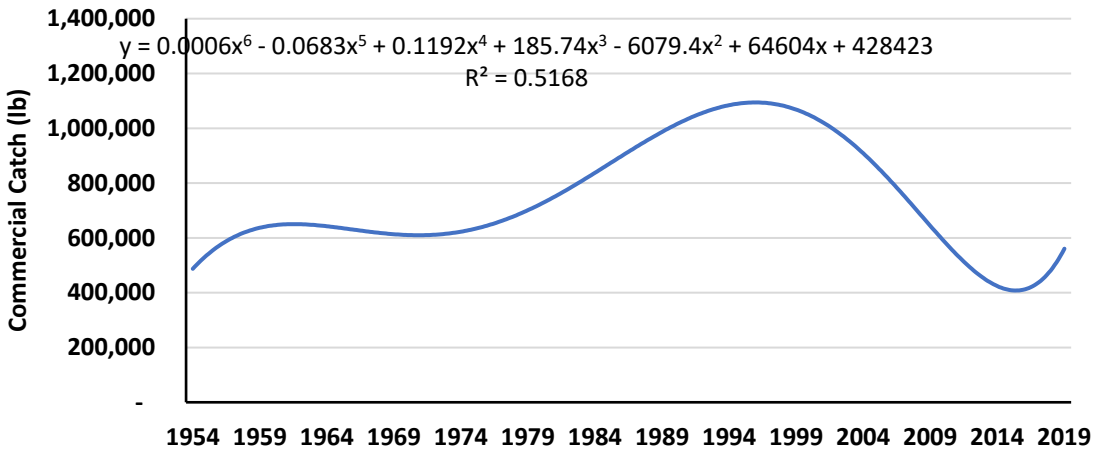

Figure 32. Trendline (fitted to a polynomial line, 6 order) for commercial California flounder landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of California flounder peaked in 1995 and then generally declined through 2015 and remained relatively stable through 2019 (Figure 33). More than 99% of all recreational landings of California flounder were in California with less than 1% in Oregon.

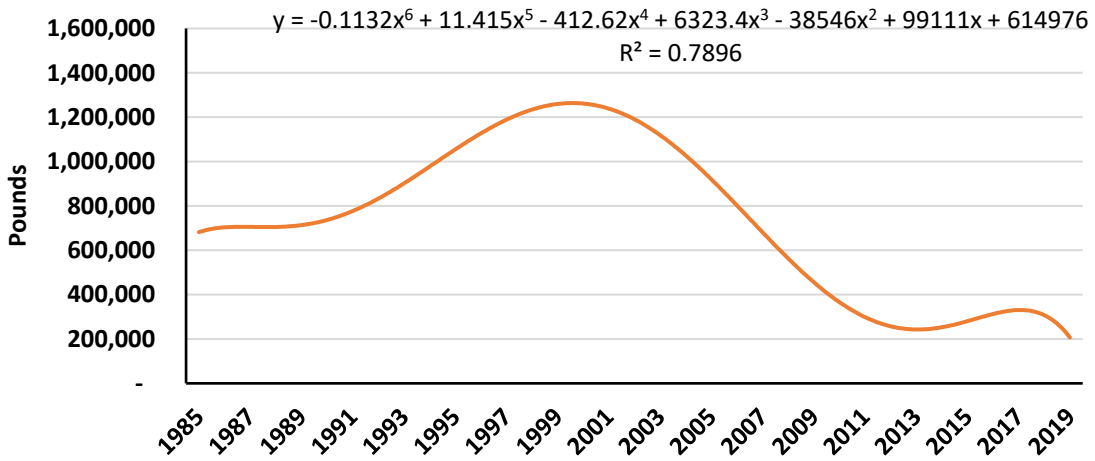

Figure 33. Trendline (fitted to a polynomial line, 6 order) for recreational California flounder landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of California flounder were 90% of commercial landings in 2019.

Market summary. The market for California flounder is a live market in California that is supplemented by imports of Japanese flounder (*Paralichthys olivaceous*) for the hirame market. The size of the hirame market in the U.S. is unknown. The minimum market size of California flounder is considered to be 3.3 lb, but it is unknown if smaller sizes would be accepted. Researchers who have worked with California flounder believe that a farmed fish is likely to be smaller, more consistent in size, and more readily available seasonally than wild fish. There are no import records available for live fish imported into California. Known primarily as halibut in California, California flounder are sold primarily fresh, as fillets or steaks.

California yellowtail (Seriola lalandi) (West Coast)

California yellowtail, also known as yellowtail amberjack, or yellowtail kingfish, is a member of the jack family found along the North American Pacific Coast from southern Washington to central Mexico. Yellowtail is primarily caught as bycatch byin fisheries targeting other species.

Aquaculture. Farming of yellowtail began in the 1960s, but of *Seriola quinqueradata*, not *S. lalandi* (Sicuro and Luzzana 2016). Globally, farmed production increased from 2,205 pounds in 2014 to 898,000 pounds in 2019 (FAO 2021a). Countries reporting farmed production in 2019 were Chile, Denmark, and The Netherlands. In the U.S., there has not yet been commercial production of California yellowtail, but a commercial scale farm has been proposed and is actively seeking required permits for an offshore facility.

Import/export of California yellowtail. Mexico is currently the only potential international source of California yellowtail. Exports of California yellowtail from Mexico are believed to be negligible. No other data are available.

Commercial landings. California yellowtail are considered to be of moderate concern (Seafood Watch: White Seabass and California Yellowtail 2018) and are not considered to be highly vulnerable. California yellowtail have been fished since the late 1800s, with a range from southern Washington to Mazatlán, Mexico. The commercial fishery is incidental to that of the commercial white sea bass drift and set gillnet fishery, but there also is a hook and line component. There is no stock assessment or fishery management plan for California yellowtail. Commercial landings of California yellowtail declined substantially from its peak of 9.4 million pounds in 1952 through the mid-1960s and have remained at low levels since (Figure 34). The 2019 landings of 26,455 pounds were 99% lower than those of the peak year of 1952. California was the only state with landings of California yellowtail in 2019.

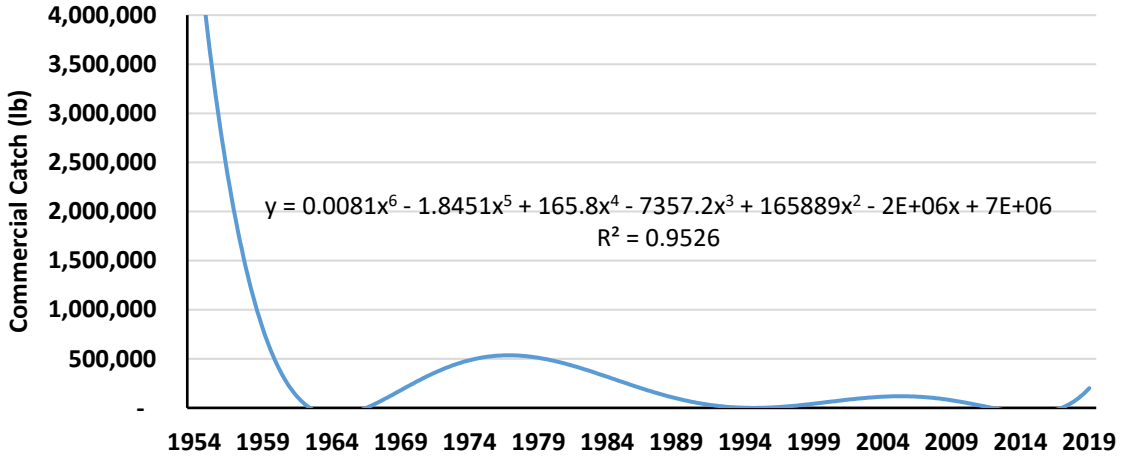

Figure 34. Trendline (fitted to a polynomial line, 6 order) for commercial California yellowtail landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. California yellowtail are increasingly targeted by U.S. anglers (Saillant et al. 2021). Recreational landings for California yellowtail peaked in 1998 at 5.6 million pounds, with what appears to be a much lower peak in 2017 (Figure 35). Nearly all the recreational landings of California Yellowtail were in California (99%) with < 1% in Oregon. The landings in 2019 were 154,273 pounds.

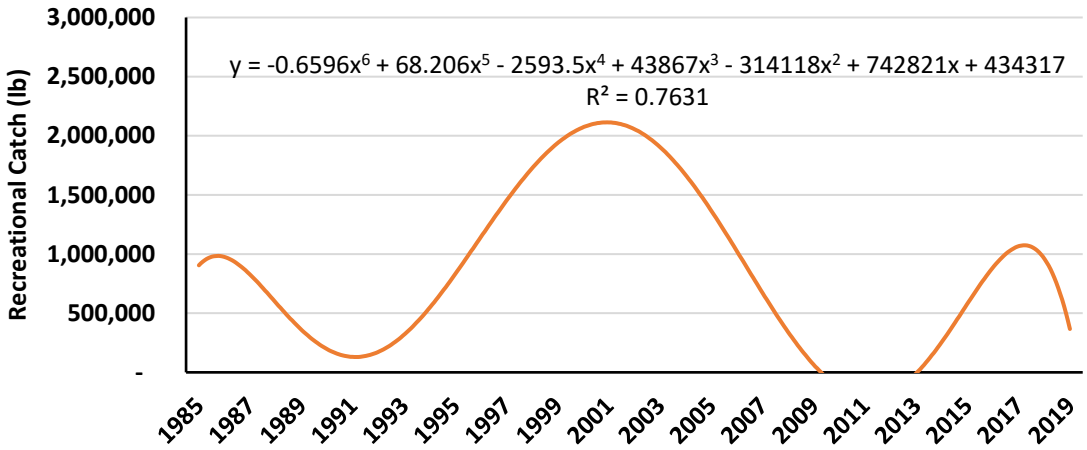

Figure 35. Trendline (fitted to a polynomial line, 6 order) for recreational California yellowtail landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of California yellowtail were 5.8 times greater than commercial landings.

Market summary. California yellowtail are sold as fillets either fresh or frozen, and either salted or dried.

White sea bass (Atractoscion nobilis) (West Coast)

White sea bass is distributed along the Pacific Coast of North America from Alaska to California. A member of the drum and croaker family, white sea bass is a target of a commercial fishery that extends from Central California to Baja California. White sea bass are considered to be of moderate concern, but not considered to be overfished.

Aquaculture. Culture of white sea bass initially emphasized production for stock enhancement (Drawbridge et al. 2021). The hatchery developed to support stock enhancement of white sea bass was credited with serving as a springboard for hatchery research on other species that included California halibut and CA yellowtail jack (*Seriola dorsalis*) (California Sea Grant 2017). From hatchery tanks, white sea bass broodstock are acclimated to ocean net pens. Hubbs-Sea World operates three coastal cages for rearing and releasing white seabass juveniles. Fingerlings are produced in RAS, but commercial growout of white sea bass likely would be in net pens, although pond production methods similar to those used for red drum might be feasible. There are no data reported by FAO (2021a) on farmed production of white seabass.

Import/export of white sea bass. No data were found on imports or exports of white sea bass. While Mexico is a potential international source of white seabass, exports from Mexico appear to be negligible. NMFS data do not differentiate between various species of seabass or grouper.

Commercial landings. There has been a commercial fishery for white sea bass since the 1890s (Seafood Watch White seabass and California Yellowtail 2018), with commercial

landings of white sea bass peaking in 1959 at 3.4 million pounds. By 1980 to 1981, the fishery had collapsed to 10% of its historic catch (Allen et al. 2017) (Figure 36). Landings remained low for the next 15 years. In 1983, California passed legislation to fund research for aquaculture for stock enhancement. The technology for hatchery production of white sea bass is now well developed. California was the only state with commercial landings in 2019.

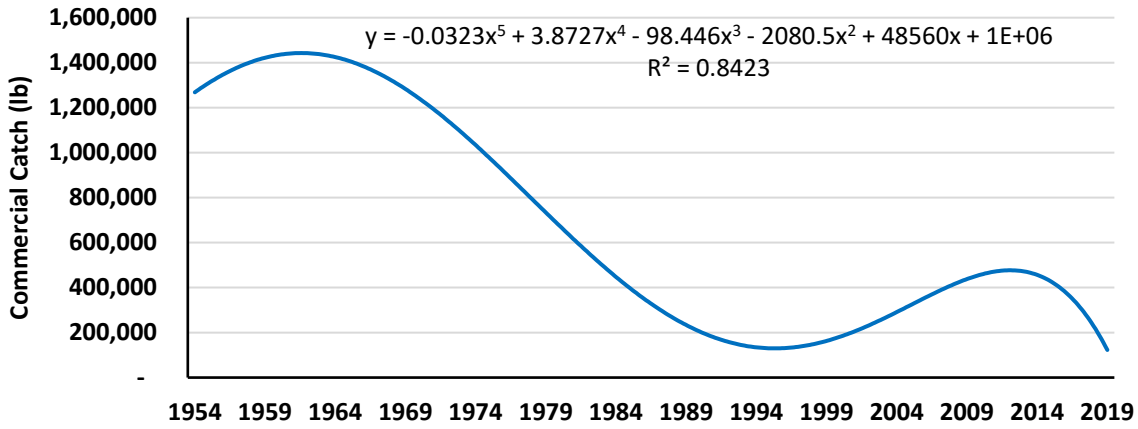

Figure 36. Trendline (fitted to a polynomial line, 5 order) for commercial white sea bass landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. White sea bass are a prized recreational fish (Drawbridge et al. 2021). Recreational landings for white sea bass peaked in 2000 at 578,621 pounds, declined through 2008 and then have fluctuated at low levels that represent only 13% of the peak recreational landings in 2000 (Figure 37). All recreational landings in 2019 were in California. Recreational landings of white sea bass in 2019 were 75,722.

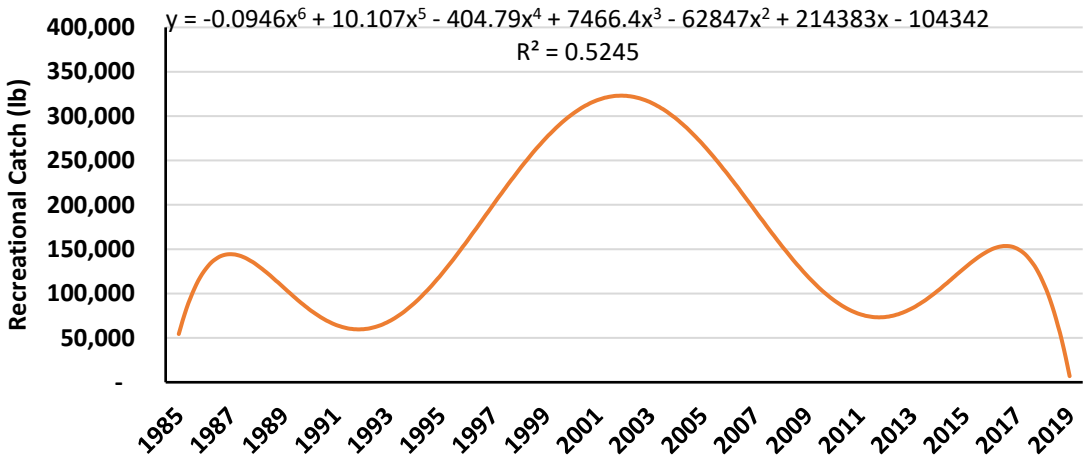

Figure 37. Trendline (fitted to a polyniomial line, 6 order) fore recreational white sea bass landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings were 47% of commercial landings in 2019.

Market summary. White sea bass are also known as corbina and are sold whole or as fillets, fresh or frozen. Anecdotal information from wholesalers indicated a potential price of from $2.00 to $3.30/lb with desired volumes of 50 to 5,000 lb/week (Drawbridge et al. 2021). Market size is considered to be 2.2 pounds that can be reached in about 18 months. White sea bass was considered to be similar to halibut in flavor and texture (Chefsresources.com).

Largely unknown in U.S. markets

Olive flounder (Paralichthys olivaceus)

Olive flounder globally is a major aquaculture species that is raised primarily in South Korea. It is native to the northwest Pacific, not to U.S. waters. There are reports of olive flounder sales in the U.S., although little systematic data are available.

Aquaculture. Olive flounder is one of the most important commercial farm-raised marine species in eastern Asia (Stieglitz 2021). Global farmed production increased from 1.4 million pounds in 1983 to nearly 100 million pounds in 2019 (FAO 2021a). The top countries for production of olive flounder include South Korea, Japan, Argentina, and Uruguay (Bai and Okorie 2007). In Asia, olive flounder are raised primarily in large, indoor flow-through concrete vats. High production density can result in efficient growout in RAS to market size, reaching 2.2 lb in 1 yr.

Import/export of olive flounder. No data were found on imports/exports of olive flounder in the U.S. Nevertheless, there are anecdotal reports of olive flounder sales in the U.S.

Commercial landings. There are no commercial landings of olive flounder in the U.S.

Recreational landings. Given that olive flounder is not native to U.S. waters, there is no recreational fishery for olive flounder.

Market summary. In the U.S., anecdotal reports indicate that olive flounder are sold primarily live in Asian markets or in sushi and sashimi restaurants. Market size is approximately 1.8 to 2.6 pounds, which is attainable in aquaculture in 12 to 18 months (Kikuchi and Takeda 2001; Seikai 2002).

Sablefish (Anoplopoma fimbria)

Sablefish, also known as sable, butterfish, and black cod is typically found in the North Pacific Ocean. It is commonly found off the coast of Alaska, Washington, Oregon, and Northern California. It is not overfished but is federally regulated under fishery management plans.

Aquaculture. The first commercial hatchery for sablefish was built in 1998 in British Columbia, Canada. Sablefish were first harvested from net pens in 2002 in Canada (Minkoff and Clarke 2003). In the early 2000s, the province of British Columbia approved 22 licenses for commercial sablefish farms, mostly on Vancouver Island, as an alternative to farmed salmon. Sablefish fishers opposed it. By 2010, farmed sablefish had reached 1.9 million

pounds (Campbell and Koop 2009; Stoner and Ethier 2015). Opposition by fishermen, combined with production problems, contributed to a decline in the number of farms, and production fell below 600,000 pounds (DFO 2018). Consistent survival during the larval stage has been reported as a problem as is the slower growth of males. At the time of this report, there was only one farm raising sablefish in British Columbia.

In the U.S., there were attempts to farm sablefish in offshore net pens in Hawaii, but the farm reportedly lacked sufficient capital to expand to a commercial scale (Consilli 2007). Growout trials conducted previously by two farms in the U.S. were discontinued, but additional trials were initiated in 2019. There also was a 2017 report of a RAS farm raising and selling small volumes of sablefish in Texas (Wiedenhoft 2017). Sablefish are reported to require two years of growout to a market size of 5.5 pounds (Echave et al. 2002).

Imports. The volume of frozen sablefish imports exhibited a large peak from 2015 to 2017 but then declined substantially afterwards to previous levels (Figure 38).

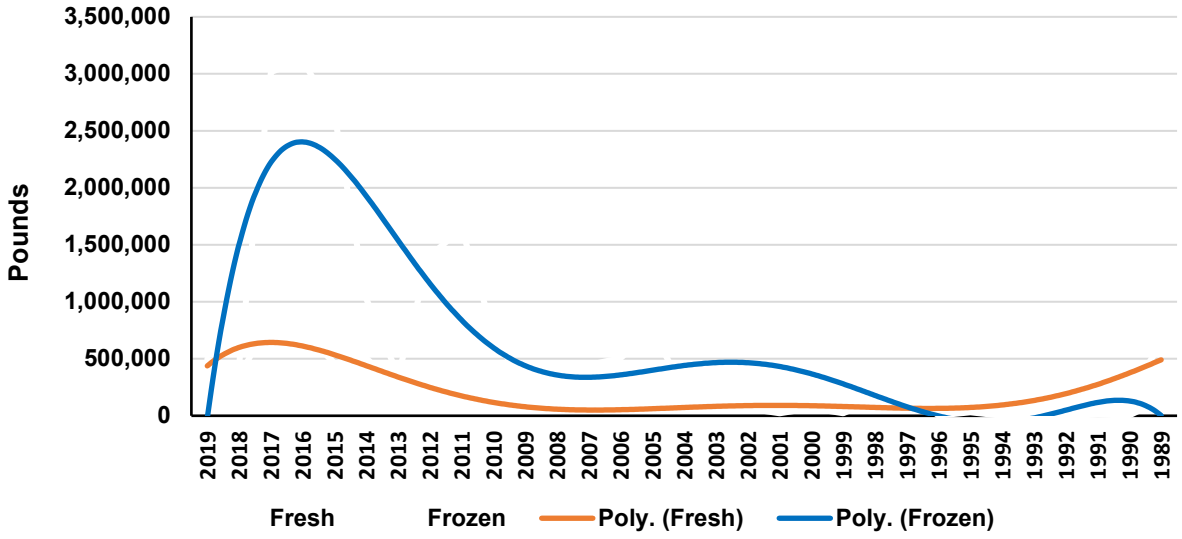

Figure 38. Trendlines by imported product (fitted to a polynomial line, 6 order) of volumes of imported sablefish. SOURCE: NOAA Foreign Trade Database (NOAA 2021a).

Commercial landings. U.S. commercial landings of sablefish peaked in the early 1990's and have generally declined since them (Figure 39). The fourth consecutive decade of the downward trend in adult sablefish biomass has been attributed to the large catches in the late 1970s and early 1980s (Stuart et al. 2011). The wild-caught supply is generally limited currently to 44 million pounds or less. Nearly three-fourths (71%) of all U.S. commercial landings of sablefish were in Alaska, with Oregon second at 14%, and California at 8%.

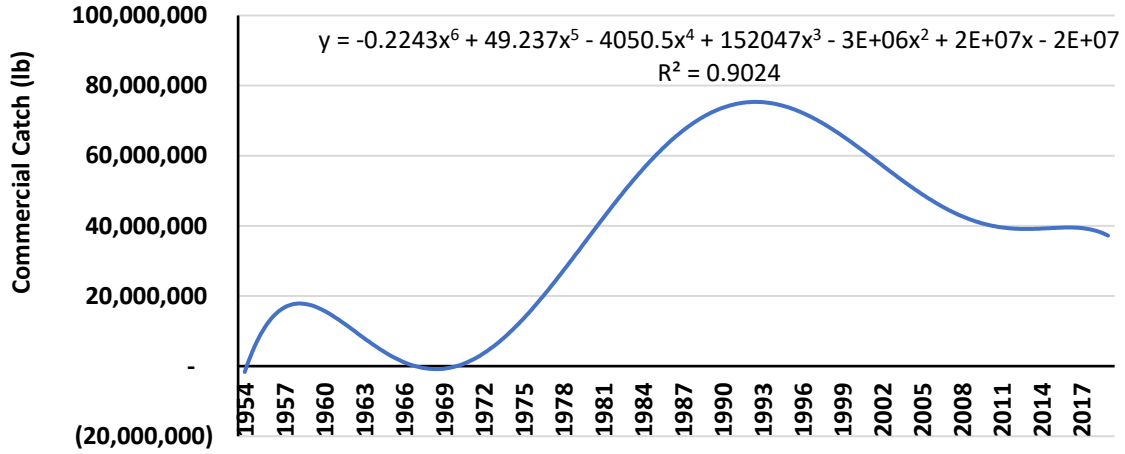

Figure 39. Trendline (fitted to a polynomial line, 6 order) of commercial sablefish landings. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of sablefish declined from the late 1980s to the late 1990s and have remained relatively stable at levels much lower than those of the 1980s (Figure 40). The only state with recreational catch of sablefish in 2019 was Oregon.

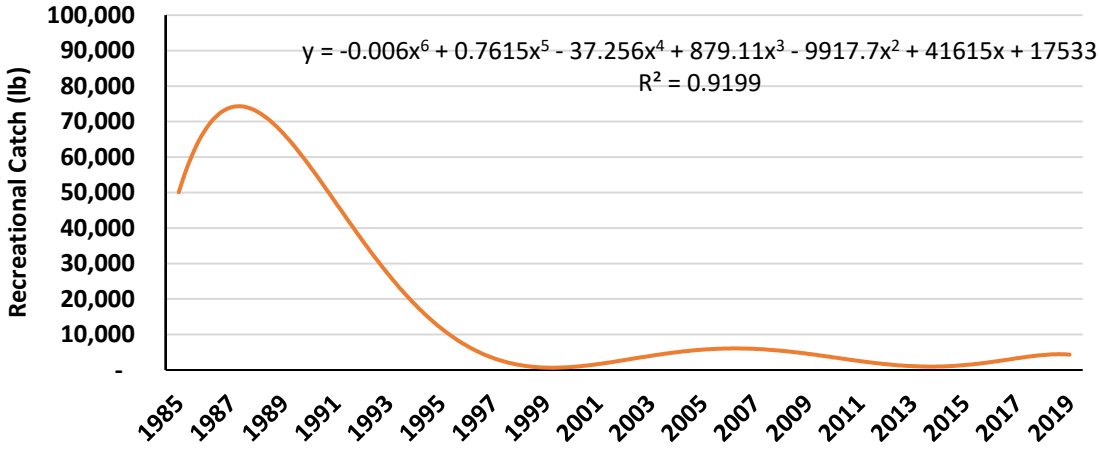

Figure 40. Trendline (fitted to a polynomial line, 6 order) of recreational sablefish landings. SOURCE: NOAA Landings Database (NOAA 2021b).

For sablefish, commercial landings have far exceeded landings from recreational fisheries.

Market summary. While sablefish has been sold as Pacific cod as a substitute for Atlantic cod, product labeled as "farmed sablefish" still will likely be considered as a new product for U.S. consumers despite its commercial landings being the greatest of the 20 species under consideration in this study. Sablefish historically has been destined for export from the U.S. and Canada to the Japanese market where sablefish is a well-known and preferred finfish. South Korea is also a major market for sablefish.

With declining stocks and landings, the supply is limited and sablefish is now viewed as a "white tablecloth" seafood that is served as a seasonal specialty dish in restaurants (Parker 2017; Hartley et al. 2020). Sablefish is increasingly priced in upscale restaurants as a luxury good (Cascorbi (2007). In the 1990s, Nobuyuki Matsuhisa, owner of Nobu restaurant in New York City introduced miso-glazed sablefish as a signature dish (Burros 2001; Morimoto 2007; Olmsted 2016) that was popularized on the Iron Chef America television program. More recently, it has become popular with sushi chefs, as a more environmentally friendly alternative to unagi (freshwater eel) (Leu 2016). Larger fish are preferred. One midwest wholesaler reportedly paid $8.14/lb for dressed, head-on product. Ex-vessel prices were $4.50/lb from 2016 to 2018, but increased to $5.29/lb in 2019. Prices are tiered by size, with 1.6-lb fish reported to be sold at $2.82/lb, while fish that were 11 lb and larger were reported to sell for $5.79/lb. Econometric demand analysis estimated that, for each 2.2 million pounds of increase in global supply, Alaska sablefish price would decrease by $0.077/kg generally, with a U.S. West Coast decrease of $0.040/kg and $0.039/kg in British Columbia, Canada (Hartley et al. 2020).

Consumers have been reported to view sablefish as a substitute for Chilean sea bass and Patagonian toothfish (Huppert and Best 2004; Sonu 2014). Midwest distributors were reported to be more accepting of farmed sablefish than were west coast distributors who have strong relationships with marine fishermen. Sablefish has been sold as frozen headed and gutted, fish fillets, and fresh headed and gutted (Seafood Watch Sablefish. BC. 2020).

Spotted wolffish (Anarhichas minor)

Spotted wolffish is found in the northern Atlantic Ocean and only in the Gulf of Maine in the U.S. Commercial and recreational harvest is prohibited in U.S. waters.

Aquaculture. Interest in farming spotted wolffish commercially has been growing globally. There are reports of one commercial farm in Norway with plans for another in Quebec, Canada. Research trials have shown that wolffish can reach 2.2 to 3.3 pounds in 2 to 2.5 years using culture methods that have been successful for commercial production of other flatfish in flow-through vats or tanks and in RAS. The spotted wolffish was listed as a top-ranked aquaculture candidate for Norway and Canada (Falk-Petersen et al. 1999; LeFrançois et al. 2002; Foss et al. 2004) because it out-performed Atlantic wolffish in culture trials (LeFrançois et al. 2021). Other than 2,205 pounds of farmed spotted wolffish production in Ireland in 2002, no other production has ben reported by FAO (2021a) through 2019.

Import/export of spotted wolffish. The trendline for imported volumes of spotted wolffish appears to show cyclical variation from 1993 to about 2007, followed by a greater decline through 2017 (Figure 41).

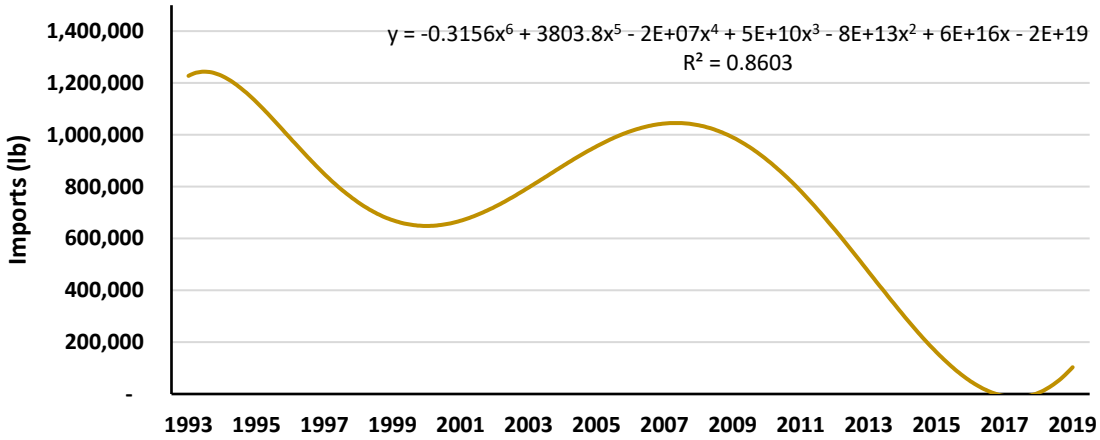

Figure 41. Trendline (fitted to a polynomial line, 6 order) of spotted wolffish imports. SOURCE: NOAA Foreign Trade Database (NOAA 2021a).

Commercial landings. Spotted wolffish have a wide distribution (Robbins and Ray 1986) and are harvested by Norway and Iceland in the eastern Atlanta. They are not harvested in Canada and no substantial landings have ever been reported in the U.S. (LeFrancois et al. 2021). Wolffish have been designated as threatened by COSEWIC (Committee on Status of Endangered Wildlife) in Canada. There is some catch of Atlantic wolffish, a closely related species in the Gulf of Maine, as incidental bycatch. Since the 1999 listing of spotted wolffish as a species of concern in U.S., there have been no more commercial landings (AWBRT 2009).

Market summary. Spotted wolffish would be a new species for U.S. consumers in spite of imports in the 1990s. Market surveys do show market potential (Richardson and Johansen 202; Johnson and Halfyard 2002; Laflamme et al. 2005). A Norwegian farm sells wolffish into the halibut segment of the seafood market at $2.27/lb as a fresh headed and gutted product. In Canada, round, gutted, head-on wolffish from wild fisheries can reach $7.71/lb.

Tripletail (Lobotes surinamensis)

Tripletail is a warmwater marine finfish found primarily on the Gulf Coast.

Aquaculture. There are no reports to date of commercial farmed production of tripletail. Research on culture of tripletail has shown progress in spawning and larval rearing methods. Limited growout trials in RAS at low density showed rapid growth to market size of approximately 2.2 pounds. There are n data reported by FAO (2021a) on farmed production of tripletail.

Import/export of tripletail. No data were found on imports or exports of tripletail.

Commercial landings. Tripletail are distributed widely in all oceans of the world. The largest tripletail fishery is in South America (Guyana, Suriname, and Brazil), of up to 6,600 lb/yr. In the U.S., low-volume commercial landings of tripletail have increased slowly from the late 1960s to 24,242 pounds in 2019 (Figure 42). The 2019 landings reached 50% of the previous peak period. In the U.S., tripletail are most abundant along the east coast of Florida that

accounts for 67% of all U.S. landings in 2019, followed by North Carolina (13%), and Mississippi (12%) with some additional landings in Alabama and Louisiana.

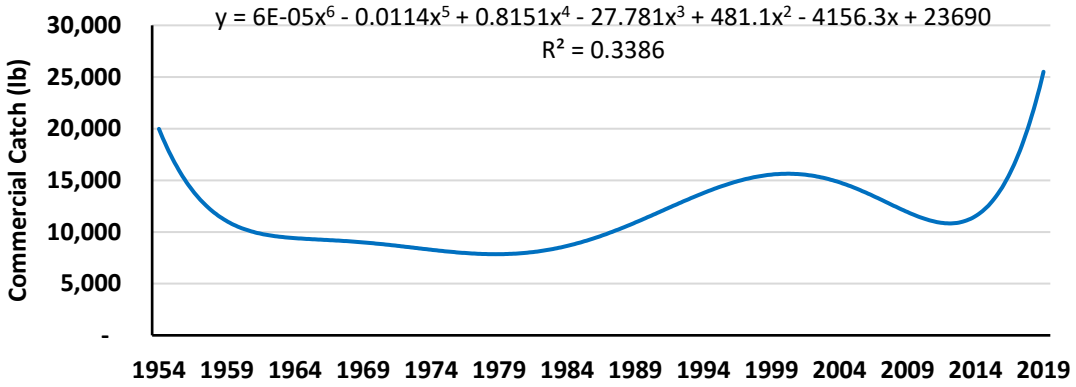

Figure 42. Trendline (fitted to a polynomial line, 4 order) for commercial tripletail landings, 1954 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Recreational landings. Recreational landings of tripletail peaked in 2000, and subsequently declined with evidence of a slight upward trend since about 2015 (Figure 43). Nevertheless, the recreational landings in 2019 were 35% of those of the peak landings in 2000. The major states for recreational landings of tripletail in 2019 were Florida (75.5%), Alabama (12%), and Mississippi (6%), with additional landings in Louisiana, North Carolina, and South Carolina.

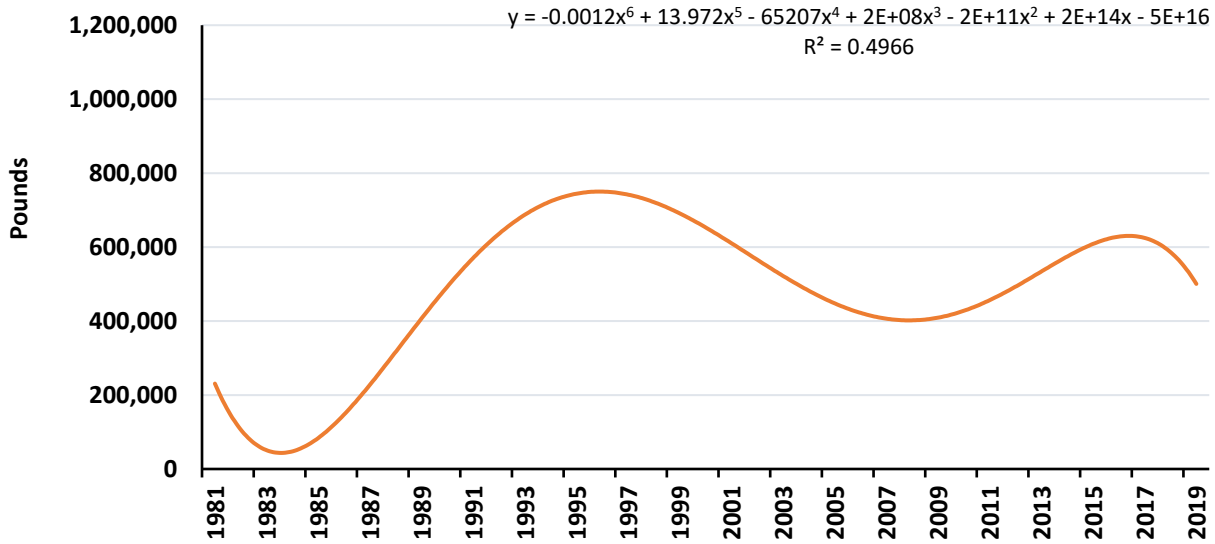

Figure 43. Trendline (fitted to a polynomial line, 6 order) for recreational tripletail landings, 1985 to 2019. SOURCE: NOAA Landings Database (NOAA 2021b).

Overall, recreational landings of tripletail were 17 times greater in 2019 (412,760 lb) than were commercial landings.

Market summary. Tripletail has been reported to be a high-quality finfish likely to be desirable by consumers (Saillant et al. 2021). There reportedly is an established demand by

restaurateurs and fish retailers of fish imported from eastern Pacific and South America (Saillant et al. 2021).

Fisheries Regulations

Commercial Fishing Regulations

The commercial availability of these species during certain times of the year (i.e. seasonality) are influenced, in part, by commercial harvest regulations. Federal and state regulations for the harvest of these species vary widely for commercial harvest and at any given time, the availability of a species may be influenced by any of these regulations to varying degrees in different locations. In federal waters, a series of Fisheries Management Councils establish annual catch limits, minimum sizes, and bag limits, or in some areas, establish total allowable catches with tradeable quotas in some cases.

Table 5 categorizes the effect of commercial regulations on seasonality of supply availability for each species in terms of the degree of restriction on commercial harvesting seasons. Species with the least restrictions on harvest are those that are open year-round to commercial harvesting, while species with the most restrictive seasons are those that are closed year-round.

Commercial fishing seasons for almaco jack, black drum, California yellowtail, cobia, Florida pompano, olive flounder, and tripletail are open year-round for harvest from state and federal waters. Fishing seasons for black sea bass, greater amberjack, spotted seatrout, striped bass, and summer flounder are open year-round, with quotas set each year, making the season subject to closure once the quota is met in each given state. The commercial Atlantic cod season is open year-round, but is subject to quota shares allocated to permit-holders each year based on annual catch entitlements by fishing sector. California flounder is subject to a short trawling season in California waters but is open year-round elsewhere. The seasons for red snapper and sablefish are closed for parts of the year in state and federal waters. Commercial red drum harvest is only allowed in Mississippi, Maryland, and Massachusetts, with varying seasons and quotas. Commercial harvests of red drum in the Gulf of Mexico were prohibited by 1990 and remained so in federal waters, largely prohibited in all Gulf States (Alabama allows some commercial harvest) (Seafood Watch: Red Drum). The commercial harvest of southern flounder is heavily regulated in North Carolina with a month-long season and Florida with strict vessel limits. Lastly, there is a federal harvest moratorium placed on spotted wolf fish, meaning that both commercial and recreational seasons are closed year-round. Detailed information on the opening and closing dates for these seasons can be found in the individual species sections of this report.

Table 5. Degree of restrictions on commercial fishing seasons.

	1 – Season Open year-round
	Almaco jack
Least	Black drum
restrictive	California yellowtail
↓	Cobia
	Florida pompano
	Olive flounder
	tripletail
	2 – Season open year-round, with catch shares or quotas in place
	Atlantic cod
	Black sea bass
	California flounder
	Greater amberjack
	Spotted seatrout
	Striped bass
	Summer flounder
	3 – Season closed part of the year, catch shares or quotas in place
	Red drum
	Red snapper
	Sablefish
	4 – Season open only a few months per year
	Southern flounder
	5 – Season closed year-round
Most	Spotted wolffish
restrictive	

Recreational Fishing Regulations

Federal and state regulations for the harvest of these species vary widely for recreational harvesting. Table 6 categorizes the effect of recreational fishing seasons on the availability throughout the year of each species. The species with the least restrictions on harvest have recreational seasons that are open year-round. The recreational seasons for almaco jack, California flounder, California yellowtail, Florida pompano, olive flounder, red drum, sablefish, spotted seatrout, tripletail, and white sea bass are open year-round. Several species, such as black sea bass, cobia, greater amberjack, southern flounder, striped bass, and summer flounder have seasons that are open year-round but are managed under strict quotas or catch shares that may lead to seasons closing early, once the quotas are met. Black drum is also subject to quotas or catch shares but also has a season that is closed part of the year. A few species such as Atlantic cod and red snapper have seasons that are only open for parts of the year. Lastly, there is a federal harvest moratorium placed on spotted wolffish, meaning that both commercial and recreational seasons are closed year-round. Detailed information on the opening and closing dates for these seasons can be found in the appendices that include details for each. Recreational harvest for red drum is tightly regulated by Gulf of Mexico states.

Table 6. Degree of restrictions on recreational fishing seasons.

	1 – Season Open year-round
	Almaco jack
Least	California flounder
restrictive	California yellowtail
	Florida pompano
	Olive flounder
	Red Drum
	Sablefish
	Spotted Seatrout
	Tripletail
	White Sea Bass
	2 – Season open year-round, with quotas in place
	Black sea bass
	Cobia
	Greater amberjack
	Southern flounder
	Striped bass
	Summer flounder
	3 – Season closed part of the year, catch shares or quotas in place
	Black drum
	4 – Season open only a few months per year
	Atlantic cod
	Red snapper
	5 – Season closed year-round
Most	Spotted wolffish
restrictive	

Potential Market Opportunities

The total commercial supply of the 20 marine finfish species under consideration in this study includes imports, commercial landings, and aquaculture production, but specific import data were not available for most species and were omitted (Table 7). For the majority of these species, there is currently little to no aquaculture production in the U.S. The exception is red drum, which supplied a total live weight of 7 million pounds in 2018. Of the 20 warmwater marine finfish species discussed in this report, sablefish has the largest total supply. The flounder species (summer, southern, California, and olive) also have comparatively large supplies in the U.S., mostly due to the large volume of non-specified flounder imports. Atlantic cod also has a large volume of imports compared to commercial landings. California yellowtail, spotted wolffish, tripletail, and white sea bass have relatively insignificant supplies in the United States.

Table 7. Total commercial supply of marine finfish in 2019.

Species	Commercial landings (lb)	Farmed production (lb)	Total commercial supply (lb)	Trend of commercial landings
Sablefish	40,843,250	-	40,843,250	decline
Red snapper	7,558,144	-	7,558,144	recent increase
Red drum	120,572	7,153,000	7,273,572	decline
Summer flounder	7,044,897	-	7,044,897	decline
Black drum	5,358,101	-	5,358,101	stable
Striped bass	4,487,603	-	4,487,603	recent decline
Black sea bass	3,802,944	-	3,802,944	decline
Atlantic cod	2,241,582	-	2,241,582	decline
Southern flounder	902,364	-	902,364	decline
Greater amberjack	811,378	-	811,378	decline
CA flounder	732,154	-	732,154	decline
Spotted seatrout	570,879	-	570,879	decline
Florida pompano	403,019	-	403,019	decline
Almaco jack	183,364	-	183,364	recent decline
White sea bass	160,717	-	160,717	decline
Cobia	137,652	-	137,652	decline
CA yellowtail	26,455	-	26,455	very low
Tripletail	24,142	-	24,142	increasing
Olive flounder	-	-	-	no U.S. landings
Spotted wolffish		-	-	decline
TOTAL	73,484,162	7,153,000	80,637,162	

Sources: NOAA Landings Database (NOAA 2021b); NOAA Foreign Trade Database (NOAA 2021a); Census of Aquaculture 2018.

From an aquaculture perspective, the total volume of commercial supply of the 20 species under consideration is fairly low. By way of comparison, the 80.6 million lb in 2019, from Table 7, constitute only 23% of the total volume sold of U.S. farmed catfish. When compared species-by-species, only sablefish volumes approached the volume produced of trout (49 million lb in 2019), the second largest sector of U.S. aquaculture, and the majority of sablefish is exported, not consumed in the U.S. market.

Another way to view these commercial supply volumes from the perspective of an aquaculture farm is to compare the number of farms that it would take to provide this supply. In the U.S. catfish industry, the average production sold from a single catfish farm was 750,000 lb/year. Thus, the total supply of half of the marine species in this report is less than that of an average U.S. catfish farm. One small, 300-acre catfish farm, producing at a conservative level of 10,000 lb/acre using current, intensive methods, would produce on that one farm more pounds of fish than 65% of the marine species examined in this study. A large catfish farm of 1,000 acres would produce a greater volume than all but the commercial supply of sablefish.

Moreover, Table 7 shows that commercial landings of only two of the 20 species examined in this study were increasing with one other showing relatively stable commercial landings. The remaining 17 showed declines. In some cases, the declines occurred a number of years ago

followed by very low landings and, in others the decline occurred in recent years. The low current volumes of supply of most of these species mean that the short-term markets to be developed will be small, niche markets that will be sufficient to support only a small number of farms until such time as additional markets can be developed.

For an industry to develop to the size of the U.S. trout or catfish industries, new market development will be essential. This requires extensive advertising and marketing efforts over time. The caveat to the above, of course, is that the data on volumes of imports of these individual species is incomplete and under-estimated in the above estimates.

An additional unknown factor is that of the recreational catch. The volume of recreational landings of various species likely creates awareness and potentially positive perceptions of a given species in the geographic areas where caught. Of the species analyzed in this study, striped bass had the greatest recreational landings and was followed by red snapper, spotted seatrout, red drum, black sea bass, summer flounder, and black drum (Figure 44). Recreational landings of the other species were much lower. Nevertheless, for 14 of the species considered in this report, the volume of recreational landings was greater than that of commercial landings. Commercial landings exceed recreational landings only for four of the 20 species. There were no recreational landings for olive flounder or spotted wolffish. The greatest influence of the recreational catch likely is that of the political pressure from sportsfishermen to allocate greater percentages of catch quotas to recreational as compared to commercial fishing. To the extent that sportsfishermen are successful in doing so, commercial landings will continue to decrease, further reducing the market supply of those species, and potentially increasing demand for aquacultured product.

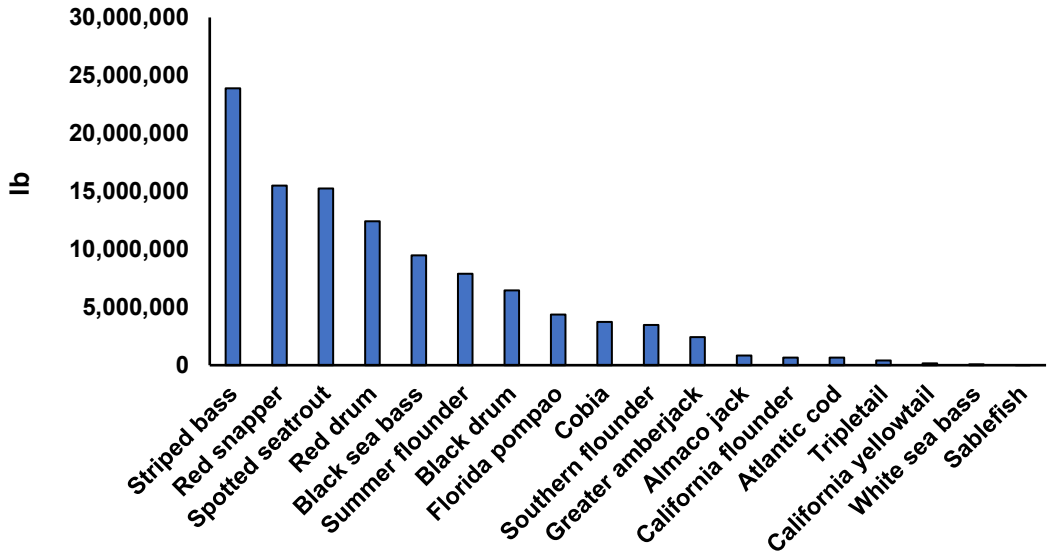

Figure 44. Recreational landings, 2010, of the 18 species for which recreational landings data were available (there were no recreational landings reported in the U.S. of olive flounder or spotted wolffish).

