Management Profile for the Gulf and Southern Flounder Fishery

in the Gulf of Mexico

November 2015

Gulf States Marine Fisheries Commission

Pub No. 247

Gulf States Marine Fisheries Commission
Commissioners and Proxies

ALABAMA
N. Gunter Guy Jr., Commissioner
Alabama Department of Conservation
and Natural Resources
64 North Union Street
Montgomery, AL 36130-1901

Proxy:
Chris Blankenship, Director
ADCNR, Marine Resources Division
P.O. Drawer 458
Gulf Shores, AL 36547

Representative Steve McMillan
P.O. Box 337
Bay Minette, AL 36507

Chris Nelson
Bon Secour Fisheries, Inc.
P.O. Box 60
Bon Secour, AL 36511

FLORIDA
Nick Wiley, Executive Director
Florida Fish and Wildlife Conservation Commission
620 South Meridian Street
Tallahassee, FL 32399-1600

Proxy:
Dan Ellinor
FWC Division of Marine Fisheries
620 South Meridian Street
Tallahassee, FL 32399-1600

Senator Thad Altman
State Senator, District 24
6767 North Wickham Road, Suite 211
Melbourne, FL 32940

Mike Hansen
Florida Council for Community Mental Health
316 E. Park Ave.
Tallahassee, FL 32301

LOUISIANA
Robert Barham, Secretary
Louisiana Department of Wildlife and Fisheries
P.O. Box 98000
Baton Rouge, LA 70898-9000

Proxy:
Randy Pausina, Assistant Secretary for Fisheries
Louisiana Dept. of Wildlife and Fisheries
P.O. Box 98000
Baton Rouge, LA 70898-9000

Senator R.L. "Bret" Allain, II
State of Louisiana
District 21
600 Main Street, Suite 1
Franklin, LA 70538

Campo "Camp" Matens
4554 Emory Avenue
Baton Rouge, LA 70808

MISSISSIPPI
Jamie Miller, Executive Director
Mississippi Department of Marine Resources
1141 Bayview Avenue
Biloxi, MS 39530

Proxy:
Kelly Lucas, Chief Scientific Officer
Mississippi Department of Marine Resources
1141 Bayview Avenue
Biloxi, MS 39530

Senator Brice Wiggins
1501 Roswell St
Pascagoula, MS 39581

Joe Gill, Jr.
Joe Gill Consulting, LLC
P.O. Box 535
Ocean Springs, MS 39566-0535

TEXAS
Carter Smith, Executive Director
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, TX 78744

Proxy
Mark Lingo
Coastal Fisheries Division
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, TX 78744

Mr. Troy Bello Williamson, II
P.O. 967
Corpus Christi, TX 78403

Texas Legistlative Member - TBD

Management Profile for the Gulf and Southern Flounder Fishery in the Gulf of Mexico

by the

Flounder Technical Task Force

edited by

Steven J. VanderKooy
Interjurisdictional Fisheries
Program Coordinator

published by the

Gulf States Marine Fisheries Commission
2404 Government St.
Ocean Springs, Mississippi 39564

November 2015 Publication Number 247

A publication of the Gulf States Marine Fisheries Commission pursuant to National Oceanic and Atmospheric Administration Award Number NA10NMF4070006. This publication is funded by a grant from the National Oceanic and Atmospheric Administration. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its sub-agencies.

Gulf States Marine Fisheries Commission

Flounder Technical Task Force

Ms. Michelle Sempsrott
Florida Fish and Wildlife Conservation Commission/
Division of Fisheries Management
Northwest Regional Office
3911 Highway 2321
Panama City, FL 32409

Ms. Karon Aplin
Alabama Department of Conservation and Natural
Resources/Marine Resources Division
P.O. Drawer 458
Gulf Shores, AL 36547

Mr. Wes Devers
Mississippi Department of Marine Resources
1141 Bayview Avenue
Biloxi, MS 39530

Mr. Jason Adriance
Louisiana Department of Wildlife and Fisheries
2021 Lakeshore Drive
Suite 407
New Orleans, LA 70122

Mr. Mike Stahl
Texas Parks and Wildlife Department
Dickinson Marine Lab
1502 FM 517 East
Dickinson, TX 77539

Dr. Ava Lasseter - *Sociology Representative*
Gulf of Mexico Fishery Management Council
2203 N. Lois Avenue
Suite 1100
Tampa, FL 33607

Dr. Charles M. Adams - *Economist*
Florida Sea Grant College Program
P.O. Box 110240
1170 McCarty Hall
Gainesville, FL 32611

Major Scott Bannon – *LEC Representative*
ADCNR/MRD
P.O. Box 189
Dauphin Island, AL 36528

Ms. Cherie O'Brien – *Habitat Representative*
Dickinson Marine Lab
1502 FM 517 East
Dickinson, TX 77539

Mr. Chris Granger - *Commercial Representative*
706 C C Land Road
Eastpoint, FL 32328

Mr. Chester Moore - *Recreational Representative*
101 Broad Street
Orange, TX 77630

GSMFC Staff

David M. Donaldson
Executive Director

Steven J. VanderKooy
IJF Program Coordinator

Debora K. McIntyre
IJF Staff Assistant

Acknowledgments

The Gulf States Marine Fisheries Commission (GSMFC) would like to thank the members of the Flounder Technical Task Force (TTF) for their many hours of work and dedication in developing the *Management Profile for the Gulf and Southern Flounder Fishery in the Gulf of Mexico*. The GSMFC also thanks the Stock Assessment Team, Law Enforcement Committee, and Technical Coordinating Committee's Habitat Subcommittee for their review, critique, and guidance based on their various areas of expertise.

The TTF gratefully acknowledges the assistance in collection and assimilation of fishery-dependent and independent data provided by Dr. Alan Lowther, Mrs. Bichnga (Jay) Boulet, and Ms. Melissa Yencho (NMFS), Dr. Bob McMichael (FWC), Mr. Craig Newton (ADCNR/MRD), Mr. Mike Harden (LDWF), and Dr. Mark Fisher (TPWD). A special word of thanks goes to Mr. Lloyd Kirk (GSMFC) for his help analyzing some of the social data presented in Section 8.0. In addition, Dr. Lindsey Campbell (TPWD) provided significant contributions and edits to Section 3.0 on topics related to flounder reproduction as well as some research priorities.

The Flounder TTF would not be able to revise and update the material in the management profile without the support of the various academic libraries and library staff across the five Gulf states and the libraries of our federal partners. We would especially like to thank Ms. Joyce Shaw, Ms. Cathy Schloss, and Ms. Maryanne Anthony at the Gulf Coast Research Laboratory's Gunter Library.

Finally, TTF members would like to express their appreciation to Ms. Debora McIntyre (GSMFC) for her support and editorial reviews of the draft management profile.

Preface

The Gulf States Marine Fisheries Commission (GSMFC) was established by the Gulf States Marine Fisheries Compact under Public Law 81-66 approved May 19, 1949. Its charge is to promote better management and utilization of marine resources in the Gulf of Mexico.

The GSMFC is composed of three members from each of the five Gulf States. The head of the marine resource agency of each state is an *ex-officio* member. The second is a member of the legislature. The third is a governor-appointed citizen with knowledge of or interest in marine fisheries. The offices of the chairman and vice chairmen are rotated annually from state to state.

The GSMFC is empowered to recommend action to the governors and legislatures of the respective states on programs helpful to the management of marine fisheries. The states, however, do not relinquish any of their rights or responsibilities to regulate their own fisheries as a result of being members of the GSMFC.

One of the most important functions of the GSMFC is to serve as a forum for the discussion of various problems and needs of marine management authorities, the commercial and recreational industries, researchers, and others. The GSMFC also plays a key role in the implementation of the Interjurisdictional Fisheries (IJF) Act. Paramount to this role are the GSMFC's activities to develop and maintain regional profiles and plans for important Gulf species.

The *Management Profile for the Gulf and Southern Flounder Fishery in the Gulf of Mexico* is a cooperative planning effort of the five Gulf states under the IJF Act. Members of the task force contributed by drafting individually-assigned sections. In addition, each member contributed his/her expertise to discussions that resulted in revisions and led to the final draft of the profile.

The GSMFC made all necessary arrangements for task force workshops. Under contract with the National Marine Fisheries Service (NMFS), the GSMFC funded travel for state agency representatives and consultants other than federal employees.

Throughout this document, metric equivalents are used wherever possible with the exceptions of reported landings data and size limits which, by convention, are reported in English units. Recreational landings in this document are Type-A and Type-B1 and actually represent total harvest, as designated by the NMFS. Type-A catch is fish that are brought back to the dock in a form that can be identified by trained interviewers and Type-B1 catch is fish that are used for bait, released dead, or filleted – i.e., they are killed, but identification is by individual anglers. Type-B2 catch is fish that are released alive – again, identification is by individual anglers and is excluded from the values in this profile.

Abbreviations and Symbols

ADCNR/MRD	Alabama Department of Conservation Natural Resources/Marine Resources Division
B	Billions
BRD	Bycatch Reduction Device
˚C	degrees Celsius
DO	Dissolved Oxygen
DMS	Data Management Subcommittee
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
FWC/FMRI/FWRI	Florida Fish and Wildlife Conservation Commission/Florida Marine Research Institute/Florida Fish and Wildlife Research Institute
FMP	Fishery Management Plan
ft	feet
g	gram
GSI	Gonadal Somatic Index
GSMFC	Gulf States Marine Fisheries Commission
hr(s)	hour(s)
ha	hectare
IJF	interjurisdictional fisheries
kg	kilogram
km	kilometer
lbs	pounds
LDWF	Louisiana Department of Wildlife and Fisheries
m	meter
M	Millions
mm	millimeters
min(s)	minute(s)
MDMR	Mississippi Department of Marine Resources
MRFSS/MRIP	Marine Recreational Fisheries Statistical Survey/Marine Recreational Information Program
mt	metric ton
n	number
NL	Notocord Length
NMFS	National Marine Fisheries Service
ppm	parts per million
‰	parts per thousand
PPI	producer price index
SAT	Stock Assessment Team
SD	Standard Deviation
SE	Standard Error
sec(s)	second(s)
SL	Standard Length
S-FFMC	State-Federal Fisheries Management Committee
SPR	Spawning Potential Ratio
TCC	Technical Coordinating Committee
TED	Turtle Exclusion Device
TL	Total Length
TPWD	Texas Parks and Wildlife Department
TTF	Technical Task Force
TTS	Texas Territorial Sea
TW	Total Weight
YOY	Young-of-the-Year
yr(s)	year(s)

Table of Contents

Chapter 6 Description of the Fishery

Chapter 7 Processing, Marketing, and Economic Characteristics of the Fishery

List of Tables

List of Figures

Chapter 1

Summary

Gulf (*Paralichthys albigutta*) and southern flounder (*P. lethostigma*) range throughout the Gulf of Mexico from Florida to Mexico. Their habitats, distribution, and abundance change with life history stages and seasonal movements (Chapters 3 and 4). They are euryhaline and found in freshwater, brackish water, and saltwater. Gulf and southern flounder are the primary species that comprise the commercial and recreational fisheries in the Gulf of Mexico because of their relatively large size. Southern flounder are most common from Mobile Bay, Alabama, to Brownsville, Texas and Gulf flounder are most abundant in the eastern Gulf along the Florida Coast. There is an area of overlap in the eastern panhandle of Florida and again in the southern reaches of the Texas Coast.

Southern flounder have been found to occur in a variety of habitats (Chapters 3 and 4). They prefer muddy substrates and are relatively abundant in areas where the substrate is composed of silt and clay sediments. Gulf flounder have been found in association with firm or sandy substrates which are more common in the eastern Gulf of Mexico. The apparent substrate preference of Gulf flounder may be more an effect of salinity selection, rather than substrate selection. Estuaries with low freshwater inflow result in higher salinities, lower sediment loads, lower turbidity, and firmer substrates.

Although flounder are not harvested in the same quantity as other popular commercial and recreational species, they are still an important component of Gulf fisheries (Chapter 6). Their popularity is primarily due to their excellent quality as food fish. As a result, southern and Gulf flounders are the dominant flatfish in commercial and recreational landings for the Gulf. The Gulf and southern flounder are valuable recreational species on the Gulf Coast where they are harvested mainly by hook-and-line and gig. Gear types used to incidentally harvest flounders are basically the same as those used to commercially harvest other marine species and include butterfly nets, shrimp trawls, gill nets, trammel nets, handlines, longlines, and haul seines. Since the implementation of regulations in the 1990s related to turtle excluder devices (TEDs) and bycatch reduction devices (BRDs), landings of flounder from nets and trawls have decreased substantially in Florida and Mississippi, which collect gear type data for commercial landings. Landings by gear type before and after these regulations are not available for Louisiana and Texas, although it is likely that these regulations affected commercial flounder landings similarly in these states. Recent data from the states recording flounder landings by gig/spear (Florida, Alabama, and Mississippi) have shown an increase in the proportion of flounder landed by this gear type.

Flounder landings in the Gulf of Mexico, while fluctuating annually, generally were between 1M and 1.6M lbs from the late 1980s into the mid-1990s. The widespread restrictions placed on entangling nets in the Gulf in the mid-1990s resulted in a sharp decline in the total landings to about 600,000 lbs at the time of the original FMP (VanderKooy 2000). Since 2000, the Gulf-wide landings have continued to decline fairly steadily due, in part, to additional regulations on bycatch; a reduction in overall effort in many of the fisheries in the Gulf; several catastrophic events in 2004, 2005, and 2008 related to extensive hurricane damages; and the 2010 Deepwater Horizon disaster (Chapter 6).

The GSMFC's Stock Assessment Team evaluated the available fishery-independent and dependent data in anticipation of conducting a Gulf-wide benchmark assessment. Because the group agreed that the data were insufficient, the existing state assessments were used as proxies. The results of the three assessments (Texas and Louisiana for southern flounder, and Florida for Gulf flounder) indicate there is no cause for immediate concern over existing flounder populations (Chapter 9). The Texas assessment suggests a transitional $SPR_{30\%}$ for southern flounder in the northwest Gulf. The Louisiana assessment indicates that, although the disappearance rate for southern flounder in the north-central Gulf is high (1.1-1.3 per year based on catch rates from 1994-1996), recent regulations should allow the LDWF to achieve an $SPR_{30\%}$. The Florida assessment of Gulf flounder on Florida's west coast (northeast Gulf) indicates that, prior to the Net Limitation Amendment, and recreational management measures which were implemented at the same time, overfishing was occurring and Gulf flounder, prior to 1995 may have been overfished; however, neither has been occurring in recent years.

Despite the fact that many of the recommendations from the original flounder FMP have been implemented, a few have not been fully addressed. Clear speciation of Gulf and southern flounder in the fishery-dependent data remains somewhat problematic although the introduction of trip tickets has helped to some degree. There is not a difference in value so commercial fishermen, processors and dealers, and even recreational anglers do not make a distinction between and frequently lump the two together as a generic 'flounder' or 'flatfish'. The NOAA commercial landings data reflect this combination of Gulf and southern flounder into flatfish generally.

The research needs and management considerations in this profile are divided between three general categories: gaps in data needed for management, population dynamics, and environmentally related considerations. The overall goal is to provide management personnel with a set of easily understandable strategies to evaluate the actions, encourage compatibility and standardization among resource agencies, facilitate enforcement's role, and reduce management conflicts.

Chapter 2

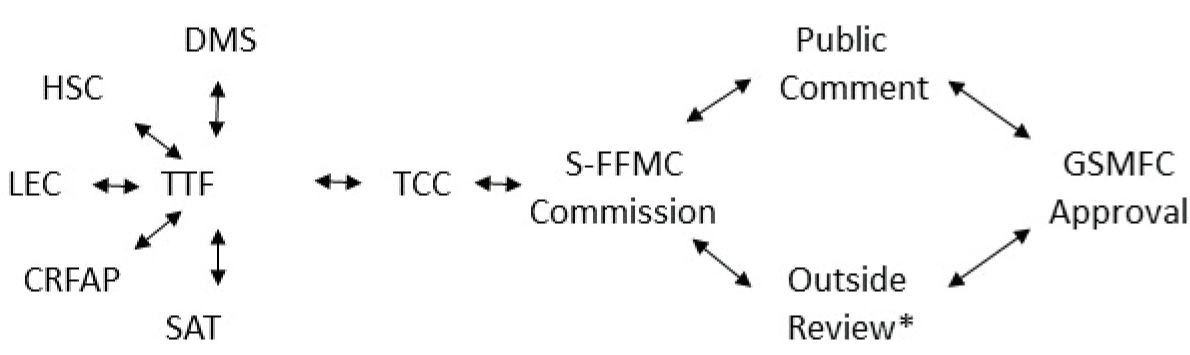
Introduction

Significant changes have occurred in the Gulf and southern flounder fisheries in the Gulf of Mexico since publication of the original management plan (VanderKooy 2000). These changes have directly and indirectly impacted flounder populations and the fishery participants; the decline of local and global economies, continued environmental perturbations, and a number of natural and man-made disasters. In addition, since the publication of the original management plan, each of the Gulf states now has implemented various regulations on size, bag, and/or trip limits on flounder.

In March 2011, the S-FFMC directed staff to begin revising the original management plan. The Flounder Technical Task Force (TTF) was reactivated and members were invited to an introductory meeting in February 2012. Since the original TTF was unable to conduct a regional stock assessment for either of the two species, it was hoped that the data and research needs identified in the first management plan would provide better species resolution. After consultation with the GSMFC's Stock Assessment Team (SAT), it was determined that the commercial and recreational landings were still not sufficiently separated to allow clean speciation. Therefore, the revision to the Gulf and southern flounder management plan is primarily an update of the available biological, habitat, and fishery data available and has been modified to a Management Profile for the fishery. A substantial effort was made to generate a more comprehensive social section considering the economic and environmental changes in the region since the publication of the original management plan.

IJF Program and Management Process

The Interjurisdictional Fisheries Act (IFA) of 1986 (Title III, Public Law 99-659) was approved by Congress to: (1) promote and encourage state activities in support of the management of interjurisdictional fishery resources and (2) promote and encourage management of interjurisdictional fishery resources throughout their range. Congress also authorized federal funding to support state research and management projects that were consistent with these purposes. Additional funds were authorized to support the development of interstate management plans by the marine fishery commissions.



DMS = Data Management Subcommittee
SAT = Stock Assessment Team
HSC = Habitat Subcommittee
LEC = Law Enforcement Committee
CRFAP = Comm/Rec Fishery Advisory Committee
TTF = Technical Task Force

TCC = Technical Coordinating Committee
S-FFMC = State-Federal Fisheries Management Committee
GSMFC = Gulf States Marine Fisheries Commission
*Outside Review = standing committees, trade associations, general public

After passage of the IFA, the GSMFC initiated the development of a planning and approval process for the management profiles and plans. The process has evolved to its current form outlined below:

The TTF is composed of a core group of scientists from each Gulf state and is appointed by the respective state directors who serve on the Commission. Also, a TTF member from each of the GSMFC's standing committees (Law Enforcement, Habitat Advisory, Commercial Fisheries Advisory, and Recreational Fisheries Advisory) is appointed by the respective committee. In addition, the TTF may include other experts in economics, socio-anthropology, population dynamics, and other specialty areas when needed. The TTF is responsible for development of the management plan, management profile, or biological profile and receives input in the form of data and other information from the DMS and the SAT.

Once the TTF completes the plan/profile, it may be approved or modified by the Technical Coordinating Committee (TCC) before being sent to the Commission for review. The Commission may also approve or modify the document before releasing it for a voluntary public review and comment. After public review, the document and all comments are considered by the Commission and it is accepted, accepted with modification, or rejected and returned to the TCC or the TTF for further revision. Once approved by the Commission, the plans/profiles are submitted to the Gulf states for their consideration as potential measures for research or management in their respective states.

Management Profile Objectives

The objectives of the *Management Profile for the Gulf and Southern Flounder Fishery in the Gulf of Mexico* are:

- To summarize, reference, and discuss relevant scientific information and studies regarding the management of Gulf and southern flounder in order to provide an understanding of past, present, and future efforts.
- To describe the biological, social, and economic aspects of the flounder fisheries.
- To review state and federal management authorities and their jurisdictions, laws, regulations, and policies affecting the Gulf and southern flounder.
- To ascertain optimum benefits of the flounder fisheries of the U.S. Gulf of Mexico to the region while perpetuating these benefits for future generations.
- To set clear and attainable management goals for the Gulf and southern flounder fisheries and to suggest management strategies and options needed to solve problems, meet the needs of the stocks, and achieve these goals.

Chapter 3

Description of Stock Comprising the Management Unit

Flatfishes of the family Paralichthyidae are represented in the Gulf of Mexico (Table 3.1) by 22-23 species of eight genera (McEachran and Fechhelm 2005). Paralichthyids are euryhaline and found in fresh water (rivers, lakes); brackish water (estuaries, bayous, canals); and salt water (bays, sounds, lagoons, offshore) (Deubler 1960, Gutherz 1967, Hoese and Moore 1998). Their habitats, distribution, and abundance change with life history stages and seasonal movements.

Many of the paralichthyids remain small even at maturity and may be critical components of commercial catch. *Paralichthys* (Gutherz 1967) is the genus that is most abundant in the directed finfish fisheries (both recreational and commercial) with *P. albigutta* and *P. lethostigma* as the two most commonly sought species in the Gulf of Mexico. Southern flounder (*P. lethostigma*) is most common from Mobile Bay, Alabama, to Brownsville, Texas (Norden 1966, Perret et al. 1971, Adkins et al. 1979, Adkins et al. 1998). Gulf flounder, *P. albigutta*, is more abundant in the eastern Gulf along the Florida coast (Hoese and Moore 1998, Gutherz 1967) (Figure 3.1). The broad flounder (*P. squamilentus*) is caught offshore, in waters up to 230m and is distributed throughout the Gulf (McEachran and Fechhelm 2005). Species of other Gulf of Mexico flatfish genera (*Ancylopsetta, Cyclopsetta, Etropus, Syacium, Chascanopsetta, and Gastropsetta*) are not a component of the directed fishery because of their small maximum size of only 250-400 mm SL.

The primary scope of this management profile will be to discuss the two most abundant species of *Paralichthys* in the Gulf of Mexico, the Gulf flounder and the southern flounder. Literature on other species is limited and summarized in Table 3.1.

Geographic Distribution

The range of southern flounder extends from Albemarle Sound, North Carolina, to Laguna de Tamiahua, in northern Mexico (Ginsburg 1952, Hoese and Moore 1998, Manooch 1984, Music and Pafford 1984, Darnell and Kleypas 1987, Gilbert 1986, Shipp 1986). This species is absent everywhere on the lower east coast of Florida (from the Loxahatchee River) and the southwest coast (south of Tampa), except in the Caloosahatchee River estuary (Gilbert 1986, Topp and Hoff 1972). Occurrences of southern flounder were reported by several researchers (Hildebrand 1954, Darnell 1985, Sanders et al. 1990) at depths of up to 120 m and were found to be seasonally distributed from shallow estuaries to deeper waters (Nall 1979, Darnell 1985). Southern flounder are found in the Gulf of Mexico offshore of Alabama, Mississippi, Louisiana, and Texas from the barrier islands to the outer shelf and in Florida, on the inner shelf from Apalachee Bay to above Tampa Bay (Reagan and Wingo 1985) (Figure 3.1). Southern flounder are more abundant in the northwestern portion of the Gulf of Mexico (Nall 1979).

In Texas bays, Gunter (1945) reported capturing southern flounder during all seasons but only during March and April in the Gulf. Southern flounder were most abundant from Sabine Pass to Port Aransas, and the lowest catch rate of southern flounder was in the upper Laguna Madre (Matlock 1982, McEachron and Fuls 1996). The distribution of southern flounder through the passes was not evenly distributed within Cedar Bayou, Matagorda Bay, Texas (King 1971). Fish were found to be more concentrated along the channel banks and on the west versus the east shoreline.

In Louisiana, Gunter (1936) stated southern flounder were never plentiful in trawl catches inside Barataria Bay and were rarely taken in nearby Gulf waters. However, Czapla et al. (1991) reported southern flounder to be common to abundant as adults and generally abundant in other life history

Table 3.1. Flatfishes of the family Paralichthyidae from the Gulf of Mexico. Species with a maximum size of less than 250 mm TL are omitted since they are not a part of the commercial or recreational fishery. Common names reported as accepted by Nelson et al. 2004.

Species	Common Name	Geographic Distribution	Maximum Size (mm)	Depth Range (m)	Notes
Ancylopsetta dilecta (Goode and Bean 1883)	Three-eyed flounder	North Carolina to Brazil, through the Gulf of Mexico and Caribbean	250 TL	Mid to deep, 60-366	Gutherz 1967 and Robins et al. 1986
Ancylopsetta quadrocellata (Gill 1884)	Ocellated flounder	North Carolina to Jupiter, Florida, and the entire Gulf of Mexico to the Campeche Banks	400 SL	Shallow to deep, 100	Inshore bays and estuaries to offshore waters in the Gulf of Mexico. Larger fish likely in deep water (Topp and Hoff 1972)
Chascanopsetta lugubris (Alcock 1894)	Pelican flounder	Atlantic coast of Florida, the Caribbean, Trinidad, and Brazil and the entire Gulf of Mexico	300 TL	Deep, 230-550	Gutherz 1967 and Robins et al. 1986
Cyclopsetta chittendeni (Bean 1895)	Mexican flounder	Limited to the NW Gulf of Mexico to further east than the Mississippi Delta. Also occurs in the Caribbean Sea from Colombia and Venezuela and to Brazil	330 TL	Mid to deep, 18-229	Common throughout the W Gulf of Mexico; it is replaced by *C. fimbriata* east of the Mississippi Delta (Dawson 1968). Topp and Hoff 1972; Gutherz 1967; Robins et al. 1986
Cyclopsetta fimbriata (Goode and Bean 1885)	Spotfin flounder	North Carolina to S Florida and the NE Gulf of Mexico, no further west than the Mississippi Delta. Also through the West Indies to British Guiana	380 TL	Mid to deep, 18-229	Not a late spring spawning season (Topp and Hoff 1972), possibly throughout summer and fall (Gutherz 1967). Not as common in NW Gulf as *C. chittendeni* (Hoese and Moore 1998)
Gastropsetta frontalis (Bean 1895)	Shrimp flounder	North Carolina to Florida Keys and along the Florida Gulf coast to the N Gulf of Mexico. Also found on the Campeche Banks and south to Panama	250 TL	Mid to deep, 35-183	This species is considered rare in the Gulf of Mexico. Spring to early summer spawning season (Topp and Hoff 1972, Robins et al. 1986)
Paralichthys albigutta (Jordan and Gilbert 1882)	Gulf flounder	North Carolina to S Florida and the Gulf of Mexico to S Texas and the Bahamas. More common along Florida's Gulf coast and NE Gulf of Mexico (not reported from Mississippi and Louisiana inshore waters)	380 TL	Shallow to deep, 128	Robins et al. 1986. Prefers hard or sandy bottom habitat (Gutherz 1967, Topp and Hoff 1972)
Paralichthys lethostigma (Jordan and Meek 1884)	Southern flounder	North Carolina to N Mexico through Gulf of Mexico. Absent south of Loxahatchee River to south of Caloosahatchee Estuary, Florida	910 TL	Shallow to mid, 66	Prefers muddy bottom habitat (Topp and Hoff 1972; Stokes 1977). A single specimen was collected in Florida Bay (FWC/FMRI unpublished data)
Paralichthys squamilentus (Jordan and Gilbert 1882)	Broad flounder	North Carolina to Mexico and throughout Gulf of Mexico	460 TL	Shallow to deep, 4-230	Large individuals in deep water but young fish inshore (Gutherz 1967, Fraser 1971, Robins et al. 1986)

Species	Common Name	Geographic Distribution	Maximum Size (mm)	Depth Range (m)	Notes
Syacium gunteri (Ginsburg 1933)	Shoal flounder	NE coast of Florida south throughout entire Gulf of Mexico and Caribbean	280 TL	Shallow to mid, 9-91	Hoese and Moore 1998. Most abundant and frequently caught flatfish on brown shrimp grounds (NW Gulf). Replaced E of Mississippi Delta by *S. micrurum* (Gutherz 1967, Fraser 1971, Robins et al. 1986)
Syacium micrurum (Ranzani 1840)	Channel flounder	SE coast (and perhaps SW coast) of Florida. Also found in the Caribbean sea to Brazil in South America as well as West Africa	300 TL	Mid to deep, 412	Generally found in depths in less than 91 m (Gutherz 1967, Fraser 1971, Robins et al. 1986). Often reported in Gulf but Hoese and Moore (1998) were unable to verify, may be S. papillosum
Syacium papillosum (Linnaeus 1758)	Dusky flounder	North Carolina to S Florida and throughout the Gulf of Mexico. Also found in the Bahamas and Bermuda, the Caribbean, and south to Brazil in South America	300 TL	Shallow to mid, 92	More common east of the Mississippi River (Hoese and Moore 1998). This species prefers more calcareous substrate, more commonly found along the Florida Shelf (see notes for *S. gunteri*). Extended spawning season from Feb-Nov (Topp and Hoff 1972, Robins et al. 1986)

stages throughout coastal Louisiana. Norden (1966) and Wagner (1973) both ranked southern flounder ninth in abundance from Vermilion and Caminada bays, Louisiana, respectively.

Southern flounder were reported the most common *Paralichthys* species in Mississippi and Alabama waters (Christmas and Waller 1973, Swingle 1971). Southern flounder were frequently encountered in the industrial bottomfish survey in Mississippi (Christmas 1973). Swingle (1971) found southern flounder to occur from the Mobile Delta to offshore waters of Alabama. The Alabama Department of Conservation and Natural Resources (ADCNR/MRD) found southern flounder present year-round in Mobile and Perdido bays in their 15 year data set from the Fisheries Assessment Monitoring Program (ADCNR/MRD unpublished data).

Compared to the west and northern Gulf of Mexico, southern flounder are less common along Florida's west coast, although they have been collected along the northwest Florida coast (Vick 1964, Nall 1979, Bass and Guillory 1979). The reported distribution of southern flounder along the southern coast of Florida is somewhat unclear. Ginsburg (1952) suggested the species is absent southward from the Indian River on the east coast to Tampa Bay on the west coast. However, recent studies have indicated southern flounder may occur in low numbers in south Florida. Gunter and Hall (1965) reportedly caught two specimens within the Caloosahatchee River estuary. Tabb and Manning (1961) reported two southern flounder specimens caught in Florida Bay, Everglades National Park, and suggested that this species is sometimes caught by recreational anglers off sandy beaches in the area. However, no southern flounder were collected in Florida Bay during routine monthly fisheries independent monitoring samples over a four-year period from 1994 to 1997 (FWC/FMRI unpublished data). One 315 mm SL southern flounder

A.