Discussion

The commercial feasibility of any business depends, of course, on whether it is profitable. Profitability, in its simplest form, can be assessed by comparing total revenue of the business with total costs. Since there are no or few commercial farms for most of the species studied in this analysis, there are no farm-level data on revenues and costs. Market prices are determined by the interaction of supply and demand relationships in any given market.

Effective demand, as defined by economists, is the volume of a product sold at the market equilibrium price. Effective demand is affected by a series of factors as depicted in Figure 45. The volume of available supply clearly establishes a baseline of the volume that is currently being purchased by consumers. For the species studied in this project, the available supply is primarily that of commercial fisheries landings summed with the volume of imports of that species, in addition to some limited domestic farmed supply for a few species. On the consumer side, effective demand is affected by several factors that include awareness of the product and the degree to which consumers readily substitute among various species of marine finfish.

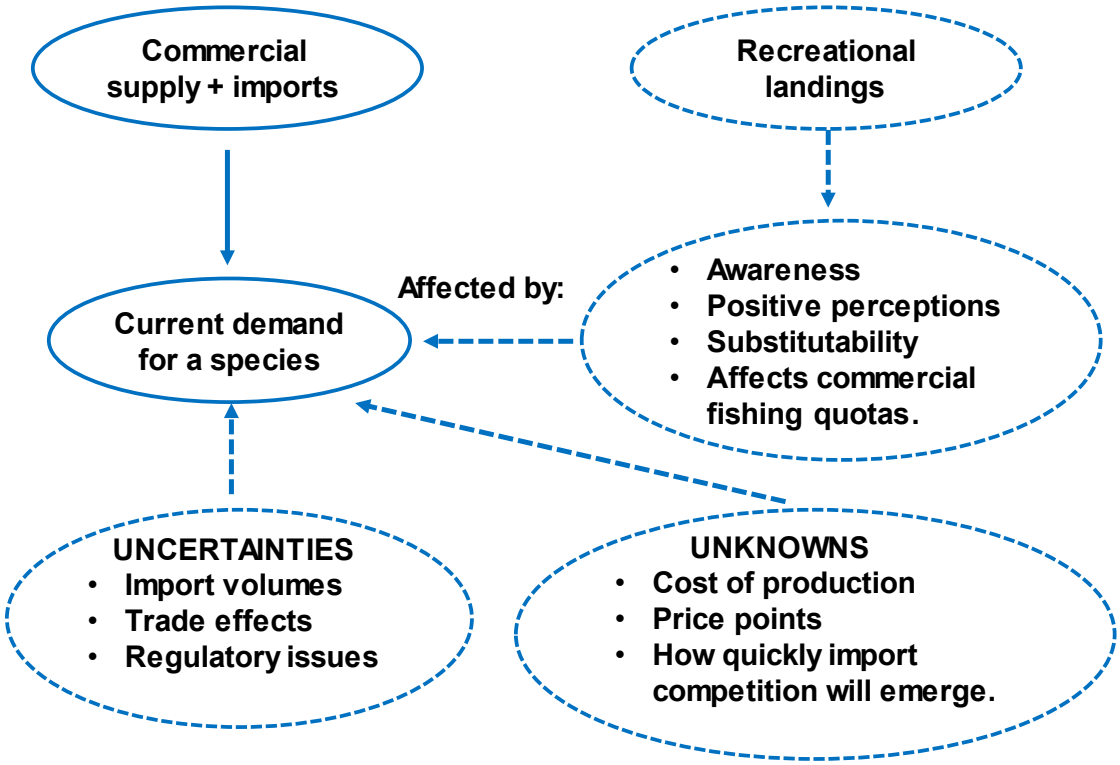

Figure 45. Factors that affect effective demand for a marine finfish species.

This particular analysis focused on the volume supplied of these 20 species of marine finfish to the U.S. market. One of the key results of this analysis is that the current volumes of commercial supply (landings plus imports) of most of these species is quite low. Such low volumes would support only a relatively small number of commercial-scale farms that would likely be relatively small. Given the economies of scale generally in aquaculture, such smaller-scale farms would operate at fairly high costs of production. Larger-scale farms would likely be feasible only if much larger markets would be created and developed for these species. Unless U.S. consumers begin to include seafood as a greater proportion of their diet, development of new markets for marine finfish would mean penetrating existing animal protein markets to capture market share either from other species (probably the major ones like pollock, tuna, salmon, tilapia) or from land-based livestock industries (i.e., chicken, pork, beef). Thus, farms seeking to raise these species will need to plan initially on supplying relatively low volumes of products for upscale markets where they can command a premium price for what will be a high-cost product.

Not only are commercial landings low for most of these species, the landings are highly variable and subjected to catch quotas and other constraints imposed by states and fisheries management councils. The variability in commercial landings may well offer an important advantage for aquaculture farms. Farmed fish production has offered consistent volumes, sizes, and quality that is an important benefit for distributors, restaurants, and supermarkets. Years and seasons of declining commercial landings may offer opportunities to penetrate markets with farmed supply of those species. Nevertheless, those farms will need to develop business plans that create the logistical infrastructure that enables them to subsequently provide a very consistent volume, size, and quality of that species to take full advantage of that opportunity.

Recreational fisheries landings create some important questions and unknowns in terms of this analysis. For some species, recreational landings far exceed commercial landings. Across a number of the species in this study, recreational landings appear to have increased in relative importance vis-à-vis commercial landings. Anglers, however, typically fish primarily for the thrill of landing the fish targeted, not to provide food for the family even though many anglers do eat the fish they catch. The effect of increased recreational landings of any given species on U.S. consumer demand for that species is unknown. No studies that directly address this question have been found in the research literature. On the one hand, species that are popular and prized by recreational anglers would be expected to be well known in the region and perhaps perceived in a positive manner. On the other hand, would an angler be willing to pay high prices for a type of fish that he/she enjoys catching from the wild, especially if they are able to catch enough to maintain a stock of those fish in their freezers?

Research literature on seafood demand in the U.S. shows a fairly high degree of substitutability among species, even those as seemingly unrelated as salmon and catfish. Furthermore, the substitutability of species varies across geographic markets (Dey et al. 2017). The degree to which consumers would substitute sablefish, for example, for Chilean sea bass or another species, is not well understood. Similarly, do consumers know what species of “flounder” they eat at a restaurant? Would it matter if they knew? In other words, is the “market” for each of these species distinct from that of the “market” for marine finfish generally? Additional research is needed to examine these questions.

One of the limitations of this study is the lack of readily available data on imported quantities of the marine finfish species included in this analysis. Competition from low-priced imports, often raised under less stringent regulatory enforcement frameworks (Abate et al. 2016), can be a critical factor in the success of early farm enterprises for that species. Moreover, as has been shown in the U.S. catfish industry, commercial farming success and market development in the U.S, will almost certainly attract competition from other countries (Engle et al. 2021). Thus, U.S. farming businesses for these species will need to develop and implement effective strategies to not just compete with current imported supplies but also to prepare for inevitable increases in imported quantities if U.S. farms are successful in creating those markets. Unfortunately, the data that were found on imports aggregated data across several species into broad categories such as “flounder,” “bass,” “snapper.” There is a strong need to make available detailed import data on the marine finfish species that are being cultured or likely to be farmed in the near future.

Limitations to the Study

Every effort was made in this study to evaluate and assemble all relevant information related to the supply of the species under consideration. There are, however, some fairly serious gaps in the available data. One of the most serious is the lack of import data on the species under consideration or emerging as farmed species in the U.S. For example, more than 8 million pounds of un-specified species of flounder were imported as frozen product in 2019. Imported fish of the same species may well be the major type of competition for development of successful aquaculture businesses for these species. New, startup, and prospective aquaculture producers will need to have access to data on imported volumes, prices, and country of origin to be able to design effective strategies to compete with what most often are lower-priced products entering the U.S.

Commercial and recreational landings data are highly variable. Year-to-year variation in landings are affected by the weather, by changing quotas and other regulations, and a number of species exhibit longer-term, multi-year spawning and production cycles. Thus, it is important to consider longer-term trends more so than short-term variations in supply. Additional variability in the data arises from differences in the population models used to estimate overall supply and catch that have changed over time (NOAA, 2021a; NOAA 2021b).

Conclusions

With the exception of sablefish and Atlantic cod, the volumes of commercial supply for the species analyzed in this study were quite low. In terms of marketing, then the existing demand and markets for each of these species is quite low. Thus, startup farms to raise these species will also be small-scale at least until the farmers are able to develop new markets that support growth of the farm.

Of the species examined in this study, the commercially available supply was found to be declining for all but black drum (which was stable) and red snapper, and tripletail for which

supply was increasing. The declining commercial supply may offer windows of market opportunity for startup farms to begin to establish their products in those markets. It may be possible for farmed supply to reach previous levels of demand for species that have been in decline, but will depend on the various dynamics of the determinants of demand.

One well-discussed advantage of fish farms is the ability to offer consistent sizes, quality, volumes, and frequency of deliveries to customers. The high degree of variability of commercial landings and supply amplify the advantage of farming the species studied in this project.

Recreational landings were greater than commercial landings for 14 of these species studied in this project. It is unlikely that recreational landings will have a direct effect on demand for these species, but likely have indirect effects. Part of the reason for increasing recreational landings is the increasing market share of the catch quota allocations being transferred to recreational from commercial landings. The political strength of recreational anglers has grown over time and likely explains the increases in recreational landings. If this trend continues, commercial landings (which constitute market supply) will likely continue to decrease, offering more opportunities for farmed production to gain a foothold in markets. Recreational landings also likely provide indirect benefits in the form of awareness of these different species and likely positive perceptions of them.

The lack of data on the volume of imports and trends for many of these specific species is problematic. Imported marine finfish will likely be the largest proportion of the competition faced by U.S. marine fish farmers. Thus, having access to data to monitor those trends will become ever more important over time.

The markets that will need to be developed for these species will be low volume, high-cost markets, at least in the short term. Farms will need to develop strong logistical support to consistently deliver extremely fresh product in very consistent sizes, quality, and frequency of delivery year-round to upscale markets for farms to be economically viable.

References

Abate, T. G., R. Nielsen, and R. Tveterås. 2016. Stringency of environmental regulation and aquaculture growth: a crosscountry analysis. Aquaculture Economics & Management 20(2):201–221.

ADCNR. 2021. Saltwater Recreational Size & Creel Limits. https://www.outdooralabama.com/fishing/saltwater-recreational-size-creel-limits.

Allen, L., D. Pondella, and M. Shane. 2007. Fisheries independent assessment of a returning fishery: abundance of juvenile white seabass (*Atractoscion nobilis*) in the shallow nearshore waters of the southern California bight, 1995-2005. Fisheries Research 88:24-32.

Andersen, L.K., J. Abernathy, D.L. Berlinsky, G. Bolton, M.M. Bocker, R.J. Borski, T. Brown, D. Cerino, M. Ciaramella, R.W. Clark, M.O. Frinsko, S.A. Fuller, S. Gabel, B.W. Green, E. Herbst, R.G. Hudson, M. Hopper, L.W. Kenter, F. Lopez, A.S. McGinty, B. Nash, M. Parker, S. Pigg, S. Rawles, K. Riley, M.J. Turano, C.D. Webster, C.R. Weirich, E. Wan, L.C. Woods III, B.J. Reading. 2021. The status of striped bass, Morone saxatilis, as a commercially ready species for U.S. marine aquaculture. Journal of the World Aquaculture Society 51(3):12812.

ASMFC. 2002. Amendment 2 to the Interstate Fishery Management Plan for Red Drum. http://www.asmfc.org/uploads/file/redDrumAm2.pdf.

ASMFC. 2011. Omnibus Amendment to the Interstate Fishery Management Plans for Spanish Mackerel, Spot, and Spotted Seatrout. http://sedarweb.org/docs/wsupp/SEDAR28-RD07%20ASMFC%202011.pdf.

ASMFC. 2015. Managed species, summer flounder. Available online at //www.asmfc.org/species/summer-flounder.

ASMFC. 2018a. Addendum I to the Black Drum Interstate Fishery Management Plan. http://www.asmfc.org/uploads/file/5b11b7ecBlackDrumAddendumI_May2018.pdf.

ASMFC. 2018b. Addendum XXXII to the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan.
http://www.asmfc.org/uploads/file/5c1a66e2SF_BSB_AddendumXXXII_Dec2018.pdf.

ASMFC. 2019a. Amendment 1 to the Interstate Fishery Management Plan for Atlantic Migratory Group Cobia. http://www.asmfc.org/uploads/file/
5ef21a4aCobiaAmendment1_August2019.pdf.

ASMFC. 2019b. Addendum VI to Amendment 6 to the Atlantic Striped Bass Interstate Fishery Management Plan. http://www.asmfc.org/uploads/file/
5dd447baStripedBassAddendumVI_Amend6_Oct2019.pdf.

AWBRT. 2009. Status review of Atlantic wolffish (Anarhichas lupus). Report to National Marine Fisheries Service Northeast Regional Office. Atlantic wolffish Biological Review Tean. September 30, 2019. 149 pp. Retrieved from https: //repository.library.noaa.gov/view/noaa17699.

Bai, S.C. and O.E. Okorie. 2007. Olive flounder culture in South Korea. Global Seafood Alliance September. Available at: https://www.globalseafood.org/advocate/olive-flounder-culture-in-south-korea/.

BC 2015. Carta Estatal Pesquera de Baja California.

Benetti, D., J. Suarez, J. Camperio, R.H. Hoenig, C.E. Tudela, Z. Daugherty, C.J. McGuigan, S. Mather, L. Anchieta, Y. Buchalla, J. Alarcón, D. Marchetti, J. Fiorentino, J. Buchanan, A. Artiles, and J.D. Stieglitz. 2021. A review on cobia, Rachycentrum canadum, aquaculture, Journal of the World Aquaculture Society 51(3):12810.

Berry, F.H. and R.K. Burch. 1978. Aspects of the amberjack fisheries. Proceedings of the Gulf and Caribbean Fisheries Institute 31:179-194.

Blaylock, R., E. Saillant, A. Apeitos, D. Abrego, P. Cason, and R. Vega. 2021. The status of spotted seatrout (*Cynoscion nebulosus*) as a technologically feasible species for U.S. marine aquaculture. Journal of the World Aquaculture Society 51(3):12805.

Burros, M. 2001. The fish that swam uptown. New York Times. Available: www.nytimes. com/2001/05/16/dining/the-fish-that-swam-uptown.html. (September 2018).

California Sea Grant. 2017. Evaluation of the ocean resources enhancement and hatchery program. Report submitted to California Department of Fish and Wildlife, Project No. P147005. Publication No. CASG-17-010.

Campbell, B., and B. F. Koop. 2009. Pilot study of sablefish genomics. Bulletin of the Aquaculture Association of Canada 107-3:53–60.

CDFG. 2002. White Seabass Fishery Management Plan. https://nrm.dfg.ca.gov/ FileHandler.ashx?DocumentID=34195&inline.

CDFW. 2021a. California Ocean Sport Fishing Regulations. https://nrm.dfg.ca.gov/ FileHandler.ashx?DocumentID=190413&inline.

CDFW. 2021b. California Commercial Fishing Regulations Digest. https://nrm.dfg.ca.gov/ FileHandler.ashx?DocumentID=191712&inline.

CFMC. 1985. Fishery Management Plan for the shallow-water reef fish fishery of Puerto Rico and the U.S. Virgin Islands. https://repository.library.noaa.gov/view/noaa/18382.

Consillio, K. 2007. Isle aquaculture farm sold. Honolulu Star-Bulletin. Available: archives.starbulletin. com/2007/07/18/business/story02.html. (October 2018).

CT DEEP. 2021. Connecticut Fishing. https://portal.ct.gov/DEEP/Fishing/CT-Fishing.

DDNREC. 2021. The Fisheries Section. https://dnrec.alpha.delaware.gov/fish-wildlife/fishing/.

Dey, M.M., P. Surathkal, O. L. Chen, and C. R. Engle. 2017. Market trends for Seafood Products in the USA: Implication for Southern Aquaculture Products. Aquaculture Economics & Management 21(1):25-43.

DFO (Fisheries and Oceans Canada). 2018a. Preliminary summary commercial statistics 1996–2015. Available: www.pac.dfo-mpo.gc.ca/stats/comm/summ-somm/index-eng.html. (October 2018).

Diversified Business Communications. 2009. Seafood Handbook. The Comprehensive Guide to Sourcing, Buying, and Preparation. Second Edition.

DOF (Diario Oficial de la Federacion). 2010. Acuerdo mediante el cual se da a conconcer la actualización De laCarta Nacional Pesquera, Jueves 2 de diciembre de 2010.

Drawbridge, M., M. Shane, and C. Silbernagel. 2021. The status of white sea bass, Atractoscion nobilis as a commercially ready species for marine US aquaculture. Journal of the World Aquaculture Society 51(3).

Dumas, C., A. Wilde. 2009. Assessing metro niche market demand for North Carolina mariculture products. North Carolina Biotechnology Center regional development Grant Program. Grant no. 2008-RDG-4003 and North Carolina Sea Grant.

Echave, K. B., Hanselman, D. H., Adkison, M. D., & Sigler, M. F. (2012). Interdecadal change in growth of sablefish (Anoplopoma fimbria) in the Northeast Pacific Ocean. Fishery Bulletin, 110, 361–374.

Engle, C. R. and Stone, N. M. 2013. Competitiveness of U.S. aquaculture within the current U.S. regulatory framework. Aquaculture Economics & Management. 17(3): 251-280.

Engle, C., O. Capps, L. Dellenbarger, J. Dillard, U. Hatch, H. Kinnucan and R. Pomeroy. 1990. The U. S. Market for Farm-Raised Catfish: An Overview of Consumer, Supermarket and Restaurant Surveys. Arkansas Agricultural Experiment Station Bulletin 925. Southern Regional Aquaculture Center Publication 511.

Engle, C. R., Van Senten, J., & Fornshell, G. 2019. Regulatory costs on US salmonid farms. Journal of the World Aquaculture Society. 50, 522-549.

Engle, C.R., G. Kumar, and J. van Senten. 2020. Cost drivers and profitability of U.S. pond, raceway, and RAS aquaculture. Journal of the World Aquaculture Society 51(4):847-873. Article DOI: 10.1002/JWAS.12706.

Engle, C.R., Kumar, G., & Hanson, T. 2021. An economic history of the U.S. catfish industry. *Aquaculture Economics & Management*. DOI: https://doi.org/10.1080/ 13657305.2021.1896606.

Fairchild, E. 2019. The Status of Spotted Wolffish, *Anarhichas minor*, as a Experimental Species for US Marine Aquaculture. [Conference presentation]. US Aquaculture, New Orleans, LA, United States. https://fau.edu/hboi/aquaculture/status-of-marine-finfish.php.

Falk-Petersen, I. B., T.K. Hansen, R. Fieler, and L.M. Sunde. 1999. Cultivation of the spotted wolffish Anarhichas minor (Olafsen)—A new candidate for cold-water fish farming. Aquaculture Research 30:711–718.

FAO. 2020. The state of world fisheries and aquaculture. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO. 2021a. *Global Aquaculture Production 1950-2019* [Database]. Food and Agriculture Organization of the United Nations. http://www.fao.org/fishery/statistics/global-aquaculture-production/query/en.

FAO. 2021b. Cultured Aquatic Species Information Programme Atlantic Cod. http://www.fao.org/fishery/culturedspecies/Gadus_morhua/en

FAO. 2021c. Cultured Aquatic Species Information Programme Greater Amberjack. http://www.fao.org/fishery/culturedspecies/Seriola_dumerili/en

Foss, A., A.K. Imsland, I.B. Falk-Petersen, and V. Oiestad. 2004. A review of the culture potential of spotted wolffish Anarhichas minor Olafsen. Reviews in Fish Biology and Fisheries, 14, 277–294.

Froese, R. and D. Pauly. Editors. 2014. FishBase. www.fishbase.org.

FWC. 2021a. Pompano. https://myfwc.com/fishing/saltwater/commercial/pompano/.

FWC. 2021b. Red Drum. https://myfwc.com/fishing/saltwater/recreational/red-drum/.

FWC. 2021c. Florida Recreational Saltwater Fishing Regulations. https://myfwc.com/media/20441/quickchart.pdf.

GADNR. 2021. Georgia Finfish Seasons, Limits, Sizes. http://www.eregulations.com/georgia/fishing/finfish-seasons-limits-sizes/.

Goetz, R., B.F Anulacion, M. R. Arkoosh, M.A Cook, W.W. Dickhoff, J.P. Dietrich, W.T. Fairgrieve, E.S. Hayman, M.B.R. Hicks, C. Jensen, R.B. Johnson, J.S. F. Lee, J. A. Luckenbach, K.C. Massee, T.H. Wade. 2021. Status of sablefish, Anoplopoma fimbria, aquaculture. Journal of the World Aquaculture Society 51(3):12769.

GOMFMC. 1984. Gulf of Mexico Reef Fish Fishery Management Plan. https://www.fisheries.noaa.gov/management-plan/gulf-mexico-reef-fish-fishery-management-plan

GOMFMC. 2001. The spotted seatrout fishery of the Gulf of Mexico, Unites States: A Regional Management Plan. https://www.gsmfc.org/publications/ GSMFC%20Number%20087.pdf.

GSMFC. 2015. Management profile for the Gulf and Southern flounder fishery in the Gulf of Mexico. VanderKooy, S.J. (ed.). Publication Number 247.

Hartley, M.L., D.M. Schug, K.F. Wellman, B. Lane, W.T. Fairgrieve, and J.A. Luckenbach. 2020. Sablefish aquaculture: an assessment of recent developments and their potential for enhancing profitability. U.S. Department of Commerce, NCAA Technical Memorandum NMFS-NWFSC-159. https: //doi.org/10.25923/cb0y-n468.

Holmyard, N. 2021. Norcod doubles cod volume, on schedule to meet production goals. Seafood Source. https://www.seafoodsource.com/news/aquaculture/norcod-doubles-cod-volume-on-schedule-to-meet-production-goals.

Huppert, D. D., and B. Best. 2004. Study of supply effects on sablefish market price. University of Washington, Seattle, Washington. Available: www.fvoa.org/reports/SablefishMarketFinalReport.pdf. (October 2020).

Johnson, H. and L.C. Halfyard. 2002. Markeing issues and opportunities for farmed wolffish in the United States and Europe. Bulletin of the Aquaculture Association of Canada 102:11-12.

Kikuchi, K., & Takeda, S. 2001. Present status of research and production of Japanese flounder, Paralichthys olivaceus, in Japan. Journal of Applied Aquaculture, 11(1–2), 165–175. https://doi.org/10.1300/J028v11n01_12.

Kumar, G. and C.R. Engle. 2016. Technological advances that led to growth of shrimp, salmon, and tilapia farming. Reviews in Fisheries Science and Aquaculture 24(2):136-152.

Kumar, G., C. Engle, and C.Tucker. 2018a. Factors driving aquaculture technology adoption. Journal of the World Aquaculture Society 49(3):447-476.

Kumar, G., C. Engle, T. Hanson, C. Tucker, T. Brown, L. Bott, L. A. Roy, J. Chappell, C. Boyd, M. Recsetar, J. Park, and L. Torrans. 2018b. Economics of alternative catfish production practices. Journal of the World Aquaculture Society 49(6):1039-1057.

Kumar, G., C. Engle, S. Hegde, and J. van Senten. 2020a. Economics of U.S. catfish farming practices: profitability, economies of size, and liquidity. Journal of the World Aquaculture Society 51(4):829-846. doi.org/10.1111/jwas.12717.

Kumar, G., C. Engle, J. Avery, L. Dorman, G. Whitis, L.A. Roy, and L. Xie. 2020b. Characteristics of Early Adoption and Non-adoption of Alternative Catfish Production Technologies in the U.S. Aquaculture Economics & Management 25(1): 70-88. DOI: https://doi.org/10.1080/13657305.2020.1803446

Laflamme, J., J-C Michaud, M. Lévesque, and N.R. LeFrançoise. 2005. Potentiel commercial et technico-financier de l'élevage de loup de mer au Québec, Rapport final GRM-UQAR-ADRA, 80 pages + 8 appendices.

LDWF. 2021a. Louisiana Recreational Saltwater Finfish. https://www.wlf.louisiana.gov/page/recreational-saltwater-finfish.

LDWF. 2021b. Louisiana Commercial Saltwater Finfish. https://www.wlf.louisiana.gov/subhome/commercial-saltwater-finfish.

Leard, R., R. Matheson, K. Meador, W. Kethly, C. Luquet, M. Van Hoose, C. Dyer, S. Gordon, J. Robertson, D. Horn, and R. Scheffler. 1993. The black drum fishery of the Gulf of Mexico, United States: A Regional Management Plan. May 1993. Gulf States Marine Fisheries commission, Ocean Springs, Mississippi.

Le François, N. R., H. Lemieux, and P.U. Blier. 2002. Biological and technical evaluation of the potential of marine and anadromous fish species for cold-water mariculture. Aquaculture Research 33:95–108.

LeFrançois, N.R., E.A. Fairchild, G. Nardi, and B-A Dupont-Cyr. 2021. The status of spotted worlfish, Anarhichas minor: a commercially ready species for U.S. marine aquaculture? Journal of the World Aquaculture Society 51(3):12793.

MDMR. 2021a. Mississippi Recreational Size and Possession Limits. https://dmr.ms.gov/recreational-catch-limits/.

MDMR. 2021b. Mississippi Commercial Catch Limits. https://dmr.ms.gov/commercial-catch-limits/.

MDNR. 2021. Maryland Fishing Regulations. https://dnr.maryland.gov/fisheries/pages/regulations/index.aspx.

Minkoff, G. and C. Clarke. 2003. Progress in commercialization of sablefish (Anoplopoma fimbria) farming. Bulletin of the Aquaculture Association of Canada 103:53–58.

Miranda, D., C. McGuigan, J. Chaiton, A. Henderson, B. Frisch, C. Nieves, C. Martinez, and D. Benetti. 2021. The Next Step Towards Commercialization: Validating the Market Potential of American Red Snapper Lutjanus campechanus. World Aquaculture June 2021: 44-46.

Morimoto, M. 2007. Morimoto: The new art of Japanese cooking. DK, New York.

Nardkarni, A. 2013. Is 2013 the year of cobia? www.intrafish.com. Available online at http://www.openblue.com/wp-content/themes/openbluf/pdfs/IntraFishOpenBlue.pdf.

Nardi, G., R. Prickett, T. van der Meeren, D. Boyce, and J. Moir. 2021. Atlantic cod aquaculture: Boom, bust, and rebirth? Journal of the World Aquaculture Society. jwas.12811.

NCDEQ. 2021a. North Carolina Marine Commercial Finfish and Shellfish Harvest: Southern Flounder. http://portal.ncdenr.org/web/mf/statistics/comstat/floundersou.

NCDEQ. 2021b. North Carolina Recreational Fishing. http://portal.ncdenr.org/web/mf/recreational-fishing-size-and-bag-limits.

NEFMC. 1985. Northeast Multispecies Management Plan. https://www.fisheries.noaa.gov/management-plan/northeast-multispecies-management-plan.

NMFS. 2016. Commercial Fisheries Statistics. Available at www.st.nmfs.noaa.gov/commercial-fisheries/index.

NMFS. 2020. Fisheries of the United States, 2018. U.S. Department of Commerce, NOAA Current Fishery Statistics No. 2018. Retrieved from: htt;s://www.fisheries.noaa.gov/national/commercial-fhishing/fishery-united states-2018.

NOAA FishWatch. 2014. U.S. Seafood Facts: Summer Flounder. www.fishwatch.gov.

NOAA. 2020a. Status of Stocks 2019: Annual Report for Congress on the Status of U.S. Fisheries. https://media.fisheries.noaa.gov/dam-migration/2019_status_of_stocks_rtc_final_7-15-20.pdf.

NOAA. 2020b. Fisheries of the United States 2018. https://media.fisheries.noaa.gov/dam-migration/fus_2018_report.pdf.

NOAA. 2021a. Foreign Trade (3.4.0.2) [Database]. NOAA Office of Science and Technology. https://www.fisheries.noaa.gov/foss/f?p=215:2:2473728947083::NO:::

NOAA. 2021b. Landings (3.4.0.2) [Database]. NOAA Office of Science and Technology. https://www.fisheries.noaa.gov/foss/f?p=215:200.

NOAA. 2021c. U.S. Aquaculture. https://www.fisheries.noaa.gov/national/aquaculture/us-aquaculture.

NPFMC. 2020a. Fishery Management Plan for Groundfish of the Gulf of Alaska. https://www.npfmc.org/wp-content/PDFdocuments/fmp/GOA/GOAfmp.pdf.

NPFMC. 2020b. Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area. https://www.npfmc.org/wp-content/PDFdocuments/fmp/BSAI/BSAIfmp.pdf.

NYS DEC. 2021. Recreational Saltwater Fishing Regulations. https://www.dec.ny.gov/outdoor/7894.html.

ODFW. 2021. Regulations. https://www.dfw.state.or.us/resources/licenses_regs/regulations.asp.

Olmsted, L. 2016. 5 fish that your taste buds, your wallet, and mother nature will thank you for eating. Forbes. Available: www.forbes.com/sites/larryolmsted/2016/10/22/5-fish-your-taste-budsyour-wallet-and-mother-nature-will-thank-you-for-eating/#4cdf64a744d4. (November 2018).

Parker, P. 2017. Texas' Perciformes Group sends first harvest of farmed sablefish to Washington DC market. SeafoodNews.com. Available: www.seafoodnews.com/Story/1051628/TexasPerciformes-Group-Sends-First-Harvest-of-Farmed-Sablefish-To-Washington-DC-Market. (October 2018).

PFMC. 2019. Coastal Pelagics Species Fishery Management Plan as Amended Through Amendment 17. https://www.pcouncil.org/documents/2019/06/cps-fmp-as-amended-through-amendment-17.pdf/.

Richardson, R. and J.A. Johansen. 2012. Cultured wolffish (Anarhicas minor) a potential species for exclusive restaurants? Bulletin of Aquaculture Association of Canada 102:13-16.

Robbins, C.R. and G.C. Ray. 1986. A field guide to the Atlantic Coast Fisheries of North America. Houghton Mifflin Company, Boston, Massachusetts. 354 pp.

SAFMC. 2020. Regulatory Amendment 33 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. https://safmc.net/download/SG_Reg-33_Jan-24-2020_submission.pdf.

Saillant, E., N. Adams, J.T. Lemus, J.S. Franks, Y. Zohar, J. Stubblefield, and C. Manley. 2021. Journal of the World Aquaculture Society 51(3).

Saillant, E. 2019. The Status of Tripletail, *Lobotes surinamensis*, as a Experimental Species for US Marine Aquaculture. [Conference presentation]. US Aquaculture, New Orleans, LA, United States. https://fau.edu/hboi/aquaculture/status-of-marine-finfish.php.

SCDNR. 2021. South Carolina Finfish Size & Catch Limits. http://www.eregulations.com/southcarolina/huntingandfishing/finfish-size-catch-limits/.

Seafood Watch: Farmed almaco jack. 2020. Farmed Almaco Jack. Monterey Bay Aquarium, Monterey, California. Accessed July 2, 2021.

Seafood Watch: Black Drum. 2018. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seafood Watch: California Flounder. 2020. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seafood Watch: Cobia-Panama Marine Net Pens. 2017. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seafood Watch: Cobia-United States Atlantic and Gulf of Mexico. 2014. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seafood Watch: Greater Amberjack. 2017. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seafood Watch: Red Drum. 2016. Red Drum: United States – Ponds. Monterey Bay Aquarium, Monterey, California. Accessed July 2, 2021.

Seafood Watch: Sablefish. 2020. BC. Monterey Bay Aquarium, Monterey, California. Accessed July 2, 2021.

Seafood Watch: Sablefish. 2014. US West Coast.

Seafood Watch: Southern Flounder. 2020. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seafood Watch: Striped bass. 2020. United States of America: Northwest Atlantic.

Seafood Watch: Summer Flounder. 2019. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seafood Watch: White Sea bass and California Yellowtail. Monterey Bay Aquarium, Monterey, California. Accessed July 2, 2021.

Seafood Watch: Wild Pompano. 2014. Monterey Bay Aquarium, Monterey, California. Accessed July 5, 2021.

Seikai, T. 2002. Flounder culture and its challenges in Asia. Reviews in Fisheries Science, 10(3–4), 421–432. https://doi.org/ 10.1080/20026491051721.

Sicuro, B. and U. Luzzana. 2016. The state of Seriola spp. other than yellowtail (*S. quinqueradata*) farming in the world. Reviews in Fisheries Science and Aquaculture 24, 31 4e325.

Sims, N. 2019. The Status of Almaco Jack, *Seriola rivoliana*, as a Commercially Ready Species for US Marine Aquaculture [Conference presentation]. US Aquaculture, New Orleans, LA, United States. https://fau.edu/hboi/aquaculture/status-of-marine-finfish.php.

Sink, T. 2019. The Status of Red Drum, *Sciaenops ocellatus*, as a Commercially Ready Species for US Marine Aquaculture [Conference presentation]. US Aquaculture, New Orleans, LA, United States. https://fau.edu/hboi/aquaculture/status-of-marine-finfish.php.

Sonu, S. C. 2014. Supply and market for sablefish in Japan. National Marine Fisheries Service, Silver Spring, Maryland. Available: www.st.nmfs.noaa.gov/Assets/commercial/market-news/sablefishSupplyMarket2014.pdf. (October 2020).

Stewart, I.J., J.T. Thorsen, C. Wetzel. 2011. Status of the U.S. sablefish resource in 2011. NMFS, NW Fisheries Science Center. NOAA.

Stieglitz, J.D., R.H. Hoenig, J.K. Baggett, C.E. Todela, S.K. Mather, and D. Benetti. 2021. Advancing production of marine fish in the United States: Olive flounder, Paralichthys olivaceous, aquaculture. Journal of the World Aquaculture Society 51(3):12804.

Stewart. I.J., J.T. Thorsen, C. Wetzel. 2011. Status of the U.S. sablefish resource in 2011. National Marine Fisheries Service, Northwest Fisheries Science Center.

Stoner, J., and V. Ethier. 2015. Sablefish. Totem Sea Farm Inc., Jervis Inlet, British Columbia: Net pens. Monterey Bay aquarium seafood watch. Monterey, California. Available: seafood.ocean.org/ wp-content/uploads/2016/10/Sablefish-Totem-Sea-Farm-Inc-Jervic-Inlet-British-Columbia.pdf. (October 2020).

Stuart, K., C. Silbernagel, and M. Drawbridge. 2021. The status of California halibut, Paralichthys californicus, as a technologically feasible species for marine U.S. aquaculture. Journal of the World Aquaculture Society 51(3):1-10/12768.

Sumaila, U.R., A. Khan, R. Watson, G. Munroa, D. Zeller, N. Baren. 2007. Fisheries Cente, University of British Columbia, 2202 Main Mall, Vancouver, B.S., Canada. The World Trade Organization and global fisheries sustainability. Fisheries Research 88:14.

TPWD. 2021. Regulations. https://tpwd.texas.gov/regulations/.

USDA-NASS. (1998). Census of aquaculture (1997). United States Department of Agriculture-National Agricultural Statistics Service (USDA-NASS).

USDA NASS. 2006. 2005 Census of Aquaculture. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/Aqua.pdf.

USDA NASS. 2014. 2013Census of Aquaculture. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/Aqua.pdf.

USDA NASS. 2019. 2018 Census of Aquaculture. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/Aqua.pdf.

van Senten, J. & Engle, C. R. 2017. The costs of regulations on US baitfish and sportfish producers. Journal of the World Aquaculture Society. 48(3), 503-517.

van Senten, J., Dey, M. M., & Engle, C. R. 2018. Effects of regulations on technical efficiency of U.S. baitfish and sportfish producers. Aquaculture Economics & Management. 22(3):284-305.

van Senten, J., Engle, C. R., Hartman, K., Johnson, K., & Gustafson, L. L. 2018. Is there an economic incentive for farmer participation in a uniform health standard for aquaculture farms? An empirical case study. Preventative Veterinary Medicine. 156, 58-67.

van Senten, J., C.R. Engle, and M. Smith. 2020a. Impacts of COVID-19 on U.S. aquaculture, aquaponics, and allied businesses. Journal of the World Aquaculture Society 51(3):571-573.

van Senten, J., Engle, C. R., Hudson, B., & Conte, F. S. 2020b. Regulatory costs on Pacific coast shellfish farms. Aquaculture Economics & Management. 24(4): 447-479.

van Senten, J., C.R. Engle, and M. A. Smith. 2021. Effects of COVID-19 on U.S. aquaculture farms. Applied Economic Perspectives and Policy 43(1): 355-367. https://doi.org/10.1002/ aepp.13140.

VMRC (2021). Virginia Creel & Length Limits. http://www.eregulations.com/virginia/fishing/creel-length-limits/

Watanabe, W., P.. Carroll, M. Shah Alam, C.F. Dumas, J.E. Gabel, T.M. Davis, and C.D. Bentley. 2021. The status of black sea bass, *Centropristis striata*, as a commercially ready species for U.S. marine aquaculture. Journal of the World Aquaculture Society 51(3):12803.

Weirich, C.R., K.L. Riley, M. Riche, K.L. Main, P. S. Wills, G. Illán, D.S. Cerino, and T.J. Pfeirffer. 2021. The status of Florida pompano, *Trachinotus carolinus*, as a commercially ready species for U.S. marine aquaculture. Journal of the World Aquaculture Society 51(3):12809.

Wiedenhoft, H. 2017. Advances in US sablefish aquaculture. Aquaculture North America. Available: www.aquaculturenorthamerica.com/finfish/advances-in-us-sablefish-aquaculture-hitssnag-1584. (September 2018).

Wilde, J.D. 2008. Analysis of a niche market for farm-raised black sea bass *Centropistis striata* in North Carolina. Masters Thesis, University of North Carolina Wilmington, 62 pp. University of North Carolina Wilmington.

Appendix A. Almaco Jack (*Seriola rivoliana*)

Almaco jack, also known as longfin yellowtail, is a pelagic gamefish in the jack family. They are found in the western Atlantic from North Carolina to Argentina and are common in the Gulf of Mexico. Commercial and recreational almaco jack fisheries are federally regulated in the Atlantic and Gulf of Mexico. Their wide distribution in the Atlantic Ocean has resulted in recognition in regional U.S. markets on the East and Gulf Coasts.

Aquaculture

While global production of the genus *Seriola* spp. has averaged approximately 331 million lb/yr (Seafood Watch: Farmed Almaco Jack 2020), there is only one producer reported to be growing almaco jack in offshore cages in Hawaii. Total annual production from this farm has averaged approximately 882,000 lb (Figure 46; Table 8). Product forms sold of almaco jack include whole fish, collar cuts, and whole or belly fillets.

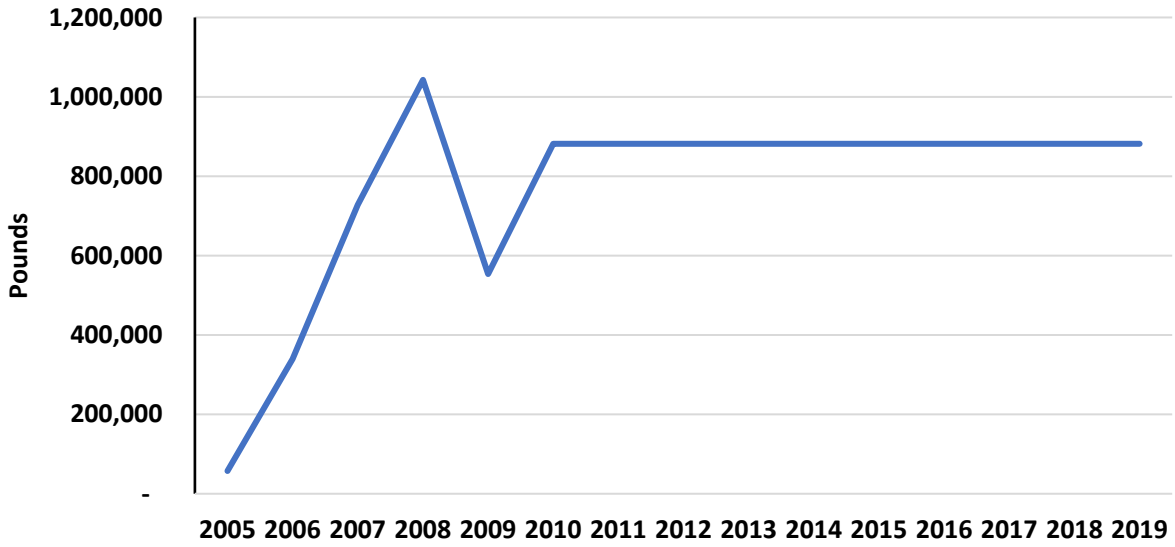

Figure 46. Global farmed production of almaco jack, 2005-2019. Source: FAO Global Aquaculture Production Database (FAO 2021a).

Table 8. Global farmed production of almaco jack, 2005-2019.

Year	Quantity (lb)
2005	57,320
2006	339,511
2007	727,525
2008	1,042,785
2009	553,360
2010	882,000

2011	882,000
2012	882,000
2013	882,000
2014	882,000
2015	882,000
2016	882,000
2017	882,000
2018	882,000
2019	882,000

Source: FAO (2021a).

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of almaco jack.

Import/export data on almaco jack

No data were found on imports/exports of almaco jack.

Commercial Landings

Commercial landings of almaco jack peaked in 2019, at levels 1.6 times greater than the previous peak in 2016 (Figure 47; Table 9). The top three states for commercial landings of almaco jack were Florida (50%), North Carolina (30%), and South Carolina (17%), with additional landings in Alabama, Louisiana, and Texas (Table 10).

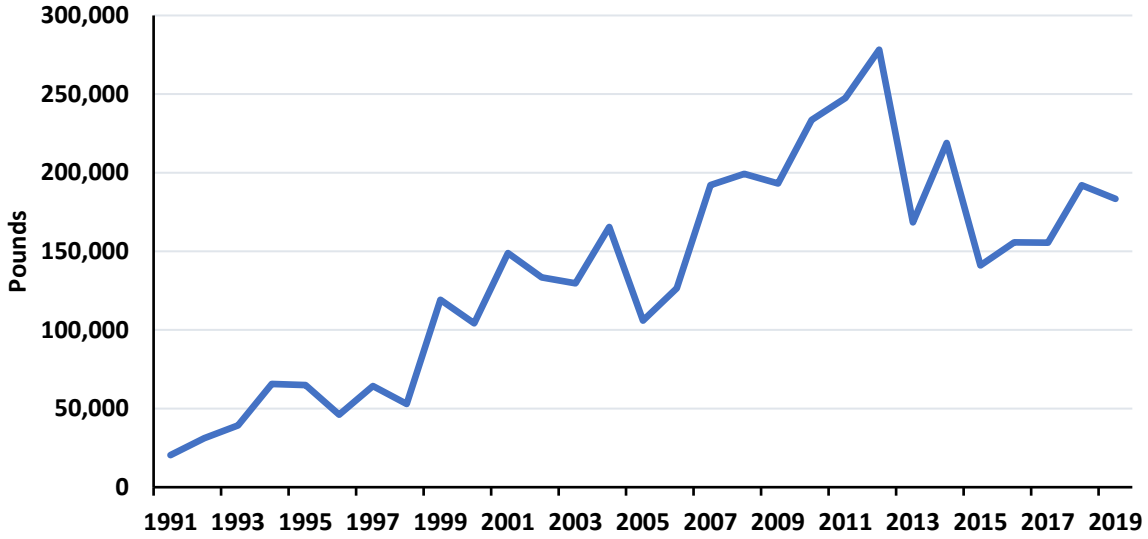

Figure 47. Total commercial U.S. almaco jack landings by volume. Source. NOAA Landings Database (NOAA 2021b).

Table 9. Total commercial U.S. almaco jack landings.

Commercial landings					
Year	**Volume (lb)**	**Dollars**	**Year**	**Volume (lb)**	**Dollars**
2019	183,364	233,454	2004	165,516	127,147
2018	192,075	219,103	2003	129,656	100,008
2017	155,464	174,207	2002	133,381	115,900
2016	155,660	166,410	2001	148,845	132,586
2015	141,048	157,864	2000	104,236	98,364
2014	218,866	244,483	1999	119,134	116,497
2013	168,475	179,466	1998	52,903	53,376
2012	278,233	266,838	1997	64,307	62,129
2011	247,534	236,056	1996	46,118	43,729
2010	233,591	213,314	1995	64,962	61,733
2009	193,131	175,761	1994	65,679	62,664
2008	199,273	187,224	1993	39,313	31,734
2007	192,174	174,790	1992	31,160	25,418
2006	126,529	106,721	1991	20,404	15,425
2005	105,987	83,781			

Source: NOAA Landings Database (NOAA 2021b).

Table 10. Top states for commercial almaco jack landings, 2019.

Rank	Commercial

	State	Volume (lb)
1.	Florida	91,441
2.	North Carolina	54,109
3.	South Carolina	30,281
4.	Louisiana	3,706
5.	Texas	3,478

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

The commercial almaco jack fishery is regulated by the South Atlantic Fishery Management Council (SAFMC) in the Atlantic and the Gulf of Mexico Fishery Management Council (GOMFMC) in the Gulf (Table 11). In both areas, the commercial and recreational seasons are open year-round, with a catch limit of 198,422 lb in the Atlantic and a combined annual harvest limit of 312,000 lb for all members of the "Other Jacks" complex (almaco jack, banded rudderfish, and lesser amberjack) in the Gulf.

Table 11. Commercial fisheries regulations for almaco jack.

State	Quota/ Catch Limit	Trip Limit	Season	Managing Agency
NC, SC, GA, FL east coast	189,422	500 lb (Jacks Complex)	Jan1-Dec 31	SAFMC
TX, LA, MS, AL, FL gulf	Rec & Commercial Harvest limit: 312,000 lb for Jacks Complex	none	Jan 1- Dec 31	GOMFMC

Recreational Landings

Recreational landings for almaco jack have shown a generally increasing trend since the first data became available in 1985. With a few exceptions, they have outpaced commercial landings consistently since 1993, with a steep increase in landings beginning around 2012 (Figure 48; Table 12). Landings in 2019 were 834,954 pounds, which was almost double the volume of 2018. The state of Florida makes up the majority (93%) of recreational landings for almaco jack at 775,124 pounds in 2019, followed by North Carolina (4%), and Alabama (1%) (Table 13).

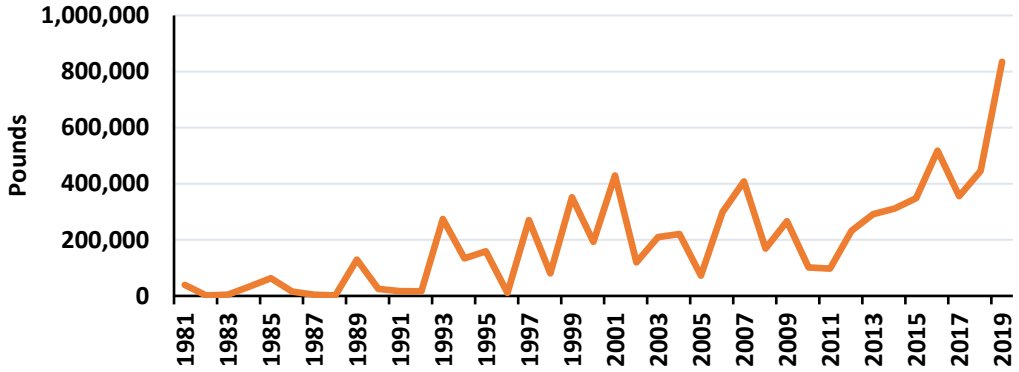

Figure 48. Total recreational U.S. almaco jack landings. Source: NOAA Landings Database (NOAA 2021b).

Table 12. Total recreational U.S. almaco jack landings.