B.

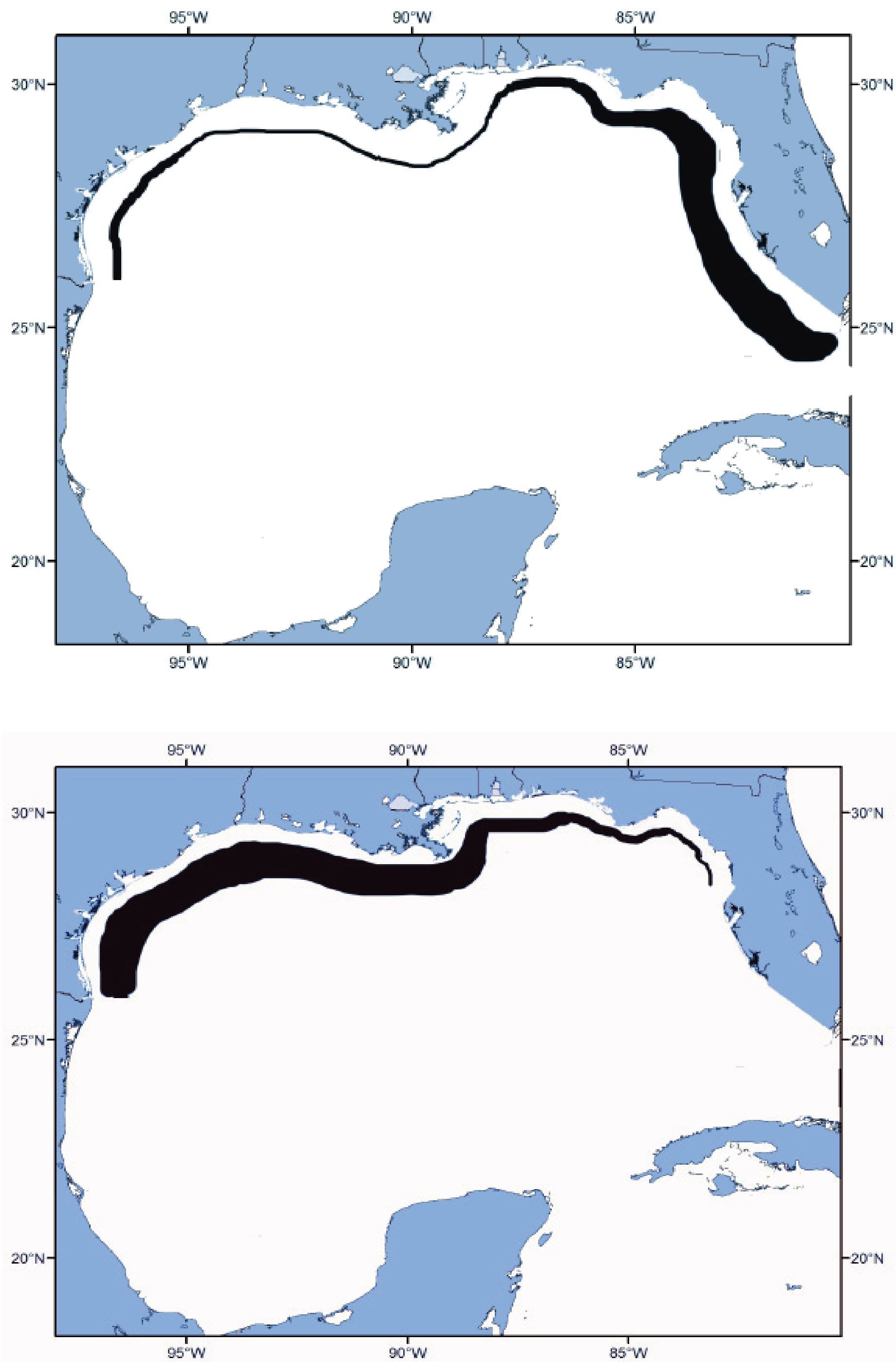


Figure 3.1 Distribution ranges of A. Gulf flounder (*Paralichthys albigutta*) and B. southern flounder (*P. lethostigma*) in the United States Gulf of Mexico. Lines do not represent inshore/offshore or location data, line weight represents relative abundance.

specimen was caught in February 1998 approximately 16 km north of Marathon, Florida, in the Gulf of Mexico. This single specimen was obtained from a commercial fish house in Marathon (FWC/FMRI unpublished data).

Gulf flounder range from Cape Lookout, North Carolina, to lower Laguna Madre, Texas, in waters less than 92m deep but occasionally in waters as deep as 128m (Ginsburg 1952, Hildebrand 1954, Simmons

1957, Gutherz 1967). They have occasionally been recorded in the western Bahamas (Böhlke and Chaplin 1993) and are most common in the eastern Gulf of Mexico along the west coast of Florida (Topp and Hoff 1972) (Figure 3.1).

In Texas, Gunter (1945) reported Gulf flounder in Aransas Bay and the western Gulf of Mexico but in relatively low numbers compared to southern flounder. Hildebrand (1954), in his study of the fauna of shrimp grounds in the western Gulf of Mexico, also indicated that Gulf flounder were relatively rare in this area. Simmons (1957) reported Gulf and southern flounder to be common in the upper Laguna Madre on the Texas coast but gave no catch data or relative abundances of the two species. Miller (1965) found both Gulf and southern flounder to be uncommon in the shallow (6-28 m) Gulf of Mexico near Port Aransas, Texas. Although Gulf flounder occur in lower numbers than southern flounder, they were most abundant along the mid to lower Texas coast (Stokes 1977, McEachron and Fuls 1996, Matlock 1982).

Gulf flounder are more common than southern flounder in lower Perdido Bay, Alabama, but are rare in Mobile Bay and the eastern Mississippi Sound (ADCNR/MRD unpublished data). No records of Gulf flounder have ever occurred in Mississippi's 40 years of fishery-independent sampling by Gulf Coast Research Laboratory (GCRL) personnel.

In Florida, Gulf flounder are more prevalent than southern flounder. Several Gulf flounder were collected at St. Andrews Bay by Vick (1964) and Naughton and Saloman (1978). Reid (1954) reported Gulf flounder to be the most common flounder at Cedar Key and collected in all months of the year. Murdock (1957) collected a single specimen of Gulf flounder near the mouth of the Manatee River. Gulf flounder sampled from Tampa Bay by Springer and Woodburn (1960) were taken during all months of the year except October. Several Gulf flounder were collected by trawl and seine during a faunal survey of Charlotte Harbor (Wang and Raney 1971). Springer and McErlean (1962) reported collecting Gulf flounder in the Florida Keys. Gulf flounder have been collected by the Fisheries Independent Monitoring Program in most major bay systems (i.e. Indian River Lagoon, Florida Bay, Charlotte Harbor, Tampa Bay, Cedar Key, Apalachicola Bay, Choctawhatchee Bay/Santa Rosa Sound, and Apalachicola Bay) throughout Florida (FWC/FMRI unpublished data).

Biological Description

All three species of *Paralichthys* in the Gulf of Mexico are robust, left-eyed flatfish with large symmetrical mouths and well-developed, canine-like teeth. These bottomfish blend with their background and are nondescript in color and mildly patterned. They are ambush predators, lying in wait on the bottom and lunging forth while creating suction with the mouth to capture shrimp and smaller fish. Gulf and southern flounder display sexual dimorphism with females being larger than males of the same age. Both species spawn a large number of buoyant, pelagic eggs. The hatchlings are bilaterally symmetrical until they undergo a metamorphosis to a flatfish shape with both eyes on the left side. Following metamorphosis, the bases of both pelvic fins are short and neither extends forward to the urohyal bone (Gilbert 1986).

Southern flounder have been found to occur in a variety of habitats. They prefer muddy substrates and are relatively abundant in areas where the substrate is composed of silt and clay sediments (Norman 1934, Ginsburg 1952, Powell and Schwartz 1977, Wolff 1977, Randall and Vergara 1978, Etzold and Christmas 1979, Nall 1979, and Phalen et al. 1989). Southern flounder are more abundant in the western Gulf, west of the Mississippi Delta where soft, muddy substrate is more common (Topp and Hoff 1972, Enge and Mulholland 1985). Where sand substrates predominate, southern flounder are relatively scarce, and Gulf flounder are more abundant. However, a study conducted in Texas around the Aransas Pass inlet found the highest abundance of juvenile southern flounder associated with vegetated sandy areas and the lowest abundance found in non-vegetated muddy bottoms in regions furthest from the inlet (Nanez-James et. al 2009).

Table 3.2 Salinities and temperatures at which southern flounder were collected by area and author. NA = not available or reported.

State	Salinity (‰)	Temperature (^{o}C)	Area	Author(s)
Texas	Adults: 2.0-36.2 (few above 25.0) Juvenile recruitment: 19.6-30.0	Adults: 9.9-30.5 Juvenile recruitment: 14.5-21.6	Coastal area	Gunter 1945
	Sharply limited above 45; occasionally found to 60	NA	Laguna Madre	Simmons 1957
	6.0-36.0	Juvenile recruitment: 16.0 (as low as 13.8, adults from 10.0-31.0)	Aransas Bay	Stokes 1977
Louisiana	0.0-30.0	5.0-34.9	Coastal area	Perret et al. 1971
	3.3-26.0	6.2-31.0	Coastal area	Dunham 1972
	1.5-26.0	14.0-35.0	Caminada Bay	Wagner 1973
	2.5-7.0	10.0-11.0	Vermilion Bay	Perret and Caillouet 1974
	0.3-8.9	8.0-30.7	Vermilion Bay	Juneau 1975
	0.0-0.9	15.0-34.9	Lakes Pontchartrain and Maurepas	Tarver and Savoie 1976
	0.3-31.9	10.4-29.8	Coastal area	Burdon 1978
	5-20	10.4-29.8	Coastal area	Barret et al. 1978
Mississippi	19.9-37.9	13.3-28.0	Coastal area	Franks et al. 1972
	0.0-36.2	5.0-34.9	Coastal area	Etzold and Christmas 1979
Alabama	0.0-30.0	8.0-32.0	Mobile Bay/ Little Lagoon	ADCNR/MRD unpublished data
Florida	0.0-30.2	12.0-31.0	St. Johns River	Tagatz 1967
Georgia	Often enter fresh water	Eurythermal in shallow waters	Estuary	Dahlberg 1972
	New recruits in least saline portion of distribution	NA	Salt marsh estuary	Rogers et al. 1984
South Carolina	0.8-34.8	7.2-30.8	Charleston Harbor, Stono, Edisto, and Coosaw rivers	Wenner et al. 1990
North Carolina	0.0-35.0 (most in upper portion of estuary less than 11.0)	7.0-29.0	Pamlico Sound and adjacent waters	Powell 1974
	0.0-28.0 (most found in 5.0-18.0)	NA	Pamlico/ Albermarle Peninsula	Epperly 1984
	0.0-33.6	7.2-31.8	Beaufort estuaries	Tagatz and Dudley 1961
	Postlarvae: 0.2-35.0	8.0-16.0	Estuary	Williams and Deubler 1968
	Juveniles: 0.0-35.0 (most below 17.0)	NA	Pamlico Sound/ adjacent estuaries	Powell and Schwartz 1977
	0.6-33.4	NA	Newport River	Turner and Johnson 1973

Table 3.3. Recruitment time and size of YOY southern flounder by area and author. All sizes reported as TL (mm), except where noted.

State	Recruitment Time	Recruitment Size (mm)	Area	Comments	Author(s)
Texas	December February-April	17-40	Aransas Bay	Youngest fish in May (80 mm)	Gunter 1945
	March-May (April)	37-120 (25-54)	Cedar Bayou, central coast	Abundant March-May	Simmons and Hoese 1959
	February-May	18-34	East Lagoon, Galveston Island	One juvenile 102 mm in September	Arnold et al. 1960
	December	Postlarvae (35-50)	Lower Laguna Madre and adjacent waters		Breuer 1962
	December-April (peak abundance January-March)	Postlarvae (mean of 11)	Coastal area	*Paralichthys* spp. (*P. lethostigma* inclusive)	King 1971
	Beginning January (peak abundance in February)	10	Aransas Bay		Stokes 1977
	February	YOY	Matagorda Bay		Ward et al. 1980
	January-February	9-57	Galveston Bay	Standard Length	Glass et al. 2008
	January-March	10-17 mm SL	Aransans Bay		Nañez-James et al. 2009
Louisiana	April	5-10	Barataria Bay	YOY were 120-150 mm by May-June	Gunter 1938
	Spring	25-51	Delta National Wildlife Refuge	Mississippi River Delta	Kelly 1965
	March	11-30	Vermilion Bay	13-51 mm in April	Norden 1966
	January (March)	21-24 (6-31)	Chandeleur Islands	YOY were 55 and 88 mm by May and June, respectively	Laska 1973
	December-February	8-14 SL	Caminada Pass		Sabins 1973
	January-March (peaks February-March)	Mostly 0-30 SL groups	SW coastal marshes	5 mm SL size groups	Rogers and Herke 1985
	March-May	Juveniles	Calcasieu Estuary	Nursery usage	Felley 1989
Mississippi	March-May	<38	Estuary		Christmas and Waller 1973
	December-May	Larvae	Coastal area	Inshore immigration to nursery	Etzold and Christmas 1979
Alabama	January-April	10-15 SL	Low salinity areas of Mobile Bay	Highest densities in Weeks Bay	ADCNR/MRD unpublished data
Florida	March	22-56	St. Johns River		Tagatz 1967
Georgia	Peaked and ended in March	YOY	Salt marsh estuaries	Highest catches in upper estuaries	Rogers et al. 1984
South Carolina	January-March (peaked in March)	Postlarvae	Charleston Harbor, Stono, Edisto, and Coosaw rivers	June catches of large and small YOY from November-January and February-March spawn, respectively	Wenner et al. 1990

State	Recruitment Time	Recruitment Size (mm)	Area	Comments	Author(s)
North Carolina	November-April (peaked in December)	Larvae	Continental shelf from Cape Cod, Massachusetts to Cape Lookout, North Carolina	*Paralichthys* sp. (*P. lethostigma*, inclusive)	Smith et al. 1975
	Winter months	8-16	Pamlico Sound and adjacent estuaries	Largest catches in upper river, low salinity areas	Powell and Schwartz 1977
	Beginning March	10-40	Coastal areas	YOY migrated to upper river areas at 18-65 mm	Ross et al. 1982
	January-March (peaked in March)	10-20 SL	Estuaries	Oligohaline marshes	Rozas and Hackney 1984
	March (peaked in April-May)	YOY	Pamlico Sound and adjacent estuaries		Ross and Epperly 1985
	December-March (peaked in early February)	Larvae	Newport River estuary, just inside Beaufort Inlet	Most abundant bothid caught	Warlen and Burke 1990
	Late November-April (peaked in February-March)	Larvae-postlarvae	Newport and North River estuaries	Largest catch on tidal flats at estuary head	Burke et al. 1991
	January-April (Peak in March)	<100 mm	Estuarine nursery areas	Forecasting year class strength of southern flounder from meteorological data	Taylor et al. 2010

Southern flounder are able to acclimate to temperatures from 5.0º-35.0ºC and salinities ranging from 0.0-60.0‰ (Table 3.2). In a laboratory study, Prentice (1989) found young and adult flounder to be more tolerant of cold in salt water than in fresh water. Physiological adaption to salinity appears to change seasonally and with age (Stickney and White 1974a). Herke (1971), Wolff (1977), and Rogers et al. (1984) found young southern flounder were more numerous in lower salinity waters during spring-early summer (recruitment), while mid-salinity waters yielded larger fish later in the year. Southern flounder are considered to be the largest flounder in the Gulf of Mexico, reaching lengths of over 900 mm TL (Hoese and Moore 1998). Sexual maturity is reached after about two years, with reproductive males being smaller at an average size of 250 mm; sexually mature females are at least 350 mm (Daniels 2000). Adult southern flounder migrate from bays and estuaries in the fall and winter for the purpose of spawning (Hildebrand and Cable 1930, Gunter 1945, Ginsburg 1952, Stokes 1977), and females will release clusters of approximately 100,000 eggs per kg of body weight per day over the course of several days (Daniels 2000). Juvenile and larval southern flounder begin to recruit into the bays and estuaries from January through April (Table 3.3). Evidence suggests that freshwater habitat is critical to juvenile southern flounder, especially northern Gulf populations, as otolith microchemistry analysis reveals (Lowe et al 2011).

Gulf flounder have been found in association with firm or sandy substrates which are more common in the eastern Gulf of Mexico (Topp and Hoff 1972, Stokes 1977, Naughton and Saloman 1978, Nall 1979). The apparent substrate preference may be more an effect of salinity selection, rather than substrate selection. Estuaries with low freshwater inflow result in higher salinities, low sediment loads, lower turbidity, and firmer substrates (Enge and Mulholland 1985).

Table 3.4. Salinities and temperatures at which Gulf flounder were collected by area and author. NA = not available or reported.

<table>
<tr><th>State</th><th>Salinity (‰)</th><th>Temperature (˚C)</th><th>Area</th><th>Author(s)</th></tr>
<tr><td rowspan="3">Texas</td><td>25.0-35.2 (one of twelve at 9.6)</td><td>15.4-30.3</td><td>Coastal area</td><td>Gunter 1945</td></tr>
<tr><td>Sharply limited above 45; occasionally found to 60</td><td>NA</td><td>Laguna Madre</td><td>Simmons 1957</td></tr>
<tr><td>Above 16.0</td><td>Juvenile recommended at 16.0 (as low as 13.8; adults from 10.0-31.0</td><td>Aransas Bay</td><td>Stokes 1977</td></tr>
<tr><td rowspan="12">Florida</td><td>30.7 (n=1)</td><td>23.0</td><td>Manatee River</td><td>Murdock 1957</td></tr>
<tr><td>13.7-33.7 (very few below 20.0)</td><td>11.2-32.5</td><td>Tampa Bay</td><td>Springer and Woodburn 1960</td></tr>
<tr><td>37.9</td><td>23.0-28.1</td><td>Florida Keys</td><td>Springer and McErlean 1962</td></tr>
<tr><td>33.0-36.0</td><td>13.0-29.0</td><td>St. Andrews Bay</td><td>Vick 1964</td></tr>
<tr><td>7.7-24.7</td><td>11.0-30.8</td><td>St. Johns River</td><td>Tagatz 1967</td></tr>
<tr><td>33.4-35.7</td><td>15.9-27.0</td><td>Florida Shelf near Tampa Bay</td><td>Topp and Hoff 1972</td></tr>
<tr><td>17.5-31.5</td><td>8.3-30.6</td><td>Cedar Key</td><td>Reid 1954</td></tr>
<tr><td>12.0-35.0</td><td>13.0-32.0</td><td>St. Andrews Bay</td><td>Naughton and Saloman 1978</td></tr>
<tr><td>1.0-37.0 (95%>20.0)</td><td>14.0-32.0</td><td>Tampa Bay</td><td rowspan="4">FWC/FWRI unpublished data</td></tr>
<tr><td>2.0-38.0 (80%>20)</td><td>14.0-33.0</td><td>Charlotte Harbor</td></tr>
<tr><td>1.0-34.0 (37%>20)</td><td>11.0-31.0</td><td>Choctawatchee Bay</td></tr>
<tr><td>21.0-42.0</td><td>16.0-34.0</td><td>Florida Bay</td></tr>
<tr><td>Alabama</td><td>6.0-35.0 (rarely below 20)</td><td>7.2-31.7</td><td>Gulf Beaches/ Perdido Bay</td><td>ADCNR/MRD unpublished data</td></tr>
<tr><td rowspan="4">North Carolina</td><td>27.5-37.8</td><td>9.4-29.5</td><td>Beaufort estuaries</td><td>Tagatz and Dudley 1961</td></tr>
<tr><td>Postlarvae: 22.0-35.0</td><td>8.0-16.0</td><td>Estuary</td><td>Williams and Deubler 1968</td></tr>
<tr><td>Juveniles: 6.0-35.0 (rarely below 20.0)</td><td>NA</td><td>Pamlico Sound adjacent estuaries</td><td>Powell and Schwartz 1977</td></tr>
<tr><td>30.2-34.5</td><td>NA</td><td>Newport River</td><td>Turner and Johnson 1973</td></tr>
</table>

Gulf flounder have been shown to tolerate a wide range of temperatures (8°-32.5°C) and salinities ranging from 6-60‰ (Table 3.4). However, most researchers report the majority of Gulf flounder are found in salinities above 20‰ (Gunter 1945, Simmons 1957, Springer and Woodburn 1960). Gulf flounder do not grow as large as southern flounder and reach a maximum size of about 600 mm TL. Like southern flounder, adult Gulf flounder spend a portion of the year in bays and estuaries and emigrate into deeper waters in the Gulf of Mexico, where spawning takes place during the fall and winter (Ginsburg 1952). The appearance of juvenile Gulf flounder in the bays and estuaries begins in January and peaks in March (Stokes 1977) (Table 3.5).

Classification and Morphology

Classification

The following classification is a complete outline of species according to McEachern and Fechhelm (2005) (see Table 3.1 for complete details about species from the family Paralichthyidae in the Gulf of Mexico). Higher classification follows that of Greenwood et al. (1966). The American Fisheries Society (Nelson et al. 2004) accepted common names, and where available, are in parentheses following the species name.

Class: Acanthopterygii
  Order: Pleuronectiformes
    Family: Paralichthyidae
      Genus: *Paralichthys*
        Species: *albigutta* (Gulf flounder)
        Species: *lethostigma* (southern flounder)
        Species: *squamilentus* (broad flounder)
      Genus: *Cyclopsetta*
        Species: *chittendeni* (Mexican flounder)
        Species: *fimbriata* (spotfin flounder)
      Genus: *Ancylopsetta*
        Species: *quadrocellata* (ocellated flounder)
        Species: *dilecta* (three-eyed flounder)
      Genus: *Syacium*
        Species: *gunteri* (shoal flounder)
        Species: *papillosum* (dusky flounder)
        Species: *micrurum* (channel flounder)
      Genus: *Gastropsetta*
        Species: *frontalis* (shrimp flounder)

Table 3.5 Recruitment time and size of young-of-year (YOY) Gulf flounder by area and author. All sizes in mm TL, except where noted.

State	Recruitment Time	Recruitment Size (mm)	Area	Comments	Author(s)
Texas	Beginning in January (peak abundance in February)	10	Aransas Bay		Stokes 1977
Alabama	February-April	15 SL	Alabama beaches	Specimens <15 SL are collected but unidentifiable	ADCNR/MRD unpublished data
Florida	January-April	12-20	Tampa Bay		Springer and Woodburn 1960
	March	51-57	St. Johns River		Tagatz 1967
	January-May	10-15 SL	Cedar Key		Reid 1954
	December-March	Larvae	Florida shelf near Tampa Bay		Topp and Hoff 1972
	Began December and January	10 SL	West coast	Some latitudinal variation in recruitment time	FWC/FWRI unpublished data
	Peaked in February		Charlotte Harbor		
	Peaked in March		Tampa Bay		
	Peaked in April		Choctawatchee Bay		

The valid name for southern flounder is *Paralichthys lethostigma* (Jordan and Meek 1884). The scientific name is derived from the Greek words *Paralichthys* meaning 'parallel fish,' *lethostigma* means 'forgetting' and 'spot.' The name assigned this fish literally means a "parallel fish that forgot its spots" (Gowanloch 1933). This refers to this species lying close to the bottom and being uniformly colored as opposed to other related flatfishes which generally possess spots. Other common names for the southern flounder include southern large flounder (Ginsburg 1952); mud flounder, halibut, plie (Louisiana French); southern fluke (Breuer 1962); lenguado (Spanish); and doormat (Gowanloch 1933, Hoese and Moore 1998, Reagan and Wingo 1985, Gilbert 1986).

The following synonymy for southern flounder is abbreviated from Jordan and Evermann (1898):

Platessa oblonga DeKay 1842
Pseudorhombus oblongus Gunther 1862
Chaenopsetta dentata Gill 1864
Pseudorhombus dentatus Goode and Bean 1879
Paralichthys dentatus Jordan and Gilbert 1882
Paralichthys lethostigma Jordan and Meek 1884.

Gulf flounder is the valid common name recognized for *P. albigutta* by the American Fisheries Society (Nelson et al. 2004). The Latinized word, *albigutta*, literally means 'white drop' and refers to the presence of three white ocelli characteristic of this species (Borror 1960). Other common names include sand flounder, flounder, and fluke (Gilbert 1986).

The valid name for Gulf flounder is *Paralichthys albigutta* Jordan and Gilbert (1882). The following synonymy is adapted from Topp and Hoff (1972):
Pseudorhombus ocellaris Jordan and Gilbert 1879
Pseudorhombus dentatus Jordan and Gilbert 1879
Paralichthys albigutta Jordan and Gilbert 1882
Paralichthys albiguttus Jordan and Evermann 1898
Paralichthys abligutulus Pearse et al. 1942
Paralichthyes albigutta Vick 1964.

Morphology

Various authors have described the morphology of *Paralichthys* spp. and other paralichthyids. The following descriptions are summarized for southern and Gulf flounder. Comments regarding other species will be noted.

Eggs

Norman (1934) and Benson (1982) reported eggs to be pelagic, buoyant, and containing a single oil globule in the yolk, though Daniels (2000) reports that southern flounder eggs have been found as deep as 200m. The eggs are spherical and have a rigid shell (Smith 1973, Ward et al. 1980). Recently released southern flounder eggs examined by Henderson-Arzapalo et al. (1988) had mean diameters of 0.92 mm. Gulf flounder eggs were spherical with mean diameters of 0.87 mm and contained an oil globule with a mean diameter of 0.18 mm (Powell and Henley 1995).

Larvae

According to Gutherz (1970), one of the problems encountered in dealing with larval flatfish is that larvae which have been collected over a wide geographic range and a long period of time may show varying rates of development between different stages. He stated,

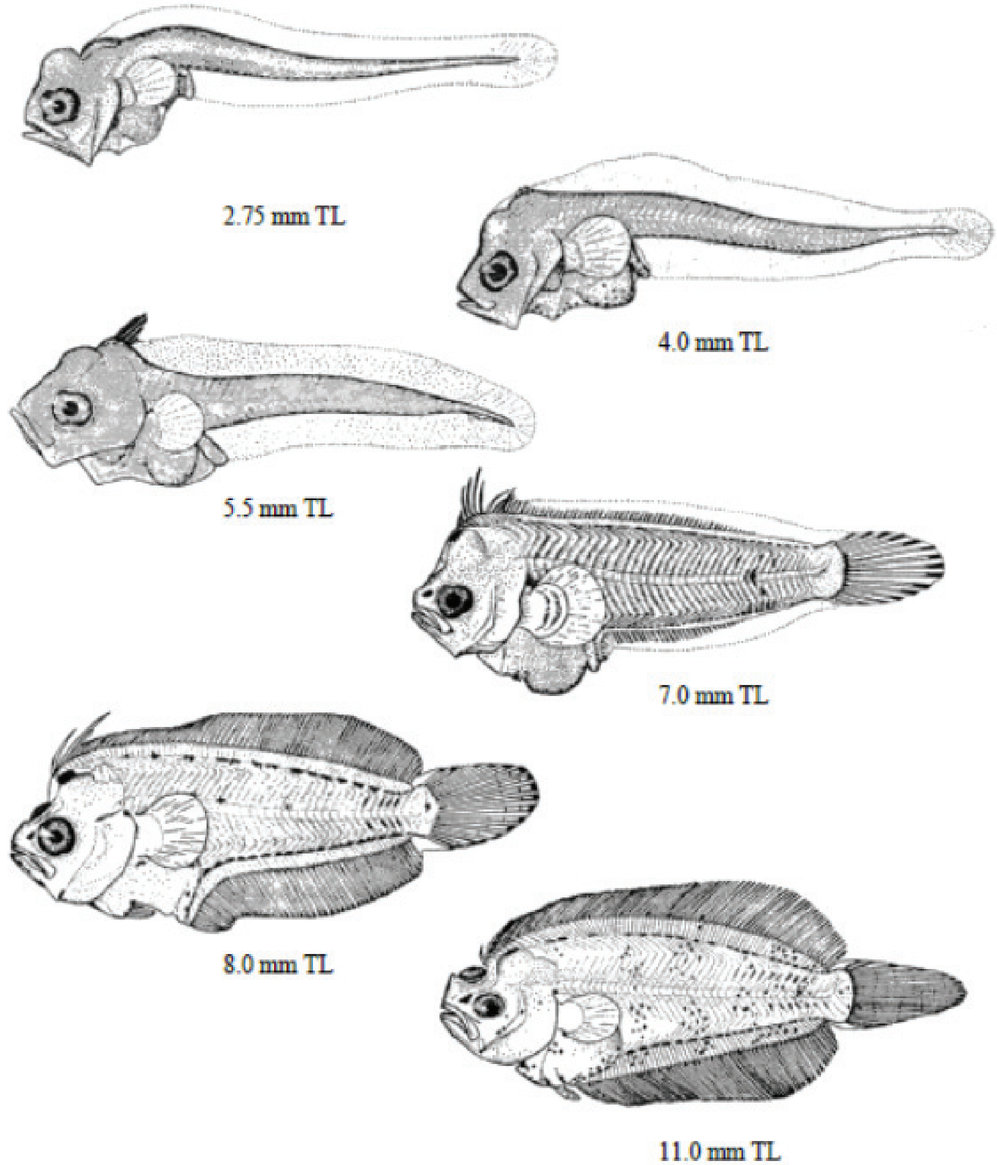


Figure 3.2 Typical larval stages of Paralichthys sp. (from Hildebrand and Cable, 1930).

> "characters that can be used to identify bothid (sic) larvae fall into two categories: (1) transitory, those which are present during part or all of the larval period but eventually are lost and (2) permanent, those which develop during the larval period and are retained in the juvenile and adult stages."

Gutherz (1970) described transitory characters such as larval pigmentation, elongate fin rays, and head and body spination. Permanent characters would include meristic counts, the placement of pelvic fin bases and fin rays, and the arrangement of the caudal fin rays with relation to the bones of the hypural plate.