Year	Volume (lb)	Year	Volume (lb)
2019	834,954	1999	351,857
2018	445,487	1998	80,421
2017	355,665	1997	270,213
2016	517,974	1996	10,569
2015	348,488	1995	159,184
2014	311,387	1994	133,701
2013	291,293	1993	274,461
2012	232,232	1992	16,367
2011	97,336	1991	17,242
2010	101,376	1990	25,113
2009	266,601	1989	129,264
2008	169,000	1988	1,616
2007	408,174	1987	4,473
2006	298,699	1986	15,591
2005	72,433	1985	62,977
2004	220,516	1984	32,928
2003	209,960	1983	4,462
2002	119,896	1982	1,682
2001	429,511	1981	39,238
2000	192,864		

Source: NOAA Landings Database (NOAA 2021b).

Table 13. Top states for recreational almaco jack landings, 2019.

Rank	State	Volume (lb)
1.	Florida	775,142

2.	North Carolina	36,449
3.	Alabama	12,086
4.	South Carolina	8,371
5.	Maryland	2,716

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

The recreational almaco jack fishery is regulated by the South Atlantic Fishery Management Council (SAFMC) in the Atlantic and the Gulf of Mexico Fishery Management Council (GOMFMC) in the Gulf (Table 14). In both areas, the recreational seasons are open year-round, with a catch limit of 198,422 lb in the Atlantic and a combined annual harvest limit of 312,000 lb for all members of the "Other Jacks" complex (almaco jack, banded rudderfish, and lesser amberjack) in the gulf. The catch limits may cause the season to close early. For example, in 2019, recreational fishing in the South Atlantic closed on September 25 as the catch limit was met.

Table 14. Recreational fisheries regulations for almaco jack.

State	Minimum size	Daily bag limit	Open season	Managing agency
NC, SC, GA, FL east coast	none	10 pp	Jan 1- Dec 31	SAFMC
TX, LA, MS, AL, FL gulf	none	w/in 20 reef fish aggregate bag limit	Jan 1- Dec 31	GOMFMC

Appendix B. Atlantic Cod (*Gadhus morhua*)

Atlantic cod is a benthopelagic fish, commonly distributed north of Cape Hatteras, North Carolina in the Atlantic Ocean. Atlantic cod was at one time one of the largest fisheries in the world. Declines in the Atlantic northwest cod stocks began in the 1970s due to overfishing and the stock collapsed in the 1990s. Atlantic cod is currently labeled as "vulnerable" on the IUCN Red List of Threatened Species and as overfished in the 2019 Status of Stocks Report to Congress (NOAA 2020a). Because of this, the fishery is heavily regulated and both commercial and recreational landings have not recovered to their pre-collapse numbers.

Aquaculture

Atlantic cod has been farmed in a number of countries, including Canada, the United Kingdom, Norway, Ireland, Iceland, the Faroe Islands, and the United States. Cod farming dates back to the 1980s and 1990s in these countries (Nardi et al. 2021). The impetus for cod farming initially was to produce juveniles for restocking programs to enhance the cod fishery, and a number of hatcheries were constructed during the 1980s and 1990s. Part of the impetus for farming cod for foodfish markets were the high cod prices in the 1990s following collapse of the fishery and the substantial decline in supply. Cod farms, however, also faced a series of technical problems in hatcheries in the early years that affected the supply of fingerlings for foodfish farms. The global economic crisis of 2008 was the final shock that resulted in the collapse of the farmed cod industry around the world. This collapse was exacerbated by a near doubling of landings of Pacific cod that replaced Atlantic cod in the marketplace. Increased landings from the Barents Sea from 2017 to 2019, along with increased imports of pangasius catfish from Asia replaced Atlantic cod sales in the EU and in the U.S.

Global farmed production of cod peaked at 50 million pounds in 2009 (FAO 2021a) (Figure 49; Table 15). In 2019 global farmed production was < 2 million pounds with production primarily from Iceland, the United Kingdom, and Norway (FAO 2021b). A cod farm in Norway has projected its first commercial harvest of 13.2 million pounds in 2021, targeting primarily Spain, Denmark, and the United Kingdom, with some value-added fillets destined for France, Germany, and the U.S. (Holmyard 2021). This company is targeting a higher-priced market for its cod.

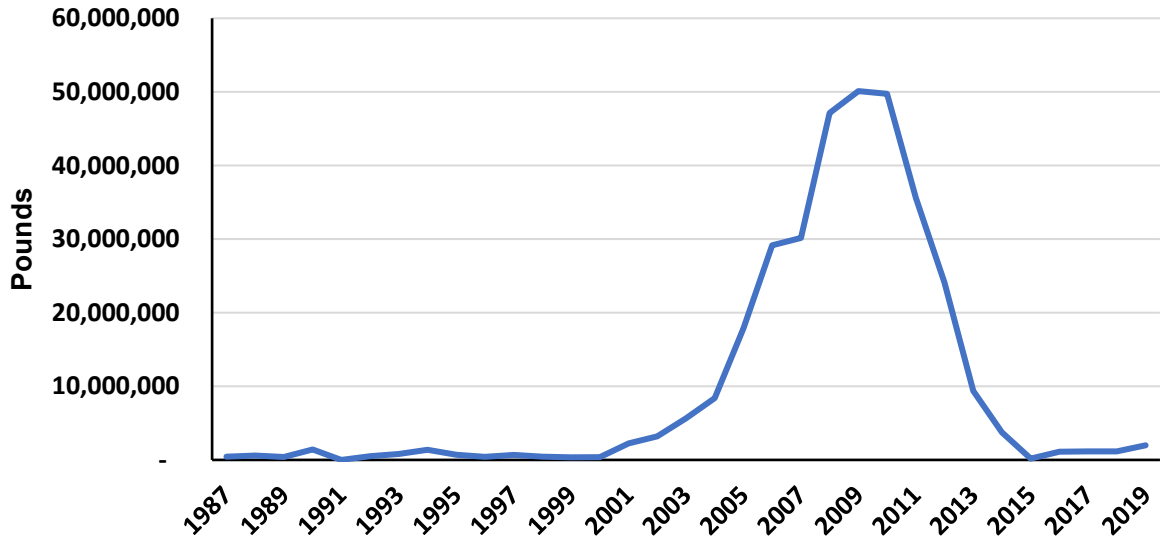

Figure 49. Global farmed production of Atlantic cod, 1987-2019. FAO Global Aquaculture Production database (FAO 2021a).

Table 15. Global farmed production of Atlantic cod, 1987-2019.

	Quantity (lb)		Quantity (lb)
1987	451,947	2004	8,397,398
1988	604,066	2005	17,903,719
1989	405,650	2006	29,162,713
1990	1,421,980	2007	30,163,611
1991	-	2008	47,136,980
1992	511,472	2009	50,108,147
1993	815,709	2010	49,731,024
1994	1,386,706	2011	35,604,613
1995	698,865	2012	24,087,017
1996	421,082	2013	9,374,942
1997	670,204	2014	3,739,036
1998	438,719	2015	174,239
1999	346,125	2016	1,122,372
2000	372,581	2017	1,148,012
2001	2,246,508	2018	1,155,728
2002	3,196,699	2019	1,983,717
2003	5,654,850		

Source: FAO Global Aquaculture Production database (FAO 2021a).

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order issued in the U.S. in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of Atlantic cod. As a gamefish in the U.S., previous Atlantic cod farms were required to tag all fish produced in net pens, adding expense in terms of manpower.

Import/Export of Atlantic Cod

Atlantic cod has been imported into the U.S. for many years. The greatest volume of Atlantic cod imports since 1992 has been frozen fillets, with volumes 10 times greater than the volumes of fish imported cod (Figure 50; Tables 16 and 17). There appears to have been some growth in frozen fillet imports. The volume of fresh fillets, while much less than that of frozen fillets, however, has generally increased since 2010.

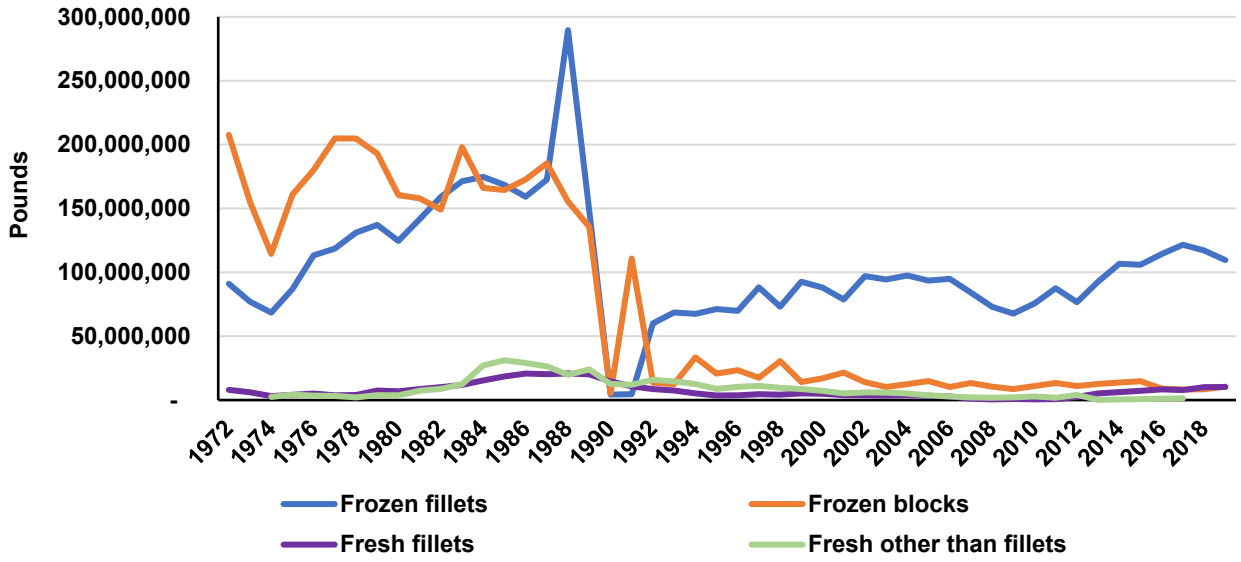

Figure 50. Atlantic cod imports by product type (1990-2019). Source. NOAA Foreign Trade Database (NOAA 2021a).

Table 16. Fresh Atlantic cod imports by product type (1990-2019).

	Total fresh fillet		Fresh	
Year	Volume (lb)	Value ($)	Volume (lb)	Value ($)
2019	10,259,819	61,225,364	6,938,495	34,375,262
2018	10,125,306	57,264,347	3,433,623	19,294,907
2017	7,827,393	43,079,353	1,373,302	7,380,847
2016	8,317,456	44,873,242	1,056,738	5,779,456
2015	7,208,316	37,593,607	664,371	2,606,832
2014	6,201,653	32,862,852	498,846	1,652,239
2013	5,188,485	25,371,512	197,748	629,869
2012	2,438,651	13,136,122	3,909,016	10,612,342
2011	670,231	3,434,689	1,860,333	3,261,385
2010	627,926	3,090,253	2,805,941	4,183,516
2009	779,816	3,342,115	2,039,818	2,992,006
2008	513,877	1,962,414	1,856,563	2,666,781
2007	1,106,741	4,567,714	2,062,556	470,313
2006	2,887,896	10,953,397	2,864,295	4,368,153
2005	3,400,174	12,656,964	3,771,968	5,103,831
2004	3,717,298	13,373,663	5,138,074	6,212,365
2003	3,410,448	11,746,999	5,855,543	6,515,658
2002	3,685,225	11,737,429	6,017,755	6,614,749
2001	3,857,470	11,503,579	5,275,515	5,660,829
2000	4,916,785	15,179,005	7,199,963	7,682,747
1999	5,180,557	16,132,368	8,628,711	9,922,166
1998	4,215,185	11,952,205	9,588,095	10,088,283
1997	4,615,350	11,245,643	11,092,616	10,356,497
1996	3,686,696	9,002,125	10,402,678	10,367,482
1995	3,608,723	8,870,027	8,693,844	8,832,502
1994	5,268,127	11,638,202	12,574,465	11,212,258
1993	7,495,108	16,178,024	14,569,469	11,531,499
1992	8,620,697	17,970,687	15,893,910	10,908,160
1991	10,760,140	22,558,610	11,930,846	7,329,742
1990	14,587,926	26,218,765	12,632,087	7,454,510
1989	20,074,558	33,156,904	23,945,791	12,903,943
1987	20,779,236	33,046,903	19,756,102	9,895,564
1988	20,285,886	38,241,774	26,325,277	16,747,344
1986	20,702,568	29,800,470	29,012,810	14,492,008
1985	18,537,049	22,176,044	31,128,053	11,688,550
1984	15,332,671	17,429,829	27,195,004	9,869,421
1983	11,916,055	14,059,722	12,314,081	4,704,261
1982	10,074,600	11,934,156	8,747,072	3,385,271
1981	8,636,965	10,149,850	7,404,146	2,889,856
1980	6,828,383	7,508,189	3,695,133	1,294,884
1979	7,487,306	8,316,097	3,852,829	1,341,514
1978	3,959,460	4,257,880	2,118,009	633,650
1977	3,666,689	3,798,921	3,176,963	918,331
1976	5,105,064	4,664,521	3,443,171	847,210
1975	4,104,368	2,974,907	4,223,587	671,080

1974	3,078,717	2,444,812	2,501,549	527,859
1973	6,037,039	4,112,131	6,938,495	34,375,262
1972	7,916,995	4,610,011	3,433,623	19,294,907

[1]n.d. = no data.

Source: NOAA Foreign Trade Database (NOAA 2021a).

Table 17. Frozen Atlantic cod imports by product type. Includes "regular" and "NSPF".

	All frozen fillets		All frozen blocks	
Year	Volume (lb)	Value ($)	Volume (lb)	Value ($)
2019	109,605,391	385,900,984	10,421,783	28,476,436
2018	117,007,347	410,249,201	8,496,885	21,095,733
2017	121,629,448	377,255,913	8,249,869	15,517,528
2016	114,355,308	331,988,113	9,037,840	16,029,974
2015	105,913,602	307,759,193	14,759,389	23,631,674
2014	106,613,047	282,825,434	13,683,166	21,405,172
2013	92,639,695	235,296,701	12,647,296	20,794,901
2012	76,670,766	232,180,495	11,030,183	21,529,085
2011	87,509,648	253,124,665	13,317,635	26,291,104
2010	75,644,218	188,898,530	10,965,118	19,980,705
2009	67,773,826	182,599,110	8,579,995	17,482,943
2008	72,928,614	251,921,427	10,459,895	23,857,814
2007	84,141,079	266,128,573	13,388,829	27,613,016
2006	94,926,371	267,139,688	10,175,622	20,199,942
2005	93,581,148	237,988,994	14,871,840	25,472,543
2004	97,510,887	233,398,774	12,538,075	21,673,339
2003	94,456,988	230,316,869	10,167,919	17,173,101
2002	96,990,652	239,870,797	14,040,484	25,666,556
2001	78,769,633	195,110,620	21,515,641	38,510,296
2000	88,072,395	235,171,709	17,054,832	29,743,833
1999	92,642,257	253,553,495	14,112,718	25,857,396
1998	3,109,108	181,096,719	30,538,365	63,264,682
1997	88,281,570	194,083,088	17,531,041	26,892,364
1996	69,904,071	153,477,398	23,438,772	33,755,208
1995	71,188,794	155,101,624	20,752,525	34,402,221
1994	67,451,500	149,812,368	33,375,244	52,795,696
1993	68,541,526	157,588,904	12,541,043	20,414,958
1992	60,116,295	147,348,355	13,666,788	28,720,051
1991	4,615,288	10,462,549	110,797,623	242,629,230
1990	4,337,092	8,034,520	5,304,977	8,010,356
1989	148,021,756	256,927,336	135,616,295	195,071,009
1988	289,588,865	517,189,200	155,427,912	247,530,136
1987	172,528,372	335,373,929	185,367,258	313,281,965
1986	159,209,418	237,166,846	172,674,926	215,946,879
1985	168,377,191	221,417,927	164,457,330	162,747,560
1984	174,701,091	227,424,942	165,991,369	162,742,258
1983	171,351,920	229,196,797	197,978,540	211,117,420
1982	158,970,245	210,094,422	149,091,376	149,579,665

1981	141,585,846	182,954,713	57,919,270	158,332,633
1980	124,582,970	156,478,699	160,418,200	156,713,598
1979	137,170,079	164,900,945	192,953,358	187,049,824
1978	131,040,355	141,674,820	204,695,539	190,971,242
1977	118,600,225	122,544,152	204,871,434	183,371,224
1976	113,342,191	97,754,458	180,125,468	117,027,205
1975	86,912,818	67,795,102	160,856,353	83,963,087
1974	68,473,872	54,500,126	114,432,585	70,186,332
1973	76,933,487	52,255,635	154,946,595	87,267,496
1972	91,017,000	48,556,979	207,536,811	87,258,374

[1]n.d. = no data.

Source: NOAA Foreign Trade Database (NOAA 2021a).

Commercial Landings

The Atlantic cod fishery was one of the world's largest fisheries for several centuries. The history of over-fishing had far-reaching effects in both the EU and the U.S. By the late 1980s, the cod fishery in Canada had collapsed and was followed by the New England cod fishery in the U.S. In the U.S., commercial landings of Atlantic cod peaked in 1980 and subsequently declined to 2019 levels that were 1.9% of the 1980 peak (Figure 51; Table 18). Landings declined from more than 75 million pounds in 1988 to just over 2 million pounds in 2019. It is of note that Pacific cod landings nearly doubled from 1988 to 2019 and have been substituted for Atlantic cod in various markets. The top three states for commercial landings in 2019 were: Massachusetts (91%), New Hampshire (4%), and Maine (4%) (Table 19). Additional landings were reported in Connecticut, New York, and Rhode Island in 2019.

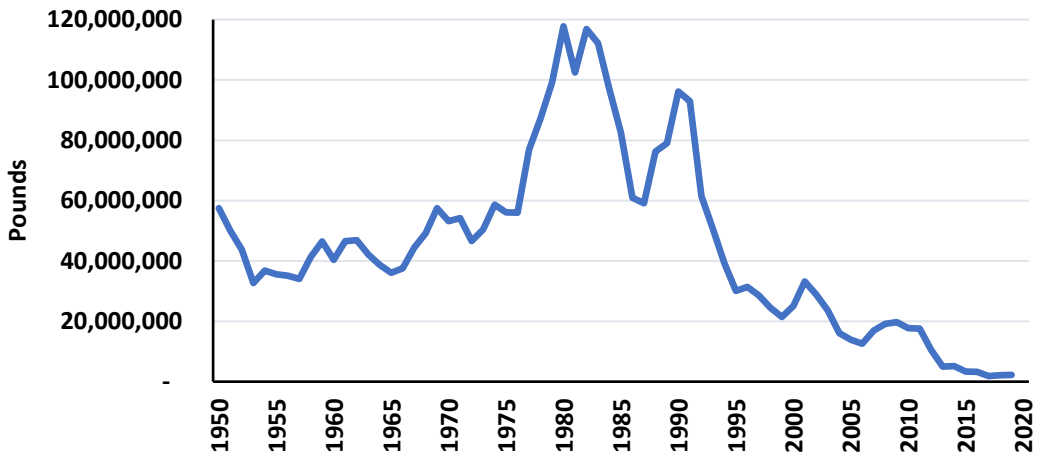

Figure 51. Total commercial U.S. Atlantic cod landings. Source: NOAA Landings Database (NOAA 2021b).

Table 18. Total commercial U.S. Atlantic cod landings (1950-2019).

	Commercial landings			Commercial landings	
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	2,241,582	5,075,297	1984	96,685,805	36,137,916
2018	2,151,271	4,777,424	1983	112,189,100	38,190,883
2017	1,856,444	4,444,300	1982	116,906,600	39,116,027
2016	3,221,095	6,139,593	1981	102,486,200	34,856,120
2015	3,364,575	6,426,911	1980	117,774,600	31,790,379
2014	5,167,476	9,355,159	1979	99,253,280	28,891,572
2013	4,987,412	10,459,152	1978	87,274,200	21,621,126
2012	10,503,564	22,191,890	1977	76,900,500	17,340,558
2011	17,597,917	32,602,722	1976	56,030,100	14,625,769
2010	17,723,275	28,143,111	1975	56,133,700	13,214,202
2009	19,738,368	25,228,936	1974	58,654,800	11,306,463
2008	19,179,208	30,786,035	1973	50,420,000	9,045,422
2007	16,943,036	27,070,716	1972	46,627,000	7,940,962
2006	12,588,182	20,440,902	1971	54,203,100	6,516,236
2005	13,912,139	20,820,272	1970	53,226,100	5,740,382
2004	16,074,747	21,699,893	1969	57,501,600	4,836,909
2003	23,599,993	27,535,027	1968	49,216,200	3,463,465
2002	28,850,296	30,638,911	1967	44,399,500	3,577,462
2001	33,208,721	32,095,090	1966	37,576,100	3,196,559
2000	25,070,131	26,397,506	1965	36,047,284	2,877,254
1999	21,437,835	23,932,403	1964	38,747,493	2,670,706
1998	24,502,026	25,460,537	1963	42,177,600	3,105,384
1997	28,614,635	24,445,400	1962	46,910,000	3,292,632
1996	31,390,613	26,613,886	1961	46,589,500	2,993,944
1995	30,054,658	28,588,556	1960	40,381,800	2,698,022
1994	39,187,760	36,575,402	1959	46,481,600	3,312,408
1993	50,609,861	44,957,832	1958	41,362,700	3,041,210
1992	61,549,189	52,191,065	1957	34,068,800	2,177,647
1991	92,986,656	74,296,075	1956	35,127,300	2,225,148
1990	96,174,274	61,444,407	1955	35,581,900	2,156,790
1989	79,052,000	48,086,272	1954	36,823,200	2,182,459
1988	76,286,500	43,046,947	1953	32,660,400	2,205,968
1987	59,139,000	44,180,015	1952	43,685,900	3,157,820
1986	60,930,900	36,027,727	1951	50,023,000	3,634,700
1985	82,522,500	35,013,361	1950	57,490,400	3,622,665

Source: NOAA Landings Database (NOAA 2021b).

Table 19. Top states for commercial Atlantic cod landings, 2019.

	State	Volume (lb)
1.	Massachusetts	2,032,364
2.	New Hampshire	98,439
3.	Maine	88,427
4.	Rhode Island	16,539
5.	Connecticut	3,082

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Atlantic cod management is divided by its two stocks in the Gulf of Maine and in the Georges Bank. NOAA Fisheries and the New England Fishery Management Council (NEFMC) manage the Gulf of Maine stock, while NOAA, NEFMC and Canada jointly manage the Georges Bank stock. Atlantic cod is also managed under the Northeast Multispecies Fishery Management Plan, which manages all groundfish in the Northeast Atlantic (NEFMC 1985). Under the NEFMC plan, groundfish commercial management is divided into four Regulated Mesh Areas (RMAs): Gulf of Maine (GOM), Georges Bank, Southern New England, and the Mid-Atlantic (NEFMC 1985). Commercial fishing is managed via a sector program outlined in the 2010 Amendment 16 to the Northeast Multispecies Fishery Management Plan, whereby each sector receives an annual catch entitlement of 15 groundfish stocks based on catch history. There is also a minimum size regulation of 19 inches.

Recreational Landings

The five-year averages of recreational landings show a trend of decreasing catch with two periods of slight increase in the mid-1980s and early 2000s (Figure 52; Table 20). Recreational landings of Atlantic cod have declined from a peak in 1988 to very low levels in 2019. The top three states for recreational landings of Atlantic cod in 2019 were Connecticut (41%), Rhode Island (22%), and New York (18%) (Table 21). Other states with recreational landings of Atlantic cod in 2019 included Maine, Massachusetts, New Hampshire, and New Jersey.

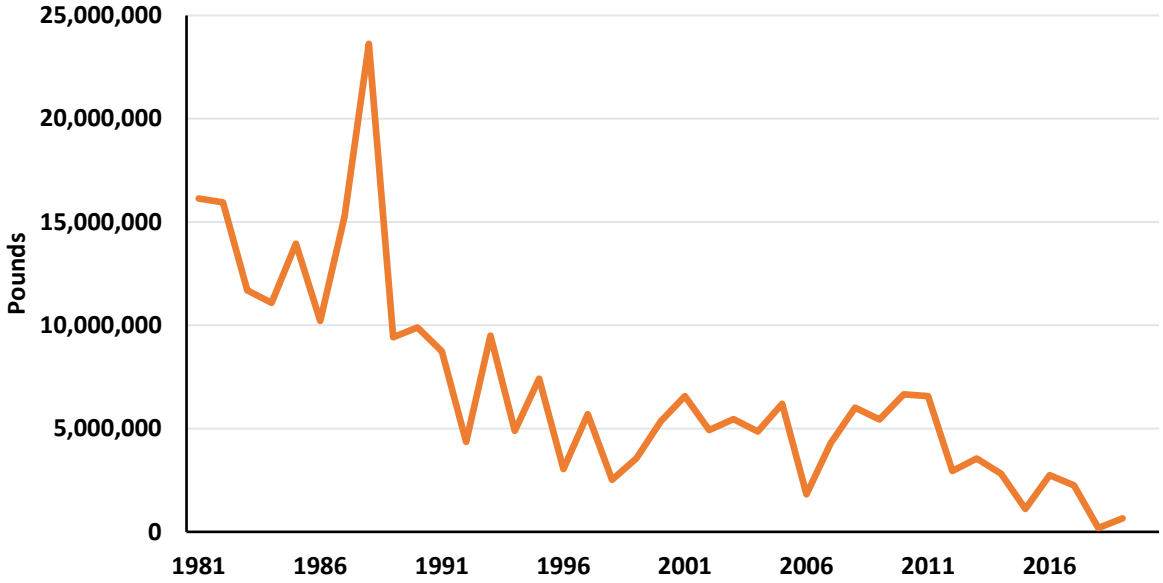

Figure 52. Total recreational U.S. Atlantic cod landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 20. Total recreational U.S. Atlantic cod landings (1981-2019).

Year	Volume (lb)	Year	Volume (lb)
2019	652,508	1999	3,559,126
2018	187,219	1998	2,522,084
2017	2,249,897	1997	5,695,557
2016	2,746,456	1996	3,042,036
2015	1,108,520	1995	7,412,708
2014	2,814,994	1994	4,889,408
2013	3,548,866	1993	9,503,360
2012	2,946,162	1992	4,354,927
2011	6,569,881	1991	8,744,644
2010	6,660,856	1990	9,895,894
2009	5,440,667	1989	9,422,989
2008	6,012,429	1988	23,627,390
2007	4,302,722	1987	15,259,964
2006	1,814,637	1986	10,208,910
2005	6,200,506	1985	13,953,334
2004	4,862,978	1984	11,088,652
2003	5,456,181	1983	11,688,779
2002	4,932,315	1982	15,951,611
2001	6,568,438	1981	16,140,974
2000	5,349,536		

Source: NOAA Landings Database (NOAA 2021b).

Table 21. Top states for recreational Atlantic cod landings, 2019.

	State	Volume (lb)
1.	Connecticut	270,565
2.	Rhode Island	143,753
3.	New York	120,143
4.	Maine	50,684
5.	New Hampshire	24,317

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Atlantic cod management is divided by its two stocks, the Gulf of Maine and Georges Bank. NOAA Fisheries and the New England Fishery Management Council (NEFMC) manage the Gulf of Maine stock, while NOAA, NEFMC and Canada jointly manage the Georges Bank stock. Atlantic cod is also managed under the Northeast Multispecies Fishery Management Plan, which manages all groundfish in the Northeast Atlantic (NEFMC 1985). Under the NEFMC plan, groundfish recreational fishery management is divided into four regulated mesh areas: Gulf of Maine, Georges Bank, Southern New England, and the Mid-Atlantic (NEFMC 1985). The recreational fishery inside the Gulf of Maine mesh area is more heavily regulated than outside the mesh area with smaller bag limits and open fishing dates than outside the area (Table 22).

Table 22. Recreational fisheries regulations for Atlantic cod.

State	Minimum size	Daily bag limit	Open season	Managing agency
Inside GOM RMA	21”	1 pp	Sep 15-30 Apr 1-14 (private) Sep 8-Oct 7, Apr 1-14 (charter/party)	NOAA & NEFMC under Northeast multispecies (groundfish) fishery management plan
Outside GOM RMA	21”	10 pp	All year	

Source: NEFMC, 1985

Total Supply

The total commercial supply of Atlantic Cod is comprised of its commercial landings and imports (Figure 53). Both imports and commercial landings have decreased since the early 1990s. The total commercial supply of Atlantic cod was 15.8 million pounds in 2019.

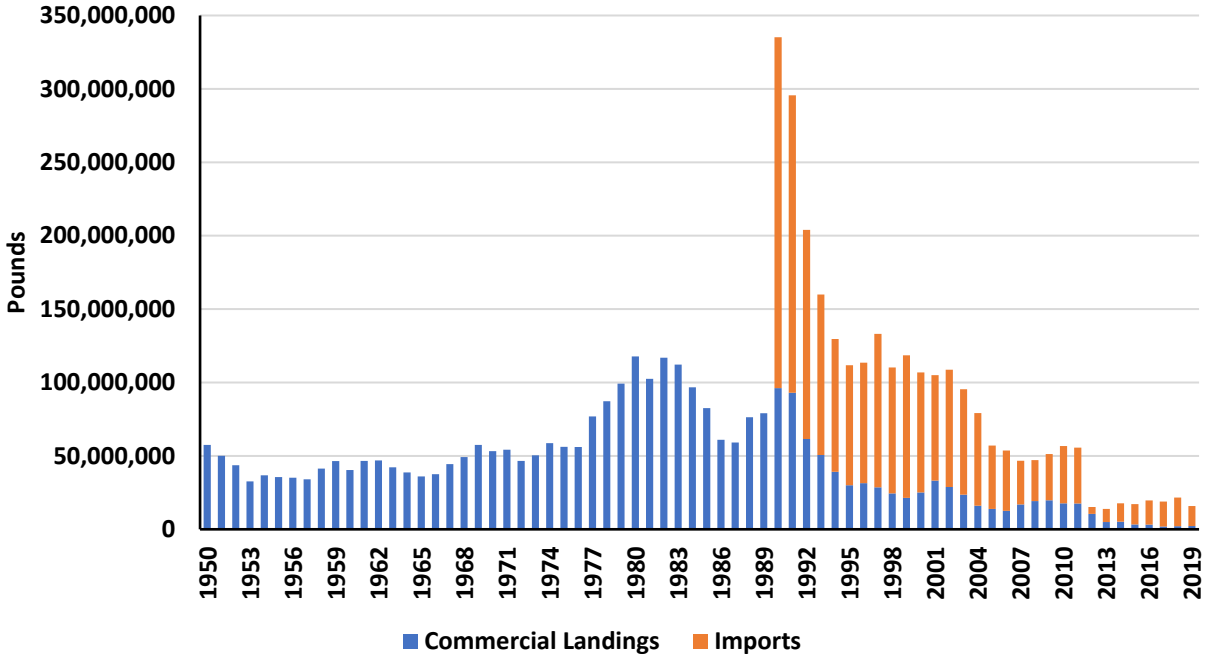

Figure 53. Total commercial supply of Atlantic cod, 1950-2019. Sources: NOAA Foreign Trade Database (NOAA 2021a); NOAA Landings Database (NOAA 2021b).

Appendix C. Black Drum

Black drum *(Pogonias cromis)*, a member of the drum family, is typically found in or near brackish waters from Nova Scotia to Florida and the Gulf of Mexico. It is federally managed in the Atlantic and the Gulf of Mexico under fishery management plans, which give states jurisdiction over harvests. Commercial harvest has been steady for the past three decades with the majority of landings occurring in the Gulf waters of Louisiana and Texas.

Aquaculture

No reports have been found of the culture of black drum. Nevertheless, its similarities to red drum may suggest it as a potential culture species for aquaculture. FAO (2021a) reports minimal volumes of production (< 15,000 lb) in the category of "Drums nei" (not elsewhere included), from 2005 to 2012, but none thereafter. However, the species of drum included are not specified. The only drum species reported separately is red drum.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of farmed black drum.

Import/Export of Black Drum

No import or export data were found for black drum, but some volume of black drum has been reported to be exported to Mexico (Leard et al. 1993).

Commercial Landings

Black drum commercial landings reached a peak in 1987, but have remained fairly stable at only slightly lower levels since (Figure 54: Table 23). Landings were 5,358,101 pounds in 2019 with a commercial value of $5,866,386. The top three states for commercial landings in 2019 were: Louisiana (59%), Texas (33%), and Virginia (2%) (Table 24). Additional commercial landings were from Alabama, Delaware, Florida, Maryland, Mississippi, New Jersey, New York, and North Carolina. Black drum is not considered overfished in the Gulf of Mexico, although it had been overfished in Louisiana in the 1980s (Seafood Watch: Black Drum 2018).

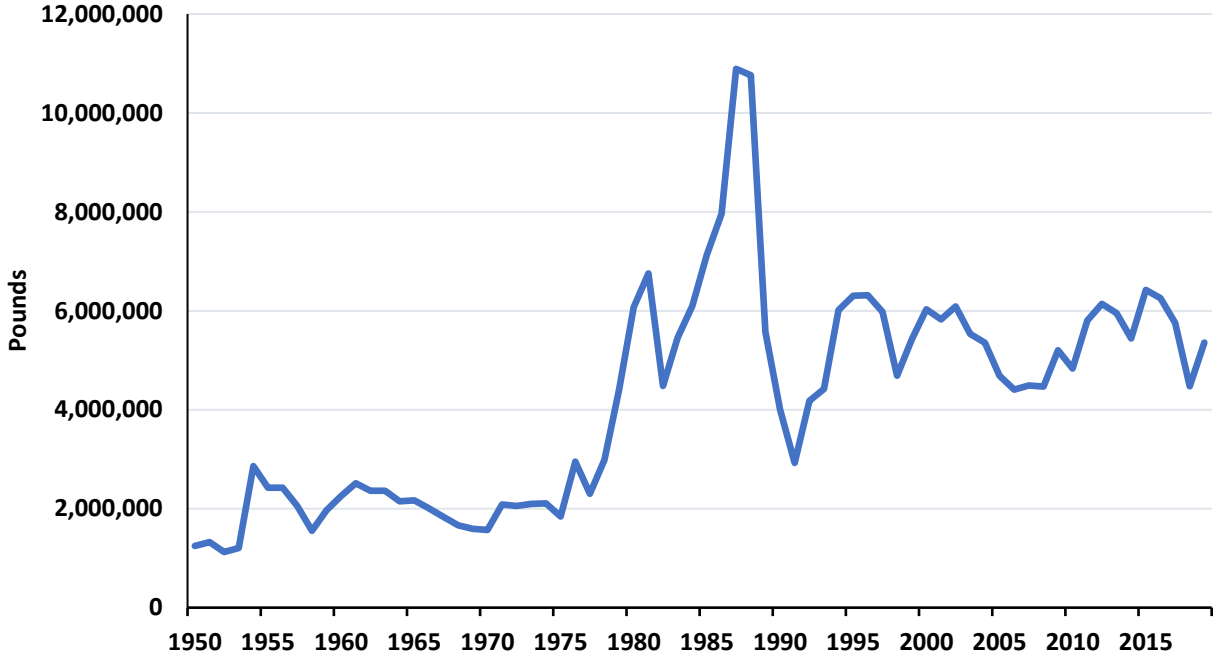

Figure 54. Total commercial U.S. black drum landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 23. Total commercial U.S. black drum landings (1950-2019).

	Commercial landings		Commercial landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollar
2019	5,358,101	5,866,386	1984	6,096,249	1,978,082
2018	4,474,921	4,580,371	1983	5,463,168	1,986,462
2017	5,755,662	5,957,500	1982	4,481,651	1,573,363
2016	6,258,754	6,362,973	1981	6,754,943	1,341,924
2015	6,421,617	6,212,506	1980	6,074,499	1,071,327
2014	5,442,590	5,407,760	1979	4,412,463	998,375
2013	5,954,767	5,311,359	1978	2,987,487	809,057
2012	6,142,293	5,275,140	1977	2,302,200	515,657
2011	5,802,959	4,609,106	1976	2,951,600	606,622
2010	4,834,578	4,213,050	1975	1,841,300	275,641
2009	5,203,592	4,132,362	1974	2,108,300	292,164
2008	4,469,134	3,597,390	1973	2,096,700	232,229
2007	4,489,922	3,644,697	1972	2,055,900	202,779
2006	4,408,448	3,478,069	1971	2,085,000	185,387
2005	4,687,620	3,733,041	1970	1,571,400	143,653

2004	5,354,162	3,601,669	1969	1,593,900	148,365
2003	5,533,205	3,423,807	1968	1,665,500	149,410
2002	6,089,498	3,616,846	1967	1,833,800	182,803
2001	5,826,995	3,419,364	1966	2,007,800	151,259
2000	6,029,551	4,187,022	1965	2,167,500	183,019
1999	5,424,103	4,359,457	1964	2,148,900	173,917
1998	4,689,774	4,528,375	1963	2,362,100	162,388
1997	5,978,890	4,680,371	1962	2,361,600	157,779
1996	6,315,907	4,998,076	1961	2,515,400	179,348
1995	6,304,678	4,969,874	1960	2,257,800	161,551
1994	6,016,423	4,150,527	1959	1,967,600	126,652
1993	4,421,223	2,725,286	1958	1,554,200	123,608
1992	4,180,425	2,237,655	1957	2,056,500	190,907
1991	2,925,557	1,787,416	1956	2,422,900	223,181
1990	3,998,188	1,768,593	1955	2,426,000	198,941
1989	5,576,461	2,551,865	1954	2,862,200	209,031
1988	10,763,485	3,193,314	1953	1,204,300	100,459
1987	10,891,484	3,779,625	1952	1,124,800	134,764
1986	7,963,523	2,786,860	1951	1,325,000	141,171
1985	7,133,364	2,038,555	1950	1,247,500	117,971

Source: NOAA Landings Database (NOAA 2021b).

Table 24. Top states for commercial black drum landings, 2019.

Rank	State	Volume (lb)
1.	Louisiana	3,173,502
2.	Texas	1,794,764
3.	Virginia	117,854
4.	Alabama	106,504
5.	North Carolina	80,036

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Black drum is managed in Atlantic waters via the Atlantic States Marine Fisheries Commission (ASMFC) 2013 Interstate Fishery Management Plan for Black Drum (and 2018 addendum) and in Gulf waters via the Gulf States Marine Fisheries Commission 1993 regional management plan (ASMFC 2018a). These plans have set the minimum size limit to 14 inches but leave room for individual states to develop specific regulations pertaining to bag limits and commercial quotas (Table 25). Commercial harvest is open year-round, with the season for the Chesapeake Bay in Maryland recently opening in 2019.

Table 25. Commercial fisheries regulations for black drum.

State	Size limit	Trip limit	Annual quota	Notes
NJ	16” min	10,000 lb	65,000 lb	
DE	16” min	10,000 lb	65,000 lb	
MD	16” min, 28” min in C.B	10 fish in C.B	1,500 lb Atlantic Coast	Chesapeake Bay (C.B) opened to commercial harvest in 2019
VA	16” min	1/person/ day*	120,000 lb	*w/out black drum harvest & Selling Permit
NC	14” min - 25” max	500 lb		
SC	14” min - 27” max	5/person		Commercial fishery primarily bycatch
GA	14” min	15/person/ day		
FL	14” min - 24” max	500 lb		

Source: ASMFC (2013); ASMFC (2018a).

Recreational Landings

Recreational landings of black drum increased throughout the 1990s, reaching a peak in 2013 (Figure 55; Table 26). Recreational landings from 2014 to 2019 appeared to be entering a cyclical trough. The top three states for recreational landings of black drum in 2019 were: Florida (40%), Mississippi (23%), and South Carolina (14%) (Table 27). Additional recreational landings were reported in Alabama, Georgia, Louisiana, New Jersey, North Carolina, South Carolina, and Virginia.

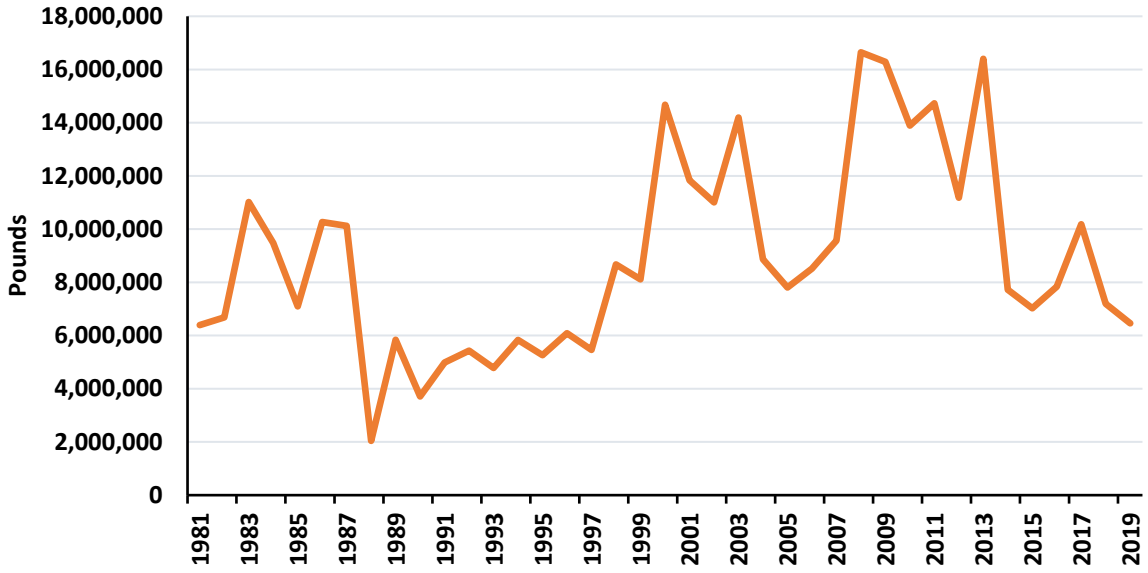

Figure 55. Total recreational U.S. black drum landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 26. Total recreational U.S. black drum landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	6,456,401	1999	8,112,505
2018	7,194,639	1998	8,671,609
2017	10,183,017	1997	5,459,583
2016	7,833,705	1996	6,085,188
2015	7,023,391	1995	5,263,593
2014	7,721,162	1994	5,836,354
2013	16,402,211	1993	4,782,218
2012	11,183,220	1992	5,433,871
2011	14,729,528	1991	4,987,779
2010	13,891,005	1990	3,711,489
2009	16,287,040	1989	5,837,329
2008	16,645,758	1988	2,041,206
2007	9,566,162	1987	10,123,856
2006	8,514,382	1986	10,269,308
2005	7,803,582	1985	7,093,941
2004	8,867,548	1984	9,477,448
2003	14,192,199	1983	11,016,743
2002	11,003,891	1982	6,684,874
2001	11,836,159	1981	6,391,016
2000	14,674,306		

Source: NOAA Landings Database (NOAA 2021b).

Table 27. Top states recreational black drum landings, 2019.

	State	Volume (lb)
1.	Florida	2,604,206
2.	Mississippi	1,456,282
3.	South Carolina	910,338
4.	Alabama	417,406
5.	North Carolina	404,456

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Black drum is managed in Atlantic waters via the Atlantic States Marine Fisheries Commission (ASMFC) 2013 Interstate Fishery Management Plan for Black Drum (and 2018 addendum) and in Gulf waters via the Gulf States Marine Fisheries Commission 1993 regional management plan (ASMFC 2018a). These plans have set the minimum size limit to 14 inches but leave room for individual states to develop specific regulations pertaining to bag limits and commercial quotas (Table 28). The recreational fishing season for black drum is open year-round in Florida and April through June in other states.

Table 28. Recreational fisheries regulations for black drum.

State	Size limit	Daily bag limit	Notes
NJ	16” min	3pp	
DE	16” min	3pp	
MD	16” min	1pp 6/vessel	Chesapeake Bay (C.B) opened to commercial harvest in 2019
VA	16” min	1pp / day	*w/out black drum harvest & Selling Permit
NC	14” min - 25” max; 1 fish > 25” may be retained	10pp/ day	
SC	14” min - 27” max	5pp	Commercial fishery primarily bycatch
GA	14” min	15pp	
FL	14” min - 24” max; 1 fish > 24” may be retained	5pp	

Source: ASMFC (2018a).

Appendix D. Black Sea Bass

Black sea bass (*Centropristis striata*), also known as blackfish, rock bass, black bass, and tallywag, is found in the Atlantic Ocean from Maine to the Florida Keys. It is an important species for recreational and commercial fisheries on the Atlantic Coast. There are two distinct stocks of black sea bass in the Atlantic, with the northern stock ranging from Cape Cod to Cape Hatteras, North Carolina, and the southern stock ranging from Cape Hatteras to the Gulf of Mexico. Both stocks are under federal management plans and are currently not overfished and not subject to overfishing (NOAA 2020a). The state of Florida also manages a stock in the Gulf of Mexico.

Aquaculture

There is some farmed production of limited volumes of black sea bass in the U.S. Black sea bass fingerlings are available from the University of North Carolina at Wilmington for farms to raise in growout RAS. Farmed black sea bass will need to compete with wild-caught black sea bass in the market. Farmers selling black sea bass target smaller markets with ultra-fresh product. FAO (2021a) lists farmed production only for 2003 and 2004 (< 25,000 lb) and only for the U.S.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of black sea bass. In North Carolina, for example, marine finfish like black sea bass, are regulated by the Division of Marine Fisheries of the North Carolina Department of Environmental and Natural Resources (NCDENR DMF), not the Department of Agriculture, as trout, hybrid striped bass, and catfish are regulated. Natural resource agencies frequently have less understanding of farming practices than do agriculture agencies. NCDENR DMF has an Aquaculture Operations Permit that allows a farmer to sell black sea bass of any size and time of year so long as each shipment is accompanied by a Bill of Lading that documents the origin of the fish during the chain of custody.

Import/Export of Black Sea Bass

The NOAA Foreign Trade Database utilizes a single category titled “Bass,” which does not specify individual species, but does include freshwater and sea bass. The import information for the “Bass” category is located in Appendix U. It should also be noted that the NOAA

Foreign Trade Database includes a category titled “sea bass (Dicentrarchus spp).” This category includes fish in the Dicentrarchus genus, including European and Spotted Seabass. Black sea bass and white sea bass are, therefore, not included in the “Sea Bass” category.

Commercial Landings

Commercial landings of black sea bass show a substantial decline from 1954 to the mid-1970s, followed by relatively stable landings since (Figure 56; Table 29). The top three major states for commercial landings of black sea bass are: New Jersey (19%), Virginia (17%), and Massachusetts (14%) (Table 30). Additional commercial landings were reported in: Connecticut, Delaware, Florida, Maryland, New Jersey, New York, North Carolina, South Carolina, and Rhode Island. Black sea bass is sustainably managed, with 2018 commercial quotas of 3.53 million lb and recreational quotas of 3.66 million lb.