The embryo becomes a larva when it switches from exclusively endogenous feeding to exogenous feeding (Balon 1975). Initial stages of paralichthyid larvae are symmetrical until the right eye migrates to the left side of the body during metamorphosis (Ahlstrom et al. 1984). The migrating eye moves

Table 3.6 Comparisons of morphometric characters for southern and Gulf flounder (*from* Gutherz 1967).

Character Type	Southern Flounder	Gulf Flounder
Dorsal fin rays	80 to 95	71 to 85
Anal fin rays	63 to 74	53 to 63
Pectoral fin rays (ocular side)	11 to 13	10 to 12
Gill rakers (upper and lower arch)	2 to 3 + 8 to 11	2 to 4 + 9 to 12
Lateral line scales	85 to 100	47 to 60
Vertebral count (precaudal and caudal)	10 or 11 + 27 or 28	10 + 27
Body depth to standard length (%)	39 to 47	39 to 47
Eye diameter to head length (%)	15 to 19 (decreasing with increasing size)	17 to 21 (decreasing with increasing size)
Upper jaw length to head length	47 to 51 (increasing with increasing size)	46 to 50 (increasing with increasing size)
Pigmentation on ocular side	Ocular side light to dark brown with diffuse nonocellated spots and blotches that tend to be absent in large specimens. Blind side immaculate or dusky.	Ocular side light to dark brown with numerous spots and blotches; three most prominent spots ocellated and arranged in a triangular pattern, usually conspicuous but sometimes faint; other spots faint and usually not ocellated. Blind side immaculate or dusky.

externally over the mid-dorsal ridge anterior to the origin of the dorsal fin or through the head between the dorsal fin and the supraorbital bars of the cranium (Gutherz 1970). All paralichthyids, except the genus Bothis, have this type of eye movement.

The larval stage of southern flounder is from hatching through metamorphosis, beginning at 40-46 days (8-11 mm TL) and completing developmental change at 50-51 days. Following this change, fingerlings become completely demersal (Arnold et al. 1977).

The following summarizes the development of larval *Paralichthys* spp. as described by Hildebrand and Cable (1930) (Figure 3.2). All measurements are total length.

> “At 2.5 mm, larvae have an enlarged head with a prominent hump over the eyes which encloses the brain, a deeply compressed body, and a long slender tail. From 2.5-4.0 mm, rows of dark spots form on the ventral edge of the abdomen and the beginnings of a small fin are evident on the nape. Metamorphosis begins around 4 mm and this fin serves as a recognition mark as larvae metamorphose. By 6 mm, the occipital hump has begun to disappear as the brain is completely enclosed and the small fin on the nape is well developed. At 7 mm, the body is more compressed and the right eye is now slightly higher than the left as it begins to migrate towards the left side of the body. The caudal fin is more fully developed and rays are appearing in the dorsal and anal fins. At 8 mm, the fish is beginning to look more like a flounder: it is much more compressed and the right eye has migrated to where it is near the dorsal ridge and is partly visible from the left side. Pigmentation is identical and equal on both sides of the fish.”

In laboratory-reared and field-collected specimens, recently hatched Gulf and southern flounder larvae ranged from 1.8 to 2.2 mm and 2.0 to 2.2 mm notochord length (NL), respectively (Powell and Henley 1995). The pigment on embryos and newly hatched larvae were relatively more developed in Gulf flounder than in southern flounder. Powell and Henley (1995) also noted that at any given size, development was generally more advanced in Gulf than in southern flounder. They used pigmentation, spination, and meristic counts to separate southern and Gulf flounder. They found differences in the pigmentation on the lateral surface of the hindgut and caudal areas between laboratory-reared specimens of the two species but cautioned that these differences may not be consistent on wild specimens. Cranial spines appeared to be diagnostic in separation of early preflexion larval forms, as southern flounder have three cranial spines, and Gulf flounder have from zero to two spines. Deubler (1958) suggested postlarval southern and Gulf flounder are difficult to separate since pigmentation and vertebral counts are similar. Although dorsal and anal ray counts generally separate the two species, he suggested a combination of characteristics be used to differentiate them (Table 3.6).

Juveniles

The juvenile stage is generally not distinguishable from adults except for size and maturity (Hoese 1965). Southern flounder were considered juveniles by Stokes (1977), Etzold and Christmas (1979), and

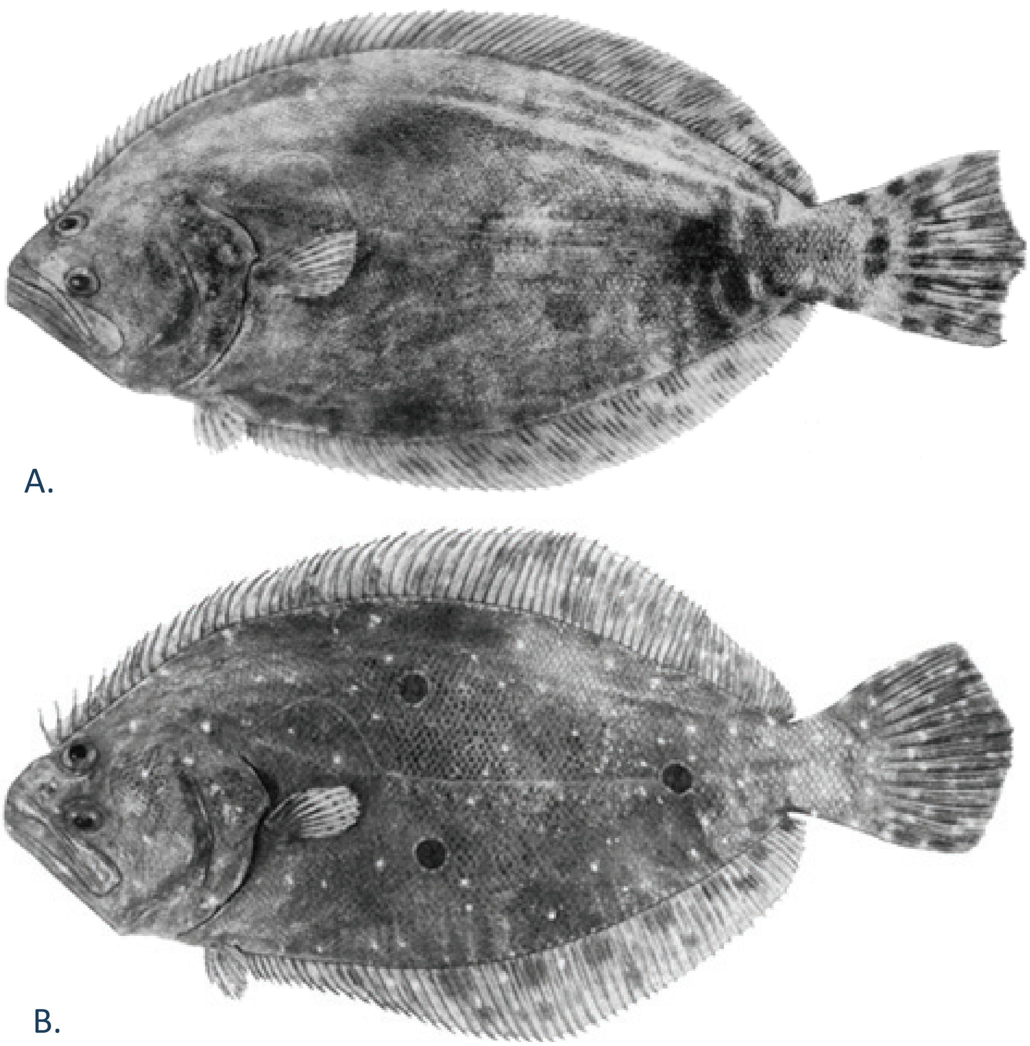


Figure 3.3 Adult A) southern flounder, *Paralichthys lethostigma*, 393 mm TL and B) Gulf flounder, *P. albigutta*, 373 mm TL (from Ginsburg 1952).

Nall (1979) from about 11-300 mm TL. The juvenile stage for Gulf flounder includes fish from about 11-290 mm TL (Topp and Hoff 1972, Stokes 1977).

In juvenile southern flounder (approximately 11 mm TL), the right eye is fully on the ridge of the head, and pigmentation has begun to change with new chromatophores more fully developed and appearing as faint crossbars on the left side, the right side remaining unchanged (Hildebrand and Cable 1930). In individuals 13 to 20 mm, the groups of chromatophores are more diffuse and so arranged to suggest broad cross bands. At about that size, specimens of Gulf flounder somewhat resemble those of southern flounder. At 16 mm, both eyes are present on the left side, and the fish is beginning to look more like an adult in appearance. Pigmentation is more pronounced with numerous chromatophores on the left side of both the body and the fins. Small southern flounder, between 20 and 45 mm, show characteristic groups of chromatophores, each group consisting of a blotch-like concentration of minute pigment dots interspersed with coarser chromatophores. This grouped concentration of chromatophores gives a gross appearance of blotches which may be somewhat coalescent. The coarser chromatophores in southern flounder may be scattered between but are especially concentrated on the blotches. Specimens ≥50 mm generally have the color pattern of large fish. Sometimes the spots are saliently distinct in specimens up to about 150 mm. In such individuals, the three spots forming the large triangle are most prominent as in Gulf flounder, but they are not ocellated. As both species grow, the eyes decrease in size relative to snout length, and the mouth has a more upward and forward curve (Hildebrand and Cable 1930).

In young Gulf flounder examined, the three characteristic ocellated spots forming the large triangle are distinct in those as small as 17 mm and resemble those of the adults. The aggregations of coarse chromatophores overlaying the blotches which are present in southern and summer (*Paralichthys dentatus*) flounder are absent or very sparsely developed in Gulf flounder. The other spots on the body are already present in fish between 17 and 30 mm in the form of small specks in five longitudinal rows, becoming large and diffuse in fish over 30 mm (Ginsburg 1952).

A description and comparison on the osteology of juvenile Gulf, southern, and summer flounder from the southeastern Atlantic coast was given by Woolcott et al. (1968). By the time most fish are 50 mm SL, they have acquired most of the adult skeletal characteristics. Posterior extremity of maxillary reaches to a vertical through posterior margin of pupil at 35 mm SL, through posterior margin of eye at 50-100 mm, and past eye in specimens over 100 mm SL. Origin of dorsal fin is somewhat behind anterior margin in specimens under 100 mm SL. Accessory scales usually begin to appear in specimens 110-120 mm SL. Woolcott et al. (1968) found juvenile Gulf flounder could be reliably separated from the other species by having lower pterygiophore, dorsal, and anal fin ray counts (Table 3.6). Delamater and Courtenay (1974) found all species of *Paralichthys* to have accessory scales, but because of the late appearance, the usefulness as a diagnostic characteristic for juveniles is limited.

Adults

Chief characteristics which distinguish *Paralichthys* spp. are of a meristic nature. Ginsburg (1952) stated that for the two common Gulf of Mexico species, the southern flounder may be readily distinguished from the Gulf flounder by its distinctive color, all of the spots being diffuse, none especially prominent or ocellated (Figure 3.3A and 3.3B). It may be possible that specimens of Gulf flounder could be confused with those of southern flounder whenever the identification is based on the presence or absence of ocelli, since these are sometimes faint (Ginsburg 1952, Gutherz 1967). However, dorsal and anal ray and scale counts are reliable diagnostic characteristics for distinguishing the two species (Table 3.6). More detailed morphological descriptions of the two species may be found in Ginsburg (1952) and Gutherz (1967).

Accessory scales are rather sparse (may be more numerous in large fish) in southern flounder with more in the Gulf flounder (Ginsburg 1952). The interorbital space in southern flounder is rather wide, becoming markedly broad in large fish and conspicuously more so than in Gulf flounder. The body becomes deep in large individuals of southern flounder.

Ginsburg's (1952) description of the coloration for adult southern flounder is detailed below:

"Body irregularly shaded with darker and lighter. The five longitudinal rows of spots more or less evident, usually diffuse, blending more or less with the darker shadings, and tending to disappear entirely in larger individuals. None of the spots ocellated. Sometimes the spots are saliently distinct in specimens up to about 150 mm, and in such individuals the three spots forming the large triangle are most prominent as in albigutta, but they are not ocellated. The relative intensity of the shadings on the body is subject to great variation as in related species; some specimens being very light all over, especially in life, and others being very dark. After being landed, specimens of this species usually have whitish spots irregularly snowed over the body; these usually disappear after the death of the fish, but are sometimes present also in preserved specimens."

The following description of the coloration for adult Gulf flounder is from Ginsburg (1952):

"The typical 5 longitudinal rows of spots more or less evident, diffuse. Most prominent spots on body, three in number, the perpendicular spot and two at anterior ends of the two intermediate rows, forming the angles of an imaginary scalene triangle; these three spots conspicuous and ocellated in the great majority of individuals, sometimes rather faint. Other spots on body fainter and mostly not ocellated; sometimes one or more ocellated spots at posterior end of subdorsal row, less frequently at posterior end of supra-anal row, and rarely at middle of intermediate rows. Body variously shaded with light and dark hues. Frequently quite light and sometimes notably dark, the ocellated character of the three spots in such specimens sometimes faint, but these spots nearly always rather more prominent than the other blotches on the body. Individuals frequently snowed over densely with white spots, tending to disappear after death but frequently persistent in preserved specimen."

Anomalies and Abnormalities

The types of anomalies encountered in the family Paralichthyidae can be grouped into either pigmentation or structural abnormalities, or in some cases, both. Hoese and Moore (1998) refer to 'reversal' in members of the Paralichthyidae family as "possessing internally correct features while exhibiting external features on the wrong side." Although this is rare in both southern and Gulf flounders (Hoese and Moore 1998), Gutherz (1967) reported 'reversal' as being common in 40%-60% of various Pacific flatfish species. Reported pigmentation abnormalities in paralichthyids include partial or complete ambicoloration, in which part or all of the blind (right) side of the fish is pigmented in addition to the normal (left) pigmented side (Norman 1934, Gudger 1935). In some cases, fish have developed both reversal and ambicoloration characteristics (Deubler and Fahy 1958, White 1962). Albinism has also been reported in flatfish (Dawson 1967, Hoese and Moore 1998). Theories explaining the cause of ambicoloration include: prolonged pelagic stage (subjecting the future blind side to prolonged light) exposure to prolonged periods of light on the blind side after metamorphosis (Norman 1934, DeVeen 1969, Gartner 1986); germinal factors, disruption of embryonic transformation mechanisms and mutations (resulting in secondary bilateral symmetry), and injuries of the vertebral column during development (Norman 1934); susceptibility of larval hatching in total darkness and low food levels during larval rearing (DeVeen 1969); temperature during larval development (DeVeen 1969, Gartner 1986); and depth of occurrence (Gartner 1986).