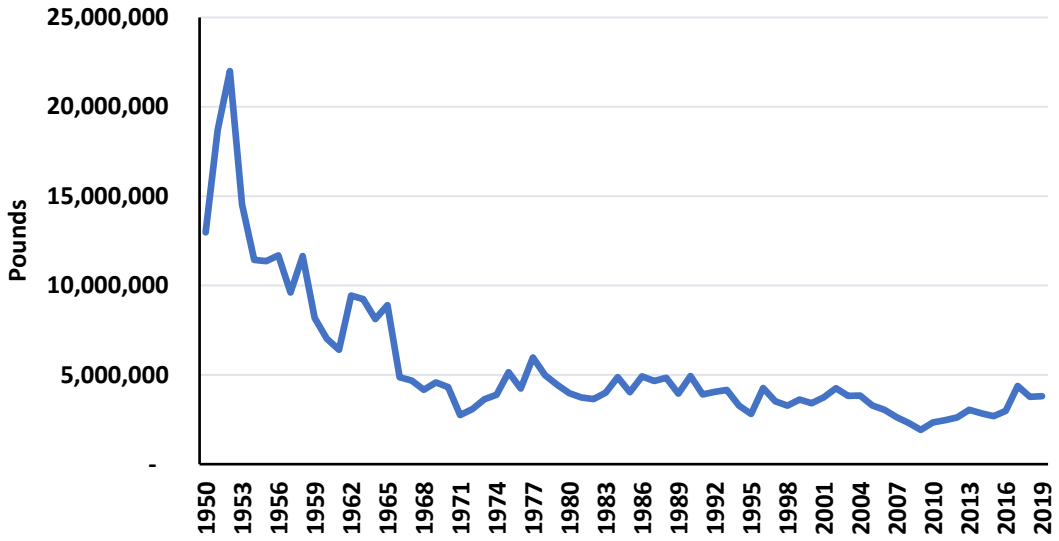

Figure 56. Total commercial U.S. black sea bass landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 29. Total commercial U.S. black sea bass landings (1950-2019).

	Commercial landings		Commercial landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	3,802,944	12,644,988	1984	4,871,108	3,803,946
2018	3,769,179	12,702,144	1983	4,000,659	2,981,856
2017	4,374,286	13,293,404	1982	3,639,454	2,659,957
2016	2,977,498	10,125,630	1981	3,735,229	2,787,092
2015	2,689,268	8,719,961	1980	3,978,009	2,713,838
2014	2,849,501	8,637,494	1979	4,439,346	2,557,158
2013	3,042,317	8,563,094	1978	4,978,602	2,210,283
2012	2,616,056	6,925,872	1977	5,969,900	2,045,493

2011	2,463,384	6,412,344	1976	4,238,900	1,505,867
2010	2,337,410	6,376,879	1975	5,152,400	1,609,120
2009	1,918,302	5,059,042	1974	3,885,700	1,354,314
2008	2,308,677	6,325,083	1973	3,638,500	1,130,084
2007	2,633,794	7,494,641	1972	3,082,900	943,678
2006	3,044,278	8,078,727	1971	2,751,100	687,879
2005	3,285,597	7,759,817	1970	4,312,700	986,250
2004	3,838,598	7,429,669	1969	4,573,000	922,575
2003	3,821,817	7,104,937	1968	4,160,000	749,969
2002	4,250,195	6,790,540	1967	4,684,400	800,242
2001	3,745,990	5,508,016	1966	4,857,300	707,646
2000	3,410,092	5,717,437	1965	8,898,100	1,022,519
1999	3,621,162	5,886,457	1964	8,120,200	1,018,554
1998	3,272,308	5,209,389	1963	9,237,200	1,171,000
1997	3,517,705	5,000,591	1962	9,437,300	1,367,718
1996	4,257,678	4,831,366	1961	6,404,200	1,092,402
1995	2,810,798	3,699,113	1960	7,019,800	1,072,112
1994	3,279,898	3,455,741	1959	8,181,400	1,127,549
1993	4,150,011	4,216,655	1958	11,645,200	1,314,801
1992	4,048,415	4,142,641	1957	9,605,900	1,131,431
1991	3,907,751	4,655,747	1956	11,688,800	1,168,665
1990	4,935,747	5,506,886	1955	11,360,000	1,106,307
1989	3,945,473	4,654,195	1954	11,437,600	1,223,699
1988	4,831,463	5,114,408	1953	14,537,000	1,461,873
1987	4,656,217	4,709,586	1952	21,997,400	2,205,575
1986	4,917,469	4,721,132	1951	18,710,800	2,115,319
1985	4,024,853	3,760,034	1950	12,974,500	1,496,146

Source: NOAA Landings Database (NOAA 2021b)

Table 30. Top states for commercial black sea bass landings, 2019.

	Commercial Landings	
Rank	**State**	**Volume (lb)**
1.	New Jersey	719,544
2.	Virginia	645,817
3.	Massachusetts	530,770
4.	Rhode Island	397,902
5.	North Carolina	385,257

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

The northern stock of black sea bass is managed by NOAA Fisheries, the Mid-Atlantic Fishery Management Council, (MAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC) under Amendment 13 of the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan (ASMFC 2018b). This plan divides an annual quota between the recreational fishery (51%) and the commercial fishery (49%) (Table 31). The commercial quota is divided among the states annually. The southern stock of black sea bass is managed by NOAA Fisheries and the South Atlantic Fishery Management Council (SAMFC) under the Snapper Grouper Fishery Management plan (SAMFC 2020). The commercial catch limit is also divided among the states based on historical harvests and vessels must obtain permits for harvest.

Table 31. Commercial fisheries regulations for black sea bass.

State	2019 Quota (lb)	2020 Quota (lb)
Northern Stock (Managed by NOAA, MAFMC, and ASMFC)		
ME	17,600	27,900
NH	17,600	27,900
MA	457,600	725,400
RI	387,200	613,800
	35,200	55,800
CT	35,200	55,800
CT, Authorized Party/Charter		
NY	246,400	390,600
NJ	704,000	1,116,000
DE	176,000	279,000
MD	387,200	613,800
VA	704,000	1,116,000
NC (North of Caper Hatteras)	387,200	5,580,000
Southern Stock (managed by NOAA and SAMFC)		
NC (South of Cape Hatteras), SC, GA, FL (Atlantic)	N/A	287,670
Gulf of Mexico Stock (managed by Florida FWCC)		
FL (Gulf of Mexico)	N/A	N/A

Source: ASMFC (2018b); SAMFC (2020).

Recreational Landings

Data for recreational landings of black sea bass were available only from 1985 on and show a slight decline through 2006 followed by an increase that in 2019 was more than double the 2006 landings (Figure 57; Table 32). The top three major states for recreational landings of black sea bass in 2019 were: New York (33%), Massachusetts (14%), and Rhode Island (13%) (Table 33). Other states with recreational landings in 2019 include: Alabama, Delaware, Connecticut, Florida, Georgia, Maryland, New Jersey, New York, North Carolina, South Carolina, and Virginia.

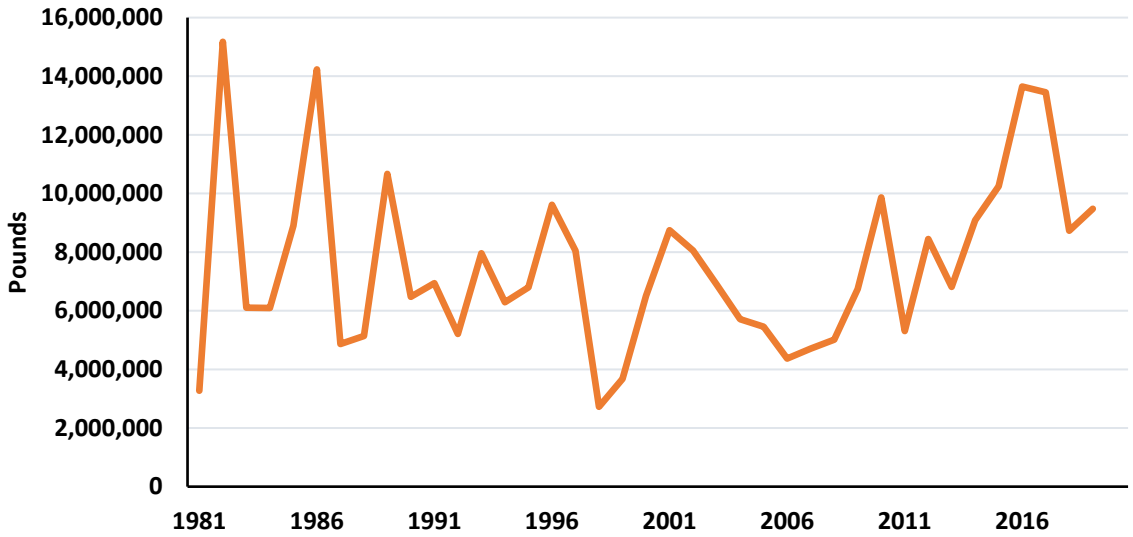

Figure 57. Total recreational U.S. black sea bass landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 32. Total recreational U.S. black sea bass landings (1981-2019).

Year	Volume (lb)	Year	Volume (lb)
2019	9,477,181	1999	3,678,129
2018	8,728,260	1998	2,723,923
2017	13,449,016	1997	8,047,451
2016	13,649,700	1996	9,616,114
2015	10,246,182	1995	6,799,361
2014	9,085,138	1994	6,290,291
2013	6,814,086	1993	7,958,034
2012	8,444,099	1992	5,211,678
2011	5,310,270	1991	6,937,392
2010	9,864,238	1990	6,475,349
2009	6,742,739	1989	10,669,257

2008	5,015,939	1988	5,137,210
2007	4,705,557	1987	4,866,422
2006	4,368,559	1986	14,232,436
2005	5,455,862	1985	8,901,413
2004	5,712,321	1984	6,093,106
2003	6,894,443	1983	6,103,807
2002	8,051,509	1982	15,173,567
2001	8,749,153	1981	3,273,650
2000	6,506,634		

Source: NOAA Landings Database (NOAA 2021b).

Table 33. Top states for recreational black sea bass landings, 2019.

Rank	State	Volume (lb)
1.	New York	3,126,508
2.	Massachusetts	1,361,124
3.	Rhode Island	1,225,072
4.	Connecticut	1,180,413
5.	New Jersey	1,117,670

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

The northern stock of black sea bass is managed by NOAA Fisheries, the Mid-Atlantic Fishery Management Council, (MAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC) under Amendment 13 of the Summer Flounder, Scup, and Black Sea Bass Fishery Management plan (ASMFC 2018b). This plan divides an annual quota between the recreational fishery (51%) and the commercial fishery (49%). The recreational fishery is managed on a regional basis with individual states deciding on minimum size, possession limits, and open season as long as they adhere to the minimum federal measures of 12.5” in length, 15 fish per vessel, and a season from May 15-December 31 (Table 34).

The southern stock of black sea bass is managed by NOAA Fisheries and the South Atlantic Fishery Management Council (SAMFC) under the Snapper Grouper Fishery Management plan (SAMFC, 2020). The recreational season of the southern stock is open from April 1 to March 31, but is subject to closure once the annual catch limit is met. The open season for recreational fisheries varies by state with varying size and catch limits (Table 34). There is also a stock of black sea bass in the Gulf of Mexico, off the shore of Florida, which is managed by the Florida Fish and Wildlife Conservation Commission (FWC 2021c). The season in the Gulf of Mexico is open year-round with a 10” minimum size limit and a possession limit of 100 lb per person.

Table 34. Recreational fisheries regulations for black sea bass.

State	Minimum size	Possession limit (# fish)	Open season
Northern Stock (Managed by NOAA, MAFMC, and ASMFC)			
ME	13”	10	May 19–Sep 21; Oct 18–Dec 31
NH	13”	10	Jan 1–Dec 31
MA	15”	5	May 19–Sep 12
RI	15”	3	Jun 24–Aug 31
		7	Sep 1–Dec 31
CT	15”	5	May 19–Dec 31
CT, Authorized Party/Charter	15”	7	May 19–Dec 31
NY	15”	3	Jun 23–Aug 31
		7	Sep 1–Dec 31
NJ	12.5”	10	May 15–Jun 22
	12.5”	2	Jul 1–Aug 31
	12.5”	10	Oct 8–Oct 31
	13”	15	Nov 1–Dec 31
DE	12.5”	15	May 15–Dec 31
MD	12.5”	15	May 15–Dec 31
VA	12.5”	15	Feb 1–Feb 28 May 15–Dec 31
NC (North of Caper Hatteras)	12.5”	15	Feb 1–Feb 28 May 15–Dec 31
Southern Stock (managed by NOAA and SAMFC)			
NC (South of Cape Hatteras), SC, GA, FL (Atlantic)	13”	7 pp	Apr 1–Mar 31
Gulf of Mexico Stock (managed by Florida FWC)			
FL (Gulf of Mexico)	10”	100 lb per person	Jan 1 – Dec 31

Source: ASMFC (2018b); SAMFC (2020); FWC (2021c).

Appendix E. California Flounder (*Paralichthys californicus*)

California flounder, also known as California halibut, is a large-tooth flounder native to the North American Pacific Coast. It is the largest flounder and supports important commercial and recreational fisheries along the Pacific Coast in California and Oregon.

Aquaculture

Initial interest in farming California flounder was for stock enhancement purposes. While research studies have been conducted on California flounder, there is no known commercial farm production of California flounder in the U.S., although some limited commercial success has been achieved in Mexico (Stuart et al. 2019). Most research studies have focused on broodstock, spawning, larval culture, and juvenile production. For growout, some limited trials have been conducted in flow-through raceways (Stuart et al. 2021). There are no data reported by FAO (2021a) on fared production of California flounder globally.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of California flounder.

Import/Export of California Flounder

Cortez flounder from Mexico are mostly sold into domestic markets in Mexico, but some are exported to the U.S. (DOF 2010; BC 2015). The volume is not known because exports are classified as “flatfish.” In 2015, 33,075 pounds of “unspecified halibut were imported from Mexico (NMFS 2016). The NOAA Foreign Trade Database utilizes a single category titled “Flatfish Flounder,” which does not specify individual species. Non-specified “flounder” import data are presented in Appendix U.

Commercial Landings

Worldwide, the only locations of California flounder are off the coast of California. Production has decreased over time, with commercial catches peaking in the 1910s and 1940s (Seafood Watch: Flounder 2020). The southern California stocks were considered to be of moderate concern, based on the southern California stock being at 14% of the unexploited bass in 2011, whereas the Central California stock was at 122% of unexploited biomass and of low concern (Seafood Watch: California Flounder 2020). One-third of the commercial landings were in

southern California in 2019. Commercial landings of California flounder peaked in 1997 at 1.34 million pounds, declined rapidly until 2012 to levels of 29% of the 1999 levels, and then nearly doubled to 732,154 pounds in 2019 (Figure 58; Table 35). All commercial landings of California flounder in 2019 were in California (Table 36).

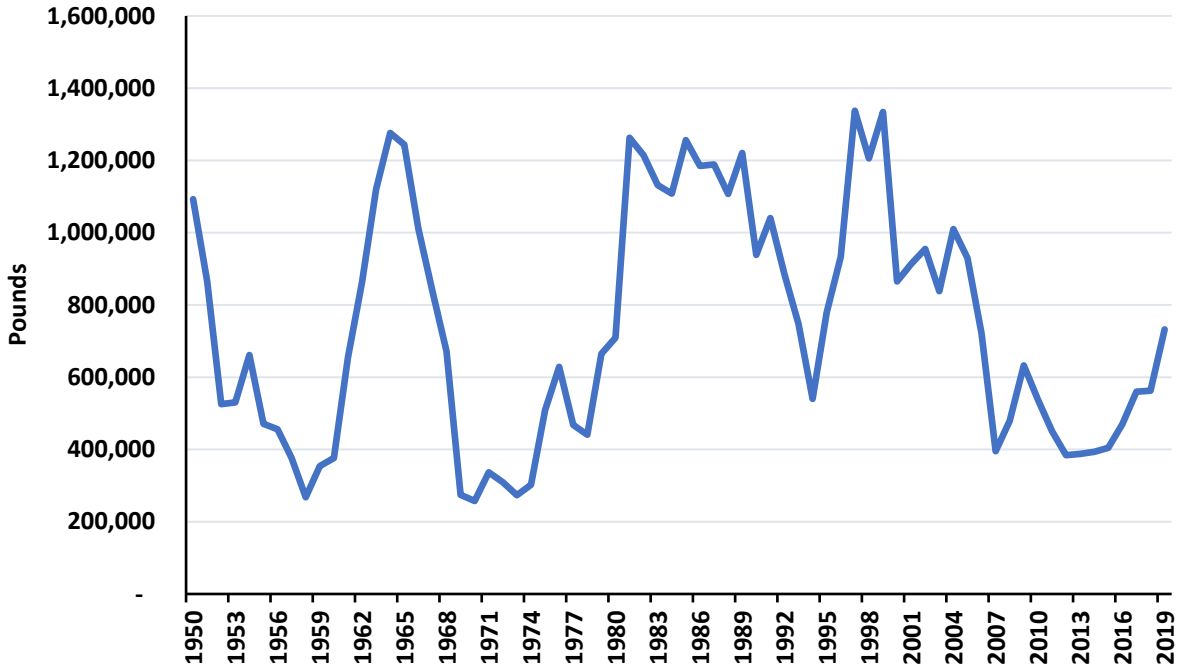

Figure 58. Total commercial U.S. California flounder landings (1950-2019). Source. NOAA Landings Database (NOAA 2021b).

Table 35. Total commercial U.S. California flounder landings (1950-2019).

	Commercial landings		Commercial landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	732,154	3,933,187	1984	1,108,208	1,946,972
2018	562,619	3,273,929	1983	1,131,741	1,774,712
2017	559,753	3,263,746	1982	1,214,140	1,884,083
2016	470,025	2,625,538	1981	1,262,828	1,924,615
2015	404,548	2,167,676	1980	709,393	1,013,637
2014	393,304	2,131,546	1979	665,053	908,615
2013	387,793	2,015,967	1978	441,000	495,211
2012	384,045	1,890,779	1977	467,900	460,480
2011	451,065	2,194,020	1976	628,500	536,325
2010	538,148	2,350,513	1975	508,800	358,344
2009	632,505	2,582,255	1974	302,400	200,664
2008	479,505	2,298,338	1973	273,300	159,712
2007	395,068	1,848,426	1972	309,300	135,566

2006	720,690	2,719,021	1971	336,900	126,280
2005	929,688	2,870,906	1970	257,400	91,213
2004	1,009,936	3,113,511	1969	274,300	85,094
2003	838,226	2,506,763	1968	671,700	185,822
2002	955,190	2,840,292	1967	838,100	226,967
2001	913,437	2,695,331	1966	1,011,400	264,036
2000	864,907	2,453,644	1965	1,243,700	292,123
1999	1,334,282	3,290,228	1964	1,276,100	288,782
1998	1,205,573	2,809,475	1963	1,120,400	244,185
1997	1,337,576	3,316,475	1962	863,100	207,728
1996	933,275	2,502,529	1961	654,600	150,706
1995	778,522	2,167,086	1960	376,300	90,157
1994	539,811	1,509,316	1959	354,200	79,559
1993	747,235	1,852,393	1958	267,500	64,213
1992	885,010	2,137,294	1957	376,200	86,193
1991	1,040,470	2,477,921	1956	455,800	105,528
1990	938,412	2,157,553	1955	471,000	101,534
1989	1,220,601	2,726,083	1954	661,300	138,378
1988	1,107,206	2,480,860	1953	530,300	124,283
1987	1,188,942	2,552,839	1952	525,300	127,068
1986	1,184,892	2,366,627	1951	865,900	198,641
1985	1,256,255	2,285,494	1950	1,092,700	224,622

Source: NOAA Landings Database (NOAA 2021b)

Table 36. Top states for commercial California flounder landings, 2019.

Rank	State	Volume (lb)
1.	California	732,154

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

California flounder is managed in California waters by the California Department of Fish and Wildlife and in Oregon waters by the Oregon Department of Fish & Wildlife. As a groundfish, California flounder is subject to the Pacific Coast Groundfish Fishery's Trawl Catch Share Program, which divides the amount of catch allocated to the trawl fishery into shares controlled by individual fishermen or groups of fishermen (cooperatives) (Table 37).

Table 37. Commercial fisheries regulations for California flounder.

State	Season	Managing agency

CA	Trawling Season: 6/16/2020-3/14/2021 (on trawl grounds); all year (in federal waters) Hook & Line: all year	CDFW
OR	N/A	ODFW

Source: CDFW (2021b).

Recreational Landings

Recreational landings of California flounder peaked in 1995 and then generally declined through 2015 and remained relatively stable through 2019 (Figure 59; Table 38). More than 99% of all recreational landings of California flounder were in California with less than 1% in Oregon (Table 39).

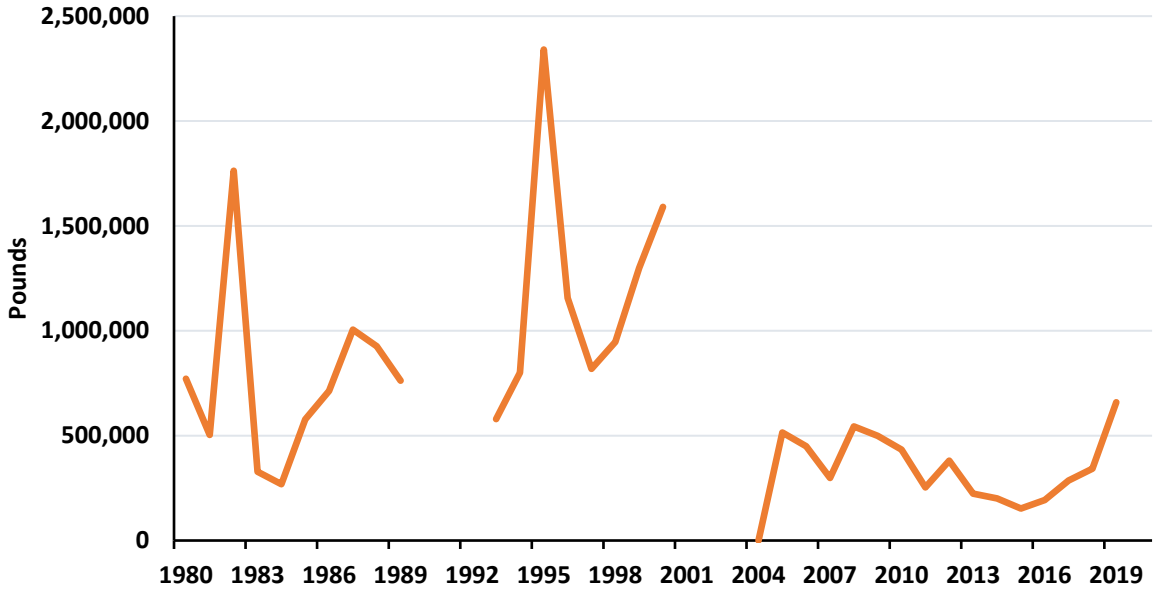

Figure 59. Total recreational U.S. California flounder landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 38. Total recreational U.S. California flounder landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	658,837	1999	1,299,038
2018	342,230	1998	946,838
2017	286,017	1997	818,525
2016	193,248	1996	1,156,506
2015	152,600	1995	2,340,650
2014	200,804	1994	800,127

2013	223,824	1993	578,837
2012	380,390	1992	n.d.[1]
2011	253,525	1991	n.d.
2010	433,322	1990	n.d.
2009	498,697	1989	762,410
2008	543,810	1988	926,390
2007	298,092	1987	1,005,150
2006	449,003	1986	713,410
2005	514,630	1985	577,479
2004	29	1984	268,742
2003	n.d.	1983	327,825
2002	n.d.	1982	1,762,802
2001	n.d.	1981	503,252
2000	1,590,562		

[1] n.d. = no data.
Source: NOAA Landings Database (NOAA 2021b).

Table 39. Top states for recreational California flounder landings, 2019.

Rank	State	Volume (lb)
1.	California	655,863
2.	Oregon	2,974

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

California flounder is managed in California waters by the California Department of Fish and Wildlife and in Oregon waters by the Oregon Department of Fish & Wildlife. In California, the recreational season is open all year with minimum size and bag limits, while in Oregon there is only a bag limit CDFW (2021a) (Table 40).

Table 40. Recreational fisheries regulations for California flounder.

State	Minimum size	Daily bag limit	Open season	Managing agency
CA	22”	3 fish north of Point Sur in Monterey County; 5 fish south	Year-round	CDFW
OR		25pp (2019)	Year-round	ODFW

Source: CDFW (2021a); ODFW (2021).

Appendix F. California Yellowtail (*Seriola lalandi*)

California yellowtail, also known as yellowtail amberjack, yellowtail kingfish, southern yellowtail amberjack, or great amberjack, is a marine fish in the jack family. It is found along the North American Pacific Coast from southern Washington to central Mexico. Yellowtail is primarily caught as bycatch in fisheries targeting other species. The recreational fishery is managed in the state of California, where the majority of landings take place.

Aquaculture

Farming of yellowtail began in the 1960s, but of *Seriola quinqueradata*, not *S. lalandi* (Sicuro and Luzzana 2016). Globally, farmed production increased from 2,205 pounds in 2014 to 897,000 pounds in 2019 (Figure 60; Table 41) (FAO 2021a). Countries reporting farmed production in 2019 were Chile, Denmark, and The Netherlands. In the U.S., there has not yet been commercial production of California yellowtail, but a commercial-scale farm has been proposed and is actively seeking required permits for an offshore facility.

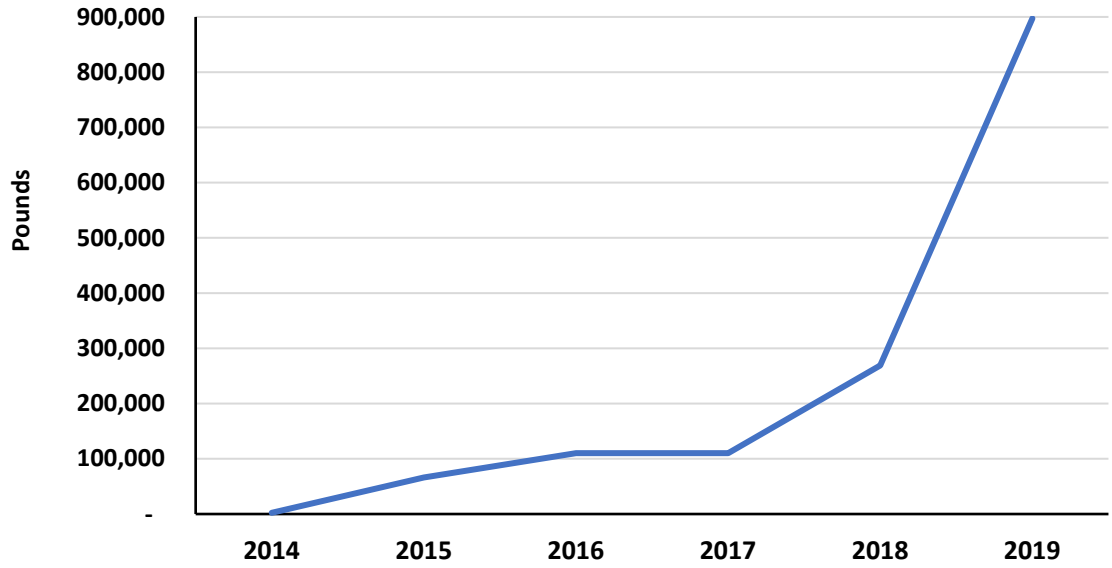

Figure 60. Global farmed production of California yellowtail, 2014-2019. Source: FAO Global Aquaculture Production Database (FAO 2021a).

Table 41. Global farmed production of California yellowtail, 2014-2019.

Year	Quantity (lb)
2014	2,205
2015	66,139
2016	110,231
2017	110,231
2018	270,044

2019	897,876

Source: FAO Global Aquaculture Production database (FAO 2021a).

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of California yellowtail.

Import/Export of California Yellowtail

Mexico is currently the only potential international source of California yellowtail. Exports of California yellowtail from Mexico are believed to be negligible. No other import/export data were found on California yellowtail.

Commercial Landings

California yellowtail are considered to be of moderate concern (Seafood Watch: White Seabass and California Yellowtail 2018) and are not considered to be highly vulnerable. California yellowtail have been fished since the late 1800s, with a range from southern Washington to Mazatlán, Mexico. The commercial fishery is incidental to that of the commercial white sea bass drift and set gillnet fishery, but there also is a hook and line component. There is no stock assessment or fishery management plan for California yellowtail. Commercial landings of California yellowtail declined substantially from its peak of 9.4 million pounds in 1952 through the mid-1960s and have remained at low levels since (Figure 61; Table 42). The 2019 landings of 26,455 pounds were 99% lower than those of the peak year of 1952. California was the only state with landings of California yellowtail in 2019 (Table 43).

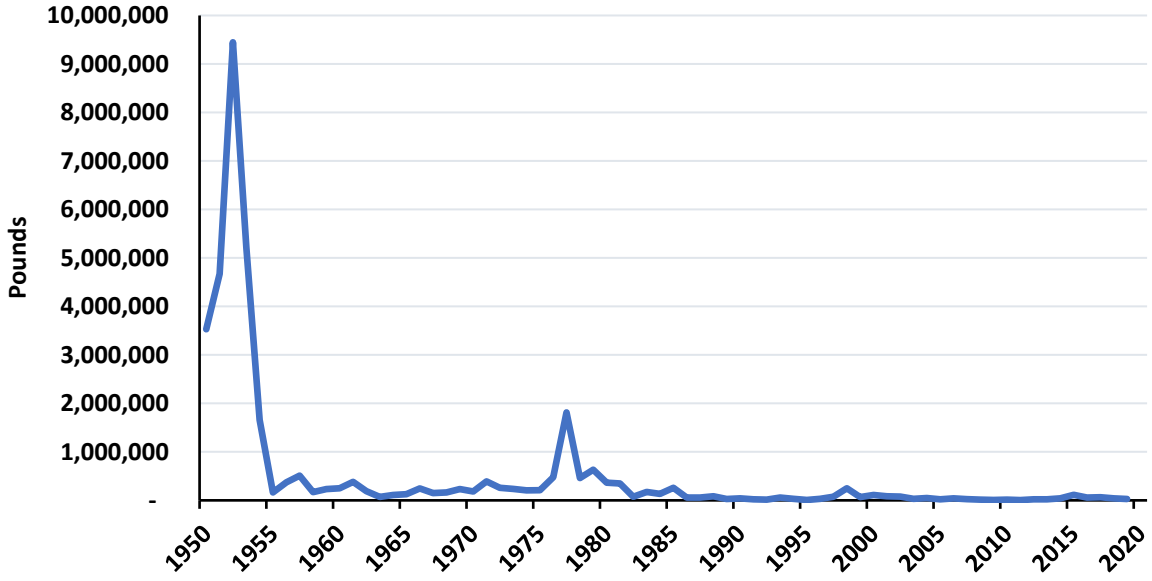

Figure 61. Total commercial U.S. California yellowtail landings. Source: NOAA Landings Database (NOAA 2021b).

Table 42. Total commercial U.S. California yellowtail landings (1950-2019).

Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	26,455	81,519	1984	132,221	74,686
2018	41,447	126,498	1983	171,922	92,440
2017	65,918	174,459	1982	74,791	29,511
2016	58,202	149,989	1981	347,055	191,661
2015	113,979	236,602	1980	365,164	171,063
2014	42,549	94,580	1979	633,401	247,466
2013	22,487	48,116	1978	460,700	148,056
2012	19,842	39,741	1977	1,814,700	381,034
2011	5,732	7,913	1976	475,900	105,752
2010	15,653	22,454	1975	210,300	47,335
2009	8,378	12,118	1974	204,900	41,088
2008	13,669	18,239	1973	235,700	38,364
2007	25,133	37,204	1972	258,100	38,972
2006	40,785	53,706	1971	390,500	44,833
2005	21,826	28,513	1970	184,200	24,798
2004	48,061	53,016	1969	234,200	28,487
2003	30,937	36,931	1968	163,200	18,090
2002	76,101	66,336	1967	150,700	15,766
2001	85,568	90,181	1966	245,200	26,650
2000	111,855	124,064	1965	127,800	14,131

1999	67,254	72,189	1964	110,100	11,694
1998	248,092	250,695	1963	69,700	6,953
1997	73,543	79,081	1962	188,400	15,992
1996	29,908	38,494	1961	380,800	27,739
1995	9,732	12,002	1960	248,700	22,556
1994	32,625	45,558	1959	231,300	18,706
1993	59,015	67,272	1958	169,600	13,810
1992	15,284	15,209	1957	509,000	36,110
1991	21,550	22,559	1956	370,900	32,006
1990	40,257	42,729	1955	164,300	13,461
1989	28,295	31,014	1954	1,656,800	139,447
1988	85,099	80,239	1953	5,212,400	489,977
1987	56,866	55,552	1952	9,447,000	874,228
1986	57,746	41,983	1951	4,669,700	443,307
1985	259,665	204,894	1950	3,529,800	314,334

Source: NOAA Landings Database (NOAA 2021b).

Table 43. Top state for commercial California yellowtail landings, 2019.

Rank	State	Volume (lb)
1.	California	26,455

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Commercial California yellowtail catch is not managed under any management plan.

Recreational Landings

California yellowtail are increasingly targeted by U.S. anglers (Saillant et al. 2021). Recreational landings for California yellowtail peaked in 1998 at 5.6 million pounds, with what appears to be a much lower peak in 2017 (Figure 62; Table 44). The landings in 2019 were 154,273 pounds.

Nearly all the recreational landings of California yellowtail were in California (99%) with < 1% in Oregon (Table 45).

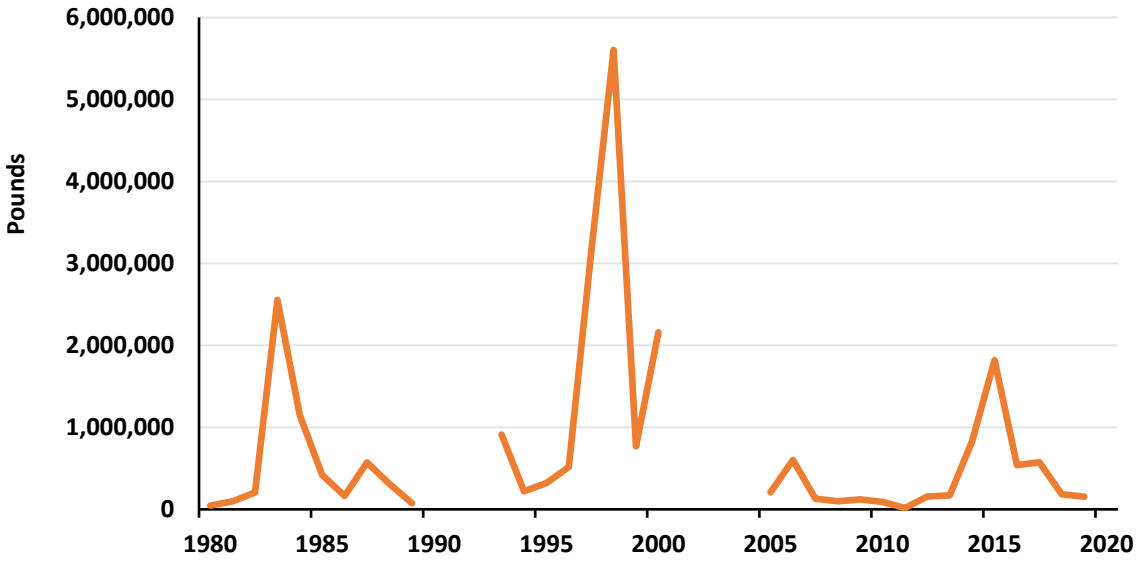

Figure 62. Total recreational U.S. California yellowtail landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 44. Total recreational U.S California yellowtail landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	154,273	1999	769,209
2018	183,775	1998	5,603,933
2017	573,753	1997	3,137,004
2016	537,961	1996	515,196
2015	1,820,105	1995	319,393
2014	832,292	1994	220,762
2013	169,743	1993	910,728
2012	155,638	1992	n.d.
2011	15,968	1991	n.d.
2010	90,566	1990	n.d.
2009	120,858	1989	74,272
2008	98,200	1988	310,788
2007	131,204	1987	571,584
2006	600,568	1986	164,249
2005	208,037	1985	417,263
2004	n.d.[1]	1984	1,145,900
2003	n.d.	1983	2,555,515
2002	n.d.	1982	205,885
2001	n.d.	1981	97,325

2000	2,159,055

[1]n.d. = no data.
Source: NOAA Landings Database (NOAA 2021b).

Table 45. Top states for recreational California yellowtail landings, 2019.

Rank	State	Volume (lb)
1.	California	154,236
2.	Oregon	37

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

California yellowtail is not managed under any specific management plan, but the California Department of Fish and Wildlife does manage the recreational fishery. They have set an open year-round season with a daily bag limit of 10 fish and a minimum size of 24 inches CDFW (2021a).

Appendix G. Cobia (*Rachycentron canadum*)

Cobia, also known as crabeater, sergeantfish, ling, cabio, cubby yew, and lemonfish, is a popular sportfish in the U.S. They are most abundant from Virginia south through the Gulf of Mexico, but can be found anywhere along the Atlantic Coast of the U.S. Cobia is managed under fishery management plans in the Gulf of Mexico and the Atlantic Ocean, with individual states setting more stringent regulations for recreational harvests.

Aquaculture

Cobia have been farmed in many countries in cages, ponds, and RAS around the world for the last three decades. From its beginnings in the late 1990s, cobia farming expanded in the 2000s (Seafood Watch: Panama Net Pens 2017). In 2013, 94.7 million pounds were produced, mostly in the Asia-Pacific region. In Panama, 1.1 million pounds were produced in 2012 and grew to 3.3 million pounds in 2014 that were exported to the U.S. (Nadkarni 2013).

At one time, 18 different countries reported farmed production of cobia (including Taiwan, China, Vietnam, Australia, U.S./Puerto Rico, Dominican Republic, Martinique, Bahamas, Cuba, Mexico, Belize, Panama, Columbia, Ecuador, Chile, Denmark, Saudi Arabia) (Benetti et al. 2021). The majority of cobia farms, and hatcheries, however, were no longer in production by 2020. Most of the commercial failures occurred in near-shore coastal areas, in and land-based ponds and RAS in the Americas. Cobia is difficult to raise anywhere other than offshore, where there is high dissolved oxygen, strong currents, and greater depths (Benetti et al. 2021). In the Americas, the only large operating cobia farm is in Panama, located in an exposed, high-energy, offshore location with submerged offshore cages (Benetti et al. 2021). The global production of 106.2 million pounds in 2019 was mostly produced in net pens in China with additional production in Viet Nam, Taiwan, and Panama (Figure 63; Table 46).

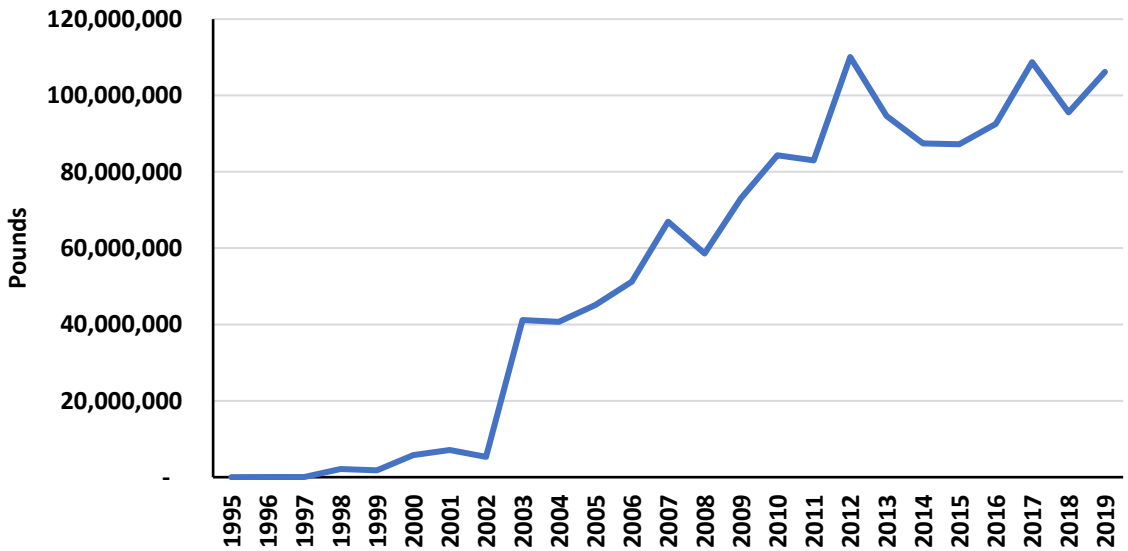

Figure 63. Global farmed production of cobia, 1995-2019. Source: FAO Global Aquaculture Production Database (FAO 2021a).

Table 46. Global farmed production of cobia, 1995-2019.

Year	Quantity (lb)	Year	Quantity (lb)
2019	106,182,127	2006	51,222,141
2018	95,582,645	2005	45,099,911
2017	108,738,318	2004	40,699,490
2016	92,568,268	2003	41,147,028
2015	87,208,219	2002	5,332,976
2014	87,423,870	2001	7,109,900
2013	94,629,235	2000	5,789,332
2012	110,076,677	1999	1,807,788
2011	82,974,048	1998	2,118,640
2010	84,337,738	1997	19,842
2009	73,072,130	1996	28,660
2008	58,589,981	1995	6,614
2007	66,952,105		

Source: FAO Global Aquaculture Production database (FAO 2021a).

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of cobia.

Import/Export of Cobia

The largest volume of cobia imported into the U.S. is fresh product (Figure 64; Table 47). Imports have decreased in the last few years, particularly of fresh product, with some increase in frozen imports since 2014.

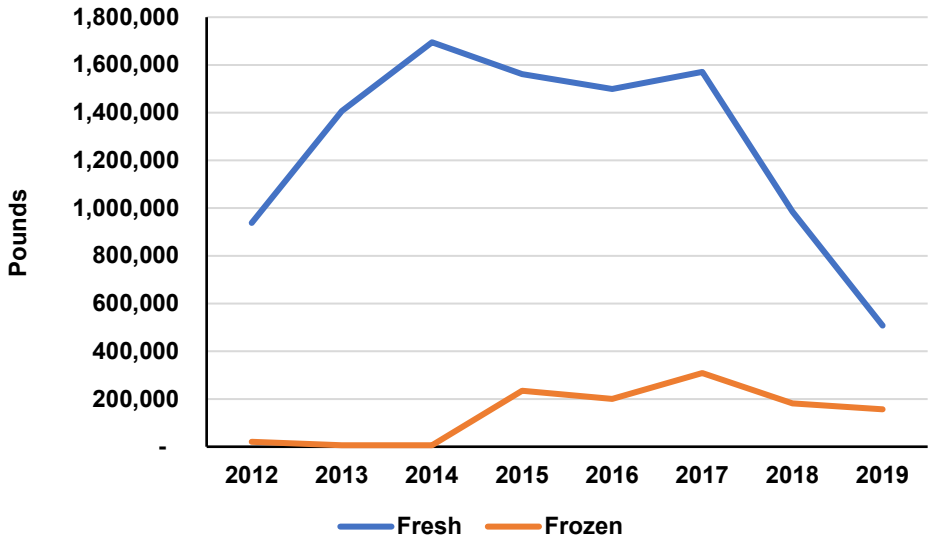

Figure 64. Fresh and frozen imports of imported cobia, 2012 to 2019.

Table 47. Volumes of fresh and frozen imported cobia, 2012 to 2019.

	Fresh		Frozen	
Year	Volume (lb)	Value (USD)	Volume (lb)	Value (USD)
2019	507,682	2,571,736	156,649	516,297
2018	985,053	4,822,543	181,557	578,859
2017	1,570,785	7,864,726	308,744	1,162,936
2016	1,498,956	7,298,134	200,310	357,265
2015	1,561,565	7,370,320	234,697	520,373
2014	1,694,870	7,032,390	6,175	0
2013	1,406,373	4,408,849	6,175	23,656
2012	937,594	2,472,253	20,913	67,740

Commercial Landings

Cobia is a retained, not a targeted species in the Atlantic and Gulf of Mexico (Seafood Watch: Cobia US. 2014). Distribution is global. There are two stocks in the Atlantic, the other in the Gulf. It is neither overfished or undergoing overfishing. Overall catch 29.5 million pounds worldwide, with 188,528 pounds in the US Atlantic and 8.2 million pounds in the Gulf of Mexico (FAO 2021a).

Commercial landings of cobia peaked in 1996 and have generally declined since then (Figure 65; Table 48). By 2019, landings had declined by 68% of their commercial peak in 1996. The top three states for commercial landings of Cobia in 2019 were: Florida (43%), Virginia (28%), and North Carolina (16%) (Table 49), with additional landings reported in Alabama, Louisiana, New Jersey, New York, Rhode Island, South Carolina, and Texas.

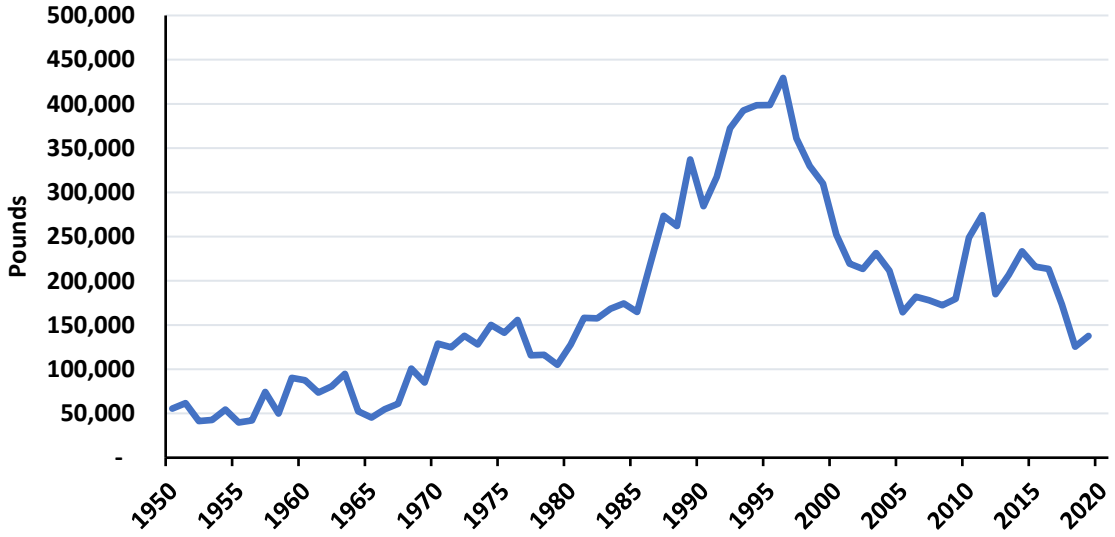

Figure 65. Total commercial U.S. cobia landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 48. Total commercial U.S. cobia landings (1950-2019).

	Commercial landings		Commercial landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	137,652	489,974	1984	174,354	117,612
2018	125,485	430,255	1983	168,480	102,415
2017	173,276	609,208	1982	157,545	81,514
2016	213,421	701,031	1981	158,078	76,552
2015	216,019	656,368	1980	127,792	48,988
2014	233,351	716,021	1979	105,150	32,903
2013	206,735	639,265	1978	116,228	36,419
2012	184,853	528,244	1977	115,800	28,699
2011	274,141	822,970	1976	155,700	32,039
2010	248,748	689,460	1975	141,200	22,905
2009	179,535	446,222	1974	150,100	17,087
2008	172,415	419,934	1973	128,000	13,820
2007	177,924	437,934	1972	137,900	12,494
2006	182,012	387,468	1971	124,800	10,789
2005	164,418	352,572	1970	128,900	11,308
2004	211,463	457,490	1969	85,000	7,006
2003	231,385	490,831	1968	100,700	8,472
2002	213,355	428,999	1967	60,900	4,384
2001	219,370	429,897	1966	54,700	3,128
2000	252,372	480,416	1965	45,400	3,097

1999	309,785	602,944	1964	52,500	3,357
1998	329,841	616,780	1963	94,700	6,850
1997	361,147	634,598	1962	80,600	4,734
1996	429,378	754,258	1961	73,600	5,449
1995	398,609	673,409	1960	87,500	7,960
1994	398,594	626,166	1959	90,200	9,037
1993	392,481	593,784	1958	49,900	3,706
1992	372,543	542,460	1957	74,400	8,206
1991	317,412	429,902	1956	42,100	4,709
1990	284,352	367,423	1955	39,800	3,656
1989	337,091	393,582	1954	54,500	6,673
1988	261,833	286,532	1953	42,600	3,667
1987	273,499	268,622	1952	41,400	3,884
1986	219,428	188,386	1951	61,600	5,551
1985	164,721	134,385	1950	55,500	4,417

Source: NOAA Landings Database (NOAA 2021b).

Table 49. Top states for commercial cobia landings, 2019.

Rank	State	Volume (lb)
1.	Florida	58,749
2.	Virginia	38,711
3.	North Carolina	21,553
4.	Louisiana	8,924
5.	Texas	2,796

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Up until 2017, cobia was managed in the Gulf of Mexico by NOAA Fisheries and the GOMFMC and by the ASMFC in the Atlantic. In 2019, management transitioned to the ASMFC under Amendment 1 to the Interstate Fishery Management Plan for Atlantic Migratory Group Cobia (Table 50) (ASMFC 2019a). Under this plan, 92% of the annual cobia harvest is allocated to recreational harvest and 8% is allocated to the commercial. The Atlantic commercial fishery has a coastwide commercial quota of 73,116 pounds annually. In the Gulf, there is a combined recreational and commercial quota of 1,500,000 pounds.

Table 50. Commercial fisheries regulations for cobia.

State	Minimum size	Daily bag limit	Open season	Managing agency
GA, SC, NC, VA	40” (36” FL)	1 pp; 6/vessel; Rec quota: 50,000 lb	Year-round	ASMFC

Source: ASMFC (2019a).

Recreational Landings

Cobia are targeted by recreational anglers. Commercial landings are only 13% of the recreational take. Data on recreational landings of cobia were available only from 1985 on. Recreational landings of cobia have remained relatively stable from the late 1990s through 2019 (Figure 66; Table 51). The top three states for recreational landings of cobia in 2019 were: Virginia (41%), Florida (36%), and Alabama (11%) (Table 52). Additional recreational landings were reported in Georgia, Louisiana, Mississippi, North Carolina, and South Carolina.

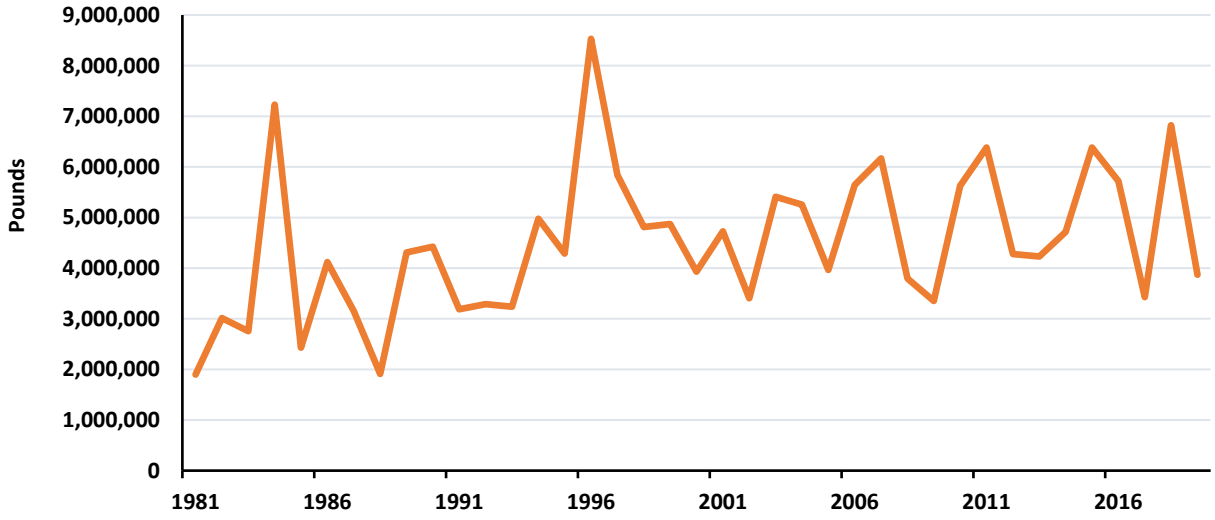

Figure 66. Total recreational U.S cobia landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 51. Total recreational U.S. cobia landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	3,869,261	1999	4,871,745
2018	6,821,876	1998	4,812,465
2017	3,426,873	1997	5,839,910
2016	5,720,526	1996	8,529,978
2015	6,382,454	1995	4,286,404
2014	4,715,369	1994	4,976,327
2013	4,229,575	1993	3,236,445
2012	4,277,647	1992	3,287,883
2011	6,384,189	1991	3,186,559
2010	5,627,440	1990	4,423,328

2009	3,350,231	1989	4,308,533
2008	3,795,160	1988	1,911,866
2007	6,167,861	1987	3,151,523
2006	5,642,180	1986	4,121,247
2005	3,965,905	1985	2,428,000
2004	5,252,909	1984	7,230,059
2003	5,408,202	1983	2,755,035
2002	3,405,924	1982	3,014,576
2001	4,727,579	1981	1,897,741
2000	3,930,855		

Source: NOAA Landings Database (NOAA 2021b).

Table 52. Top states for recreational cobia landings, 2019.

Rank	State	Volume (lb)
1.	Virginia	1,573,502
2.	Florida	1,381,945
3.	Alabama	409,875
4.	North Carolina	254,965
5.	Louisiana	134,663

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Up until 2017, cobia was managed in the Gulf of Mexico by NOAA Fisheries and the GOMFMC and by the ASMFC in the Atlantic. In 2019, management transitioned to the ASMFC under Amendment 1 to the Interstate Fishery Management Plan for Atlantic Migratory Group Cobia (ASMFC 2019a). Under this plan, 92% of the annual cobia harvest is allocated to recreational harvest and 8% is allocated to the commercial. A coastwide recreational harvest target for 2021-2023 was set for Atlantic states at 76,908 fish total. Statewide targets were set at 7,229 fish for Georgia, 9,306 fish for South Carolina, 29,302 fish for North Carolina, 30,302 fish for Virginia, and 769 fish elsewhere. In the Gulf, there is a combined recreational and commercial quota of 1,500,000 pounds. Several states also have specific regulations regarding recreational Cobia fishing in state waters (Table 53).

Table 53. State recreational fisheries regulations for cobia.

State	Minimum size	Daily bag limit	Open season	Managing agency
GA	36” FL	1pp, 6 per boat	Mar 1- Oct 31	GADNR
VA	40”	1pp, 3 per boat	June 1 – Sep 30	VMRC
MD	40”	1pp; 2/vessel	June 15 – Sep 15	MDNR
DE	40”	1pp; 3/vessel	June 1 – Sep 15	DDNREC

NC	36” FL	1 pp; 6/vessel	May 1 – Dec 31	NCDEQ
SC	36” FL	1pp, 3/vessel south of Jeremy Inlet; 6/vessel to north	Jan 1 – Dec 31, closed May 1 - 31 south of Jeremy Inlet	SCDNR
FL (Atlantic)	33”	1pp or 6/vessel		FWC
FL (gulf)	33”	1pp or 2/vessel	Year round	FWC
AL, LA, MS, TX	36” FL	2pp	Year round	State agencies

Source: ASMFC (2019a); DDNREC (2021); FWC (2021c); GADNR (2021); MDNR (2021); NCDEQ (2021b); SCDNR (2021); VMRC (2021).

Total Supply

The total supply of cobia is comprised of its commercial landings and imports (Figure 67). Recordings of imports began in 2012 and have since made up the majority of its supply. In 2019, the total commercial supply of cobia was 801,984 pounds.

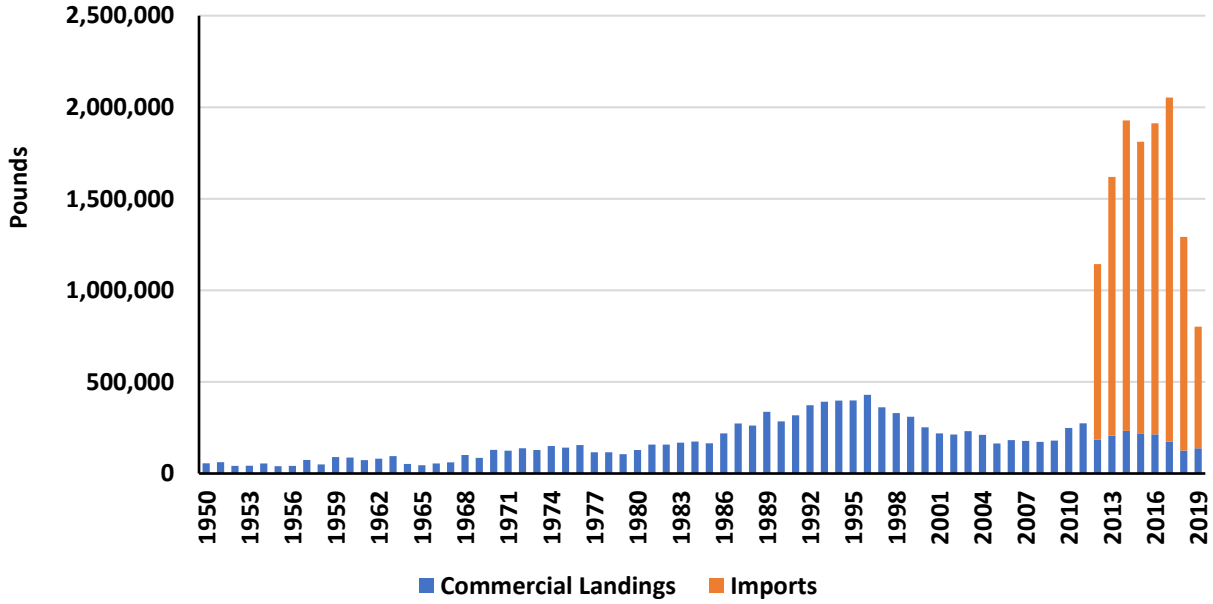

Figure 67. Total commercial supply of cobia, 1950-2019. Sources: NOAA Foreign Trade Database (NOAA 2021a); NOAA Landings Database (NOAA 2021b).

Appendix H. Florida Pompano (*Trachinotus carolinus*)

Florida pompano is a marine finfish in the jack family. It has a wide distribution and can be found from Massachusetts to Brazil, but is common near Florida and the Gulf of Mexico. Prized by both commercial and recreational fishermen (Weirich et al. 2021), Florida pompano commands a high price per pound (Seafood Watch: Wild Pompano 2014). Landings exhibit an overall declining trend (Seafood Watch: Wild Pompano 2014). Recreational harvest is regulated in several Gulf states, while commercial harvest is regulated only in Florida.

Aquaculture

Research on aquaculture of pompano date back to the 1950s (Weirich et al. 2021). Total global production of "pompano" (this FAO category includes species other than Florida pompano), was just over 370 million pounds in 2019 (Figure 68; Table 54) (FAO 2021a). Pompano have been raised mostly in RAS, but have also been raised in net pens and cages. At one point, up to 1.7 million pounds of Florida pompano were raised in the Bahamas, the Dominican Republic, and in Panama. Production in the Bahamas ceased in 2017, following damage from hurricanes. Pompano raised in net pens from Panama continue to be imported into the U.S. Florida pompano have been shown to grow to 1.5 pounds in 275 days. In the U.S., there is a RAS, a pond-based operation, and a breeding/juvenile production facility in Florida. Global farmed production of Florida pompano was 1.4 million pounds in 2019, primarily in Panama (FAO 2021a).

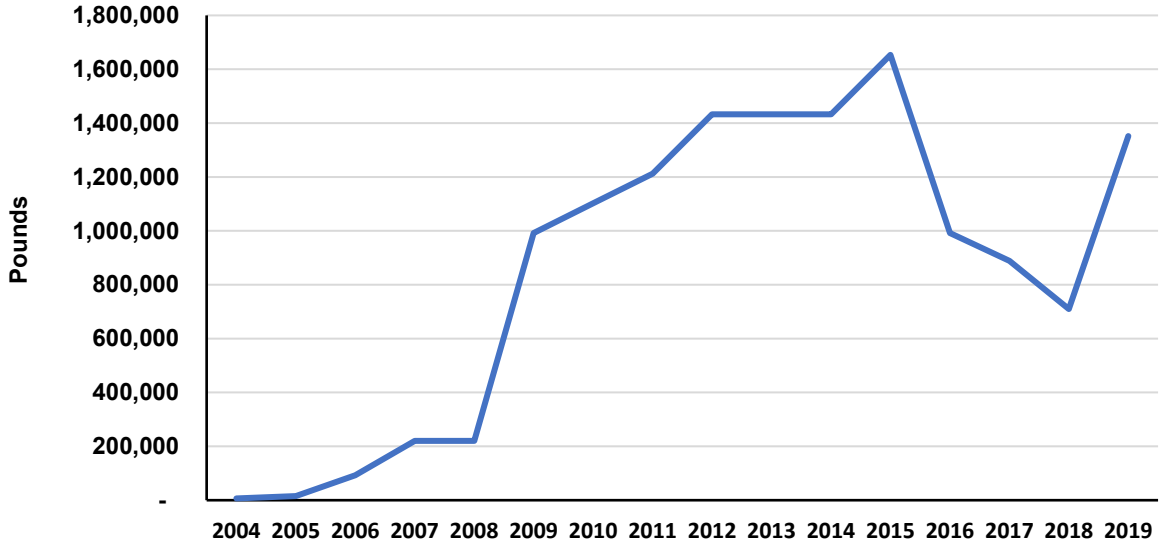

Figure 68. Global farmed production of pompano, 2004 to 2019.

Table 54. Global farmed production of Florida pompano, 2004 to 2019.

Year	Quantity (lb)

2019	1,351,873
2018	709,888
2017	888,462
2016	992,079
2015	1,653,465
2014	1,433,003
2013	1,433,003
2012	1,433,003
2011	1,212,541
2010	1,102,310
2009	992,079
2008	220,462
2007	220,462
2006	92,594
2005	15,432
2004	6,614

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of Florida pompano.

Import/Export of Florida Pompano

Florida pompano is imported to the U.S. from Mexico, Brazil, and the Dominican Republic, but wild-caught and farmed imports are not differentiated (Weirich et al. 2021). Other pompanos (Trachinotus spp.) are imported from China, Thailand, Vietnam, and Australia, with prices ranging from $3.17 to $8.16/lb (average of $4.99/lb) and wholesale fillets selling for $9.52/lb (range of $6.35 to $14.06/lb) (NOAA 2021a).

Commercial Landings

The commercial harvest of Florida pompano is small and unpredictable. Commercial landings have generally declined from their peak in 1968 of 1.7 million lb to 405,720 lb in 2019 (Figure 69; Table 55). The top three major states for commercial landings of Florida pompano in 2019 were: Florida (76%), North Carolina (6%), and Louisiana (2%) (Table 56). Additional commercial landings were reported in Alabama, Texas, and Virginia.

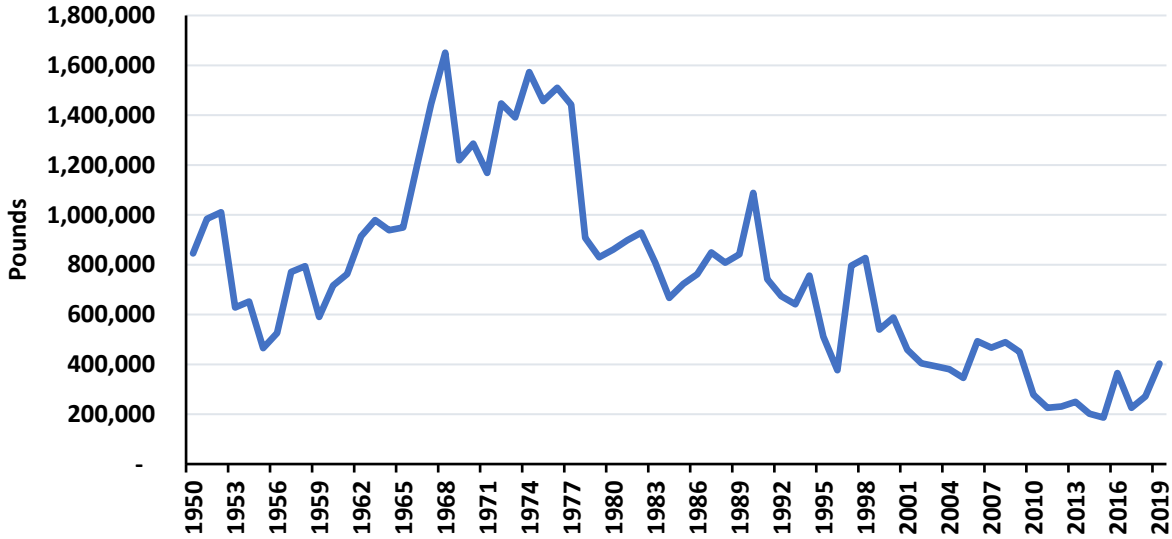

Figure 69. Total commercial U.S. Florida pompano landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 55. Total commercial U.S. Florida pompano landings (1950-2019).

	Commercial landings		Commercial landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	403,019	1,963,291	**1984**	666,792	1,967,611
2018	271,096	1,333,261	**1983**	807,375	2,227,286
2017	225,470	1,115,771	**1982**	928,757	2,251,325
2016	365,351	1,551,482	**1981**	897,967	2,266,236
2015	186,582	837,332	**1980**	860,881	2,243,066
2014	202,030	924,859	**1979**	830,111	2,056,878
2013	249,756	1,004,485	**1978**	907,351	1,810,305
2012	230,678	936,601	**1977**	1,442,700	2,135,859
2011	225,919	914,519	**1976**	1,509,500	1,972,103
2010	278,132	1,077,351	**1975**	1,456,300	1,584,614
2009	450,205	1,408,877	**1974**	1,572,700	1,883,463
2008	489,252	1,595,260	**1973**	1,391,000	1,555,990
2007	467,114	1,572,354	**1972**	1,447,200	1,706,939
2006	493,125	1,723,029	**1971**	1,168,300	1,275,942
2005	345,963	1,327,014	**1970**	1,285,800	1,344,794
2004	380,226	1,430,382	**1969**	1,219,200	1,007,647
2003	392,655	1,348,650	**1968**	1,650,600	995,963
2002	404,459	1,363,497	**1967**	1,445,800	850,602
2001	458,917	1,449,939	**1966**	1,200,800	800,728
2000	587,981	1,848,208	**1965**	949,100	580,308

1999	539,811	1,598,901	**1964**	938,700	539,207
1998	826,971	2,178,373	**1963**	978,900	607,436
1997	795,984	2,054,788	**1962**	913,700	665,921
1996	376,890	1,158,531	**1961**	762,400	517,514
1995	511,726	1,679,999	**1960**	716,200	456,326
1994	756,205	2,344,898	**1959**	590,500	322,958
1993	640,849	1,994,458	**1958**	794,100	372,955
1992	674,064	2,018,835	**1957**	771,000	603,546
1991	741,788	2,044,429	**1956**	525,300	466,314
1990	1,087,919	3,041,552	**1955**	465,500	356,667
1989	841,188	2,560,965	**1954**	651,900	422,222
1988	807,991	2,285,146	**1953**	628,200	336,157
1987	849,456	2,534,081	**1952**	1,010,300	586,842
1986	762,054	2,231,181	**1951**	984,000	489,273
1985	722,409	2,300,871	**1950**	845,400	458,962

Source: NOAA Landings Database (NOAA 2021b).

Table 56. Top states for commercial Florida pompano landings, 2019.

Rank	State	Volume (lb)
1.	Florida	364,131
2.	North Carolina	25,285
3.	Louisiana	7,356
4.	Virginia	4,665
5.	Alabama	1,201

Source: NOAA Landings Database (NOAA 2021b).

Florida is the only state with commercial fishing regulations for Florida pompano. A special permit zone was established in which commercial harvest is prohibited (FWC 2021a). Outside the special permit zone, commercial fishers targeting other species are allowed an incidental bycatch trip limit of 100 Florida pompano. Within what has been classified as a pompano endorsement zone, commercial fishermen with a saltwater products license, with a restricted species endorsement, and a pompano endorsement, can harvest an unlimited number of pompanos with gill and entangling nets. Those without the pompano endorsement are subject to a daily harvest and landing limit of 250 pompano.

Recreational Landings

Recreational landings of Florida pompano peaked in 2004 followed by a generally declining trend (Figure 70; Table 57). Recreational landings in 2019 were more than double those in 2018, appearing in Figure 68 as an increasing trend in recent years. The top three major states for recreational landings of Florida Pompano in 2019 were: Florida (76%), North Carolina (18%), and South Carolina (5%) (Table 58). Additional recreational landings were reported in Alabama, Georgia, Louisiana, Mississippi, and Virginia.

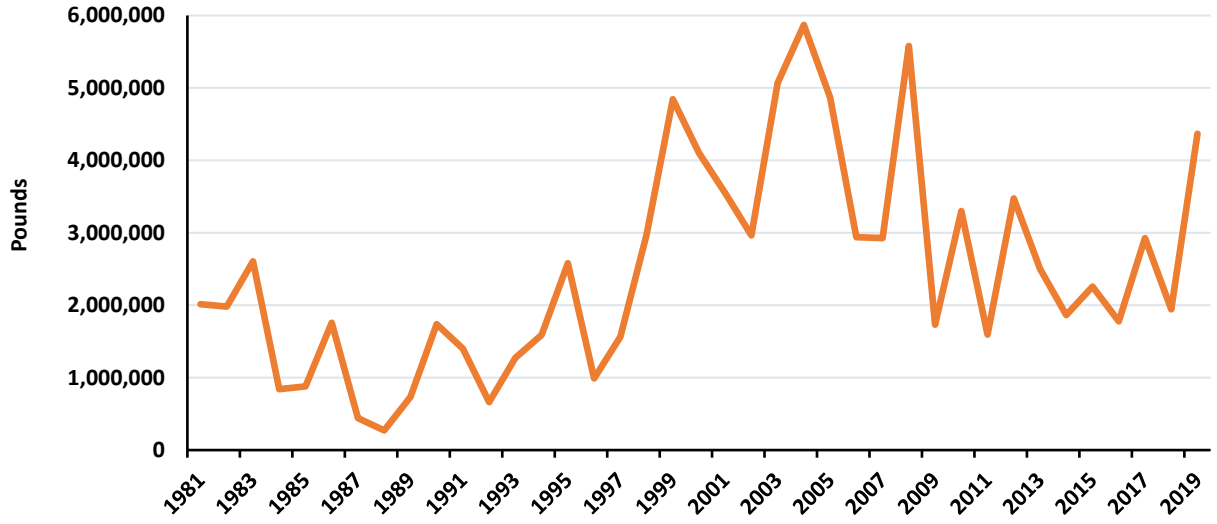

Figure 70. Total recreational U.S Florida pompano landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 57. Total recreational U.S. Florida pompano landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	4,366,380	**1999**	4,844,191
2018	1,942,856	**1998**	2,975,738
2017	2,925,323	**1997**	1,563,168
2016	1,776,904	**1996**	988,062
2015	2,258,136	**1995**	2,579,218
2014	1,863,515	**1994**	1,590,575
2013	2,502,361	**1993**	1,274,187
2012	3,474,170	**1992**	663,065
2011	1,593,579	**1991**	1,400,459
2010	3,300,685	**1990**	1,737,815
2009	1,731,133	**1989**	732,611
2008	5,580,246	**1988**	271,562
2007	2,926,835	**1987**	440,653
2006	2,939,396	**1986**	1,758,826
2005	4,867,577	**1985**	879,539
2004	5,869,608	**1984**	840,778
2003	5,066,695	**1983**	2,606,726
2002	2,964,997	**1982**	1,980,420
2001	3,550,281	**1981**	2,014,346

2000	4,104,041

Source: NOAA Landings Database (NOAA 2021b).

Table 58. Top states for recreational Florida pompano landings, 2019.

Rank	State	Volume (lb)
1.	Florida	3,297,986
2.	North Carolina	769,610
3.	South Carolina	208,714
4.	Alabama	71,465
5.	Georgia	7,853

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Florida pompano is not federally regulated. Some individual states have their own regulations for recreational harvest (Table 59). Other states, such as Texas, do not have any limits or regulations.

Table 59. Florida pompano recreational fishing regulations.

State	Minimum size	Daily bag limit	Open season	Managing agency
FL	11” FL	6pp	Year round	FWC
AL	12”	3pp	Year round	ADCNR
MS	No limit	No limit	Year round	MDMR
LA	12”	3pp	Year round	LDWF

Source: ADCNR (2021); FWC (2021a); LDWF (2021a); MDMR (2021a).

Appendix I. Greater Amberjack (*Seriola dumerili*)

Greater amberjack, also known as amberjack, medregal, and coronado, is a large ray-finned fish in the jack family. It has a wide distribution, ranging from New England, to the Southeast Atlantic and the Gulf of Mexico. It is categorized as overfished in the Gulf of Mexico (Seafood Watch: Greater Amberjack 2017). Although considered to be abundant in the Southeast Atlantic, it is also considered to be subject to overfishing in the South Atlantic (NOAA 2020a). Greater amberjack is federally regulated in the South Atlantic, Gulf of Mexico, and in the Caribbean. Commercial harvest is subject to annual catch limits and limited seasons. Recreational landings are larger in volume than commercial landings with the majority of both landings in Florida.

Aquaculture

Global farmed production of greater amberjack has been reported in FAO data from 1985, at levels that have ranged from several thousand to several hundred thousand pounds a year (Figure 71; Table 60). Greater amberjack are farmed primarily in net pens. The greatest volumes of farmed production of greater amberjack are from China, South Korea, Japan, and Taiwan (FAO 2021c). There is no commercial production of greater amberjack in the U.S., although there is on-going research on farming methods for greater amberjack in the U.S.

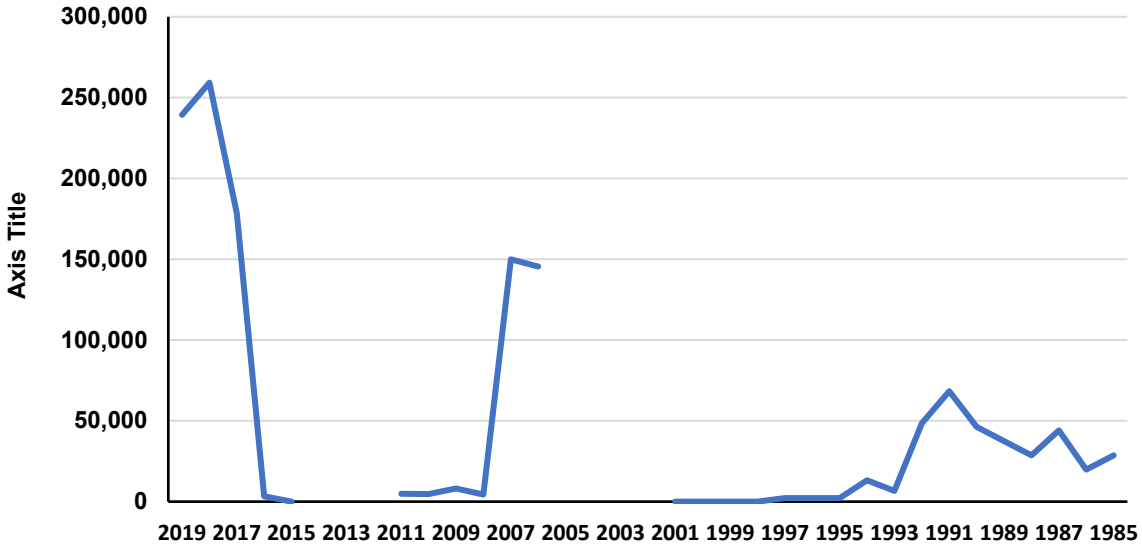

Figure 71. Global farmed production of greater amberjack, 1985-2019. Source: FAO Global Aquaculture Production Database (FAO 2021a).

Table 60. Global farmed production of greater amberjack, 1985-2019.

Year	Volume (lb)	Year	Volume (lb)
2019	239,356	2001	-
2018	259,241	2000	-
2017	178,574	1999	-

2016	3,214	1998	-
2015	-	1997	2,205
2014	-	1996	2,205
2013	-	1995	2,205
2012	-	1994	13,228
2011	4,872	1993	6,614
2010	4,630	1992	48,502
2009	8,179	1991	68,343
2008	4,409	1990	46,297
2007	149,914	1989	37,479
2006	145,505	1988	28,660
2005	-	1987	44,092
2004	-	1986	19,842
2003	-	1985	28,660
2002	-		

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of greater amberjack.

Import/Export of Greater Amberjack

No data were found on imports or exports of greater amberjack.

Commercial Landings

Data on commercial landings of greater amberjack were available only from 1992 on (Figure 72; Table 61). More than two-thirds of the commercial greater amberjack catch is from the Gulf of Mexico, with the rest from the South Atlantic. Commercial landings of 2.7 million pounds in 1992 declined by approximately 70% to 0.8 million pounds in 2019. Although still considered to be abundant in the Southeast Atlantic, greater amberjack are considered to be overfished in the Gulf of Mexico.

The top three states for commercial landings of greater amberjack are: Florida (70%), Alabama (8%), and South Carolina (8%) (Table 62). Additional landings have been reported in Louisiana, North Carolina, and Texas.

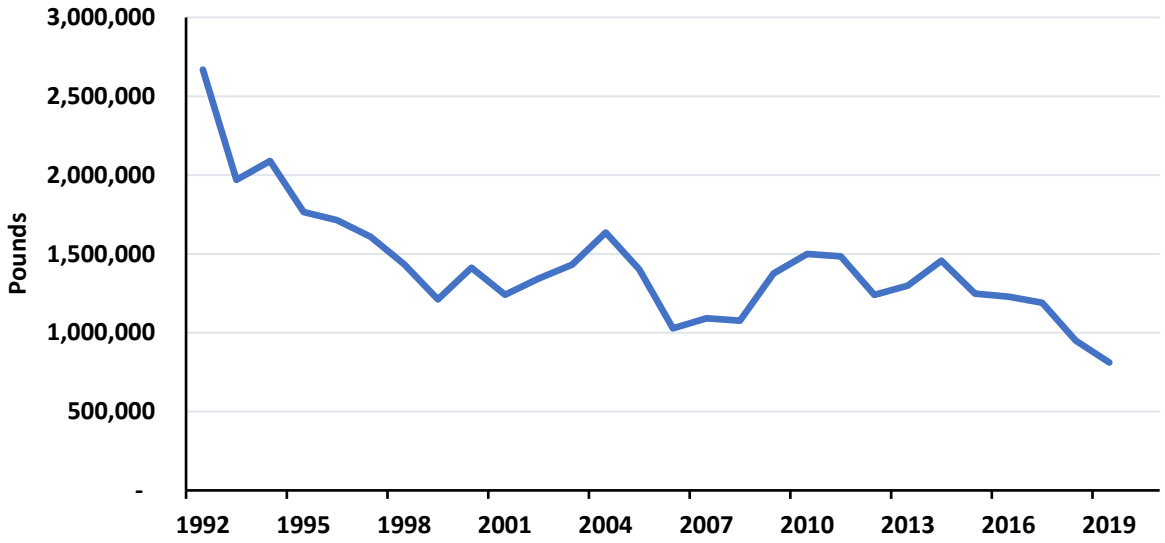

Figure 72. Total commercial U.S greater amberjack landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 61. Total commercial U.S. greater amberjack landings (1981-2019).

Commercial landings					
Year	**Volume (lb)**	**Dollars**	**Year**	**Volume (lb)**	**Dollars**
2019	811,378	1,451,967	**2005**	1,401,138	1,266,636
2018	949,681	1,633,743	**2004**	1,636,137	1,455,084
2017	1,190,275	1,914,877	**2003**	1,432,252	1,273,785
2016	1,228,751	2,004,001	**2002**	1,343,351	1,267,532
2015	1,248,212	1,887,819	**2001**	1,240,814	1,184,929
2014	1,457,743	2,059,944	**2000**	1,412,338	1,472,651
2013	1,298,537	1,703,927	**1999**	1,211,358	1,253,406
2012	1,240,017	1,426,164	**1998**	1,433,604	1,459,194
2011	1,485,036	1,629,121	**1997**	1,608,249	1,603,836
2010	1,499,458	1,510,952	**1996**	1,713,918	1,683,605
2009	1,376,018	1,380,280	**1995**	1,765,599	1,734,223
2008	1,076,655	1,164,866	**1994**	2,089,146	1,904,923
2007	1,092,346	1,156,892	**1993**	1,969,378	1,561,998
2006	1,027,435	1,094,370	**1992**	2,669,161	1,535,994

Source: NOAA Landings Database (NOAA 2021b).

Table 62. Top states for commercial greater amberjack landings, 2019.

Rank	State	Volume (lb)
1.	Florida	570,250

2.	Alabama	66,759
3.	South Carolina	63,447
4.	Louisiana	54,445
5.	North Carolina	45,389

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Greater amberjack is managed by NOAA Fisheries and the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils. In the South Atlantic they are managed under the Snapper-Grouper Fishery Management Plan, which does not have a recreational annual catch limit and divides the commercial annual catch limit into two seasons (SAFMC, 2020). A commercial fishing permit is required in the South Atlantic and Gulf of Mexico.

In the Gulf of Mexico, greater amberjack are managed under the Reef Fish Resources of the Gulf of Mexico Fishery Management Plan, under which the annual catch limit of 1,794,000 lb is divided between the commercial limit (484,380 lb) and the recreational limit (1,309,620 lb) (GOMFMC 1984) (Table 63). When 75% of the annual catch limit is landed in the Gulf, the commercial trip limit is reduced to 250 lb.

In federal waters of the Caribbean, greater amberjack are managed as part of a greater "Jacks Complex" that includes seven jack species, under the Fishery Management Plan for the Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (CFMC 1985). Annual catch limits are developed of the Jacks Complex for all jacks, but not for individual species. Greater amberjack cannot be sold commercially in Puerto Rico.

Table 63. Commercial fisheries regulations for greater amberjack.

State	Annual catch limit	Trip limit	Season	Managing agency
NC, SC, GA, FL (Atlantic)	60% of ACL (461,633 lb)	1200 lb (size: 36")	Mar 1-Aug 31 (No sale in April)	SAFMC
	40% of ACL (307,755 lb)	1000 lb (size: 36")	Sep 1 – End of Feb	
TX, LA, AL, MS, FL (gulf)	484,380 lb	1000 lb*	Jan-Feb; Jun-Dec	GOMFMC
PR	86,059 (all jacks)		Year round	CFMC
VI	68,396 (all jacks)		Year round	

Note: *In the Gulf of Mexico, when 75% of the annual catch limit is landed, the commercial trip limit is reduced to 250 lb. Source: SAFMC (2020); GOMFMC (1984); CFMC (1985).

Recreational Landings

Recreational landings of greater amberjack were substantially greater in the late 1980s than in the 2000's (Figure 73; Table 64), averaging 2.1 million lb/year from 2006 to 2015 (NMFS 2016). The 2019 recreational landings were 12% of those in 1987. The top three states for recreational landings in 2019 were: Florida (81%), Alabama (6%), and Louisiana (4%) (Table 65). Additional landings were reported in Georgia, Mississippi, North Carolina, and South Carolina.

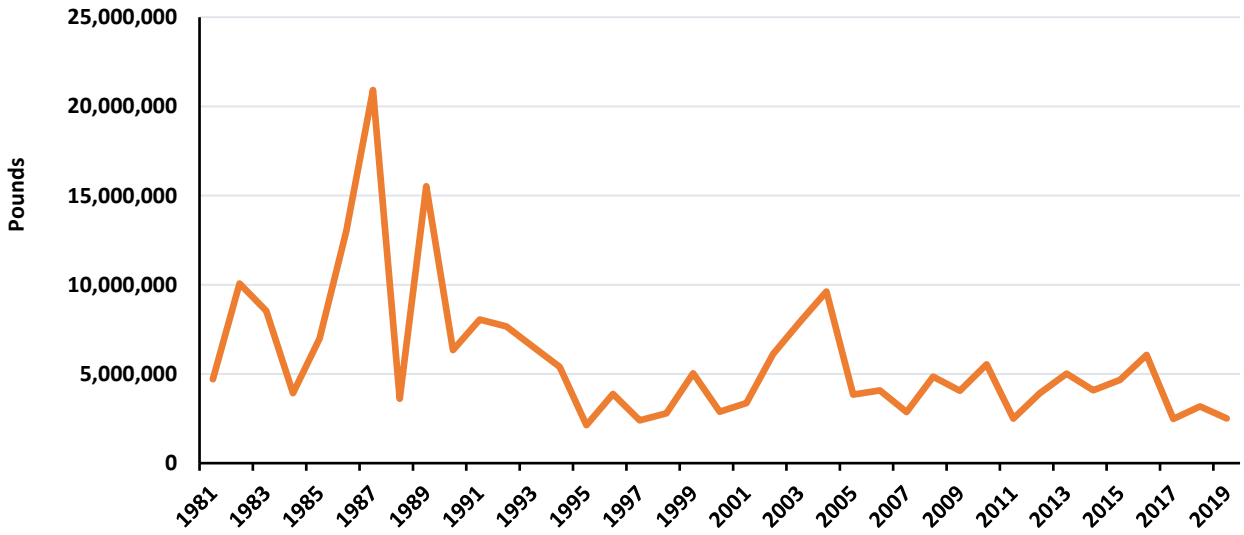

Figure 73. Total recreational U.S. greater amberjack landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 64. Total recreational U.S. greater amberjack landings (1981-2019).

Recreational landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	2,502,950	**1999**	5,033,887
2018	3,184,256	**1998**	2,796,045
2017	2,480,219	**1997**	2,396,530
2016	6,065,857	**1996**	3,878,615
2015	4,667,887	**1995**	2,130,180
2014	4,087,742	**1994**	5,395,982
2013	5,020,772	**1993**	6,528,134
2012	3,928,702	**1992**	7,668,142
2011	2,501,036	**1991**	8,049,000
2010	5,539,869	**1990**	6,341,073
2009	4,060,587	**1989**	15,520,650
2008	4,847,830	**1988**	3,612,121
2007	2,862,170	**1987**	20,920,143
2006	4,078,578	**1986**	13,003,334

2005	3,840,905	**1985**	6,979,297
2004	9,617,893	**1984**	3,926,913
2003	7,913,583	**1983**	8,530,851
2002	6,117,770	**1982**	10,070,403
2001	3,371,499	**1981**	4,706,965
2000	2,887,605		

Source: NOAA Landings Database (NOAA 2021b).

Table 65. Top states for recreational greater amberjack landings, 2019.

Rank	State	Volume (lb)
1.	Florida	1,856,472
2.	Alabama	138,955
3.	Louisiana	82,936
3.	North Carolina	81,770
4.	Georgia	64,091

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Greater amberjack is managed by NOAA Fisheries and the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils. In the South Atlantic they are managed under the Snapper-Grouper Fishery Management Plan, which does not have a recreational annual catch limit and divides the commercial annual catch limit into two seasons (SAFMC 2020) (Table 65).

In the Gulf of Mexico, they are managed under the Reef Fish Resources of the Gulf of Mexico Fishery Management Plan, under which the annual catch limit of 1,794,000 lb is divided between the commercial limit (484,380 lb) and the recreational limit (1,309,620 lb) (GOMFMC 1984) (Table 66). In Gulf state waters of the Gulf of Mexico, the same size and bag limit restrictions apply but the recreational season is open year-round.

In federal waters of the Caribbean, greater amberjack are managed as part of a greater "Jacks Complex" including seven jack species, under the Fishery Management Plan for the Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (CFMC 1985) (Table 66). Annual catch limits for the Jacks Complex are developed for all jacks, but not for individual species.

Table 66. Recreational fisheries regulations for greater amberjack.

State	Minimum size	Daily bag limit	Open season	Managing agency
NC, SC, GA, FL (Atlantic)	28" FL	1pp	Mar 1 – Feb 28	SAFMC
TX, LA, AL, MS, FL (gulf)	34" FL	1pp	Aug 1 – Oct 31; May 1-31	GOMFMC

PR	34” FL	1pp	Year-round	CFMC
VI	34” FL	1pp	Year-round	

Source: CFMC (1985); GOMFMC (1984); SAFMC (2020).

Appendix J. Olive Flounder (*Paralichthys olivaceus*)

Olive flounder, also known as bastard halibut or Japanese halibut, is a species of large-tooth flounder native to the northwest Pacific, not to U.S. waters. It is one of the most important commercial farm-raised marine species in eastern Asia, particularly in South Korea. Olive flounder globally is a major aquaculture species that is raised primarily in South Korea. It is native to the northwest Pacific, not to U.S. waters.

Aquaculture

Olive flounder is one of the most important commercial farm-raised marine species in eastern Asia (Stieglitz 2021). Global farmed production increased from 1.4 million pounds in 1983 to nearly 100 million pounds in 2019 (FAO 2021a) (Figure 74; Table 67). The top countries for production of olive flounder include South Korea, Japan, Argentina, and Uruguay (Bai and Okorie 2007). In Asia, olive flounder are raised primarily in large, indoor flow-through concrete vats. High production density can result in efficient growout in RAS to market size, reaching 2.2 lb in 1 yr. There is no commercial production of olive flounder in the U.S.

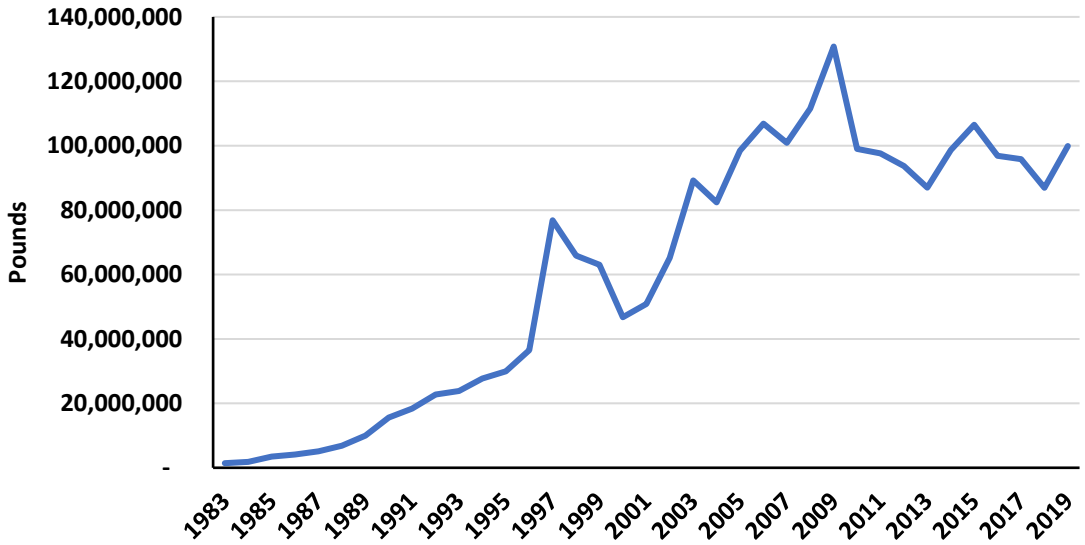

Figure 74. Global farmed production of olive flounder, 1983-2019. Source: FAO Global Aquaculture Production Database (FAO 2021a).

Table 67. Global farmed production of olive flounder, 1983-2019.

Year	Quantity (lb)	Year	Quantity (lb)
2019	99,913,378	**2000**	46,742,353
2018	86,941,394	**1999**	63,014,653
2017	95,806,171	**1998**	65,878,455
2016	96,846,752	**1997**	76,846,439
2015	106,491,964	**1996**	36,493,075
2014	98,634,699	**1995**	29,934,330
2013	86,961,236	**1994**	27,694,436
2012	93,687,532	**1993**	23,818,714
2011	97,620,574	**1992**	22,767,111
2010	99,009,484	**1991**	18,364,485
2009	130,910,336	**1990**	15,599,891
2008	111,668,412	**1989**	9,991,338
2007	100,995,847	**1988**	6,862,982
2006	106,846,908	**1987**	5,101,491
2005	98,471,557	**1986**	4,111,616
2004	82,413,105	**1985**	3,465,663
2003	89,227,585	**1984**	1,847,472
2002	65,188,409	**1983**	1,428,594
2001	50,847,356		

Source: FAO Global Aquaculture Production database (FAO 2021a).

Aquaculture Regulations

Farming of olive flounder would likely be subjected to state regulations related to non-native species in addition to general fish farming federal, state, and local regulations.

Import/Export of Olive Flounder

No data were found on imports/exports of olive flounder in the U.S. The NOAA Foreign Trade Database utilizes a single category titled “Flatfish Flounder,” which does not specify individual species of flounder. The generic data on “flounder” imports is included in Appendix U and shows that large volumes of “flounder” are imported into the U.S., especially in frozen form.

Nevertheless, there are anecdotal reports of sales of live olive flounder into the U.S. despite the lack of systematic data specifically on olive flounder imports.

Commercial Landings

There are no commercial landings of olive flounder in the U.S.

Commercial Fisheries Regulations

There is no commercial fishery for olive flounder that is not native to U.S. waters.

Recreational Landings

Given that olive flounder is not native to U.S. waters, there is no recreational fishery for it in the U.S.

Appendix K. Red Drum (*Sciaenops ocellatus*)

Red drum, also known as redfish, channel bass, puppy drum, or spottail bass, is a gamefish in the drum family. Red drum can be found in the Atlantic Ocean from Massachusetts to Florida and in the Gulf of Mexico. Commercial harvest is prohibited in federal waters. Recreational harvests are regulated by individual states, with seasons typically open year-round.

Aquaculture

Aquaculture production of red drum began in the 1970s with the goal of enhancing wild stocks and supplementing the declining supply (Seafood Watch: Red Drum 2016). Red drum farming has become a global aquaculture industry with total global farmed production of 170 million pounds in 2019 (FAO 2021a). Red drum are raised primarily in earthen ponds, although there is at least one large net pen operation in Mauritius that raises and exports red drum.

In the U.S., there were two red drum farms in 2005 (USDA-NASS 2006) (Table 68). By 2018, the number of red drum farms had increased to 12 farms, with reported production of 7.2 million pounds and a value of $7.2 million pounds (USDA-NASS 2019). Next to salmon, red drum is the second largest marine finfish sector of aquaculture in the U.S.

Table 68. Aquaculture production of red drum, 2005-2018 Census of Aquaculture.

Year	Number of Farms	Live Weight	Sales
2018	12	7,153,000 lb	$ 19,448,000
2013	7	3,312,000 lb	$ 10,161,000
2005	2	Withheld to avoid disclosing data for individual firms	Withheld to avoid disclosing data for individual firms

Global farmed production of red drum has increased from 2,205 pounds in 1987 to 169.8 million pounds in 2019 (FAO 2021a) (Figure 75; Table 69). The top countries for farmed red drum production in 2019 were China, followed by the U.S., Mauritius, Israel, Martinique, and Guadalupe (FAO 2021a).

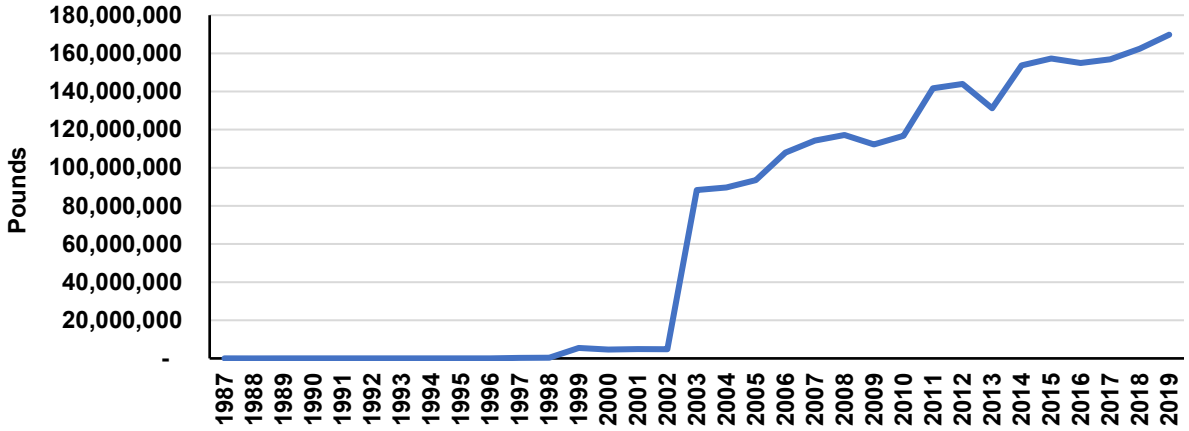

Figure 75. Global farmed production of red drum, 1987-2019. Source: FAO Global Aquaculture Production Database (FAO 2021a).