Complete ambicoloration is usually associated with hooked-shaped dorsal fin and incomplete migration of the eye (Dawson 1962). Gudger and Firth (1936) examined several partial ambicolored, four-spotted flounder (*P. oblongus*) and concluded that whenever the entire lower body of the blind side is pigmented and one-quarter to one-third of the head on the blind side is pigmented, the rotating eye will not complete migration beyond the dorsal crest and the anterior dorsal fin will be 'hooked'. Gray (1960) also described a partial ambicolored southern flounder and noted the presence of a hooked dorsal fin on this specimen. Powell and Schwartz (1977), using radiographic examinations of southern flounder, found incomplete ambicolorates manifested no structural abnormalities while totally ambicolored specimens possessed atypical osteological structures in the orbital region and hooked dorsal fins. They believed skeletal damage did not cause ambicoloration or the hooked conditions in southern flounder. Dawson (1967) described two southern flounder with osteological and pigmentation abnormalities, one with pterygiophore and the other with vertebral abnormalities. In another publication, Dawson (1969) described a nearly total ambicolorate southern flounder with a hooked dorsal fin and partially rotated eye and another specimen with a combination of melanism, albinism, and xanthochromism (golden-yellow coloration). Several southern flounder of various stages of ambicoloration have been collected in Louisiana (specimens on file, LDWF). Deubler and Fahy (1958) described a reversed ambicolorate summer flounder from North Carolina. This specimen possessed both eyes on the right side of the head, rather than the left, and the right pectoral fin, normally the shorter, was longer than the left.

Powell and Schwartz (1972) described the caudal structure of a double-tail southern flounder from North Carolina waters, as well as other pigment anomalies of the genus *Paralichthys*. Ginsburg (1952) reported pectoral fin abnormalities in one specimen that possessed no pectoral rays on the eyed side and 11 on the blind side.

Morphological anomalies of Gulf flounder have been reported in the literature and follow the patterns seen in other paralichthyids. White (1962) described a reversed ambicolorate postlarval Gulf flounder from Bogue Sound, North Carolina, which represents the first reported reversal and ambicoloration of this species. This flounder was a 8.5 mm SL postlarval individual with pigmentation on both sides of the body and the migrating eye located on the dorsal ridge. The hooked dorsal fin, present on all other complete ambicolorates, was likely not yet developed in this postlarval flounder. A partial ambicolorate Gulf flounder from Tampa Bay, Florida, was reported by Hoff (1969). In his specimen, the pelvic fin on the blind side was equal in length to that of the eyed side. Pelvic fins are usually unequal in length in paralichthyid flounders. Although the entire head was unpigmented on the blind side and the rotated eye was completely migrated, this specimen possessed a slightly hooked anterior dorsal fin.

Age and Growth

White and Stickney (1973) and Ginsburg (1952) referred to southern flounder as the largest paralichthyid flounder of the Gulf Coast. Jordan and Gilbert (1883) reported the largest southern flounder in South Carolina to be 762 mm TL. The largest specimen examined by Ginsburg (1952) from North Carolina was 660 mm TL. Stunz et al. (2000) recorded specimens up to 633 mm during sampling in Texas coastal waters, while Fischer and Thompson (2004) documented a 764 mm specimen during their investigations in Louisiana waters. Nall (1979) had previously documented a 585 mm TL specimen as the largest from the northern Gulf of Mexico. Hoese and Moore (1998) reported this species reaches a length of 910 mm TL, and Pew (1966) reported weights of up to 11.8 kg. The all-tackle world record for recreationally-caught southern flounder was landed in 1983 in Nassau Sound, Florida, and was 838 mm TL and 9.3 kg (IGFA 2013) (see Table 6.13).

Yolk sac larvae of laboratory-spawned southern flounder measured 1.2-1.4 mm TL with a 0.7 mm long yolk sac containing a single oil globule at its posterior edge (Lasswell et al. 1978). Metamorphosis of southern flounder laboratory-cultured yolk sac larvae began at 40-46 days (8-11 mm TL) and was complete at 50-51 days, after which time fingerlings became completely demersal (Arnold et al. 1977). In preserved postlarvae collected for growth studies, Deubler (1960) measured 8-12 mm SL southern flounder which weighed 15 mg. In January, Wenner et al. (1990) found newly recruited southern flounder young-of-the-year (YOY) were 10 mm in length (after preservation) and ranged between 20-130

Table 3.7 Mean observed total length (OBS TL) with sample size (n), standard deviation (SD), and predicted von Bertalanffy total length (VB TL) for each sex of southern flounder by yearly quarters; units are mm (*from* Wenner et al. 1990).

Age	Males				Females			
	n	SD	OBS TL	VB TL	n	SD	OBS TL	VB TL
0.375	10	13	139	155	14	20	138	151
0.625	71	30	180	176	166	31	194	186
0.875	50	36	209	197	89	40	218	218
1.125	21	45	201	216	21	43	222	249
1.375	74	39	219	234	74	48	265	278
1.625	115	23	251	251	89	43	296	305
1.875	117	23	271	267	74	51	320	331
2.125	15	21	378	282	7	42	346	356
2.375	18	30	399	296	65	52	404	379
2.625	47	37	322	309	56	50	427	400
2.875	28	31	316	321	56	56	409	421
3.125	0			333	47	172	452	440
3.375	4	46	310	344	21	52	488	458
3.625	3	50	328	354	18	48	448	475
3.875					10	71	464	491
4.125					2	62	564	507
4.375					0			521
4.625					5	73	520	535
4.875					2	229	493	547
5.125					0			559
5.375					1		572	571
5.625					4	37	546	582
5.875					1		571	592
7.125					1		703	634

mm by May according to modes of progressive monthly histograms. Glass et al. (2008) observed peak recruitment in the Galveston Bay system between January and February and collected newly recruited southern flounder as small as 9 mm SL.

Wenner et al. (1990) found little growth of southern flounder in shallow marsh habitats from January through March in South Carolina. As water temperatures warmed to 20°C in May, growth rate and average size accelerated. White and Stickney (1973) found water temperatures below 20°C and above 30°C to retard growth and suggested the optimum was within the 20°-30°C range. Deubler (1960) and Deubler and White (1962) noted better postlarvae growth at cooler temperatures and higher salinities (30‰). While not reporting better growth rates, Glass et al. (2008) did note comparable growth rates to previous laboratory studies from cooler estuarine waters. Postlarval southern flounder seek lower salinity water in the spring, summer, and fall and return to more saline waters in winter as they approach age-1. Stickney and White (1974a) found postlarval southern flounder growth most rapid at salinities as high as 30‰. Studies conducted in Texas estuaries suggest that salinity and proximity to tidal inlets may be the most important factor in postlarval settlement of southern flounder (Nanez-James et al. 2009, Glass et al. 2008, Glass 2003). Salinity requirements change rapidly with age, and within a few months,

Table 3.8 Mean observed weight (OBS WT) in g, total length (OBS TL) in mm, and predicted von Bertalanffy total length (VB TL) in mm for southern flounder by age in years (*from* Wenner et al. 1990).

Age	Male					Female				
	n	OBS WT	n	OBS TL	VB TL	n	OBS WT	n	OBS TL	VB TL
1	320	180	327	248	206	251	298	258	288	234
2	99	350	108	310	274	173	869	184	410	344
3	7	335	7	316	327	49	1258	53	467	431
4						9	1908	9	524	499
5						6	2014	6	554	554
6						0		0		597
7						1	5000	1	703	630

Table 3.9 Estimates of von Bertalanffy growth parameters for southern flounder by author. Symbols are as follows: M = male; F = female; C = sexes combined; L∞ = asymptotic length (i.e., the mean length of the fish of a given stock would reach if they grew forever); K = curvature parameters of the von Bertalanffy growth formula, t_0 = the 'age' of fish at length zero.

State	Sex	Unit of Measure	L∞	K	t_0	Notes	Author
Texas	M F	TL (mm)	309 660	0.701 0.209	-0.421 -1.317	Back-calculated models	Stunz et al. 1996
Louisiana	F	TL (mm)	509	0.8846	0.0954	Utilizes age data from fish collected by Thompson, Fischer and Thompson and LDWF fishery-independent surveys	Blanchet 2010
	M F	TL (mm)	332 556	1.03 0.51	-0.25 -0.62		Fischer & Thompson 2004
Alabama/ Florida	F	TL (mm)	607 734	0.38 0.21	0.40 -0.55	Age 1-3 Age 1-5 — Back-calculated models	Frick 1988
South Carolina	M F	TL (mm)	518 759	0.246 0.235	-1.066 -0.570	Mean observed length modals	Wenner et al. 1990
NW Florida	C	SL (mm)	1461	0.0308	1.8629	Back-calculated model	Nall 1979*

*Subsequent studies have questioned the accuracy of these data.

juvenile southern flounder grow most rapidly at low (5-10‰) salinities. These changes probably relate to their normal migration patterns.

Etzold and Christmas (1979) indicated there was some evidence of differing growth rates from various areas. Stickney and White (1974a) found five-month old southern flounder to average 28 g in North Carolina and 15 g in Georgia. Growth in North Carolina required ten weeks for a 500% weight increase from the initial 0.5 g. Christmas and Waller (1973) collected individuals less than 38 mm TL in March,

Table 3.10 Length-weight relationships and predictive equations for southern flounder separated by sex (M = male, F = female, C = combined sexes). NA = not available.

State	Sex	Length-weight Relationship	Predictive Equations	Author(s)
Texas	C	Log_{10} W=3.13 Log_{10} TL-5.26 (r^2=0.984, n=2211)	TL=8.96+1.18 SL (r^2=0.995, n=2417)	Harrington et al. 1979
	M	Log_{10} W=3.31 Log_{10} TL-5.69 (r^2=0.975, n=33)	NA	Stuntz 1995
	F	Log_{10} W=3.30 Log_{10} TL-5.66 (r^2=0.991, n=206)		
	C	Log_{10} W=3.27 Log_{10} TL-5.61 (r^2=0.990, n=239)		
Louisiana	F	Log_{10} W=3.18369 * Log_{10} TL-5.386116	NA	Blanchet 2010
	C	TW(g)=3.47*10-6(TL3.21) (r^2=0.98, n=1236)		Fischer and Thompson 2004
NW Florida	C	Log_{10} W=3.10 Log_{10} SL-4.92 (r^2=NR, n=175)	SL=5.34+0.82 TL (r^2=0.985, n=NR)	Nall 1979
South Carolina	M	Log_{10} W=3.17 Log_{10} TL-5.38 (r^2=0.984, n=675)	TL=6.95+1.19 SL (r^2=0.991, n=655)	Wenner et al. 1990
	F	Log_{10} W=3.15 Log_{10} TL-5.33 (r^2=0.995, n=926)	TL=9.09+1.18 SL (r^2=0.997, n=885)	
	C	Log_{10} W=3.13 Log_{10} TL-5.28 (r^2=0.994, n=1753)	TL=6.12+1.19 SL (r^2=0.997, n=1737)	
Georgia	M	Log_{10} W=2.98 Log_{10} TL-4.89 (r^2=0.95, n=12)	NA	Music and Pafford 1984
	F	Log_{10} W=2.97 Log_{10} TL-4.84 (r^2=0.98, n=105)		
	C	Log_{10} W=3.09 Log_{10} TL-5.16 (r^2=0.98, n=233)		

April, and May in Mississippi estuaries. Young fish from 17-40 mm TL were caught in Aransas Bay, Texas, during December, February, March, and April (Gunter 1945). The youngest fish were 80 mm TL in May and increased rapidly during summer. Martin and McEachron (1986) reported that mean lengths of southern flounder in Texas waters increased from 42 mm TL in February to 66 mm TL in March. Powell and Schwartz (1977) reported 130 mm TL southern flounder by December of the first year while Ross et al. (1982) found 60-160 mm TL fish in October and November. Analysis of otoliths confirmed the YOY grew to 170 mm in June, averaging 210 mm by November (Wenner et al. 1990). Their age/growth observations indicated 90-100 mm TL fish taken in spring may have been slow growing age-1 juveniles recruited the previous year.

In his review of age/growth studies of *Paralichthys,* Gilbert (1986) noted analysis of size classes may be of limited value because of variable individual growth rates and protracted spawning seasons. In North Carolina, Fitzhugh (1993) found differential growth among age-0 southern flounder and attributed the broad variation in size differences of juveniles to differential growth rates among individuals rather than date of spawn. He also suggested ontogenetic change in diet (switch to piscivory) was a major contributing factor for growth differences among age-0 flounder. Growth rates might have also been influenced by size and availability of prey as well as environmental factors. His observed growth rates ranged from 0.35-1.5 mm TL/day (0.65±0.28 mm TL/day; mean±SD). Glass et al. (2008) observed average daily growth rates of 0.40 mm SL for newly settled (27-78 days old) southern flounder in the Galveston Bay Estuary. In pond studies, Wright et al. (1993) noted instantaneous daily growth rates were determined to be 0.012 g/g/day for small flounder (216 mm SL) and 0.0052 g/g/day for large flounder (268 mm SL). Based upon multiple tag recaptures of five southern flounder in South Carolina, Wenner et al. (1990) estimated growth rate of 0.17 mm/day. Matlock (1985) estimated mean daily growth rate from tagged southern flounder at 0.647 mm TL/day for fish between 250-560 mm TL in Texas bays.

Table 3.11 Age/length estimates for southern flounder by author and area. Age corresponds to number of otolith annuli, except where noted.

State	Sex	Unit of Measure	Age										Author(s)
			0	1	2	3	4	5	6	7	8	9	
Texas	F	Observed TL	10-300	301-450	451-530	531-570	571-620						Stokes 1977
	M	Observed TL	10-230	231-280	281-320								
	F	TL[1]		253	328	402	429						Stunz et al. 1996
	M	TL[1]		194	252	284	292						
Louisiana	U	Mean TL	129.0										Fischer and Thompson 2004
	M		256.0	271.8	317.4	302.4	374.02						
	F		319.5	396.3	438.1	471.2	522.3	530.6	586.02	538.02	675.52		
Mississippi	NR	Mean TL	230	340	480								Etzold and Christmas 1979
Florida/ Alabama	F	Weighted Mean TL		232	351	411	468	527[2]					Frick 1988
	M	Weighted Mean TL		179	278								
	F	TL[1]		258	366	422	474	527[2]					
	M	TL[1]		169	278								
Florida (NW)	NR	Weighted Mean FL		115	210	283	326	332	376	420	426[2]	405[2]	Palko 1984[3]
Georgia	F	TL[1]		173	334	460	585	605	680				Music and Pafford 1984[4]
	M	TL[1]		119	244	342							
South Carolina	F	TL[1]		234	344	431	499	554	597	630			Wenner et al. 1990
	M	TL[1]		206	274	327							

[1] Mean back-calculated lengths.
[2] Based on sample sizes ≤5 fish.
[3] Age corresponds to vertebral rings.
[4] Age corresponds to scale circuli.

Wenner et al. (1990) calculated lengths of southern flounder based on von Bertalanffy's growth equation as listed in Tables 3.7 and 3.8. The von Bertalanffy growth parameters by various authors and locations are shown in Table 3.9. Most authors report similar parameters except Nall (1979), who predicted a theoretical maximum age of 20 years and a maximum SL of 1,461 mm. The oldest fish in Nall's study was ten years old; he suggested growth was limited by life span and not by maximum size. In contrast, most researchers believe in a much shorter life span and maximum size (Stokes 1977, Wolff 1977, Music and Pafford 1984, Palko 1984, Frick 1988, Wenner et al. 1990, Stunz et al. 1996). For example, Stunz et al. (1996) estimated the theoretical size of southern flounder at 309 mm and 660 mm TL for males and females, respectively.

Nall (1979) described growth of southern flounder as isometric where weight increased directly with length. Some length-weight relationships (male and female combined) calculated for southern flounder are:

Texas: Log_{10}(weight, g) = 3.13 log_{10}(TL, mm)-5.26 (Harrington et al. 1979)

Northern Gulf of Mexico: Log_{10}(weight, g) = 3.10 log_{10}(SL, mm)-4.92 (Nall 1979)

Additional length-weight relationships and predictive equations are given in Table 3.10.