Table 69. Global farmed production of red drum, 1987-2019.

Year	Volume (lb)	Year	Volume (lb)
2019	169,774,656	2002	4,836,936
2018	162,429,435	2001	4,920,712
2017	156,856,134	2000	4,662,771
2016	154,926,581	1999	5,518,164
2015	157,259,006	1998	326,284
2014	153,662,014	1997	255,736
2013	131,197,421	1996	22,046
2012	143,957,277	1995	15,432
2011	141,677,700	1994	26,455
2010	116,770,785	1993	22,046
2009	112,224,197	1992	33,069
2008	117,145,791	1991	22,046
2007	114,242,086	1990	11,023
2006	107,948,777	1989	13,228
2005	93,481,840	1988	-
2004	89,615,598	1987	2,205
2003	88,301,645		

Source: FAO Global Aquaculture Production database (FAO 2021a).

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which has constrained sales of farmed red drum.

Import/export of red drum

No data were found on imports/exports of red drum.

Commercial Landings

Commercial landings of red drum peaked in 1986 at 14.4 million pounds, followed by a substantial decline (Figure 76; Table 70). Commercial landings of red drum in 2019 were 92% lower (120,572 pounds) than those of the peak in 1986. The top three states for commercial landings of red drum in 2019 were: Mississippi (51%), North Carolina (47%), and Virginia (2%) (Table 71). No commercial landings were reported in other states.

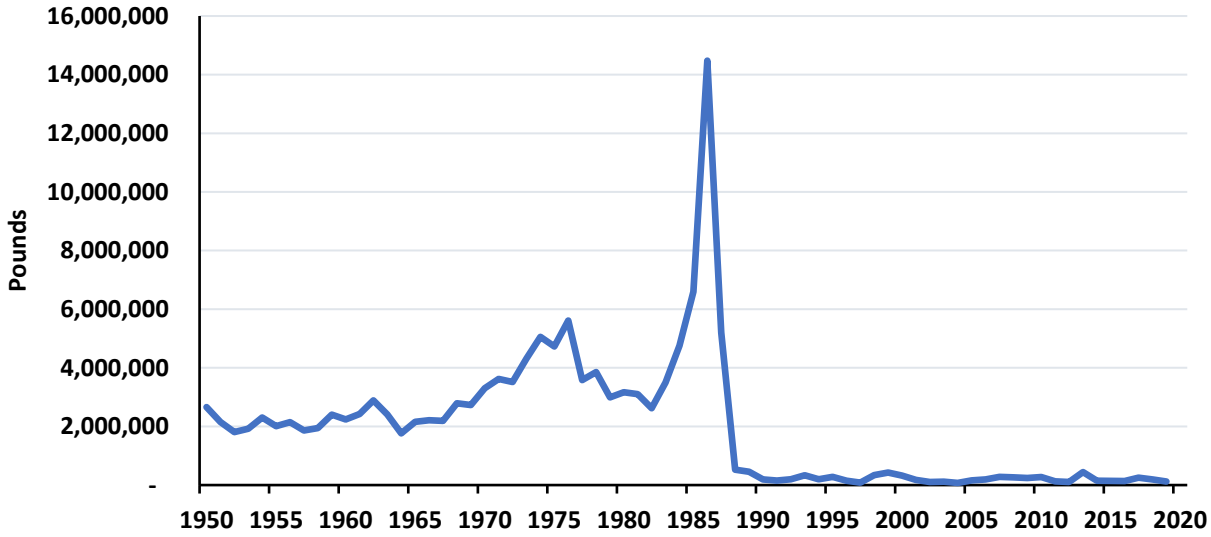

Figure 76. Total commercial U.S. red drum landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 70. Total commercial U.S. red drum landings (1950-2019).

	Commercial landings			Commercial landings	
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	120,572	327,048	1984	4,756,609	3,014,182
2018	193,178	503,963	1983	3,497,266	2,122,714
2017	250,568	652,128	1982	2,621,086	1,649,607
2016	140,242	357,595	1981	3,100,189	2,042,166
2015	142,682	350,781	1980	3,169,244	1,960,449
2014	148,920	331,370	1979	2,994,673	1,592,608
2013	441,602	839,327	1978	3,856,864	1,688,896

2012	104,517	214,250	1977	3,581,500	1,331,360
2011	124,739	234,193	1976	5,611,220	1,809,141
2010	272,260	493,479	1975	4,726,700	1,384,129
2009	241,740	395,140	1974	5,057,500	1,254,974
2008	262,958	404,424	1973	4,320,900	1,050,243
2007	280,102	399,628	1972	3,514,700	769,887
2006	193,542	264,975	1971	3,618,700	774,117
2005	159,693	212,794	1970	3,305,400	630,350
2004	73,373	95,542	1969	2,729,900	484,817
2003	116,717	139,103	1968	2,789,100	484,457
2002	107,150	122,398	1967	2,189,600	416,272
2001	177,745	212,758	1966	2,211,200	436,359
2000	323,357	366,419	1965	2,154,900	377,001
1999	427,676	477,086	1964	1,763,800	295,408
1998	338,042	351,438	1963	2,406,700	390,605
1997	81,692	91,888	1962	2,885,900	449,490
1996	150,041	157,694	1961	2,426,300	370,876
1995	278,554	259,061	1960	2,240,300	335,171
1994	197,830	165,333	1959	2,402,300	375,642
1993	334,978	317,810	1958	1,944,800	330,194
1992	195,901	178,725	1957	1,860,200	293,853
1991	152,129	102,225	1956	2,146,400	389,135
1990	192,655	118,234	1955	2,010,700	340,605
1989	454,130	406,591	1954	2,303,000	400,180
1988	527,778	524,583	1953	1,919,700	312,495
1987	5,205,180	5,684,015	1952	1,808,400	340,206
1986	14,476,777	9,538,556	1951	2,153,300	333,882
1985	6,592,491	4,144,212	1950	2,659,700	423,329

Source: NOAA Landings Database (NOAA 2021b).

Table 71. Top states for commercial red drum landings, 2019.

Rank	State	Volume (lb)
1.	Mississippi	61,563
2.	North Carolina	56,393
3.	Virginia	2,616

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

A harvest moratorium via Presidential Executive Order in 2007 prevents any recreational or commercial harvest of red drum in federal waters. In state waters, Mississippi, North Carolina, and Virginia allow for commercial harvest of red drum in state waters, with individual regulations. Mississippi allows a total allowable catch of 60,000 pounds divided equally into three seasons (January 1 to April 30; May 1 to August 31; September 1 to December 31).

Recreational Landings

Red drum is a popular sport and foodfish, especially in the Gulf of Mexico in the U.S. Recreational landings of red drum peaked in 2013 at 42.7 million pounds, following more than a decade of relatively stable landings (Figure 77; Table 72). In 2019, recreational landings were 71% lower (at 12.4 million pounds) than those of the 2013 peak landings. The major states for recreational landings in 2019 were: Louisiana (29%), Florida (17%), Mississippi (21%), Alabama (10%), and South Carolina (5%) (Table 73) with additional landings in Georgia, Maryland, New Jersey, North Carolina, and Virginia.

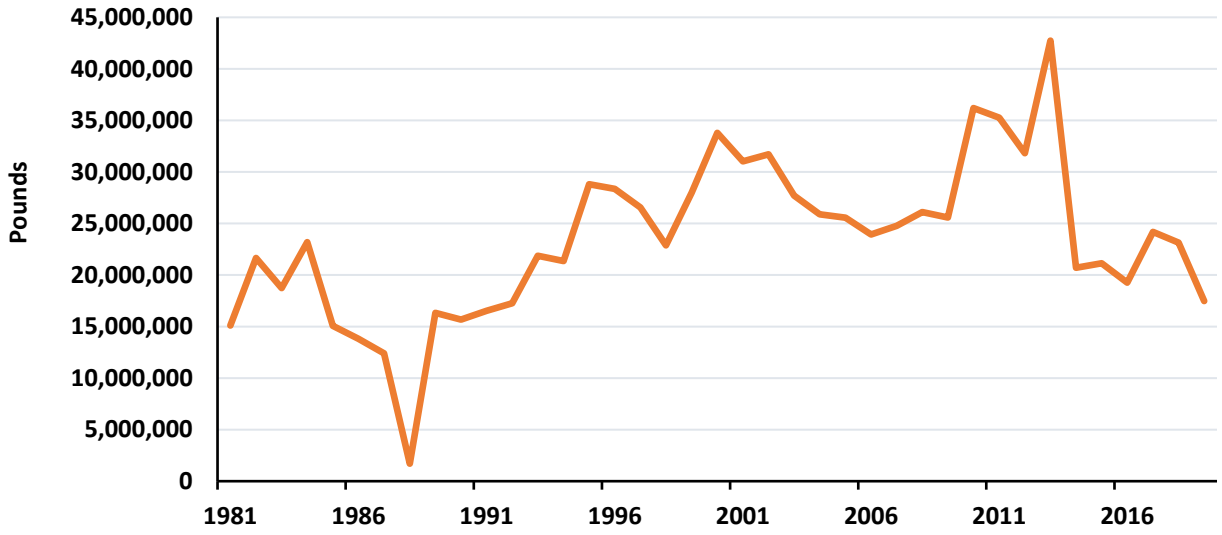

Figure 77. Total recreational U.S. red drum landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 72. Total recreational U.S. red drum landings (1981-2019).

Recreational landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	17,469,384	1999	27,993,716
2018	23,136,121	1998	22,873,080
2017	24,187,768	1997	26,552,387
2016	19,268,104	1996	28,362,925
2015	21,147,291	1995	28,803,455

2014	20,711,536	1994	21,361,062
2013	42,738,157	1993	21,863,396
2012	31,812,321	1992	17,258,828
2011	35,269,801	1991	16,527,869
2010	36,199,242	1990	15,683,873
2009	25,573,813	1989	16,324,406
2008	26,103,655	1988	1,699,470
2007	24,768,112	1987	12,408,511
2006	23,933,015	1986	13,811,811
2005	25,557,869	1985	15,070,527
2004	25,885,968	1984	23,192,690
2003	27,713,415	1983	18,738,778
2002	31,704,365	1982	21,650,190
2001	31,021,868	1981	15,095,515
2000	33,795,256		

Source: NOAA Landings Database (NOAA 2021b).

Table 73. Top states for recreational red drum landings, 2019.

Rank	State	Volume (lb)
1.	Louisiana	5,049,817
2.	Florida	4,646,224
3.	Mississippi	3,583,324
4.	Alabama	1,784,192
5.	South Carolina	862,134

Source: NOAA Landings Database (NOAA 2021b)

Recreational Fisheries Regulations

The harvest moratorium via Presidential Executive Order in 2007 also prevented any recreational harvest of red drum in federal waters. The ASMFC manages red drum through Amendment 2 of the Interstate FMP requiring states to implement recreational creel and size limits, including a maximum size limit of 27 inches (ASMFC 2002). Table 74 details specific regulations for recreational red drum fishing in state waters. The state of Florida mandated a catch-and-release only regulation in 2020 for parts of the Gulf Coast. Following a prolonged red tide from 2017 to 2019, the catch-and-release regulation was extended it to 2021 to aid in recovery of the species (FWC 2021b).

Table 74. Red drum recreational fishing regulations.

State	Minimum size	Daily bag limit	Open season	Managing agency
GA	14”-23”	5 pp	Year-round	GADNR
AL	16”-26”	3 pp	Year-round	ADCNR
VA	18”	3pp	Year-round	VMRC

FL (Flagler – Nassau counties)	18-27”	2pp; 8/vessel	Year-round	FWC
FL (Gulf & Atlantic south Nassau county)	18-27”	1 pp; 8/vessel	Year-round	
SC	15-23”	2 pp; 6/vessel	Year-round	SCDNR
NC, MD, NJ	18-27”	1 pp	Year-round	State agencies
DE	20-27”	5 pp	Year-round	DDNREC
NY	27” max.	No limit < 27”; 0 > 27”	Year-round	NYS DEC
CT	27” max	1pp	Year-round	CT DEEP

Source: ADCNR (2021); ASMFC (2002); CT DEEP (2021); FWC (2021b); GADNR (2021); SCDNR; VMRC (2021).

Appendix L. Red Snapper (*Lutjanus campechanus*)

Red snapper is commonly found off the coast of the Southeast US in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. The South Atlantic Stock is overfished and subject to overfishing, but the Gulf of Mexico stock is not (NOAA, 2020a). Both stocks are rebuilding and have fishery management plans to regulate recreational and commercial harvests. Individual states have further restrictions to limit recreational harvests in state waters.

Aquaculture

Global aquaculture statistics do not separate out individual snapper species, but rather report production volumes for "snapper" as a group (FAO 2021a). The total world farmed production of fish labeled as "snapper" was 19.7 million pounds in 2019, from 235,894 pounds in 1987 (FAO 2021a).

Red snapper have been raised in research studies in flow-through systems, RAS, and in-pond raceways (Miranda et al. 2021). Fish were reported to reach a pound in about nine months from hatching. Beaver Street Fisheries, a seafood distributor, has reported raising red snapper to market size in a little more than a year in flow-through tanks in the Bahamas.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of farmed red snapper.

Import/export of red snapper

No import or export data specific to red snapper were found. The NOAA Foreign Trade Database utilizes a single category entitled "Snapper (Lutjanidae spp)," which includes all species in the *Lutjanidae* family. Import information for the snapper category is available in Appendix U.

Commercial Landings

Commercial landings of red snapper reached a peak of 14 million pounds in 1967, followed by a decline through the early 1990s to a relatively stable level (Figure 78; Table 75). The data appear to show an increasing trend of landings through 2019. The top three states in terms of commercial landings of red snapper in 2019 were: Florida (39%), Texas (34%), and Louisiana (18%) (Table 76). Additional commercial landings were recorded in Alabama, Mississippi, North Carolina, and South Carolina.

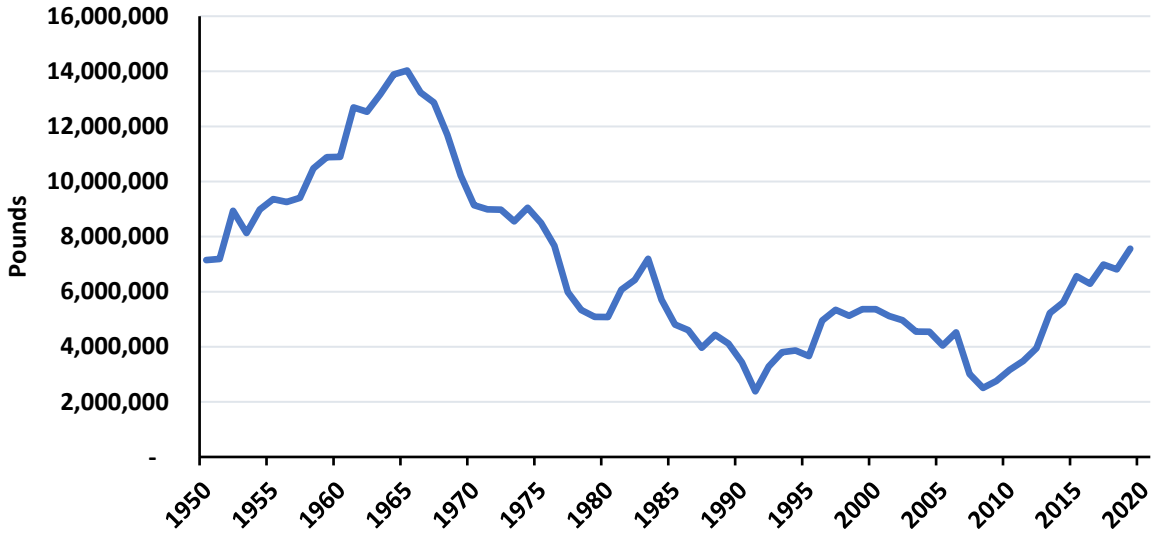

Figure 78. Total commercial U.S. red snapper landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 75. Total commercial U.S. red snapper landings (1950-2019).

	Commercial Landings		Commercial Landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	7,558,144	32,564,955	1984	5,707,045	10,627,598
2018	6,809,001	29,290,172	1983	7,191,872	12,762,280
2017	6,984,602	28,779,707	1982	6,426,168	11,291,364
2016	6,286,242	25,851,808	1981	6,071,804	10,404,100
2015	6,558,921	26,792,133	1980	5,078,735	8,099,498
2014	5,612,377	22,831,896	1979	5,086,975	7,158,882
2013	5,226,990	20,382,122	1978	5,333,310	6,331,255
2012	3,949,760	13,349,684	1977	5,984,400	6,079,232
2011	3,482,364	11,109,272	1976	7,669,300	6,633,317
2010	3,161,539	9,845,439	1975	8,494,100	6,349,899
2009	2,756,945	8,899,340	1974	9,044,500	6,137,497
2008	2,509,254	8,481,572	1973	8,553,600	5,205,144
2007	3,014,375	9,625,783	1972	8,974,900	4,968,904
2006	4,524,108	12,869,400	1971	8,987,300	4,377,183

2005	4,044,480	11,178,199	1970	9,141,100	4,231,978
2004	4,547,447	11,444,185	1969	10,212,000	4,377,464
2003	4,550,225	10,770,968	1968	11,694,800	4,090,306
2002	4,962,461	11,157,572	1967	12,867,900	4,223,937
2001	5,114,505	12,058,077	1966	13,227,800	4,252,405
2000	5,365,659	12,610,860	1965	14,028,500	4,133,234
1999	5,366,151	11,565,046	1964	13,884,800	4,062,004
1998	5,126,636	11,565,336	1963	13,164,500	3,534,763
1997	5,341,053	10,642,534	1962	12,530,100	3,160,533
1996	4,952,610	10,380,802	1961	12,687,700	3,265,558
1995	3,664,848	8,344,930	1960	10,891,300	2,806,778
1994	3,865,919	8,797,594	1959	10,881,400	2,823,023
1993	3,801,569	7,946,699	1958	10,476,200	2,728,116
1992	3,284,728	6,742,220	1957	9,409,500	2,462,853
1991	2,382,889	5,716,828	1956	9,253,600	2,308,528
1990	3,436,342	9,594,253	1955	9,360,300	2,399,451
1989	4,116,559	10,756,217	1954	8,984,100	2,335,446
1988	4,433,106	10,150,584	1953	8,129,200	2,267,008
1987	3,966,723	9,473,594	1952	8,936,000	2,116,927
1986	4,605,787	10,214,620	1951	7,188,000	1,862,817
1985	4,805,522	10,161,287	1950	7,146,800	1,722,141

Source: NOAA Landings Database (NOAA 2021b).

Table 76. Top states for commercial red snapper landings, 2019.

Rank	State	Volume (lb)
1.	Florida	2,934,300
2.	Texas	2,603,427
3.	Louisiana	1,356,384
4.	Alabama	451,905
5.	Mississippi	195,068

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Red snapper is managed by the Gulf of Mexico and South Atlantic Fishery Management Councils along with NOAA fisheries. It is managed under the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico and under the Fishery Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region in the South Atlantic (GOMFMC 1984; SAFMC 2020). The rebuilding plans included in the red snapper management plans have implemented annual catch limits for commercial fisheries.

Commercial harvest in federal waters off the coasts of North Carolina, South Carolina, Georgia, and East Florida typically opens the second Friday in July, if NOAA Fisheries determines a season is allowed. In 2020, NOAA Fisheries announced a limited opening of commercial seasons in the South Atlantic. Commercial harvest is subject to an annual catch limit of 124,815 lb, with an open season beginning in July of each year, if allowed (Table 77). A limited access Snapper Grouper permit is required to commercially fish for red snapper and commercial trips are limited to 75 lb per trip with no minimum or maximum size limit.

In the Gulf of Mexico, commercial fishing is managed under an individual fishing quota (IFQ) program with a requirement for a commercial vessel permit for reef fish. The minimum size limit for commercial harvest is 13 inches.

Table 77. Commercial fisheries regulations for red snapper.

State	Annual catch limit	Trip limit	Season	Managing agency
NC, SC, GA, East FL	124,815 lb	75 lb (no min. size)	Jul 13-Jan 1	SAFMC
Gulf States	7,701,000 lb	IFQ		GOMFMC

Source: GOMFMC (1984); SAFMC (2020).

Recreational Landings

Recreational landings of red snapper exhibit a roughly 10-year cycle (Figure 79). The 2017 peak of 19.5 million lb, however, is approximately 3 million pounds (approximately one-third) greater than the previous peak (Table 78). The top three states for recreational landings of red snapper in 2019 were: Florida (51%), Alabama (39%), Mississippi (7%), Louisiana (2%), and Georgia (1%) (Table 79). Additional recreational landings were reported in South Carolina.

Recreational landings of red snapper were nearly double those of commercial landings in 2019.

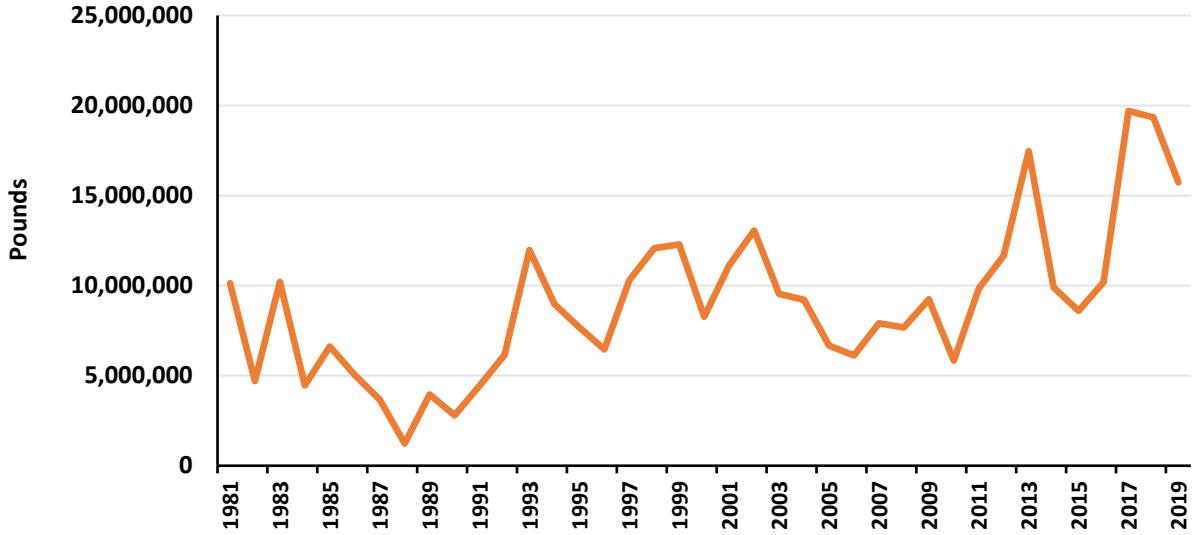

Figure 79. Total recreational U.S. red snapper landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 78. Total recreational U.S. red snapper landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	15,734,258	1999	12,285,816
2018	19,344,345	1998	12,070,347
2017	19,700,855	1997	10,296,106
2016	10,186,491	1996	6,462,725
2015	8,598,644	1995	7,673,693
2014	9,900,619	1994	8,975,728
2013	17,462,237	1993	11,978,068
2012	11,667,752	1992	6,147,679
2011	9,834,479	1991	4,441,573
2010	5,833,022	1990	2,803,371
2009	9,240,081	1989	3,953,739
2008	7,674,505	1988	1,234,746
2007	7,903,719	1987	3,668,000
2006	6,123,422	1986	5,034,403
2005	6,676,588	1985	6,623,061
2004	9,211,348	1984	4,463,330
2003	9,541,123	1983	10,208,964
2002	13,061,501	1982	4,701,743
2001	11,121,232	1981	10,134,963
2000	8,270,460		

Source: NOAA Landings Database (NOAA 2021b).

Table 79. Top states for recreational red snapper landings, 2019.

Rank	State	Volume (lb)
1.	Florida	7,963,897
2.	Alabama	6,119,669
3.	Mississippi	1,038,367
4.	Louisiana	246,280
4.	Georgia	185,008

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Red snapper is managed by the Gulf of Mexico and South Atlantic Fishery Management Councils along with NOAA fisheries. It is managed under the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico and under the Fishery Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region in the South Atlantic (GOMFMC 1984; SAFMC 2020). The management plans include rebuilding plans that implemented annual catch limits for recreational fisheries.

Recreational harvest in federal waters off the coasts of North Carolina, South Carolina, Georgia, and East Florida typically opens the second Friday in July, if NOAA Fisheries determines a season is allowed. In 2020, NOAA Fisheries announced a limited opening of recreational and commercial seasons in the South Atlantic. A recreational catch limit of 29,656 fish was also implemented with a bag limit of one fish per day (Table 80).
In the Gulf of Mexico, recreational harvest of red snapper is managed by individual Gulf states. Season opening dates vary by state and year and close once the state quotas are met. In 2020, Florida had a quota of 1,913,451 lb, Alabama 1,122,662 lb, Mississippi 151,550 lb, Louisiana 784,332 lb, and Texas 265,105 lb. Generally, there is a two fish per person bag limit with a minimum size of 16 inches.

Table 80. Recreational fisheries regulations for red snapper.

State	Minimum size	Daily bag limit	Open season	Managing agency
Interstate management Plans				
NC, SC, GA, East FL	none	1 pp 29,656 fish	Jul 10-12 2020; Jul 17-18 2020	SAFMC
Gulf States	See individual state plans; Annual Catch Limit: 7,399,00 lb			GOMFMC
Individual State Regulations				
FL (Gulf)	16”	2 pp	tbd	FWC
GA	20”	2pp	Year Round	GADNR

AL	16”	2pp	May 22-July 3, 2020 (weekends only); Oct 10-Oct12	ADCNR
MS	16”	2pp	May 22 until quota met	MDMR
LA	16”	2pp	May 22 – Aug 13, 2020 (weekends only); Sep 4-7	LDWF
TX	16”	2pp	Jun 1 – Aug 3, 2020	TPWD

Source: ADCNR (2021); FWC (2021c); GADNR (2021); GOMFMC (1984); LDWF (2021a); MDMR (2021a); SAFMC (2020); TPWD (2021).

Appendix M. Sablefish (*Anoplopoma fimbria)*

Sablefish, also known as sable, butterfish, black cod, and Pacific cod, is a marine fish typically found in the North Pacific Ocean. In the U.S. it is commonly found off the coast of Alaska, Washington, Oregon, and Northern California. It is not overfished but is federally regulated under fishery management plans. Commercial landings of sablefish far outweigh both imports and recreational landings. The majority of commercial landings occur in Alaska, while Oregon is the only state that reports recreational landings. Sablefish has been sold under the name Pacific cod as a substitute for Atlantic cod in U.S. markets.

Aquaculture

The first commercial hatchery for sablefish was built in 1998 in British Columbia, Canada. Sablefish were first harvested from net pens in 2002 in Canada (Minkoff and Clarke 2003). In the early 2000s, the province of British Columbia approved 22 licenses for commercial sablefish farms, mostly on Vancouver Island, as an alternative to farmed salmon. Sablefish fishers opposed it. By 2010, farmed sablefish had reached 1.9 million pounds (Campbell and Koop 2009; Stoner and Ethier 2015). Opposition by fishermen, combined with production problems, contributed to a decline in the number of farms, and production fell below 600,000 pounds (DFO 2018). Consistent survival during the larval stage has been reported as a problem as is the slower growth of males. At the time of this report, there was only one farm raising sablefish in British Columbia. Sablefish are reported to require two years of growout to a market size of 5.5 pounds (Echave et al. 2002).

In the U.S., there were attempts to farm sablefish in offshore net pens in Hawaii, but the farm reportedly lacked sufficient capital to expand to a commercial scale (Consilli 2007). Growout trials conducted previously by two farms in the U.S. were discontinued, but additional trials were initiated in 2019. There also was a 2017 report of a RAS farm raising and selling small volumes of sablefish in Texas (Wiedenhoft 2017). There is no current domestic commercial production (Goetz 2019).

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S.

Import/Export of Sablefish

Sablefish are imported into the U.S. as both fresh and frozen product forms. Frozen sablefish imports exceeded fresh imports from 1997 through 2018, but fell below fresh imports in 2019. Frozen imports of sablefish have fluctuated from under 100,000 pounds in volume to more than 3 million pounds at their peak in 2016 (Figure 80; Table 81). Shortly after, frozen sablefish decreased dramatically to 445,569 pounds in 2018 and further to 209,578 pounds in 2019. The 2019 total value of frozen imports was $1.5 million as compared to $3.6 million for fresh sablefish imports.

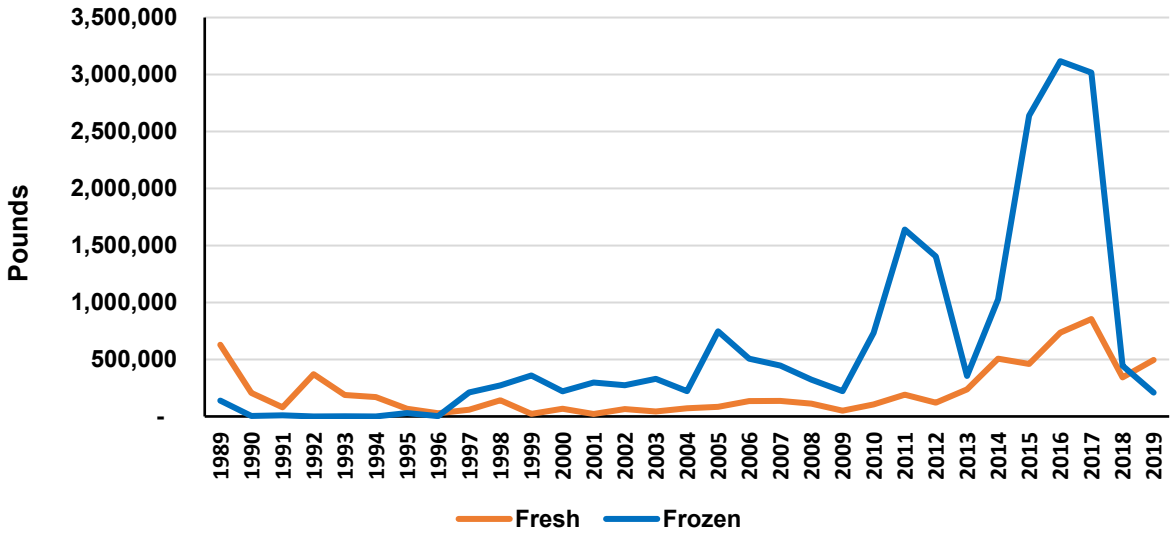

Figure 80. Sablefish imports by product type (2000-2019). Source: NOAA Foreign Trade Database (NOAA 2021a).

Table 81. Sablefish imports by product type (2000-2019).

	Fresh		Frozen	
Year	Volume (lb)	Value ($)	Volume (lb)	Value ($)
2019	496,255	3,587,828	209,578	1,521,643
2018	342,261	2,296,653	445,569	1,985,128
2017	854,497	2,080,932	3,016,202	2,549,361
2016	735,307	1,755,550	3,116,918	2,777,364
2015	461,200	1,619,544	2,638,983	2,715,686
2014	506,355	1,708,857	1,028,080	1,472,210
2013	237,625	912,246	354,917	472,361
2012	120,533	574,577	1,403,867	1,422,760
2011	190,495	548,697	1,639,973	1,379,601
2010	106,093	486,471	732,974	1,255,735
2009	50,398	319,008	222,226	1,124,436
2008	111,812	666,922	322,917	1,655,963
2007	135,648	715,268	446,409	1,911,365
2006	135,053	540,186	506,712	1,997,312
2005	84,128	274,447	747,271	2,353,879
2004	71,970	291,907	221,617	866,445
2003	43,416	155,547	329,939	1,555,378

2002	64,699	49,125	274,244	943,202
2001	21,693	48,845	297,222	942,789
2000	66,884	122,340	219,847	981,600
1999	21,881	44,558	359,651	1,279,210
1998	142,579	118,881	271,832	764,672
1997	59,168	157,562	210,616	930,009
1996	27,677	56,797	2,888	11,548
1995	67,602	117,674	30,000	93,000
1994	169,304	242,144	-	-
1993	188,453	204,053	1,001	3,650
1992	370,500	586,493	-	-
1991	80,630	125,440	9,345	6,027
1990	206,255	199,509	4,045	5,817
1989	628,438	284,466	138,829	102,035

[1]n.d. = no data.
Source: NOAA Foreign Trade Database (NOAA 2021a).

Commercial Landings

Commercial landings for sablefish are substantially larger in volume than recreational landings. Commercial landings stayed below 20 million pounds prior to 1975, when landings sharply increased up to their peak of 106 million pounds in 1988 (Figure 81; Table 82). Commercial landings then sharply decreased until the early 2000s when landings began to fluctuate between 30 and 50 million pounds. Overall, the trend suggests an increase in landings since 1950. In 2019, commercial landings were 40.8 million pounds, with a commercial value of $89.1 million. The majority (71%) of commercial landings were in Alaska, with Oregon following behind with 14% of total landings and California with 8% (Table 83).

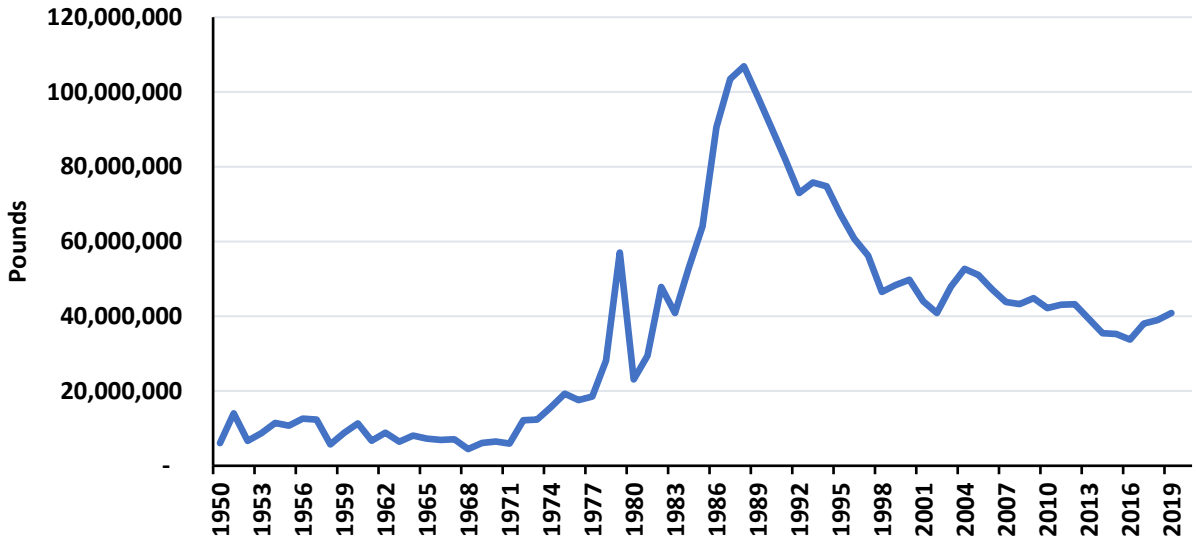

Figure 81. Total commercial U.S. sablefish landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 82. Total commercial sablefish landings (1950-2019).

	Commercial Landings		Commercial Landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	40,843,250	89,118,701	1984	52,922,202	13,669,404
2018	38,966,484	111,507,241	1983	40,875,065	12,088,607
2017	38,030,334	143,860,156	1982	47,824,472	13,952,263
2016	33,746,761	117,044,131	1981	29,425,708	7,493,164
2015	35,270,553	113,127,308	1980	23,092,520	5,141,941
2014	35,474,500	111,875,224	1979	57,052,517	20,253,360
2013	39,360,830	101,885,565	1978	28,159,262	7,821,853
2012	43,217,068	148,520,255	1977	18,533,200	4,060,345
2011	43,101,075	184,625,363	1976	17,587,300	2,292,648
2010	42,201,559	133,168,723	1975	19,278,200	2,615,140
2009	44,842,951	121,606,975	1974	15,632,800	2,128,009
2008	43,251,157	125,502,721	1973	12,366,000	1,400,069
2007	43,825,485	115,441,749	1972	12,193,400	1,498,977
2006	47,180,907	131,983,440	1971	5,915,900	493,170
2005	51,063,146	136,117,225	1970	6,474,500	608,172
2004	52,689,799	134,902,329	1969	6,089,400	521,191
2003	47,874,912	100,131,287	1968	4,471,000	367,940
2002	40,853,702	78,076,465	1967	7,074,400	641,096
2001	44,016,073	80,344,414	1966	6,930,900	668,422
2000	49,748,930	101,252,489	1965	7,282,400	716,266
1999	48,334,034	97,242,211	1964	8,067,900	876,081
1998	46,521,802	97,528,877	1963	6,464,300	653,233
1997	56,213,045	160,893,941	1962	8,858,300	841,409
1996	60,772,519	107,739,630	1961	6,703,500	693,698
1995	67,289,564	121,559,583	1960	11,324,454	1,087,227
1994	74,737,375	96,586,994	1959	8,795,679	767,709
1993	75,802,475	64,662,121	1958	5,702,411	428,257
1992	72,969,028	67,543,734	1957	12,337,570	910,585
1991	82,002,291	75,355,431	1956	12,602,700	932,373
1990	90,427,226	57,209,130	1955	10,748,259	840,686
1989	98,778,699	73,374,407	1954	11,453,050	946,168
1988	106,865,064	90,996,159	1953	8,721,471	712,786
1987	103,482,302	61,436,575	1952	6,644,117	589,129
1986	90,613,144	45,965,218	1951	14,018,505	1,232,614
1985	64,065,758	30,054,174	1950	6,048,701	482,398

Source: NOAA Landings Database (NOAA 2021b).

Table 83. Top states for commercial sablefish landings, 2019.

Rank	State	Volume (lb)
1.	Alaska	29,015,684
2.	Oregon	5,837,393
3.	California	3,183,030
4.	Washington	2,680,597

Source: NOAA Landings Database (NOAA 2021b)

Commercial Fisheries Regulations

Sablefish is managed in Alaska by NOAA Fisheries and the North Pacific Fishery Management Council under the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Fishery Management Plans (Table 84) (NPFMC 2020a, b). In federal waters, sablefish are managed by regions in order to distribute exploitation. The acceptable biological catch (ABC) is apportioned between these regions and then allocated between gear types. Fixed gear harvests 90% of the annual quota and trawl harvests about 10%. Fixed gear is managed under an individual fishing quota (IFQ) program with requirements for commercial vessel permits. The commercial season typically begins March 1st and continues through November 15th, but is subject to change. Commercial vessels must apply for permits with varying catch limits.

Sablefish is managed along the Washington, Oregon, and California coast by NOAA Fisheries and the Pacific Fishery Management Council under the Pacific Coast Groundfish Fishery Management Plan (Table 82) (PFMC, 2019). The fishery is for limited entry, fixed gear, sablefish-endorsed vessels fishing in Washington, Oregon, and California. The season begins April 1st and ends October 31st or closes for an individual vessel when they meet their tier limit, whichever is earlier. Commercial vessels must apply for permits with varying catch limit designations at three tier levels.

Table 84. Interstate management plans for commercial harvest of sablefish.

States	Annual catch limit	Season	Managing agency
AK	Varies by IFQ	Mar 1 – Nov 15 (subject to change)	NPFMC
WA, OR, CA	Varies by permit Tier 1 Permit: 48,642 lb Tier 2 Permit: 22,110 lb Tier 3 Permit: 12,634 lb	Apr 1 – Oct 31	PFMC

Source: NPFMC (2020a, b); PFMC (2019).

Recreational Landings

Recreational landings of sablefish are largely insignificant when compared to the commercial catch, fluctuating in recent years between 1,000 and 5,000 pounds (Figure 82; Table 85). In 2019, the total volume of recreational landings was 4,572 pounds, all of which was landed in Oregon (Table 86).

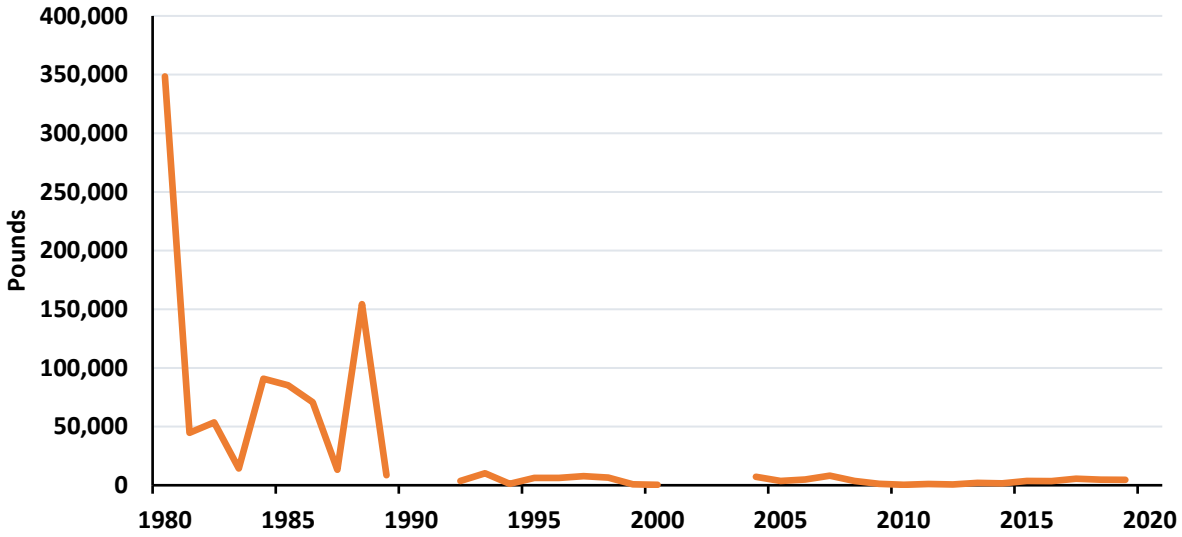

Figure 82. total recreational U.S. sablefish landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 85. Total recreational sablefish landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	4,572	1999	767
2018	4,755	1998	6,484
2017	5,538	1997	7,796
2016	3,574	1996	6,215
2015	3,677	1995	6,312
2014	1,609	1994	1,177
2013	2,073	1993	10,192
2012	657	1992	3,677
2011	1,107	1991	n.d.
2010	412	1990	n.d.
2009	1,250	1989	8,580
2008	3,651	1988	154,311
2007	8,168	1987	13,254
2006	4,846	1986	70,751
2005	3,677	1985	85,145
2004	7,143	1984	90,864

2003	n.d.[1]	1983	14,273
2002	n.d.	1982	53,614
2001	n.d.	1981	44,676
2000	375		

[1]n.d. = no data.
Source: NOAA Landings Database (NOAA 2021b).

Table 86. Top states for recreational sablefish landings, 2019.

Recreational Landings		
Rank	**State**	**Volume (lb)**
1.	Oregon	4,572

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Sablefish is managed in Alaska by NOAA Fisheries and the North Pacific Fishery Management Council under the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Fishery Management Plans (NPFMC, 2020a, b). Individuals are limited to 50 sablefish per year for personal use (non-commercial). There is no minimum size or daily bag limit, with the season being open year-round.

Sablefish is managed along the Washington, Oregon, and California Pacific coast by NOAA Fisheries and the Pacific Fishery Management Council under the Pacific Coast Groundfish Fishery Management Plan (PFMC 2019). Recreational fishing for sablefish is negligible as their depth distribution typically places them beyond most sport fishing activity. Thus, states do not have individual regulations for sablefish harvest outside of the Pacific Coast Groundfish Fishery Management Plan.

Appendix N. Southern Flounder (*Paralichthys lethostigma*)

Southern flounder is a species of large-tooth flounder native to the Atlantic Coast of the U.S. and Gulf of Mexico. It is a popular game fish with high commercial value. Recreational harvest of Southern flounder is regulated by several South Atlantic and Gulf states, while commercial harvest is only regulated in North Carolina and Florida. Import data specific to southern flounder is limited, but "flounder" more generally is imported into the U.S. in large volumes, especially in frozen forms. Recreational landings outweigh commercial landings, with the majority of recreational landings occurring in Florida and the majority of commercial landings occurring in North Carolina and Florida.

Aquaculture

Globally, there were 33,000 pounds of generic flatfish farmed in 2019, a nearly four-fold increase over the 2015 production of 8,800 pounds (FAO 2021a). The FAO data do not report farmed flatfish or flounder production by species. The 2018 USDA Census of Aquaculture listed three flounder farms in the U.S., although the species was not identified and the production volume not reported, for confidentiality reasons.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of southern flounder.

Import/Export of Southern Flounder

Little data were found on imports of specific species of flounder. However, relatively large volumes of un-specified species of flounder are imported into the U.S., mostly as frozen product.
The NOAA Foreign Trade Database utilizes a single category titled "Flatfish Flounder," which does not specify individual species. Total imported volumes of frozen flounder products in 2019 were 21.9 million lb. The NOAA import data on "Flatfish Flounder" is available in Appendix U.

Commercial Landings

Commercial landings of southern flounder peaked in 1994, followed by a substantial decline to a level in 2019 of 902,364 lb, that was 82% less than the 1994 peak of 4.9 million pounds (Figure 83; Table 87). The only two states that recorded commercial landings of southern flounder in 2019 were North Carolina (90% of total commercial landings) and Florida (10% of total commercial landings) (Table 88).

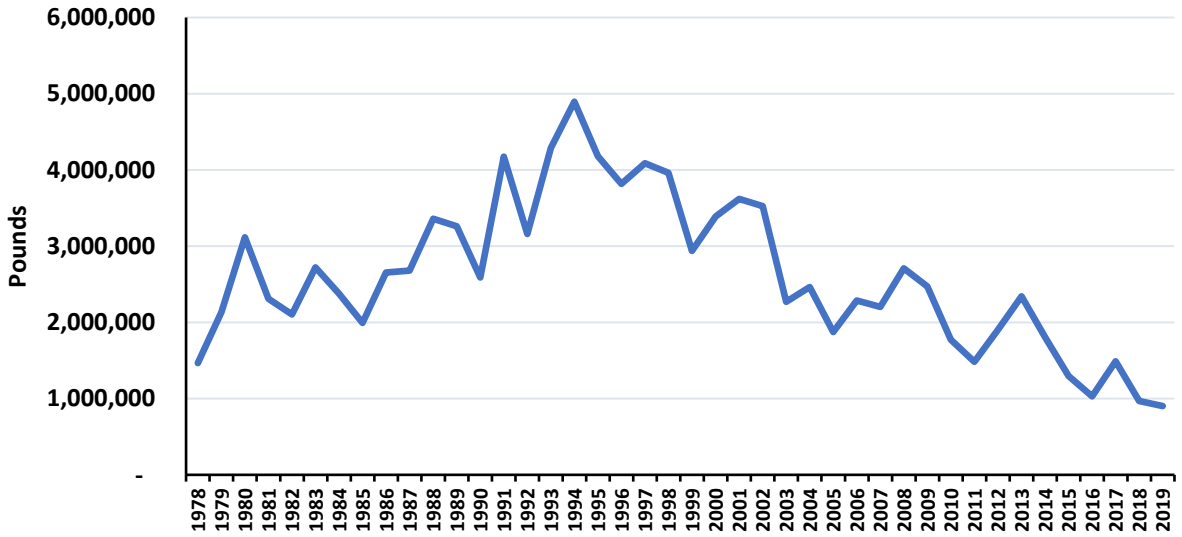

Figure 83. Total commercial U.S. southern flounder landings (1978-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 87. Total commercial U.S. southern flounder landings (1978-2019).

	Commercial landings			Commercial landings	
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	902,364	3,448,421	1998	3,961,893	7,128,881
2018	968,353	4,039,209	1997	4,088,174	7,993,259
2017	1,489,865	5,951,918	1996	3,817,481	7,248,186
2016	1,030,142	4,012,395	1995	4,181,439	7,626,779
2015	1,296,244	15,669	1994	4,895,558	8,062,040
2014	1,806,841	5,235,249	1993	4,286,734	5,612,533
2013	2,342,654	6,124,086	1992	3,161,273	4,040,783
2012	1,904,383	5,128,737	1991	4,173,952	4,988,075
2011	1,482,375	3,363,768	1990	2,588,671	4,136,542
2010	1,771,836	3,915,007	1989	3,261,718	5,300,105
2009	2,472,553	4,811,407	1988	3,360,741	3,616,241
2008	2,709,861	5,933,396	1987	2,680,165	3,280,466
2007	2,203,364	5,300,897	1986	2,653,623	2,677,494
2006	2,287,933	4,850,217	1985	1,993,494	1,679,939

2005	1,874,113	3,464,426	1984	2,377,845	1,739,110
2004	2,463,685	3,889,758	1983	2,721,256	1,679,251
2003	2,270,290	3,742,104	1982	2,104,895	1,472,540
2002	3,524,928	5,251,762	1981	2,310,080	1,485,008
2001	3,619,515	5,794,495	1980	3,115,566	1,690,640
2000	3,389,886	5,892,048	1979	2,134,132	1,071,589
1999	2,938,528	5,140,713	1978	1,465,813	819,643

Source: NOAA Landings Database (NOAA 2021b).

Table 88. Top states for commercial southern flounder landings, 2019.

Rank	State	Volume (lb)
1.	North Carolina	902,364
2.	Florida	102,592

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Commercial harvest of southern flounder is regulated in North Carolina and Florida waters. In North Carolina, commercial harvest of southern flounder is limited to a roughly month-long season from mid-September to the end of October, depending on the management area, with a 15-inch minimum size. In Florida, commercial harvest of several flounder species (Gulf, southern, summer, and fringed) began to be restricted on March 1, 2021 with a size limit of 14-inch and a vessel limit of 150 fish from December 1 to October 14 and 50 fish from October 15 to November 30.

The Gulf States Marine Fisheries Commission (GSMFC) has a regional management plan that coordinates the state regulations for southern flounder. Texas directly manages the entirety of the commercial and recreational fishery up to nine nautical miles off the coast of Texas.

Recreational Landings

Recreational landings of southern flounder have been relatively stable through about 2013, but subsequently exhibit an approximately 40% decline from 2013 to 2019 landings of 3.5 million pounds (Figure 84; Table 89). The major states with recreational landings in 2019 were Florida (66%), North Carolina (11%), and Mississippi (8%) with additional landings in Alabama, Georgia, Louisiana, South Carolina, and Virginia (Table 90).

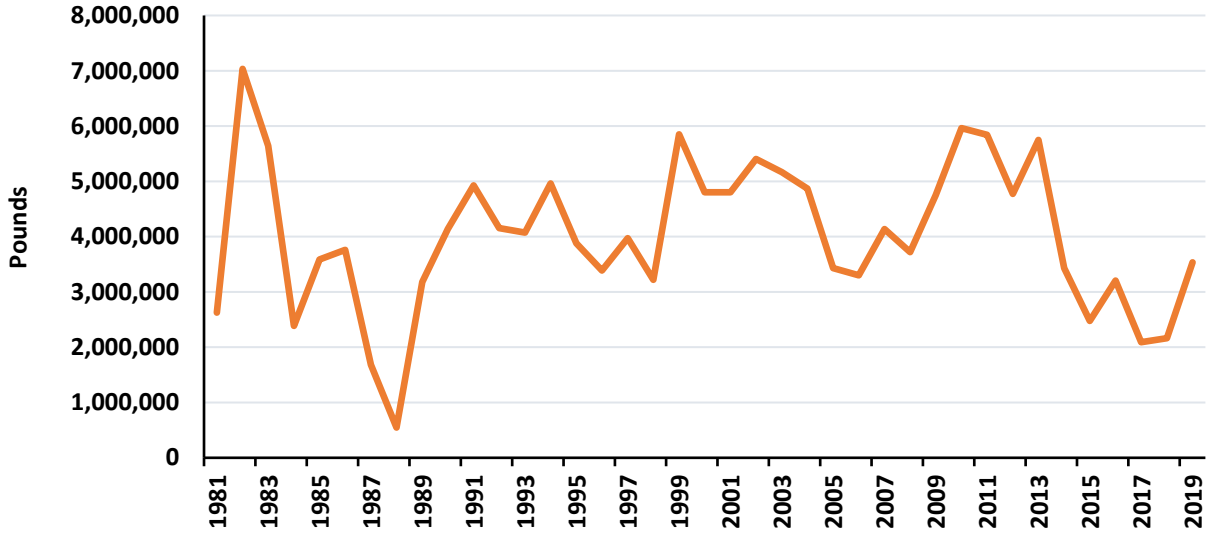

Figure 84. Total recreational U.S. southern flounder landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 89. Total recreational U.S. southern flounder landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	3,536,007	1999	5,851,145
2018	2,162,052	1998	3,220,199
2017	2,089,776	1997	3,972,558
2016	3,204,374	1996	3,388,000
2015	2,475,733	1995	3,879,942
2014	3,430,494	1994	4,961,482
2013	5,748,068	1993	4,072,206
2012	4,773,514	1992	4,155,032
2011	5,839,874	1991	4,927,027
2010	5,961,749	1990	4,139,996
2009	4,751,554	1989	3,180,296
2008	3,720,921	1988	547,131
2007	4,137,881	1987	1,682,316
2006	3,301,180	1986	3,760,973
2005	3,432,069	1985	3,587,364
2004	4,868,746	1984	2,386,131
2003	5,166,342	1983	5,641,396
2002	5,403,595	1982	7,033,734
2001	4,801,953	1981	2,627,074
2000	4,802,262		

Source: NOAA Landings Database (NOAA 2021b).

Table 90. Top states for recreational southern flounder landings, 2019.

Rank	State	Volume (lb)
1.	Florida	2,342,585
2.	North Carolina	387,207
3.	Mississippi	269,498
4.	South Carolina	241,049
5.	Georgia	148,329

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Southern flounder recreational harvest is regulated by individual states (Table 91). Regulations often group several species of flounder together (i.e. southern, summer, and Gulf). The minimum size varies by state, with typical bag limits of 10 flounder per person per day, and a year-round open season, with some exceptions.

Table 91. Recreational fishing regulations for southern flounder.

State	Minimum size	Daily bag limit	Open season	Managing agency
SC*	15”	10 pp NTE 20 per vessel	Year-round	SCDNR
AL*	14”	5 pp	Closed annually in November	ADCNR
FL*	12” (14” beginning Mar 1, 2021)	10 pp (5 beginning Mar 1, 2021)	Closed Oct 15 -Nov 30	FWC
GA*	12”	15 pp	Year-round	GADNR
LA	none	10 pp	Year-round	LDWF
MS*	12”	10 pp	Year-round	MDMR
VA	15”	6 pp	Year-round	VMRC

*Regulations apply to all flounders (southern, summer, & Gulf). Source: ADCNR (2021); FWC (2021c); GADNR (2021); LDWF (2021a); MDMR (2021a); SCDNR (2021); VMRC (2021).

Appendix O. Spotted Seatrout (*Cynoscion nebulosus*)

Spotted seatrout, also known as speckled trout, spec, and spotted weakfish, is a popular gamefish found in the Southeastern coast of the United States from Maryland to Florida and along the coasts of the Gulf of Mexico. It is federally regulated in the Atlantic and Gulf of Mexico under federal management plans, with additional regulations by individual states.

Aquaculture

Spotted seatrout fingerlings have been raised for a number of years in ponds for stock enhancement purposes. Culture techniques for spotted seatrout were adapted from those developed for red drum (Blaylock et al. 2021). Mississippi, Texas, and South Carolina have initiated aquaculture-based stock enhancement programs (Blaylock et al. 2021). By 2018, 80 million 25 to 30-day old seatrout had been produced through aquaculture for stock enhancement. Research on tank production of market-sized spotted seatrout showed that 1.1-lb spotted seatrout can be produced in 10 months (Blaylock et al. 2021). No data were found on farmed production of spotted seatrout elsewhere in the world.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of spotted seatrout.

Import/Export of Spotted Seatrout

No data were found on imports or exports of spotted seatrout.

Commercial Landings

The commercial supply of spotted seatrout is seasonal and variable (Blaylock et al. 2021). Commercial landings of spotted seatrout have declined fairly steadily from their peak of 8.8 million pounds in 1973 to 1999, thereafter leveling off at levels 7% (570,879 lb) of the volumes in their peak years (Figure 85; Table 92). The top three states for commercial landing in 2019 were: North Carolina (66%), Virginia (24%), and Mississippi (6%) (Table 93). Additional landings were reported in Alabama and Louisiana.

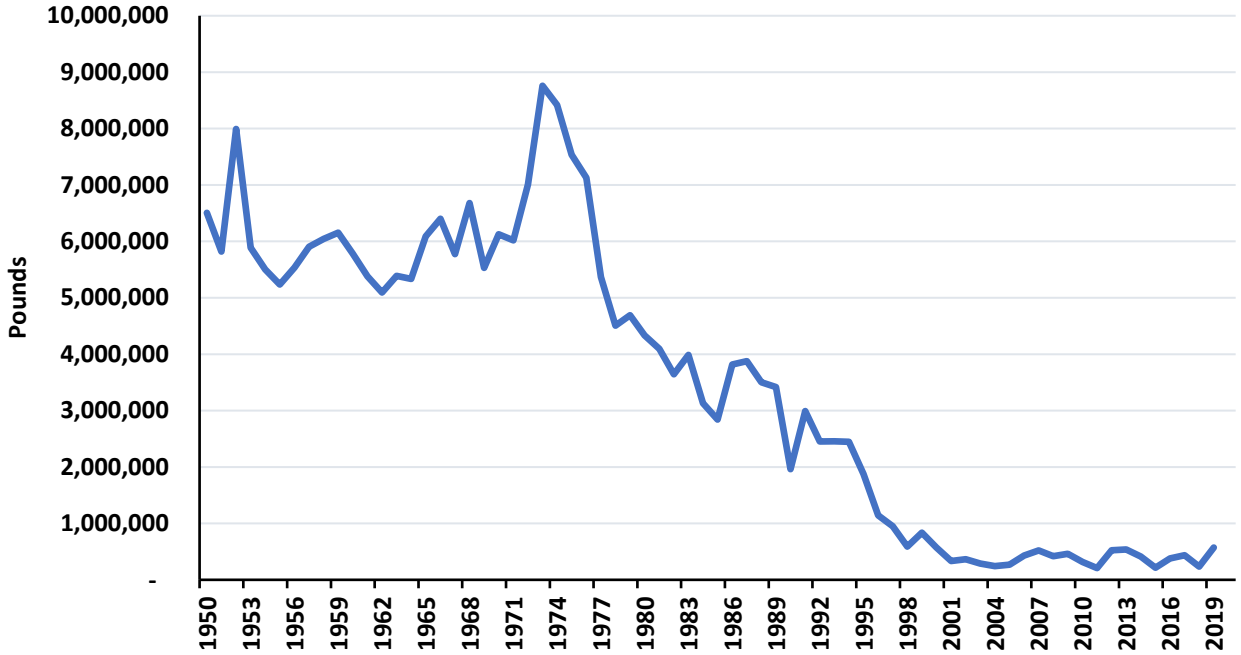

Figure 85. Total commercial U.S. spotted seatrout landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 92. Total commercial U.S. spotted seatrout landings (1950-2019).

	Commercial Landings		Commercial Landings		
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	570,879	1,424,404	1984	3,129,854	3,022,283
2018	234,523	661,905	1983	3,986,106	3,587,217
2017	434,692	1,209,747	1982	3,642,832	3,190,310
2016	378,279	1,019,094	1981	4,094,846	3,451,408
2015	214,276	544,497	1980	4,334,714	3,256,976
2014	412,440	960,958	1979	4,690,309	3,285,615
2013	537,091	1,208,087	1978	4,505,682	2,675,784
2012	522,493	1,056,252	1977	5,369,600	2,679,421
2011	208,122	440,417	1976	7,126,600	3,150,739
2010	316,123	594,535	1975	7,535,700	2,931,700
2009	462,587	831,121	1974	8,419,200	2,856,046
2008	420,154	689,909	1973	8,759,000	2,947,162
2007	520,671	809,842	1972	7,007,700	2,122,184
2006	431,206	628,592	1971	6,018,000	1,697,856
2005	269,700	427,521	1970	6,126,100	1,735,750
2004	241,778	380,552	1969	5,529,500	1,586,336
2003	287,656	444,082	1968	6,679,600	1,762,282

2002	364,087	562,302	1967	5,774,300	1,466,782
2001	335,011	563,568	1966	6,400,200	1,633,387
2000	570,934	785,320	1965	6,088,000	1,521,532
1999	835,332	1,145,009	1964	5,334,400	1,377,916
1998	588,991	866,500	1963	5,388,100	1,310,721
1997	948,173	1,123,195	1962	5,092,500	1,240,930
1996	1,142,740	1,229,147	1961	5,378,800	1,282,325
1995	1,877,582	2,186,816	1960	5,782,800	1,294,157
1994	2,447,894	2,872,229	1959	6,155,100	1,358,538
1993	2,454,716	2,918,908	1958	6,043,400	1,313,645
1992	2,452,287	2,832,584	1957	5,905,400	1,409,815
1991	2,992,782	3,442,152	1956	5,537,100	1,348,286
1990	1,963,154	2,550,785	1955	5,234,300	1,315,013
1989	3,416,844	3,403,839	1954	5,501,000	1,364,329
1988	3,501,153	3,661,419	1953	5,888,100	1,436,735
1987	3,876,335	3,629,091	1952	7,992,200	1,799,082
1986	3,818,138	3,408,400	1951	5,819,900	1,391,921
1985	2,840,254	2,819,256	1950	6,505,300	1,457,142

Source: NOAA Landings Database (NOAA 2021b).

Table 93. Top states for commercial spotted seatrout landings, 2019.

Rank	State	Volume (lb)
1.	North Carolina	378,491
2.	Virginia	135,729
3.	Mississippi	36,913
4.	Florida	19,708
5.	N/A	

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Spotted seatrout is managed in Atlantic federal waters by the Atlantic States Marine Fisheries Council under the 2011 Omnibus Amendment for spotted seatrout and Spanish mackerel (ASMFC 2011). The amendment included measures to protect the spawning stock and required a coastwide minimum size of 12 inches. Spotted seatrout is managed in the Gulf of Mexico by the Gulf States Marine Fisheries Commission under the spotted seatrout Fishery regional management plan (GSMFC 2001). Several states also have varying commercial regulations (Table 94). The state of Florida mandated a catch-and-release only regulation in 2020 for parts of the Gulf Coast and extended it to 2021 to aid in recovery of the species following a prolonged red tide that occurred from 2017-2019. Florida also has spotted seatrout management zones with varying regulations per zone (FWC 2021c).

Table 94. Commercial fisheries regulations for spotted seatrout.

State	Annual catch limit	Trip limit	Season	Managing agency
GA	Unregulated; minimal catch			GADNR
AL	Commercial fishing prohibited			ADCNR
LA	Quota: 1,000,000 lb	25/day	Jan 2 -Dec 31; no harvest on weekends	LDWF
NC		75/day	Year Round	NCDMF
SC	N/A			SCDNR
MS	50,000 lb		Feb 1 – Oct 31	MDMR
VA	51,104 lb	100 lb when 80% ACL met	Year Round	VMRC
FL	Varies by management zone			FWC

Source: ASMFC (2011); FWC (2021c); GSMFC (2001).

Recreational Landings

Spotted seatrout is a popular recreational fish in the Gulf of Mexico, reported to be among the top five marine fish harvested recreationally in the U.S. (Blaylock et al. 2021). The National Marine Fisheries Service (2020) reported more than 56 million angler trips in 2018. The Texas saltwater fishery alone generated $2 billion per year in economic impact. Overall recreational landings have risen fivefold since the early 1990s (Blaylock et al. 2021). The importance of the recreational fishery has resulted in a shift over time from commercial to recreational fisheries, with 98% of the spotted seatrout harvest currently in the recreational fishery (NMFS 2020).

However, recreational landings of spotted seatrout peaked in 2012 and have declined sharply since then to 2019 levels (15.2 million lb) that were 36% of their 2012 peak volumes (Figure 86; Table 95). The top three states for recreational landings were: Florida (32%), North Carolina (19%), and Louisiana (12%) (Table 96). Additional landings were reported in Alabama, Georgia, Mississippi, South Carolina, and Virginia.

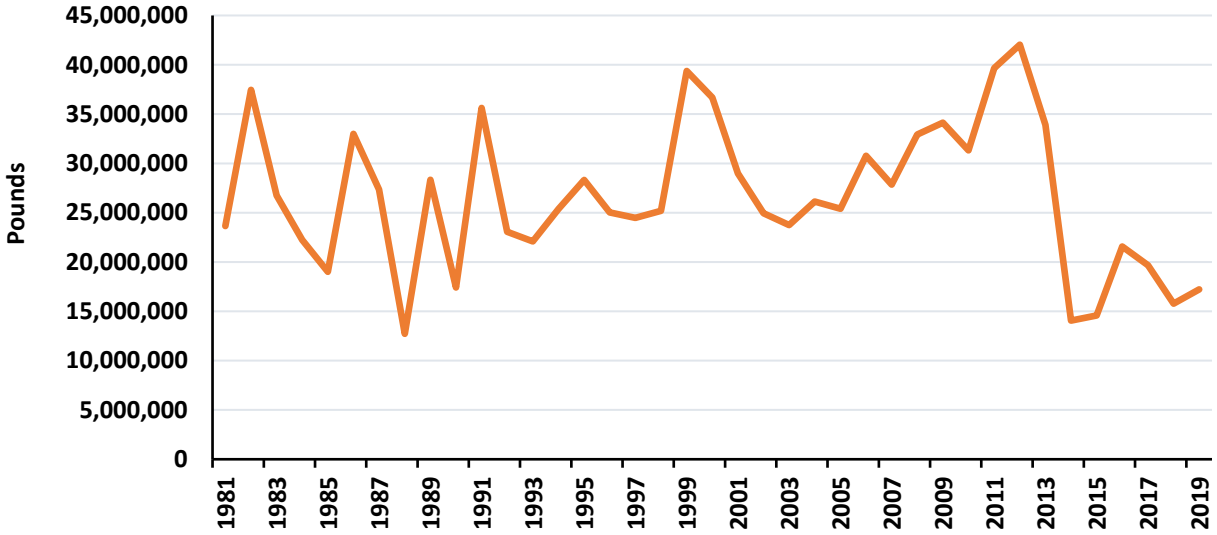

Figure 86. Total recreational U.S. spotted seatrout landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 95. Total recreational U.S. spotted seatrout landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	17,231,699	1999	39,366,990
2018	15,786,310	1998	25,182,482
2017	19,675,002	1997	24,469,571
2016	21,572,974	1996	25,027,152
2015	14,572,175	1995	28,321,201
2014	14,053,443	1994	25,379,352
2013	33,903,832	1993	22,098,831
2012	42,037,295	1992	23,069,934
2011	39,654,375	1991	35,630,428
2010	31,315,982	1990	17,422,517
2009	34,130,902	1989	28,336,176
2008	32,928,661	1988	12,721,667
2007	27,855,694	1987	27,353,538
2006	30,778,938	1986	32,995,649
2005	25,396,873	1985	19,008,413
2004	26,138,642	1984	22,240,632
2003	23,743,479	1983	26,752,937
2002	24,950,302	1982	37,449,061
2001	28,983,827	1981	23,644,606
2000	36,675,497		

Source: NOAA Landings Database (NOAA 2021b)

Table 96. Top states for recreational spotted seatrout landings, 2019.

Rank	State	Volume (lb)
1.	Florida	5,492,167
2.	North Carolina	3,334,199
3.	Louisiana	1,992,174
4.	Mississippi	1,899,972
5.	Virginia	1,256,929

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Spotted seatrout is managed in Atlantic federal waters by the Atlantic States Marine Fisheries Council under the 2011 Omnibus Amendment for spotted seatrout and Spanish Mackerel (ASMFC 2011). The amendment included measures to protect the spawning stock and required a coastwide minimum size of 12 inches. It is managed in the Gulf of Mexico by the Gulf States Marine Fisheries Commission under the Spotted Seatrout Fishery Regional Management Plan (GSMFC 2001). Several states also have varying recreational regulations (Table 97). The state of Florida mandated a catch-and-release only regulation in 2020 for parts of the Gulf Coast and extended it to 2021 to aid in recovery of the species following a prolonged red tide that occurred from 2017. Florida also has spotted seatrout management zones with varying regulations per zone (FWC 2021c).

Table 97. Recreational fisheries regulations for spotted seatrout.

State	Minimum size	Daily bag limit	Open season	Managing agency
GA	14”	15 pp	Year Round	GADNR
AL	15”-22”	6 pp	Year Round	ADCNR
LA	12”	25 pp; 15pp in certain areas	Year Round	LDWF
NC	14”	4 pp	Year Round	NCDMF
SC	14”	10 pp	Year Round (not by gig Dec 1 – Feb 28)	SCDNR
MS	15”	15 pp	Year Round	MDMR
VA	14”	4 pp	Year Round	VMRC
FL	Varies by management zone			FWC

Source: ASMFC (2011); FWC (2021c); GSMFC (2001).

Appendix P. Spotted Wolffish (*Anarhichas minor*)

Spotted wolffish, also known as the leopard fish, is a bottom-dwelling species found in the northern Atlantic Ocean. In the U.S., they are only found in the Gulf of Maine. Spotted wolffish is one of three wolffish species (the others are the Atlantic and the Northern Wolffish). Commercial and recreational harvest is prohibited in U.S. waters.

Aquaculture

There are reports of one commercial wolffish farm in Norway with plans for another in Quebec, Canada. Research trials have shown that wolffish can reach 2.2 to 3.3 pounds in 2 to 2.5 years using culture methods that have been successful for commercial production of other flatfish in flow-through vats or tanks and in RAS. The spotted wolffish was listed as a top-ranked aquaculture candidate for Norway and Canada (Falk-Petersen et al. 1999; LeFrançois et al. 2002; Foss et al. 2004) following culture trials in which it out-performed Atlantic wolffish (LeFrançois et al. 2021). Other than 2,205 pounds of farmed spotted wolffish production in Iceland in 2002, no other production has been reported by FAO (2021a) through 2019.

Aquaculture Regulations

Farming of spotted wolffish would likely be subjected to federal regulations related to their designation as a species of concern in the U.S. State regulations related to non-native species as well as general fish farming federal, state, and local regulations would likely also be applied to spotted wolffish farms.

Import/Export of Spotted Wolffish

Import/export of spotted wolffish. Imported volumes of wolffish (species not specified) have generally declined (Figure 87; Table 98). Prior to 2018, spotted wolffish were imported into the U.S. as frozen fillets and frozen fillet blocks, but in decreasing volumes (NOAA 2021a). There are no records of imported wolffish after 2018. Fresh wolffish were imported into the U.S. primarily from Canada, with minor quantities from France, St. Pierre, United Kingdom, and Brazil. Volumes imported were of several hundred thousand pounds a year. However, in 1972 to 1973, large volumes of 8.7 million to 10.3 million lb of wolffish were imported as "fresh/frozen" with the greatest volumes from Canada and Iceland.

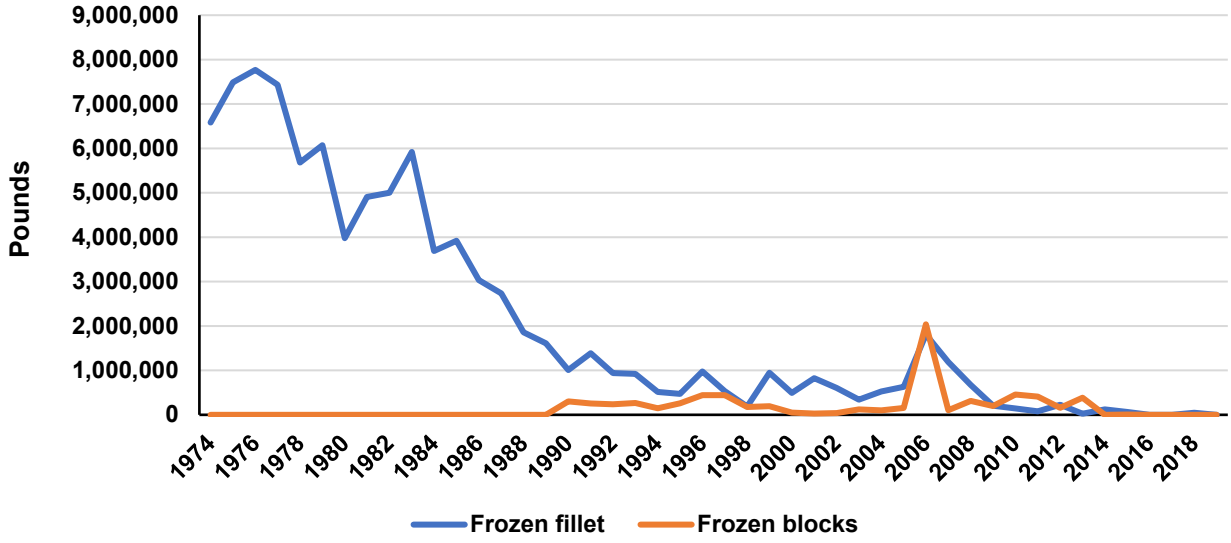

Figure 87. Spotted wolffish imports by product type (1990-2019). Source: NOAA Foreign Trade Database (NOAA 2021a).

Table 98. Wolffish imports by product type (1974-2019).

	Frozen fillet		Frozen fillet blocks > 9.9 lb	
Year	Volume (lb)	Value ($)	Volume (lb)	Value ($)
2019	-		-	-
2018	46,771	58,311	-	-
2017	-		-	-
2016	-		-	-
2015	65,113	49,848	1,199	7,680
2014	123,362	83,823	-	-
2013	25,999	59,490	223,337	384,623
2012	226,800	324,507	43,651	156,660
2011	78,749	173,259	139,409	411,979
2010	144,517	304,536	255,698	456,483
2009	204,408	404,990	115,776	197,778
2008	673,238	1,159,269	184,747	314,952
2007	1,190,541	2,215,688	56,341	104,312
2006	1,808,258	3,173,443	1,131,574	2,037,711
2005	630,598	1,017,737	85,625	154,945
2004	524,849	908,682	64,119	99,652
2003	342,946	550,267	85,500	123,105
2002	605,005	1,183,864	21,385	40,222
2001	823,855	1,329,276	17,886	29,522
2000	492,283	830,520	51,742	50,944
1999	946,807	1,832,182	185,483	194,514
1998	188,806	402,128	107,213	174,566
1997	533,849	1,014,752	252,526	443,822
1996	976,622	2,135,589	287,870	441,687
1995	470,014	1,033,566	187,622	258,400

1994	514,285	996,796	110,661	149,076
1993	923,617	1,930,131	199,734	267,927
1992	941,360	1,781,200	171,826	235,990
1991	1,388,501	2,532,569	181,826	256,087
1990	1,009,092	1,802,780	216,855	302,677
1989	1,611,425	3,046,556	n.d.[1]	n.d.
1988	1,859,077	3,440,432	n.d.	n.d.
1987	2,735,351	5,127,120	n.d.	n.d.
1986	3,032,779	4,632,621	n.d.	n.d.
1985	3,919,903	6,097,121	n.d.	n.d.
1984	3,688,682	5,426,619	n.d.	n.d.
1983	5,920,386	8,235,614	n.d.	n.d.
1982	5,000,144	6,579,391	n.d.	n.d.
1981	4,909,109	5,688,463	n.d.	n.d.
1980	3,978,541	5,189,540	n.d.	n.d.
1979	6,071,883	7,887,345	n.d.	n.d.
1978	5,681,248	6,396,897	n.d.	n.d.
1977	7,433,388	7,235,182	n.d.	n.d.
1976	7,767,943	6,561,753	n.d.	n.d.
1975	7,488,135	5,248,397	n.d.	n.d.
1974	6,583,211	4,398,353	n.d.	n.d.

[1]n.d. = no data.

Source: NOAA Foreign Trade Database (NOAA 2021a).

Commercial Landings

Spotted wolffish have a wide distribution (Robbins and Ray 1986) and are harvested by Norway and Iceland in the eastern Atlanta. They are not harvested in Canada, and no substantial landings have ever been reported in the U.S. (LeFrancois et al. 2021). Wolffish have been designated as threatened by the COSEWIC (Committee on Status of Endangered Wildlife) in Canada. There is some incidental bycatch of Atlantic wolffish, a closely related species, in the Gulf of Maine. Since the 1999 listing of spotted wolffish as a species of concern in U.S., there have not been any more commercial landings (AWBRT 2009).

Commercial Fisheries Regulations

Commercial harvest of spotted wolffish is prohibited in U.S. waters (Fairchild 2019).

Recreational Landings

No data were found on recreational landings of spotted wolffish.

Recreational Fisheries Regulations

Recreational harvest of spotted wolffish is prohibited in U.S. waters (Fairchild 2019).

Appendix Q. Striped Bass (*Morone saxatilis*)

Striped bass (*Morone saxatilis*), also known as striper, linesider, and rockfish, is a popular game and foodfish in the United States. It is commonly found along the Atlantic Coast, ranging from Canada to Florida (Andersen et al. 2021) and a separate strain, referred to as Gulf Coast striped bass, can be found in the Gulf of Mexico. Commercial and recreational fisheries for striped bass date back to pre-colonial times. The striped bass fishery is principally a recreational fishery that accounts for 60% to 70% of the total catch, with the remaining 30% to 40% from commercial landings.

The striped bass fishery collapsed in the 1980s, and a moratorium declared in 1989. Stocks had recovered substantially by 1995, with total landings increasing from 3.3 million pounds to 6.0 million pounds by 2019. The fisheries was then declared overfished and closed from the Oregon inlet to the South Carolina state line (Seafood Watch: Striped Bass 2020). Striped bass have also been widely introduced to inland recreational fisheries across the U.S. Harvest of striped bass is regulated federally in state waters, with commercial quotas divided among individual states and between the Atlantic Ocean and Chesapeake Bay. Wild-caught striped bass are caught fresh or frozen and in either whole or filleted forms.

Aquaculture

Culture of striped bass began in the 1970s, but did not evolve into a farmed industry. There has been little farmed production of striped bass globally. Earliest reported farm production was 6,614 pounds annually in 2005 and 2006 in Mexico, with no further reports of production until 2014. From 2014 to 2019, volumes of farmed striped bass have ranged from approximately 450,000 lb a year to 1 million lb a year (FAO 2021a) (Figure 88; Table 99). Most of the production in 2019 was in Mexico with some minimal production in Palestine. In North America, there is one farm in Mexico that raises striped bass in floating net pens (Seafood Watch: Striped Bass 2020). Production from this farm was 1.2 million pounds in 2018, all of which were exported to the U.S. While striped bass are not native to the Pacific Ocean, they were introduced to California in the 1880s and stocked by the California Department of Fish and Wildlife until 2000. Striped bass have already been raised experimentally in RAS, reaching 3 lb in 18 months and 5 lb in 24 months. Available seasonally in markets, striped bass sell for $2.95 to $4.60/lb (Andersen et al. 2021).

Hybrid striped bass (*Morone chrysops* x *Morone saxatilis*), a cross between the white and striped bass, have been farmed commercially since the 1980s collapse of the wild Chesapeake Bay striped bass fishery. Hybrid striped bass, however, are sold as a different product, at a smaller size of 1.5 to 2.0 lb at a price of $3.83 to $4.20/lb (Andersen et al. 2021).

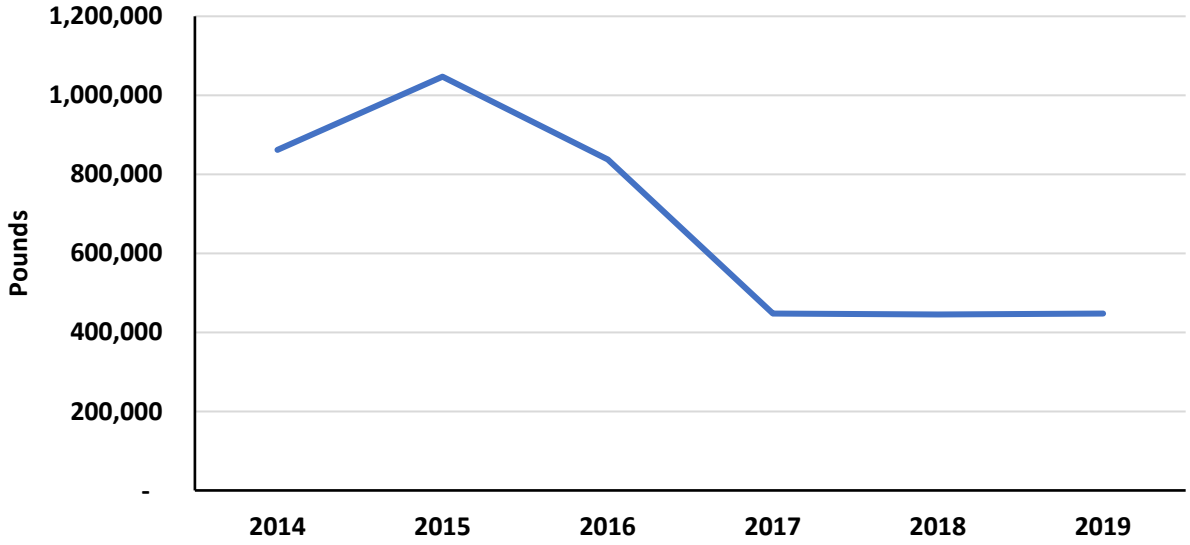

Figure 88. Global farmed production of striped bass, 2014-2019. Source: FAO Global Aquaculture Production Database (FAO 2021a).

Table 99. Global farmed production of striped bass, 2014-2019.

Year	Quantity (lb)
2019	447,538
2018	445,333
2017	447,538
2016	837,756
2015	1,047,195
2014	862,006

Source: FAO Global Aquaculture Production database (FAO 2021a).

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of striped bass. In California, farmed hybrid striped bass must be either tagged or packaged according to regulations to ensure that fish were not caught from the wild. It is likely that similar requirements would be enacted for farmed striped bass in California and other states. State laws on marine gamefish have constrained aquaculture of various marine fish species.

Import/Export of Striped Bass

Striped bass do not fall under the NOAA Foreign Trade Database category for "Bass." As such, no information is available on striped bass imports.

Commercial Landings

Commercial landings of striped bass have decreased since 1950 and have steadily remained under 10 million pounds since the mid-1970s (Figure 89; Table 100). In 2019, commercial landings were 4.5 million pounds, valued at $16.6 million. The top states for commercial striped bass landings were Maryland (39%) with 1.7 million pounds, followed by Virginia (31%), and Massachusetts(13%) (Table 101).

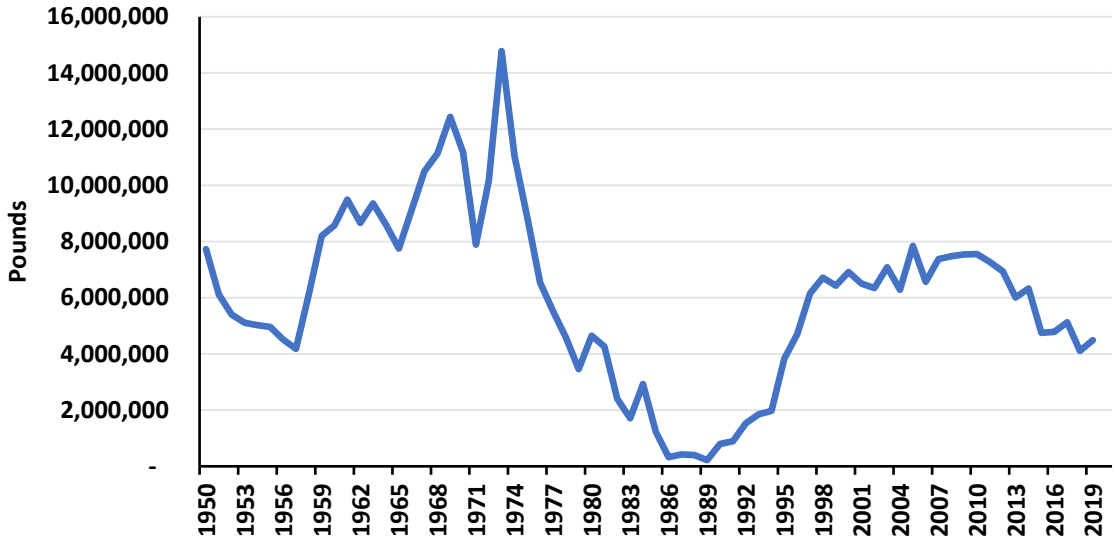

Figure 89. Total commercial U.S. striped bass landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 100. Total commercial U.S. striped bass landings (1950-2019).

	Commercial landings			Commercial landings	
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	4,487,603	16,603,648	1984	2,929,690	4,097,655
2018	4,105,322	17,095,073	1983	1,709,709	3,078,601
2017	5,127,491	22,555,991	1982	2,407,746	4,178,437
2016	4,786,202	19,108,475	1981	4,261,724	5,671,211
2015	4,753,274	17,027,328	1980	4,650,412	5,419,022
2014	6,329,439	22,123,543	1979	3,457,384	4,148,117
2013	6,008,911	22,258,752	1978	4,587,764	4,788,652
2012	6,940,077	18,764,796	1977	5,519,300	3,820,802
2011	7,266,781	17,982,340	1976	6,538,000	3,796,963

2010	7,555,083	17,039,729	1975	8,850,700	4,149,126
2009	7,540,929	15,942,710	1974	11,052,000	3,351,425
2008	7,476,922	15,794,622	1973	14,780,000	4,682,414
2007	7,378,123	15,822,328	1972	10,164,300	2,790,331
2006	6,566,182	14,425,897	1971	7,890,300	2,139,972
2005	7,843,326	15,793,216	1970	11,186,100	2,528,033
2004	6,280,511	11,382,209	1969	12,436,900	2,493,911
2003	7,084,398	12,739,758	1968	11,129,900	2,283,261
2002	6,346,119	11,058,311	1967	10,501,200	1,729,207
2001	6,503,077	11,549,463	1966	9,125,100	1,655,567
2000	6,917,943	12,261,144	1965	7,753,400	1,458,930
1999	6,430,034	10,633,533	1964	8,606,400	1,378,557
1998	6,713,764	9,709,650	1963	9,357,200	1,313,392
1997	6,155,042	8,951,527	1962	8,665,600	1,345,473
1996	4,703,898	8,046,563	1961	9,493,800	1,268,832
1995	3,829,738	5,847,404	1960	8,580,800	1,337,436
1994	1,971,114	3,461,491	1959	8,204,200	1,435,258
1993	1,851,563	3,531,226	1958	6,113,640	1,286,052
1992	1,526,343	2,568,094	1957	4,179,300	902,076
1991	891,075	1,525,653	1956	4,513,500	976,455
1990	798,795	1,172,506	1955	4,964,300	1,114,384
1989	221,230	324,190	1954	5,023,600	1,060,461
1988	400,945	510,570	1953	5,111,600	1,120,263
1987	424,793	477,903	1952	5,398,300	1,173,760
1986	327,721	339,468	1951	6,116,600	1,299,857
1985	1,231,888	1,687,662	1950	7,731,100	1,369,181

Source: NOAA Landings Database (NOAA 2021b).

Table 101. Top states for commercial striped bass landings, 2019.

Rank	Commercial landings	
	State	Volume (lb)
1.	Maryland	1,747,499
2.	Virginia	1,389,039
3.	Massachusetts	586,128
4.	New York	347,884
5.	Rhode Island	144,227

Source: NOAA Landings Database (NOAA 2021b)

Commercial Fisheries Regulations

Striped bass is managed by the Atlantic States Marine Fisheries Commission under the Interstate Fishery Management Plan for Atlantic Striped Bass (Table 102) (ASMFC 2019b). Federal conservation and management efforts are also directed by the Atlantic Striped Bass Conservation Act and the Atlantic Coastal Fisheries Cooperative Act (16 USC §5151; 16 USC §5101). The commercial catch quota is divided between states and between the ocean stock and the Chesapeake Bay stock in Maryland and Virginia. Commercial fishing is closed in federal waters.

Table 102. Commercial regulations for striped bass in state waters.

State	Ocean commercial quota	Notes
Maine	154 lb	Commercial harvest/sale prohibited
New Hampshire	3,537 lb	Commercial harvest/sale prohibited
Massachusetts	713,247 lb	
Rhode Island	148,889 lb	
Connecticut	14,607 lb	Commercial quota re-allocated to recreational sector
New York	652,552 lb	
New Jersey	197,877 lb	Commercial quota re-allocated to recreational sector
Delaware	118,970 lb	
Maryland	74,396 lb	
Virginia	113,685 lb	
North Carolina	295,495 lb	
Chesapeake Bay Total	2,588,603 lb	Minimum Size: 18”
Ocean Total	2,333,408 lb	

Source: ASMFC (2019b).

Recreational Landings

Recreational landings of striped bass increased steadily from the late 1980s to their peak in 2013 and have since declined (Figure 90; Table 103). Recreational landings in 2019 were 37% of those in 2013. The top three states for recreational landings in 2019 were: New York (30%), New Jersey (29%), and Maryland (14%) (Table 104). Additional landings were reported in: Connecticut, Delaware, Georgia, Louisiana, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Rhode Island, and Virginia.

Recreational landings of striped bass were the greatest of all the species considered for this report. Moreover, recreational landings were 5.3 times greater than those of commercial landings in 2019 for striped bass.

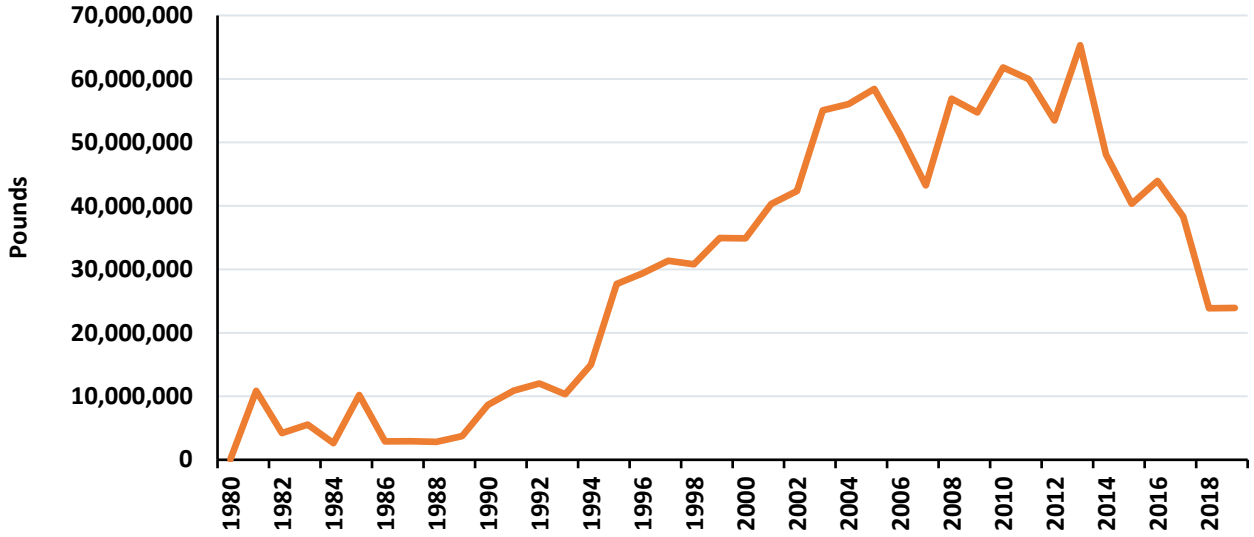

Figure 90. Total recreational U.S striped bass landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 103. Total recreational U.S. striped bass landings.

Recreational landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	23,920,966	1999	34,938,189
2018	23,882,299	1998	30,810,917
2017	38,324,459	1997	31,354,089
2016	43,937,933	1996	29,355,798
2015	40,341,698	1995	27,706,514
2014	48,130,394	1994	14,975,965
2013	65,310,895	1993	10,334,472
2012	53,454,731	1992	12,032,361
2011	59,962,270	1991	10,895,367
2010	61,813,346	1990	8,656,843
2009	54,711,875	1989	3,737,333
2008	56,898,935	1988	2,810,748
2007	43,235,752	1987	2,914,656
2006	51,274,113	1986	2,888,772
2005	58,423,418	1985	10,210,351
2004	56,036,804	1984	2,614,067
2003	55,060,726	1983	5,537,930
2002	42,345,185	1982	4,208,527
2001	40,297,207	1981	10,875,490
2000	34,880,341		

Source: NOAA Landings Database (NOAA 2021b).

Table 104. Top states for recreational striped bass landings, 2019.

Rank	Recreational Landings	
	State	Volume (lb)
1.	New York	7,072,422
2.	New Jersey	6,674,370
3.	Maryland	3,152,849
4.	Massachusetts	2,697,766
5.	Rode Island	2,299,617

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Striped bass is managed by the Atlantic States Marine Fisheries Commission under the Interstate Fishery Management Plan for Atlantic Striped Bass (ASMFC 2019b). Federal conservation and management efforts are also directed by the Atlantic Striped Bass Conservation Act and the Atlantic Coastal Fisheries Cooperative Act (16 USC §5151; 16 USC §5101). In state waters, recreational harvest is limited to 1 fish per person per day and a size limit of 28 to 35 inches. Recreational fishing is closed in federal waters.

Appendix R. Summer Flounder (*Paralichthys dentatus*)

Summer flounder, also known as flounder, fluke, northern fluke, and hirame, is one of the most commercially and recreationally sought-after fish along the Atlantic Coast. It is commonly found from Maine to Florida. It is federally managed under an interstate fishery management plan with several states having stricter regulations and unique recreational regulations. There are also recreational harvest limits and commercial quotas in place.

Aquaculture

Globally, there were 33,000 pounds of generic flatfish farmed in 2019, a nearly four-fold increase over the 2015 production of 8,820 pounds (FAO 2021a). The FAO data do not report farmed flatfish or flounder production by species.

The 2013 and 2018 Censuses of Aquaculture (USDA-NASS 2014, 2019) indicated that there was some farmed production of flounder in the U.S. in Florida, Missouri, and Nebraska, but did not specify species or provide production volumes for confidentiality reasons.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of summer flounder.

Import/Export of Summer Flounder

Little data were found on imports of specific species of flounder. However, large volumes of un-specified species of flounder are imported into the U.S., mostly as frozen product. Total imported volumes of frozen flounder products in 2019 were 21.9 million lb. The NOAA Foreign Trade Database utilizes a single category titled “Flatfish Flounder,” which does not specify individual species. The NOAA data on “Flatfish Flounder” is available in Appendix U.