Ageing techniques include length/frequency, dorsal and anal fin ray count, and use of scales and hard parts (otoliths and vertebrae). An evaluation of hard parts by Palko (1984) for determining age of selected fish, including Gulf and southern flounder, revealed both otoliths and vertebrae were useful (the former giving the best results). Various authors have used scales and/or otoliths to age southern flounder and found annuli to be formed once annually (Music and Pafford 1984, Nall 1979, Stokes 1977, Wenner et al. 1990). Wenner et al. (1990) found annulus deposition began in January and was completed by April in most YOY. One translucent and one opaque ring were formed annually and were determined suitable for age estimates. Stunz et al. (1996), using marginal increment analysis, found one opaque band was formed on otoliths of southern flounder from Texas once each year during January to April. Utilizing the same technique, Fischer and Thompson (2004) reported similar results with an opaque band being formed each year from January through May on otoliths of Louisiana sampled southern flounder.

Various ages of southern flounder have been reported. Most authors report southern flounder females up to age-6 and males to age-3 (Stokes 1977, Wolff 1977, Music and Pafford 1984, Palko 1984, Frick 1988, Wenner et al. 1990, Stunz et al. 1996) (Table 3.11). However, Nall (1979) reported collecting a fish ten years of age, while Fischer and Thompson (2004) reported females up to age-8 and males up to age-4. The Louisiana Department of Wildlife and Fisheries has documented two male specimens to age-7 (LDWF unpublished data.)

A significant difference in growth rates was noted between male and female southern flounder beginning at ages-0 and -1 (Table 3.11). By December, male YOY averaged 263 mm TL and females 330 mm TL, and on an annual basis, age-2 females averaged 100 mm TL longer than males (Wenner et al. 1990). Stokes (1977) also reported males exhibited slower growth than females and did not exceed 320 mm TL. His data indicated five age classes of females (to 620 mm TL) and three age classes of males. He found males and females of equal size had comparable weights, but females at age were larger. In a northern Gulf of Mexico study, Frick's (1988) oldest, female southern flounder was an age-4, 623 mm TL fish; the oldest male was an age-1, 340 mm TL fish. He also noted the growth rate among females to be greater than males. Other published length-at-age estimates are listed in Table 3.11.

Gulf flounder do not get as large as southern flounder. Early reports by Ginsburg (1952) and Jordan and Swain (1885) gave 390 mm TL as the largest Gulf flounder specimen examined. The largest female

Table 3.12 Age/length estimates for Gulf flounder by author and area. Age corresponds to number of otolith annuli.

State	Sex	Unit of Measure (mm)	Age 0	1	2	3	4	5	6	Author(s)
Texas	F	Observed TL	10-290	291-360	361-420					Stokes 1977
	M	Observed TL	10-220	221-290						
Florida (both Coasts)	F	Mean SL	235	279	324	329	409[1]			FWC/FWRI unpublished data
	M	Mean SL	208	241	265[1]	260[1]	251[1]	296[1]		
Florida (NW)	NR	Weighted Mean FL	152	238	332	359[1]	519[1]			Palko 1984

[1] Based on sample sizes ≤5 fish.

Table 3.13 Length-weight relationships and predictive equations for Gulf flounder separated by sex (M = male, F = female, C = combined sexes). NA = not available.

State	Sex	Length-weight Relationship	Predictive Equations	Author(s)
Florida NW	C	Log_{10} W=2.81 Log_{10} SL-4.23 Log_{10} (r^2=NR, n=34)	SL= -4.82+0.83 TL (r^2=0.999, n=NA)	Nall 1979
Florida	C	Log_{10} W=3.104 Log_{10} TL-4.196 (r^2=0.992, n=376)	TL=1.70+1.20 SL (r^2=0.989, n=376)	FWC/FWRI unpublished data
		Log_{10} W=3.029 Log_{10} SL-4.769 (r^2=0.992, n=998)	SL=1.12+0.83 TL (r^2=0.989, n=376)	
North Carolina	C	Log_{10} W=3.13 Log_{10} TL-5.24 (r^2=0.96, n=75)	NA	Safrit and Schwartz 1988

and male Gulf flounder examined by Stokes (1977) was 420 and 290 mm TL, respectively. Vick (1964) reported an individual measuring 710 mm TL (sex not indicated) from St. Andrews Bay, Florida, but this may have been based on a misidentified specimen of southern flounder. However, Safrit and Schwartz (1988) supported Vick's reported size of Gulf flounder using a length-weight regression of their own data from North Carolina. Their largest reported male and female Gulf flounders were 426 mm and 673 mm TL, respectively. The largest specimen of Gulf flounder examined by Nall (1979) was 467 mm TL (sex not indicated). The all-tackle IGFA world record for recreationally caught Gulf flounder is 533 mm TL and 2.8 kg, caught in 1996 on Dauphin Island, Alabama (see Table 6.13).

In a technical report on the evaluation of aging determination for several species, Palko (1984) found five "mark groups" that are presumed to represent annuli from Gulf flounder otoliths. Using otoliths for age determination, her back-calculated, weighted mean TL for Gulf flounder were 152, 238, 332, 359, and 519 mm for mark groups I through V (ages 0-4), respectively. Palko's largest specimen examined was 548 mm TL. Palko (1984) concluded scales were not satisfactory aging structures for either southern or Gulf flounder because of inconsistent or indistinguishable markings.

Only one published age and growth study on the Gulf flounder exists (Stokes 1977). Based on 123 specimens, Stokes suggested that male and female Gulf flounder from Aransas Bay, Texas, live only two and three years, respectively (Table 3.12). However, Stokes believed that older Gulf flounder may reside in deeper water outside of his sampling area.

Preliminary age determination of 296 Gulf flounder sampled from Florida's east and west coast (FWC/FWRI unpublished data) indicated individuals from Florida may live longer than those reported by Stokes (1977) from the Texas coastal waters. One age-5 male and three age-4 female Gulf flounder were examined (Table 3.12). These data indicated males (n=51) reached a maximum size of 270 mm SL in their first year; the largest male was an age-1 individual at 368 mm SL. Female Gulf flounder (n=245) grew to a larger size in their first year than males and reached a maximum of 293 mm SL; the largest female Gulf flounder measured was 456 mm SL and was age-4 (Table 3.12). Recent aging of Gulf flounder from St. Andrews Bay, Florida, by other researchers corroborate these findings (Fitzhugh personal communication).

Stokes (1977) reported upper weights for male Gulf flounders in their first and second years at 0.15 kg and 0.27 kg, respectively. Upper weights for female Gulf flounder in their first, second, and third years of life were 0.27 kg, 0.57 kg, and 1.01 kg, respectively.

Male Gulf flounder from Aransas Bay, Texas, grew slower than females but had similar length-weight relationships (Stokes 1977). Based on 34 unsexed individuals, Nall (1979) calculated the length-weight relationship for Gulf flounder from the northern Gulf of Mexico as:

$$\text{Log}_{10}(\text{weight, g}) = 2.81 \log_{10}(\text{SL, mm})-4.23$$

The length-weight relationship for Gulf flounder (sexes combined) from Florida (FWC/FWRI unpublished data) was:

$$\text{Log}_{10}(\text{weight, g}) = 3.104 \log_{10}(\text{TL, mm})-5.196$$
$$(r^2 = 0.992, n=376)$$
$$\text{Log}_{10}(\text{weight, g}) = 3.029 \log_{10}(\text{SL, mm})-4.769\ (r^2=0.992, n=998)$$

Length-weight relationships and predictive equations for Gulf flounder are given in Table 3.13.

Based on 34 individuals, Nall (1979) reported Gulf flounder from the northern Gulf of Mexico to have allometric growth (weight increases proportionally at a slower rate than length), whereas southern flounder have isometric growth. However, the isometric growth suggested by Nall (1979) does not agree with other studies of southern flounder, and its accuracy has been in question (Wenner et al. 1990). Nall's

Table 3.14 Gonadosomatic index (GSI) by size category for male and female southern flounder collected from Matagorda Bay, Texas, from September 1994 to January 1995. Numbers in parenthesis indicate sample size (*from* Stunz et al. 1996).

Size Categories	Mean GSI + 1 SD	
	Male	Female
201-205	0.052 + .018 (5)	0.173 + 0.067 (27)
251-300	0.246 + .230 (13)	0.215 + 0.198 (38)
301-350	0.417 + .300 (13)	0.538 + 0.279 (20)
351-400		1.284 + 1.500 (45)
401-450		1.749 + 1.177 (38)
451-500		1.471 + 0.960 (11)

small sample size of Gulf flounder precluded him from attempting any age and growth analyses with that species.

Reproduction and Genetics

Reproduction

Gonadal Development

Stokes (1977) first found sexual differentiation of southern flounder gonads discernible when they attained approximately 170 mm TL and indicated both southern and Gulf flounder females matured at two years of age in this Texas study. Music and Pafford (1984) found the smallest southern flounder for which sex could be determined through gross examination to be 130 mm TL (age-0) for females and 232 mm TL (age-1) for males in coastal Georgia waters. Gonadal histological examinations of southern flounder from North Carolina found that sexual differentiation occurred between the sizes of 75 and 120 mm TL with the larger individuals displaying more meiotic divisions and structural changes (Luckenbach et al. 2003). Likewise, Takade-Heumacher and Batsavage (2009) also state that female southern flounder begin to sexually mature at age-1 and age-2 in North Carolina.

In Texas, gravid southern flounder were noted when they were age-2 with an initial spawn occurring at the same age. Etzold and Christmas (1979) found southern flounder to become sexually mature by age-3 (~338 mm SL) in Mississippi waters, with the smallest sexually mature fish at 229 mm SL. In a Louisiana study, the smallest female captured with spawning potential (based on use of gonadosomatic indices) was 243 mm TL, while the smallest, potentially-spawning male was 170 mm TL (Shepard 1986). Gonadal Somatic Indices (GSI) by size categories for southern flounder collected from Matagorda Bay (Stunz et al. 1996) are listed in Table 3.14. In a South Carolina study (Wenner et al. 1990), first maturity of male and female southern flounder was noted by macroscopic examinations at 230 mm and 320 mm TL, respectively. All males greater than 310 mm and females greater than 380 mm TL were mature. Midway and Scharf (2012) reported from histological examinations that female southern flounder in North Carolina sexually mature at larger sizes and older ages than previously reported. The majority of female southern flounder were not sexually mature until the age-2 and length at 50% maturity occurred at 408 mm TL.

Based on gonadal examination, Topp and Hoff (1972) reported female Gulf flounder mature at about 145 mm SL. Stokes (1977) indicated that Gulf flounder contained maturing gonads at the end of their first year of life and had developed and/or gravid gonads from October through December of their second year of life. Fitzhugh et al. (2008) determined from histological and macroscopical examination that male Gulf flounder are sexually mature around 263 mm TL and females mature around 318 mm TL.

Sex ratios of southern flounder as reported by Music and Pafford (1984) in Georgia may also affect reproductive success. An overall female to male ratio of 9.5:1 was recorded from a total of 116 southern flounder. Other female to male ratios have been reported by Stunz et al. (1996) from Texas (6F:1M) and Shepard (1986) who sampled 206 southern flounder in Louisiana (6.35F:1M). Colura (personal communication) suggests that a lower ratio of males (possibly due to bycatch) may lead to decreased spawning success and stated that a high number of males are necessary for mixing of milt and eggs for a successful spawn. However, where fish were sampled from may affect the reported sex ratios, as males have been reported (Stokes 1977, Midway personal communication) to be located off shore or in Gulf waters instead of bays and estuaries.

Luckenbach et al. (2003) determined that southern flounder have environmental sex determination, wherein outside factors, beyond genetics can influence sex determination. Genetic XY male flounder develop into males, but XX females can become phenotypic males during early development, but once

Table 3.15 Gonadal condition of southern flounder exposed to a four-month compressed conditioning cycle, Perry R. Bass Marine Fisheries Research Station, Palacios, Texas, 1985-1986. Spawning occurred from December 8, 1985 through February 13, 1986. Tank temperature was kept at 18°C, photoperiod at 9 hrs light/day *(modified from* Henderson-Arzapalo et al. 1988).

Date	Females		Males	
	TL (mm)	Mean ovum diameter (mm) (+ 1 SD)	Number with flowing milt	Number without flowing milt
September 4, 1985	430	no sample	0	4
	435	fluid only		
	452	no sample		
	522	fluid only		
December 6, 1985	415	no sample	0	4
	435	0.56 ± 0.12		
	440	fluid only		
	457	no sample		
	532	tissue and fluid		
December 20, 1985	410	1.05 ± 0.04	3	1
	437	0.52 ± 0.80		
	445	0.60 ± 0.08		
	468	0.56 ± 0.08		
	533	0.50 ± 0.05		
February 13, 1986	415	0.75 ± 0.30	3	1
	430	0.45 ± 0.24		
	445	0.69 ± 0.12		
	460	0.87 ± 0.28		
	535	0.60 ± 0.09		

the juvenile stage is passed, flounder do not change sex (Luckenbach et al. 2004). One main factor influencing sex determination in southern flounder is water temperature during juvenile development (~35-80 mm SL) (Luckenbach et al. 2003, Montalvo et al 2012). Texas southern flounder exhibit a near 1:1 proportion of males and females reared at 18°C in captivity and warmer temperatures substantially induce male differentiation (Montalvo et al. 2012). However, In North Carolina, exposure of fry to high (28°C) and low (18°C) temperatures showed male-biased sex ratios (>7:1), while those exposed to a midrange temperature (23°C) exhibited a sex ratio near 1:1, suggesting possible latitudinal differences (Luckenbach et al. 2003).

Sex ratios for Gulf flounder were found to be 4.9F:1M from a total of 299 individuals collected in a statewide Fisheries Independent Monitoring Program in Florida (FWC/FWRI unpublished data). No other reports of sex ratios exist for Gulf flounder.

Spawning and Season

Stokes (1977) concluded that virtually all spawning by adult Gulf and southern flounder occurs offshore in the Gulf of Mexico due to the number of individuals in advanced stages of gonadal development collected from the Aransas Pass area of Texas. The adult individuals that did not migrate offshore showed no further gonadal development in Aransas Bay, Texas. Maximum emigration of flounder from Aransas Pass occurred during November 11-14. Additionally, tag returns indicated that for southern flounder along the Texas coast, it was probable that older males do not return to the bays after emigration, remaining instead offshore for the duration of their lives (Stokes 1977). He concluded that emigration of male southern flounder preceded that of females, and male flounder were not present in the samples after November 25. Benson (1982) also reported that Mississippi southern flounder spawned offshore and utilized waters 30-66 m deep.

The GSIs plotted by month indicated an increase in gonadal condition of females beginning in August and continuing to November for southern flounder caught in Louisiana (Shepard 1986). Shepard (1986) concluded that peak spawning activity occurred in December in Louisiana based on female gonadal condition, though extent of spawning period was not determined due to lack of samples collected in subsequent months.