Commercial Landings

Summer flounder is caught only in the U.S. It is not currently overfished nor is overfishing occurring (Seafood Watch: Summer Flounder 2019). Commercial landings of summer flounder peaked in the mid-1980s (Figure 91; Table 105). While commercial landings have exhibited fluctuations of more than 15 million lb over cycles, there was no clear upwards or

downwards trend of commercial landings through 2013. The 2013 peak was much lower than the 1979 peak of 39.9 million pounds followed by subsequent declines to 7.0 million pounds in 2019. The top states for commercial landings of summer flounder were Virginia (27%), Rhode Island (24%), and New Jersey (23%) (Table 106).

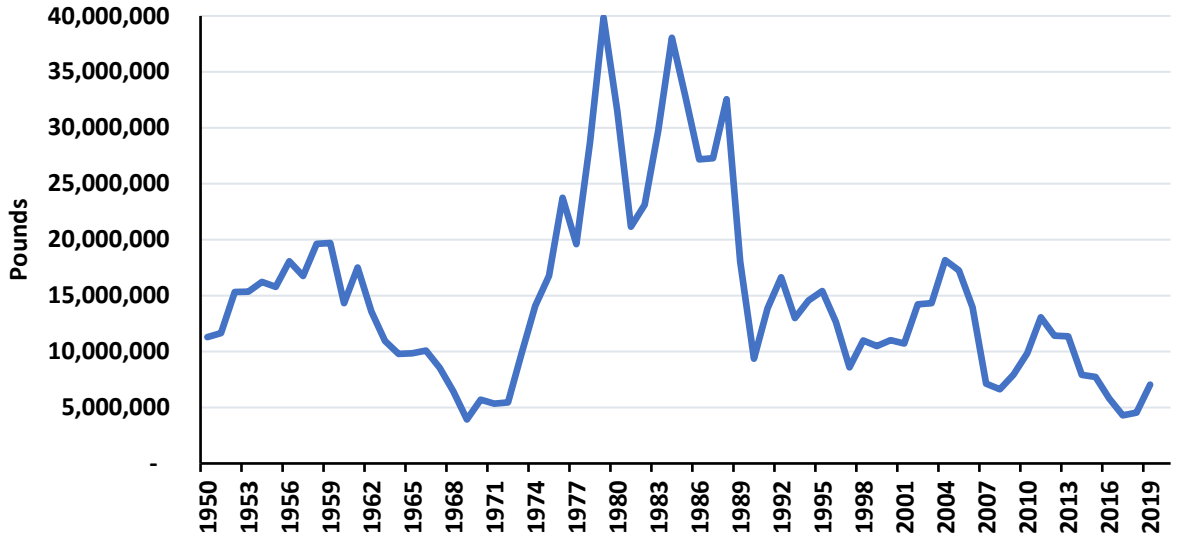

Figure 91. Total commercial U.S summer flounder landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 105. Total commercial U.S. summer flounder landings (1950-2019).

	Commercial landings			Commercial landings	
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	7,044,897	22,744,552	1984	38,047,130	26,133,714
2018	4,536,223	19,536,376	1983	29,769,779	20,075,545
2017	4,297,757	18,903,890	1982	23,112,585	16,754,748
2016	5,808,004	22,537,718	1981	21,160,200	14,698,916
2015	7,732,564	24,365,275	1980	31,490,667	16,191,097
2014	7,914,414	23,941,165	1979	39,853,819	21,001,026
2013	11,367,456	27,245,598	1978	28,669,465	16,456,957
2012	11,413,556	27,416,515	1977	19,595,000	10,193,779
2011	13,058,621	25,638,910	1976	23,741,000	10,702,110
2010	9,852,881	21,369,797	1975	16,772,300	6,645,711
2009	7,934,754	16,837,778	1974	14,073,300	4,231,095
2008	6,625,790	16,687,560	1973	9,842,200	3,578,168
2007	7,131,035	17,482,425	1972	5,461,500	2,069,396
2006	13,959,339	29,764,388	1971	5,348,400	1,835,786
2005	17,259,905	30,455,184	1970	5,696,900	1,902,803

2004	18,169,115	29,203,555	1969	3,928,800	1,402,616
2003	14,328,181	23,188,120	1968	6,450,000	2,009,324
2002	14,227,332	21,071,477	1967	8,539,200	2,250,693
2001	10,715,630	17,331,869	1966	10,092,700	2,303,842
2000	11,019,193	19,692,892	1965	9,842,700	2,251,614
1999	10,490,449	18,962,932	1964	9,787,600	2,413,105
1998	10,984,277	19,396,227	1963	10,942,300	2,781,621
1997	8,591,554	16,061,323	1962	13,586,900	2,959,672
1996	12,656,451	20,598,368	1961	17,507,200	3,024,365
1995	15,410,322	27,509,727	1960	14,327,300	2,382,138
1994	14,572,895	24,226,621	1959	19,701,000	3,364,668
1993	13,000,319	19,344,682	1958	19,631,900	3,444,783
1992	16,635,703	23,058,053	1957	16,749,500	2,973,292
1991	13,868,625	19,098,509	1956	18,071,500	2,999,173
1990	9,363,357	16,482,383	1955	15,785,000	2,842,899
1989	18,037,003	28,184,549	1954	16,231,200	2,715,399
1988	32,558,749	40,800,843	1953	15,355,100	2,724,589
1987	27,286,622	38,213,425	1952	15,331,500	2,863,244
1986	27,173,410	32,962,414	1951	11,655,100	2,298,363
1985	32,706,142	31,310,296	1950	11,296,500	1,897,140

Source: NOAA Landings Database (NOAA 2021b).

Table 106. Top states for commercial summer flounder landings, 2019.

Rank	State	Volume (lb)
1.	Virginia	1,918,045
2.	Rhode Island	1,661,014
3.	New Jersey	1,598,740
4.	New York	866,403
5.	Massachusetts	551,267

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Summer flounder is jointly managed by NOAA Fisheries, the Mid-Atlantic Fishery Management Council (ASMFC), and the Atlantic States Marine Fisheries Commission under the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan (ASMFC 2018b). Annual set limits have been in place since 1993 divided into 60% commercial and 40% recreational (ASMFC 2015). Commercial harvest is subject to annual quotas with no federal possession limits and a minimum size limit of 14 inches. The annual commercial quota is 11.53 million pounds. The annual quota is divided into percentage shares for each state with 2020 quotas for each state (Table 107).

Table 107. Commercial quotas for summer flounder.

State	2020 Quota (lb)
ME	5,484
NH	53
MA	786,399
RI	1,808,248
CT	260,241
NY	881,698
NJ Coast & DE Bay	1,928,391
DE	2,051
MD	235,108
VA	2,457,822
NC	3,164,505

Source: ASMFC (2018b).

Recreational Landings

Recreational landings data for summer flounder were available only from 1985 on and demonstrated a roughly 10-year cycle (Figure 92; Table 108) and entered a declining period from 2016. The top three states for recreational landings of summer flounder were: New Jersey (41%), followed by New York (31%), and Rhode Island (11%) (Table 109). Additional recreational landings were reported in Connecticut, Delaware, Florida, Georgia, Maryland, Massachusetts, New Jersey, North Carolina, South Carolina, and Virginia.

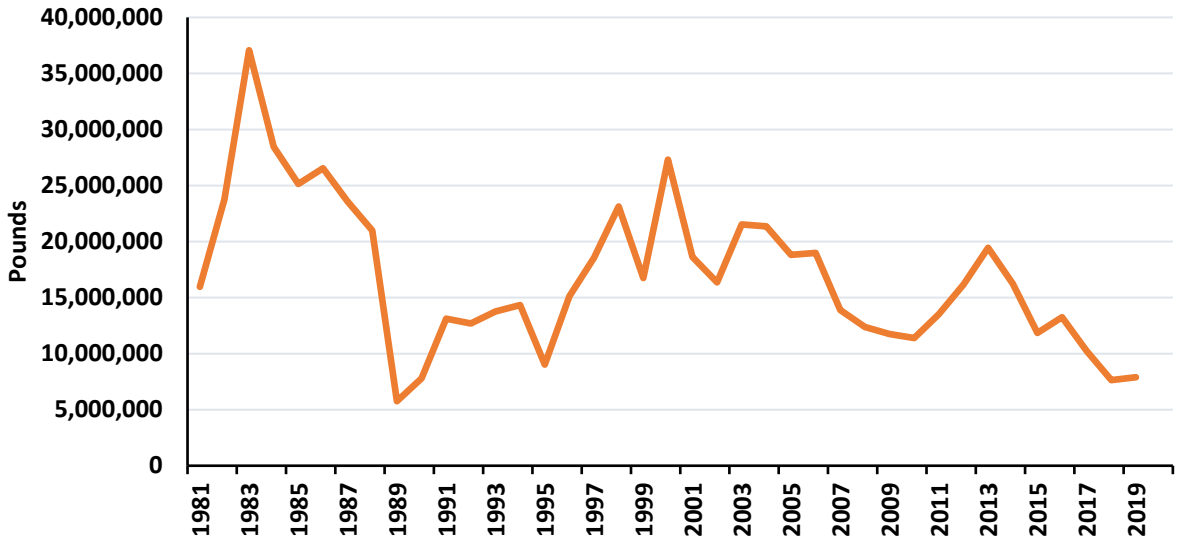

Figure 92. Total recreational U.S. summer flounder landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 108. Total recreational U.S. summer flounder landings (1981-2019).

Recreational Landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	7,892,407	1999	16,752,437
2018	7,633,649	1998	23,121,170
2017	10,240,294	1997	18,560,983
2016	13,245,352	1996	15,123,052
2015	11,850,428	1995	9,017,784
2014	16,245,251	1994	14,337,218
2013	19,444,937	1993	13,759,124
2012	16,166,299	1992	12,690,658
2011	13,524,151	1991	13,114,361
2010	11,387,093	1990	7,800,763
2009	11,743,563	1989	5,754,371
2008	12,373,692	1988	20,982,249
2007	13,897,596	1987	23,566,482
2006	18,982,020	1986	26,532,838
2005	18,810,600	1985	25,142,687
2004	21,350,468	1984	28,450,323
2003	21,532,659	1983	37,070,005
2002	16,358,833	1982	23,776,478
2001	18,628,752	1981	15,966,477
2000	27,308,125		

Source: NOAA Landings Database (NOAA 2021b).

Table 109. Top states for recreational summer flounder landings, 2019.

Rank	State	Volume (lb)
1.	New Jersey	3,229,094
2.	New York	2,441,758
3.	Rhode Island	837,116
4.	Virginia	368,959
5.	Connecticut	292,457

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Summer flounder is jointly managed by NOAA Fisheries, the Mid-Atlantic Fishery Management Council and the Atlantic States Marine Fisheries Commission under the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan, limiting recreational harvest to 7.7 million pounds (ASMFC 2018b). State recreational regulations conform to the federal fishery management plan with the exception of Maine and New Hampshire (Table 110). Recreational harvest in state waters is regulated by individual states and regulations often

group several species of flounder together (i.e. southern, summer, & Gulf). The minimum size varies by state, with typical bag limits of 10 per person per day, and a year-round open season, with some exceptions.

Table 110. Recreational fishing regulations for summer flounder.

State	Minimum size	Daily bag limit	Open season	Managing agency
ME	12”	8	Year Round	MAFMC &
NH	15”	n/a	Year Round	ASMFC
MA	17”	5	May 23–Oct 9	under the
RI	19”	6	May 1–Dec 31	Summer
CT	19”	4	May 4–Sep 30	Flounder,
NY	19”	4	May 4–Sep 30	Scup, and
NJ Coast	18”	3	May 25–Sep 22	Black Sea Bass Fishery
NJ DE Bay	17”	3	May 25–Sep 22	Management Plan
DE	16.5”	4	Jan1–Dec 31	
MD	17”	4	Jan1–Dec 31	
	16.5”	4	Apr 1–Dec 31	
VA	16.5”	4	Jan1–Dec 31	
NC	15”	4	Jan1–Dec 31	
SC*	15”	10 pp NTE 20 per vessel	Year-round	SCDNR
AL*	14”	5 pp	Closed annually in November	ADCNR
FL*	12” (14” beginning Mar 1, 2021)	10 pp (5 beginning Mar 1, 2021)	Closed Oct 15 -Nov 30	FWC
GA*	12”	15 pp	Year-round	GADNR
MS*	12”	10 pp	Year-round	MDMR

*Regulations apply to all flounders (southern, summer, & Gulf). Source: ASMFC (2018b).

Appendix S. Tripletail (*Lobotes surinamensis*)

Tripletail is a warmwater marine finfish found on the Gulf Coast from spring to early fall, and then migrate to warmer waters in the winter. Tripletail harvest is regulated by individual states with sparse commercial regulations. Recreational landings are substantially larger in volume than commercial landings, with the majority of both occurring in Florida.

Aquaculture

There are no reports to date of commercial farmed production of tripletail. Research on culture of tripletail has shown progress in spawning and larval rearing methods. Limited growout trials of tripletail in RAS at low density showed rapid growth to market size of approximately 2.2 pounds. There are no data reported by FAO (2021a) on farmed production of tripletail.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may impact the sale of tripletail.

Import/Export of Tripletail

No data were found on imports or exports of tripletail.

Commercial Landings

Tripletail are distributed widely in all oceans of the world. The largest tripletail fishery is in South America (Guyana, Suriname, and Brazil), of up to 6,600 lb/yr. In the U.S., low-volume commercial landings of tripletail have increased slowly from the late 1960s to 24,242 pounds in 2019 (Figure 93; Table 111). The 2019 landings reached 50% of the previous peak period. In the U.S., tripletail are most abundant along the east coast of Florida that accounts for 67% of all U.S. landings in 2019, followed by North Carolina (13%), and Mississippi (12%) with some additional landings in Alabama and Louisiana (Table 112).

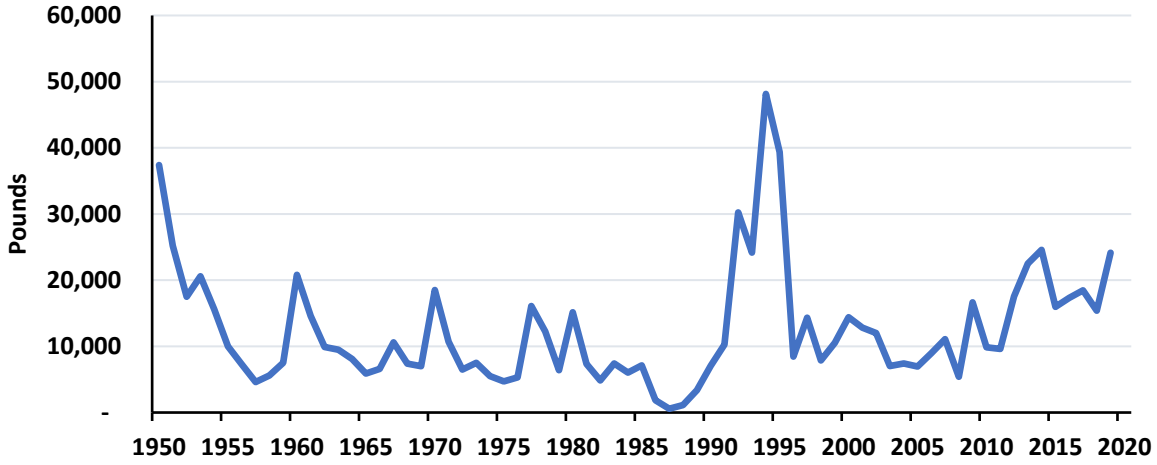

Figure 93. Total commercial U.S. tripletail landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 111. Total commercial U.S. tripletail landings (1950-2019).

	Commercial landings			Commercial landings	
Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	24,142	91,269	1984	6,031	2,207
2018	15,384	51,291	1983	7,422	2,787
2017	18,459	61,192	1982	4,838	1,549
2016	17,321	58,677	1981	7,334	2,405
2015	15,977	49,443	1980	15,139	2,844
2014	24,578	86,514	1979	6,401	1,993
2013	22,500	65,935	1978	12,239	1,974
2012	17,537	43,393	1977	16,100	2,336
2011	9,607	24,242	1976	5,300	911
2010	9,847	30,291	1975	4,700	448
2009	16,658	30,053	1974	5,500	515
2008	5,406	12,447	1973	7,500	716
2007	11,098	23,812	1972	6,500	636
2006	8,955	13,810	1971	10,700	875
2005	6,965	15,277	1970	18,500	1,419
2004	7,410	11,452	1969	7,000	560
2003	7,031	10,953	1968	7,400	546
2002	12,008	16,543	1967	10,600	954
2001	12,824	20,451	1966	6,600	622
2000	14,391	22,433	1965	5,900	363
1999	10,532	13,727	1964	8,100	500
1998	7,877	13,246	1963	9,500	470

1997	14,323	20,365	1962	9,900	636
1996	8,461	11,379	1961	14,600	796
1995	39,349	49,982	1960	20,800	1,323
1994	48,141	57,552	1959	7,500	441
1993	24,157	24,499	1958	5,600	289
1992	30,227	29,962	1957	4,600	312
1991	10,268	9,084	1956	7,300	573
1990	7,062	4,196	1955	10,000	1,024
1989	3,385	1,930	1954	15,600	1,862
1988	1,136	589	1953	20,600	1,720
1987	573	209	1952	17,500	1,411
1986	1,848	863	1951	25,200	2,167
1985	7,119	2,698	1950	37,400	3,378

Source: NOAA Landings Database (NOAA 2021b).

Table 112. Top states for commercial tripletail landings, 2019.

Rank	State	Volume (lb)
1.	Florida	16,249
2.	North Carolina	3,213
3.	Mississippi	3,014
4.	Louisiana	1,083
5.	Alabama	583

Source: NOAA Landings Database (NOAA 2021b)

Commercial Fisheries Regulations

Tripletail is not managed federally. Instead, individual states have various regulations for commercial and recreational harvest (Table 113). Commercial regulations for tripletail also vary by state with year-round seasons and minimal trip limits for harvest.

Table 113. Commercial fisheries regulations for tripletail.

State	Annual catch limit	Trip limit	Season	Managing agency
MS	n/a	3/ vessel	Year-round	MDMR
LA	n/a	100 lb	Year-round	LDWF
FL	n/a	10/ vessel	Year-round	FWC

Source: FWC 2021c; LDWF 2021b; MDMR 2021a.

Recreational Landings

Recreational landings of tripletail peaked in 2000, and subsequently declined with evidence of a slight upward trend since about 2015 (Figure 94; Table 114). Nevertheless, the recreational

landings in 2019 were 35% of those of the peak landings in 2000. The major states for recreational landings of tripletail in 2019 were Florida (75%), Alabama (12%), and Mississippi (6%), with additional landings in Louisiana, North Carolina, and South Carolina (Table 115).

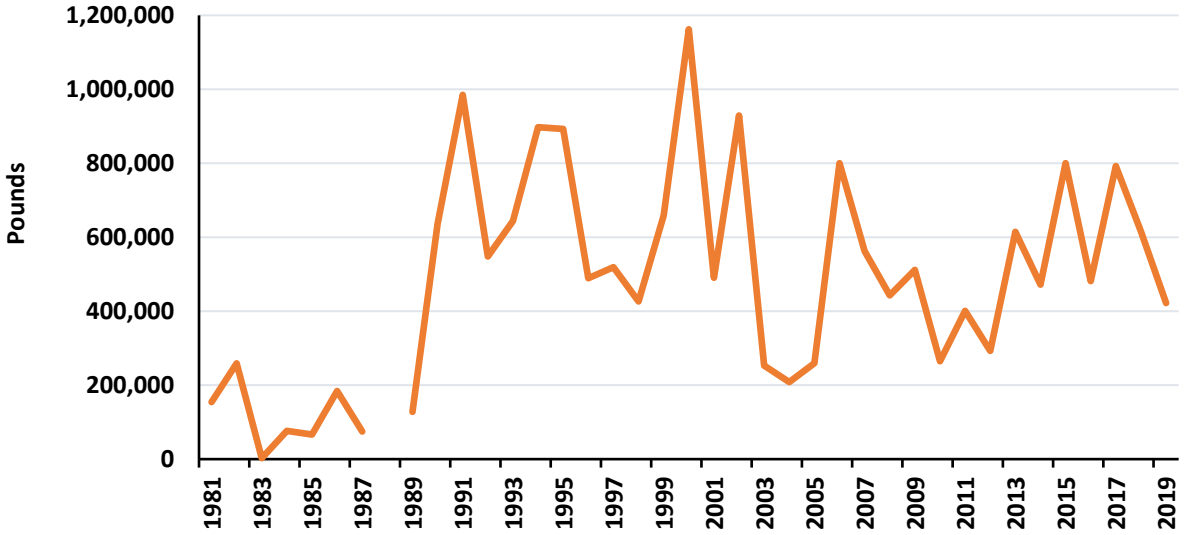

Figure 94. Total recreational U.S. tripletail landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 114. Total recreational U.S. tripletail landings (1981-2019).

		Recreational landings	
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	422,066	1999	658,883
2018	615,461	1998	426,414
2017	792,238	1997	519,178
2016	481,531	1996	489,144
2015	800,093	1995	892,723
2014	471,695	1994	897,486
2013	614,398	1993	644,229
2012	292,866	1992	548,081
2011	400,692	1991	984,928
2010	264,398	1990	636,357
2009	511,530	1989	127,690
2008	442,878	1988	n.d.[1]
2007	562,261	1987	74,658
2006	800,060	1986	183,964
2005	259,312	1985	66,404
2004	208,473	1984	76,538
2003	252,763	1983	2,535
2002	929,007	1982	258,909

2001	490,519	1981	154,183
2000	1,162,289		

[1]n.d. = no data.
Source: NOAA Landings Database (NOAA 2021b).

Table 115. Top states for recreational tripletail landings, 2019.

Rank	State	Volume (lb)
1.	Florida	318,672
2.	Alabama	48,764
3.	Mississippi	25,560
4.	South Carolina	19,473
5.	Louisiana	9,306

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Tripletail is not managed federally. Instead, individual states have various regulations for commercial and recreational harvest (Table 116). The recreational harvest is open year-round in all states with a minimum size of 18" and a daily bag limit ranging from 2 to 5 fish per person.

Table 116. Recreational fisheries regulations for tripletail.

State	Minimum size	Daily bag limit	Open season	Managing agency
GA	18"	2 pp	Year round	GADNR
AL	18"	3pp	Year round	ADCNR
MS	18"	3pp	Year round	MDMR
SC	18"	3pp	Year round	SCDNR
LA	18"	5pp	Year round	LDWF
FL	18"	2pp	Year round	FWC

Source: ADCNR (2021); FWC (2021c); GADNR (2021); LDWF (2021a); MDMR (2021); SCDNR (2021).

Appendix T. White Seabass (*Atractoscion nobilis*)

White Seabass, also known as white weakfish, is a species of croaker distributed along the Pacific Coast of North America from Alaska to California. Commercial and recreational harvest is regulated in California under a fishery management plan.

Aquaculture

Culture of white sea bass initially emphasized production for stock enhancement (Drawbridge et al. 2021). The hatchery developed to support stock enhancement of white sea bass was credited with serving as a springboard for hatchery research on other species that included California halibut and California yellowtail (*Seriola dorsalis*) (California Sea Grant 2017). White sea bass broodstock from the hatchery are acclimated to ocean net pens. White seabass juveniles are reared in three coastal cages by Hubbs-Sea World. Fingerlings are produced in RAS, but commercial growout of white sea bass likely would be in net pens, although pond production methods similar to those used for red drum might be feasible. There are no data reported by FAO (2021a) on farmed production of white seabass.

Aquaculture Regulations

Regulations by state and federal agencies have constrained development of offshore aquaculture of marine finfish (Engle and Stone 2013). An executive order in May, 2020, however, mandated changes to the regulatory system for commercial aquaculture to streamline the process including development of nationwide permits and identification of aquaculture opportunity areas (85 C.F.R. § 28471). This order may impact the future of finfish regulations in the U.S. Additionally, several states in the Southeast U.S. prohibit the sale of gamefish, which may affect sales of white sea bass.

Import/Export of White Sea Bass

No data were found on imports or exports of white sea bass. While Mexico is a potential international source of white seabass, exports from Mexico appear to be negligible. NMFS data do not differentiate between various species of seabass or grouper.

The NOAA Foreign Trade Database utilizes a single category titled “Bass,” which does not specify individual species, but does include freshwater and sea bass. The import information for this category can be found in Appendix U. It should also be noted that the NOAA Foreign Trade Database includes a category entitled “sea bass (Dicentrarchus spp).” This category includes fish in the *Dicentrarchus* genus, including European and spotted seabass. Black sea bass and white sea bass are not included in “sea bass” category.

Commercial Landings

There has been a commercial fishery for white sea bass since the 1890s (Seafood Watch White Seabass and California Yellowtail 2018), with commercial landings of white sea bass peaking in 1959 at 3.4 million pounds (Figure 95; Table 117). By 1980 to 1981, the fishery had collapsed to 10% of its historic catch (Allen et al. 2017). Landings remained low for the next 15 years. In 1983, California passed legislation to fund research for aquaculture for stock enhancement. The technology for hatchery production of white sea bass is now well developed. California is the only state with commercial landings of white sea bass (Table 118).

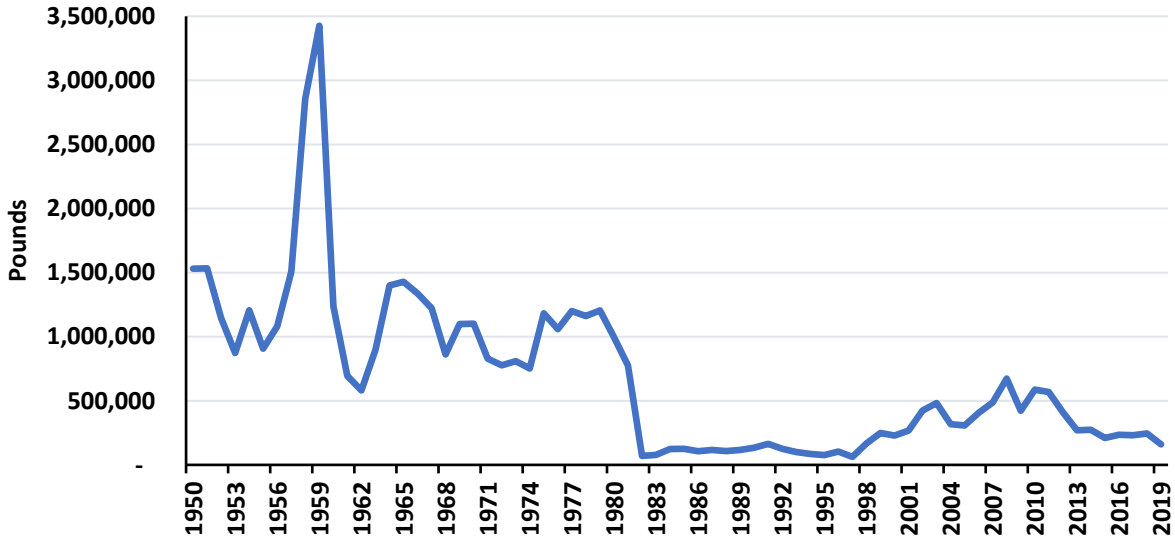

Figure 95. Total commercial U.S. white sea bass landings (1950-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 117. Total commercial U.S. white sea bass landings (1950-2019).

Year	Volume (lb)	Dollars	Year	Volume (lb)	Dollars
2019	160,717	734,913	1984	124,056	237,973
2018	244,492	988,808	1983	78,096	144,192
2017	231,044	910,648	1982	70,862	127,228
2016	235,674	851,956	1981	776,095	1,059,152
2015	210,762	898,821	1980	997,292	1,201,800
2014	273,593	1,134,702	1979	1,205,519	1,274,824
2013	269,845	1,026,343	1978	1,160,800	997,234
2012	410,941	1,407,831	1977	1,199,800	885,939
2011	569,012	1,635,508	1976	1,058,700	670,768
2010	587,311	1,575,566	1975	1,182,400	663,997
2009	421,744	897,742	1974	752,400	456,213
2008	673,732	1,507,345	1973	809,000	474,991

2007	487,441	1,156,646	1972	777,400	393,155
2006	406,311	805,303	1971	829,100	328,050
2005	307,544	762,954	1970	1,101,400	386,164
2004	317,465	612,265	1969	1,098,700	351,464
2003	482,618	771,727	1968	861,900	259,242
2002	424,195	727,084	1967	1,222,800	342,930
2001	267,322	494,724	1966	1,337,800	375,161
2000	228,843	438,372	1965	1,428,100	315,286
1999	249,440	418,609	1964	1,400,200	309,717
1998	168,286	314,548	1963	898,300	242,140
1997	62,333	127,648	1962	581,100	177,040
1996	103,501	197,237	1961	695,000	216,622
1995	76,134	162,950	1960	1,236,800	312,042
1994	84,692	150,642	1959	3,426,200	463,663
1993	100,178	205,442	1958	2,856,200	396,401
1992	125,157	263,008	1957	1,507,100	276,325
1991	163,772	341,619	1956	1,081,300	256,421
1990	133,685	287,039	1955	906,300	216,149
1989	116,022	250,288	1954	1,206,100	250,694
1988	107,616	219,860	1953	873,400	245,089
1987	116,490	223,468	1952	1,147,000	354,103
1986	106,675	215,365	1951	1,533,000	364,620
1985	125,380	242,820	1950	1,531,300	321,572

Source: NOAA Landings Database (NOAA 2021b).

Table 118. Top states for commercial white sea bass landings, 2019.

Rank	State	Volume (lb)
1.	California	160,717

Source: NOAA Landings Database (NOAA 2021b).

Commercial Fisheries Regulations

Commercial and recreational harvest of white seabass is regulated in the state of California. The California Fish and Game Commission regulates the white seabass fishery and the California Department of Fish and Game manages it through the White Seabass Fishery Management Plan (CDFG 2002). The commercial season is closed March 15th to June 15th in certain areas. There is a minimum size limit of 28 inches.

Recreational Landings

Recreational landings of white sea bass are minimal compared to commercial landings, ranging between 46,000 and 197,000 since 2005. In 2019, recreational landings were 75,722 pounds, all of which also landed in California (Figure 96; Table 119). California is the only state with recreational landings of white sea bass (Table 120).

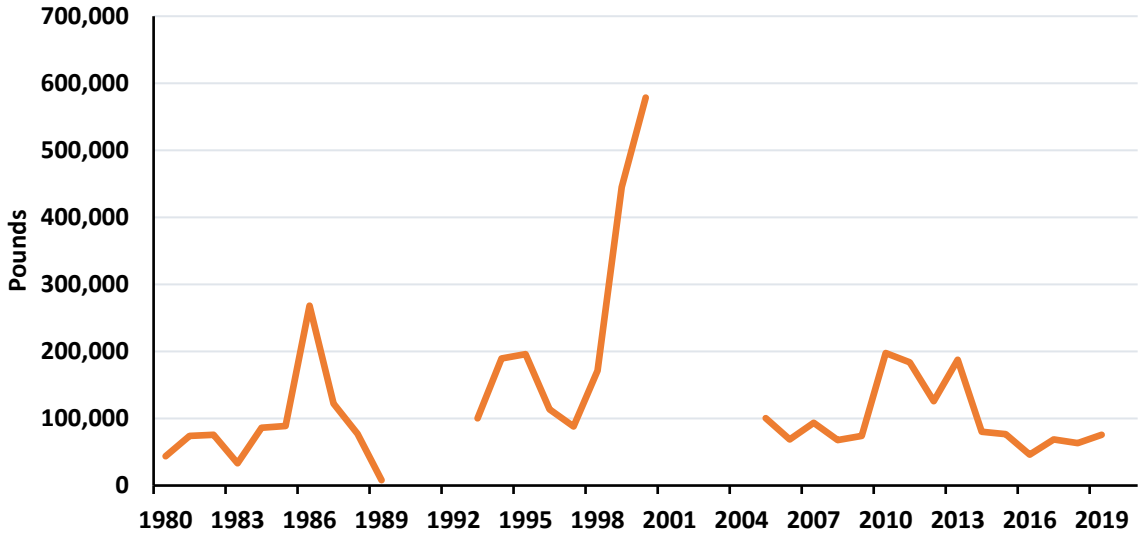

Figure 96. Total recreational U.S. white sea bass landings (1981-2019). Source: NOAA Landings Database (NOAA 2021b).

Table 119. Total recreational U.S. white sea bass landings (1981-2019).

Recreational landings			
Year	**Volume (lb)**	**Year**	**Volume (lb)**
2019	75,722	1999	445,072
2018	63,359	1998	171,436
2017	68,769	1997	88,198
2016	46,015	1996	113,600
2015	76,741	1995	196,020
2014	80,204	1994	189,516
2013	187,503	1993	100,169
2012	125,882	1992	n.d.
2011	183,877	1991	n.d.
2010	197,629	1990	n.d.
2009	74,091	1989	8,005
2008	67,713	1988	77,210
2007	93,547	1987	122,209
2006	68,749	1986	268,345
2005	100,474	1985	88,811

2004	n.d.[1]	1984	86,298
2003	n.d.	1983	33,301
2002	n.d.	1982	75,570
2001	n.d.	1981	73,974
2000	578,621		

[1]n.d. = no data.
Source: NOAA Landings Database (NOAA 2021b)

Table 120. Top states for recreational white sea bass landings, 2019.

	Recreational Landings	
Rank	**State**	**Volume (lb)**
1.	California	75,722

Source: NOAA Landings Database (NOAA 2021b).

Recreational Fisheries Regulations

Commercial and recreational harvest of white seabass is regulated in the state of California. The California Fish and Game Commission regulates the white seabass fishery and the California Department of Fish and Game manages it through the White Seabass Fishery Management Plan (CDFG 2002). The recreational season is open year-round with a minimum size of 28” and a daily bag limit of 3 per person.

Appendix U. Import Data Available in Aggregated Form (Bass, Flounder, and Snapper)

Bass Imports

Imports are reported for fresh product of "Bass" and fresh and frozen "Seabass." Species are not specified, other than that the "Seabass" category includes fish of the Dicentrarchus genus. The greatest volume of bass imports is in the fresh seabass category, at 19.7 million lb in 2019, followed by fresh bass, at 2.2 million lb in 2019, and then frozen seabass with 1.6 million lb in 2019 (Figure 97; Table 121). Fresh seabass imports have increased since 2012 while the other categories show greater fluctuation.

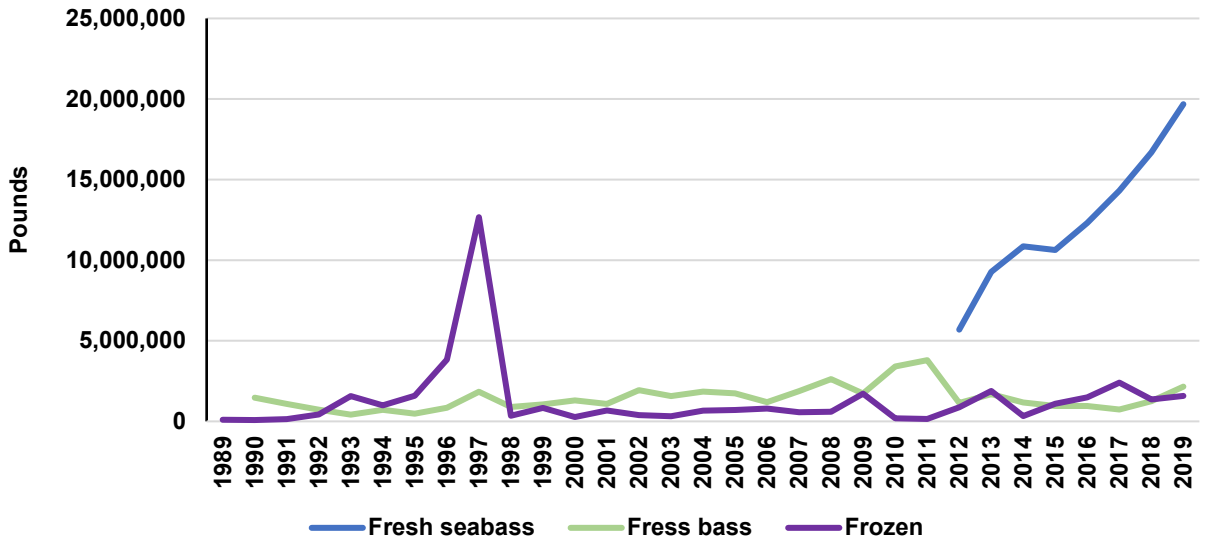

Figure 97. Bass imports (2000-2019). Source: NOAA Foreign Trade Database (NOAA 2021a).

Table 121. Bass and seabass imports, quantity (lb) (2000-2019).

	Bass	Seabass	
	Fresh	Fresh	Frozen
2019	2,158,605	19,679,106	1,579,910
2018	1,254,286	16,688,189	1,356,580
2017	732,779	14,318,420	2,406,087
2016	955,544	12,306,279	1,494,146
2015	956,360	10,628,921	1,093,220
2014	1,175,186	10,863,697	325,858
2013	1,691,334	9,268,851	1,889,216

2012	1,139,464	5,690,764	872,300
2011	3,797,645	n.d.[1]	144,971
2010	3,401,918	n.d.	191,143
2009	1,732,432	n.d.	1,714,813
2008	2,621,311	n.d.	593,087
2007	1,880,197	n.d.	566,080
2006	1,189,516	n.d.	799,717
2005	1,736,939	n.d.	707,840
2004	1,848,195	n.d.	664,854
2003	1,568,975	n.d.	314,745
2002	1,934,470	n.d.	391,805
2001	1,084,514	n.d.	679,087
2000	1,304,811	n.d.	268,688
1999	1,049,046	n.d.	831,417
1998	896,729	n.d.	343,755
1997	1,834,570	n.d.	12,669,034
1996	842,555	n.d.	3,832,677
1995	479,732	n.d.	1,588,116
1994	717,663	n.d.	993,527
1993	417,088	n.d.	1,573,490
1992	728,303	n.d.	424,630
1991	1,080,943	n.d.	137,154
1990	1,467,477	n.d.	82,098
1989	n.d.	n.d.	98,372

[1]n.d.=No data.
Source: NOAA Foreign Trade Database (NOAA 2021a).

Flounder Imports

The majority of flounder imports into the U.S. are frozen fillets, varying from 10 million to 29 million pounds a year between 1990 and 2019 (Figure 98; Tables 122,123). Frozen flounder fillets peaked in 2011 and have shown a generally declining trend since 2011. Imports of fresh and fresh flounder fillets have also shown a generally declining trend, with fresh flounder imports declining from 7.6 million pounds in 1999 to 394,2765 pounds in 2019.

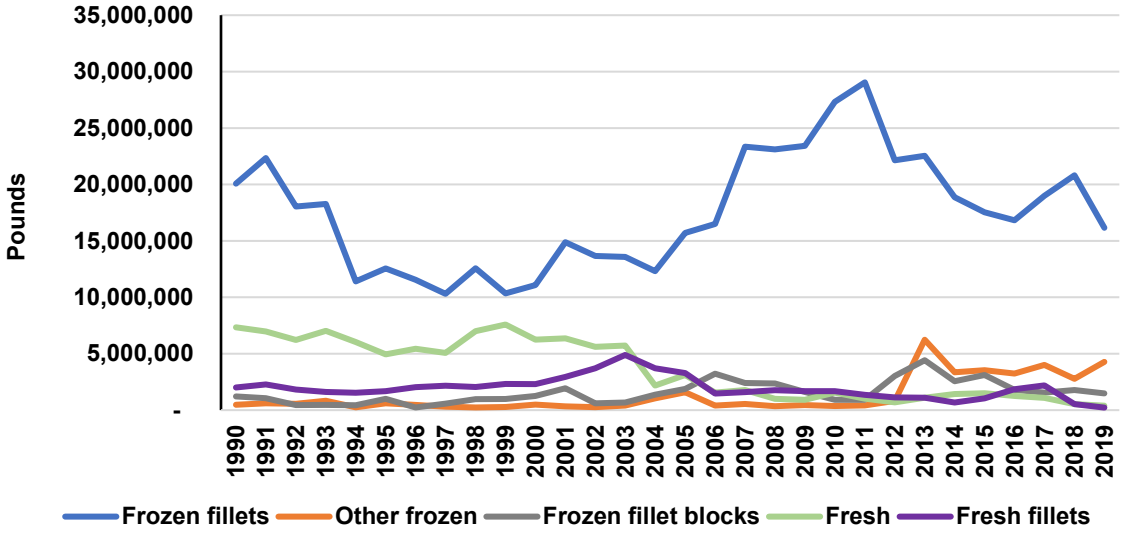

Figure 98. Flounder imports by product type (2000-2019). Source: NOAA Foreign Trade Database (NOAA 2021a).

Table 122. Fresh flounder imports by product type (2000-2019).

Year	Fresh flounder (lb)	Fresh fillet (lb)	Fresh meat (lb)
2019	394,276	223,758	107,339
2018	529,664	530,714	256,935
2017	1,091,543	2,197,246	180,796
2016	1,257,050	1,858,144	416,120
2015	1,495,826	1,050,537	448,578
2014	1,429,782	672,678	623,740
2013	1,103,633	1,101,567	167,020
2012	684,687	1,128,971	1,175,301
2011	1,018,415	1,349,876	n.d.[1]
2010	1,553,616	1,680,357	n.d.
2009	915,632	1,680,716	n.d.
2008	1,007,904	1,764,278	n.d.
2007	1,780,987	1,590,924	n.d.
2006	1,549,799	1,475,056	n.d.
2005	3,120,296	3,277,675	n.d.
2004	2,184,157	3,713,378	n.d.
2003	5,724,611	4,889,999	n.d.
2002	5,604,999	3,708,387	n.d.
2001	6,367,533	2,937,255	n.d.
2000	6,252,715	2,307,076	n.d.
1999	7,586,122	2,319,051	n.d.
1998	6,995,323	2,049,763	n.d.
1997	5,077,884	2,157,737	n.d.
1996	5,446,216	2,041,311	n.d.
1995	4,947,068	1,682,473	n.d.
1994	6,041,957	1,540,441	n.d.

1993	7,030,291	1,608,160	n.d.
1992	6,216,160	1,818,516	n.d.
1991	6,977,860	2,280,920	n.d.
1990	7,338,750	2,009,053	n.d.

[1]n.d. = no data.
Source: NOAA Foreign Trade Database (NOAA 2021a)

Table 123. Frozen flounder imports by product type (2000-2019).

Year	Frozen fillet (lb)	Frozen fillet blocks (lb)	Frozen (lb)
2019	16,156,628	1,483,035	4,281,683
2018	20,813,066	1,779,089	2,773,718
2017	18,990,727	1,558,598	4,007,646
2016	16,819,540	1,792,248	3,240,756
2015	17,536,998	3,117,516	3,539,584
2014	18,869,953	2,565,604	3,359,859
2013	22,536,690	4,422,653	6,238,365
2012	22,149,334	3,024,320	815,205
2011	29,049,288	911,282	419,164
2010	27,320,035	915,782	365,486
2009	23,415,615	1,607,496	443,018
2008	23,101,505	2,364,623	348,246
2007	23,343,936	2,411,581	543,560
2006	16,495,022	3,230,818	400,725
2005	15,705,382	1,873,464	1,580,322
2004	12,311,350	1,374,684	1,046,897
2003	13,572,803	680,341	406,711
2002	13,658,207	610,737	261,620
2001	14,885,550	1,941,719	338,092
2000	11,089,530	1,251,838	495,376
1999	10,340,312	993,578	281,457
1998	12,578,706	978,066	237,989
1997	10,308,300	569,004	313,389
1996	11,545,110	236,670	467,887
1995	12,559,224	1,004,246	609,727
1994	11,411,940	438,481	249,563
1993	18,277,281	468,541	826,322
1992	18,047,884	453,598	559,367
1991	22,337,415	1,052,929	609,379
1990	20,071,211	1,212,894	4,281,683

Source: NOAA Foreign Trade Database (NOAA 2021a)

Snapper Imports

Imports of both fresh and frozen snapper have increased generally since about 2013 (Figure 99; Table 124). The volumes of fresh snapper imports have generally exceeded those of frozen imports over time, but the increased rate of growth of fresh snapper imports since about 2013 has led to volumes of fresh imports that are 2 to 3 times greater than those of frozen

snapper imports. In 2019, fresh snapper imports were 32.8 million pounds as compared to 11.4 million pounds of frozen snapper imports.

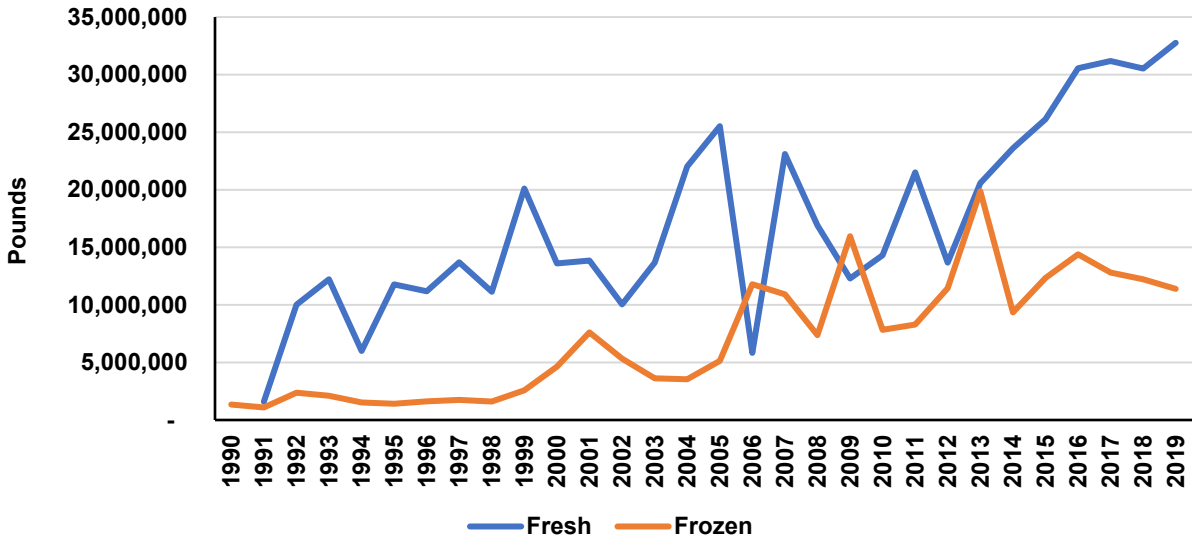

Figure 99. Snapper imports by product type (2000-2019). Source: NOAA Foreign Trade Database (NOAA 2021a).

Table 124. Snapper imports by product type (2000-2019).

Year	Fresh snapper (lb)	Frozen snapper (lb)
2019	32,764,862	11,395,257
2018	30,530,166	12,218,381
2017	31,185,578	12,806,748
2016	30,556,900	14,388,168
2015	26,117,350	12,342,170
2014	23,605,947	9,342,282
2013	20,574,239	19,867,808
2012	13,669,166	11,445,324
2011	21,513,357	8,290,513
2010	14,301,996	7,825,479
2009	12,288,633	15,959,200
2008	16,901,245	7,372,873
2007	23,102,698	10,917,342
2006	5,837,298	11,790,045
2005	25,527,308	5,140,259
2004	22,022,754	3,537,604
2003	13,666,922	3,616,972
2002	10,035,739	5,336,750
2001	13,850,710	7,610,284
2000	13,597,391	4,639,235
1999	20,101,227	2,583,499
1998	11,146,446	1,605,874
1997	13,700,838	1,741,643

1996	11,179,663	1,618,403
1995	11,783,088	1,412,024
1994	5,996,469	1,517,065
1993	12,218,037	2,104,354
1992	10,019,806	2,365,138
1991	1,591,352	1,089,682
1990	n.d.[1]	1,346,888

[1]n.d.=no data.

Source: NOAA Foreign Trade Database (NOAA 2021a).