Gulf flounder appear to spawn offshore in the Gulf of Mexico in the late fall and early winter, with some spawning occurring in the late winter (Ginsburg 1952, Fitzhugh et al. 2008). Based on GSI and histological results, Gulf flounder in northwest Florida also display a Fall-Winter gonad development with a peak occurring during the month of November (Fitzhugh et al. 2008). Reid (1954) reported that in the Cedar Key area, gravid females were collected in October, and based on young fish appearing in January, spawning probably occurs in late fall or early winter. Stokes (1977) suggests Gulf flounder migrate from Texas bays to the Gulf of Mexico for spawning from mid-October through December. Macroscopic examination of 80 specimens by Topp and Hoff (1972) led investigators to conclude Gulf flounder spawn in the Gulf of Mexico from November through February. They also examined ripe males in January from the northern Gulf of Mexico and spent females from Tampa Bay in February.

Courtship and Spawning Behavior

Lasswell et al. (1977) observed several spawning acts of wild caught southern flounder in their brood tanks and reported each act to involve one male and one female in Texas. In each observation, the male released a small amount of sperm which may have been insufficient to fertilize all eggs released by the female.

Table 3.16 Photoperiod and temperature regimes used to induce spawning of southern flounder in a 29.92 kl spawning tank, August 1976 through January 1977 (*from* Arnold et al. 1977).

Month	Photoperiod (hours)		Mean Temperature (°C)	Temperature Range (°C)	Laboratory Season
	Light	Dark			
August	15	9	26.5	26.0-27.0	Spring
September	12	12	26.5	25.5-27.5	Summer
October	12	12	22.8	20.7-25.0	Late Summer
November	9	15	17.0	16.0-19.5	Fall
December[1]	9	15	17.0	16.5-17.5	Fall
January[2]	9	15	17.0	16.5-17.5	Fall

[1] First spawn December 21, 1976
[2] Last spawn January 3, 1977

Table 3.17 Number of eggs released by captive southern flounder, Perry R. Bass Marine Fisheries Research Station, Palacios, Texas. Tank conditions were 18ºC and 9-hour light: 15-hour dark photoperiod except for the period from January 7 through March 25, 1985 when photoperiod was reduced to 4 hours of light daily. ND = not determined (*from* Henderson-Arzapalo et al. 1988).

1984-1985 Spawning Season		1985-1986 Spawning Season	
Date	Number of Eggs	Date	Number of Eggs
December 18, 1984	ND	December 8, 1985	5,000
December 19, 1984	ND	December 13, 1985	3,200
December 26, 1984	ND	December 17, 1985	2,900
December 31, 1984	ND	December 18, 1985	2,400
January 2, 1985	ND	December 24, 1985	1,400
January 3, 1985	ND	December 30, 1985	66
January 8, 1985	1,900	December 31, 1985	6,900
January 9, 1985	6,200	January 1, 1986	4,000
January 10, 1985	3,100	January 2, 1986	1,000
January 17, 1985	3,100	January 6, 1986	18,800
January 18, 1985	18,100	January 7, 1986	28,900
		January 10, 1986	1,500
		January 11, 1986	4,800
		January 13, 1986	9,500
		January 17, 1986	6,100
		January 24, 1986	6,100
		January 26, 1986	1,600
		January 29, 1986	4,700
		January 30, 1986	2,800
		January 31, 1986	20,500
		February 1, 1986	1,900
		February 7, 1986	3,200
		February 9, 1986	3,500
		February 13, 1986	28,400

Arnold et al. (1977) conducted laboratory experiments and reported courtship and spawning behavior of southern flounder (Table 3.15). They noted males attended females three weeks prior to spawning. Males followed females and positioned their heads near the female's vent when they rested. Actual spawning occurred at midday in the laboratory, near the surface, and only the larger (>2 kg) females spawned. They spawned more than three times each. They further classified southern flounder as serial spawners, having an extended spawning season of variable duration. Additional courtship and spawning behaviors have been observed for southern flounder in South Carolina. In Smith et al. (1999), males were observed spending several hours each day courting females prior to spawning in brood tanks. Two to three males would try to force the female to the surface. In the successful attempts, the males would release sperm and splash at the surface. The female would release her eggs in the vicinity of the sperm while the males would return to the bottom of the tanks.

Observations of courtship and/or spawning behavior for Gulf flounder have not been reported in the literature. Visual observations by researchers near Cedar Key, Florida, indicated spawning Gulf flounder form aggregations consisting of up to 40 individuals over natural and artificial reef habitat during winter months. Although actual spawning has not been observed, ‘pre-spawning’ behavior consisting of several smaller males lying on top of a single female has been documented (Voss personal communication).

Spawning Duration

Several studies reported southern flounder spawning in winter, primarily November to January, along the Gulf of Mexico coast over the inner and central continental shelf (Gunter 1938, Gunter 1945, Simmons 1951, Ginsburg 1952, Stokes 1977). Ginsburg (1952) and Hildebrand and Cable (1930) stated southern flounder may spawn for extended periods, although the general season was fall and early winter. Etzold and Christmas (1979) stated spawning took place in near offshore waters of Mississippi from September to January with peak activity occurring in October. Histological work by Fischer (1999) in Louisiana indicates that spawning in southern flounder occurs for 60 days from December through January. Arnold et al. (1977) observed spawning of six pairs of adult southern flounder on 12 consecutive days after an initial spawn on December 21, 1976 in Texas during their laboratory spawning and larval study.

Normal winter spawning conditions of 18°C and a 9-hour light: 15-hour dark photoperiod induced spawning in southern flounder exposed to a four-month compressed conditioning cycle (Table 3.16) (Henderson-Arzapalo et al. 1988). Gonadal maturation and release of eggs occurred only when laboratory conditions patterned the natural season. Regardless of temperature and photoperiod manipulation, eggs were released only during December-February and were usually released between 0500-0900 hours (Henderson-Arzapalo et al. 1988) with mean ovum diameters of 0.45-1.05 mm (Table 3.17).

Two studies, one from North Carolina and one from South Carolina concluded that wild caught southern flounder can have extended spawning periods in a culture setting with an acclimation period and increased winter photoperiod regime (Smith et al. 1999, Watanabe et al. 2001). The natural spawning period in these Atlantic states occurs during the months of December and January (Berlinsky et al. 1996, Henderson-Arzapalo et al. 1988, Smith et al. 1999) Watanabe et al. (2001) found viable embryos were produced without hormone injections from January through late April 1999. The spawning period in two tanks of southern flounder consisted of 142 days with eggs collected on 70 days in one tank (eight females, three males, two unknown) and 53 days in the other tank (five females, two males, five unknown) with number of eggs collected per day from each tank ranging from 5,490-601,250 (Watanabe et al. 2001). Smith et al. (1999) used a combination of photothermal conditioning and GnRHa (Gonadotrophin-releasing hormone agonists) implants on their southern flounder broodstock that led to an extended spawning period of 99 days from January to late April.

The spawning period for Gulf flounder, like that of southern flounder, is late fall-early winter (Ginsburg 1952, Fitzhugh et al. 2008). Stokes (1977) collected gravid females moving through the channels toward the Gulf of Mexico near Aransas Bay, Texas, from October through December. Topp and Hoff (1972) reported collecting ripe males and gravid females between 20-40 m depths in the eastern Gulf of Mexico from November through February. Fitzhugh et al. (2008) estimated spawning frequency of Gulf flounder to be almost every day (1.14-1.29 days) in northwest Florida.

Location and Effects of Temperature, Salinity, Dissolved Oxygen, and Photoperiod

Mass emigration of adults from bays and estuaries in response to colder water temperature has been reported for both southern and Gulf flounders by numerous researchers (Hildebrand and Cable 1930, Gunter 1945, Ginsburg 1952, Reid 1954, Topp and Hoff 1972, Stokes 1977, and Benson 1982). Stokes (1977) reported emigration of both adult southern and Gulf flounder from Aransas Bay, Texas, occurred when water temperatures declined approximately 4°-5°C (from an average of 23.0°C in October to 14.1°C in December). Gulf flounder from the Gulf coast of Florida follow a similar pattern of emigration following a drop in water temperatures during the fall and winter (Topp and Hoff 1972). These movements appear to be triggered by the onset of cold fronts (Fitzhugh personal communication, Voss personal communication). Miller et al. (1984) suggested several advantages of winter spawning including: greater survival at reduced temperature associated with reduced metabolism, refuge from predation, and advantageous currents into nursery areas from offshore spawning grounds.

Immigration of juvenile Gulf flounder into the bays and estuaries of Aransas Bay, Texas began in December when water temperatures were as low as 13.8°C and peaked in February with temperatures near 16°C (Stokes 1977). Juvenile Gulf flounder in Florida indicated a similar immigration pattern (FWC/FWRI unpublished data). In Charlotte Harbor and Tampa and Choctawhatchee bays, juvenile recruitment peaked in February, March, and April, respectively, when average water temperatures were near 18°C.

Stickney and White (1974a, 1974b) reported southern flounder may not be physiologically adapted to lower salinities until late post-larval size and various salinity trials with eggs, larval, and juvenile southern flounder by Smith et al. (1999) indicated that salinity tolerance increases with age. In Smith et al.'s experiments, eggs incubated at 0 or 5ppt did not survive and eggs incubated at 10ppt did hatch but subsequently all larvae died; equal hatching success (98% hatched) was found at 15 to 35%. Complete mortality of larvae was found at 0‰ (Daniels et al 1996) and post-metamorphosis flounder had lower survival (20%) than those at higher salinities, 5-30‰ (Smith et al. 1999). Although, Lasswell et al. (1977) acclimated newly metamorphosed southern flounder from 28-32‰ into fresh water (<1‰) within a three hour period and achieved 100% survival. Older juveniles (95 mm TL) seem to be tolerant of low salinities and fresh water, as well as high salinities (Daniels et al 1996, Daniels and Borski 1998, Smith et al 1999). Effects of salinity on advanced postlarval southern flounder indicate a preference of 5-15‰ and suggest a physiological adaptation to a seasonal distribution pattern which appears to change seasonally and with age (Stickney and White 1974a).

Weinstein et al. (1980) found numbers of paralichthyid larvae collected at night exceeded those taken during daylight indicating a high light sensitivity and diurnal behavior. They also found a tidal response exhibited by paralichthyid (presumably southern flounder) larvae. Apparently they settled to the bottom during ebb tide and rose to the surface during flood tide, resulting in a net landward transport.

Controlled experiments indicate strongly that postlarvae of *Paralichthys lethostigma* respond negatively to water of low oxygen concentrations when given the opportunity to choose between poorly-oxygenated and well-oxygenated water (Deubler and Posner 1963). Postlarvae migrate away from water with dissolved oxygen levels less than 3.7 ml/L. In Bell and Eggleston (2005), southern flounder displayed a strong threshold avoidance response to hypoxic water (threshold DO < 2-3 mg/L) in North Carolina's Neuse River Estuary, with similar avoidance found by Eby and Crowder (2002). Taylor and Miller (2001) found in their laboratory experiments that juvenile southern flounder can acclimate to constant hypoxic and moderate hypoxic conditions (2.7 and 4.5 mg L^{-1}) after two-three weeks indicated by an increase in growth rate after an initial decline, but do not acclimate to low DO when faced with oscillating dissolved oxygen concentrations. In Del Toro-Silva et al. (2008), juvenile southern flounder in North Carolina had a 50% reduction in growth when dissolved oxygen concentrations were reduced from 6 mg/L to 4 mg/L at their optimum temperature (29ºC) for growth.

Larval Transport

Following a winter spawn on the continental shelf, eggs and early life stages drift passively toward estuaries with prevailing currents. In North Carolina waters, Miller et al. (1984) analyzed shelf currents and believed larval distribution more likely a function of currents than active swimming.

Williams and Deubler (1968) reported southern flounder postlarval immigration related to lunar phase in North Carolina, but no correlation was found between rate of immigration and wind. King

(1971), however, found the rate of immigration of paralichthyid postlarval species in Texas waters was significantly correlated with wind direction, and immigration was greatest during onshore or southerly winds. His data also indicated higher rates of immigration with increased salinities and current velocities along with more turbid water and increased tidal amplitude (including duration of flood tides). King (1971) further recorded postlarval *Paralichthys* spp. in greatest numbers near the sides of channels and slightly higher numbers near the west bank as opposed to the east bank of the inlet at Cedar Bayou, Texas. Horizontal distribution was uneven within the inlet. Taylor et al. (2010) found plausible mechanistic links in their North Carolina meteorological data showing that E-SE and N-NE wind-induced currents favor southern flounder larval transport toward the nurseries.

Smith (1981) reported localized movement associated with tidal stages in South Carolina, as southern flounder moved on and off of shallow bars and flats with the rise and fall of tides. In a southeast Louisiana tidal pass, Sabins (1973) and Sabins and Truesdale (1975) noted juvenile southern flounder catch appeared to be affected by tidal stages more than light cycles. He described the tendency for young to concentrate along channel edges, especially in quieter waters along the western edge of the tidal channel during ebb tide and then move inland with flood tides. Both papers suggested similar diel patterns among immigrating juveniles might aid individuals to maintain a shoreward transport and avoid being flushed seaward. In North Carolina estuaries, peak recruitment of juvenile *Paralichthys* spp. usually occurred when stratification and tidal exchange ratios were at a yearly maximum (Weinstein et al. 1980). To avoid being flushed from the estuary following recruitment, flounders exhibited behavioral responses to photoperiod and tide. Weinstein et al. (1980) suggested postlarval transport into the marshes and freshwater areas was enhanced by a surface migration on flood tides at night and 'riding out' ebb tides on or near the bottom. The study implied tidal response might be the primary mechanism utilized by postlarval flounder to reach suitable nursery habitats.

Southern flounder larvae and juveniles have been collected as early as November from East Coast waters but no earlier than December along the Gulf coast with some variation among researchers by area (Table 3.3). In a study spanning four winters in two North Carolina estuaries, Burke et al. (1991) collected immigrating metamorphosing, planktonic larvae from a tidal pass late November to mid-April with a peak in February. Immigration of juvenile southern flounder began during February 1974 and January 1975 near Aransas Pass, Texas (Stokes 1977). As indicated by the incidence of capture, February was the month of greatest immigration during both years. Using dredge and minnow seines, juveniles were recorded in passes near the Gulf first, inshore channels second, and inshore bays last. Nañez-James et al. (2009) collected juvenile southern flounder in Aransas-Copano Bay, Texas during January through March (2004-2005) with mean temperatures between 16.7°-19.6°C. The researchers discovered that newly settled juvenile southern flounder densities in Aransas Pass, Texas were highest in more saline vegetated habitats near the pass and lowest in less saline non-vegetated habitats away from the pass. Glass et al. (2008) found peak recruitment of southern flounder within Galveston Bay during January and February of 2005.

In Louisiana, studies in the major estuarine systems indicated initial arrival of southern flounder recruits in January, increasing in February and March, and continuing through April (Table 3.3). Size at recruitment ranged from a 0-5 mm SL group in January (Rogers and Herke 1985) to 51 mm TL in April (Norden 1966). Rogers and Herke (1985), while investigating arrival of YOY in southwest Louisiana marshes, found catch/sample occurring in two peaks (February and March). Felley (1989) reported juvenile southern flounder appeared during spring months (March-May) in the Calcasieu Lake estuary, Louisiana. Norden (1966) also collected 11-30 mm TL juveniles in March, while Gunter (1938) found numerous small southern flounder (50-100 mm TL) along outer beaches of Barataria Bay, Louisiana, during April and larger fish (120-150 mm TL) in trawl catches one to two months later. Southern flounder juveniles 21-24 mm TL were collected during January near Chandeleur Island, Louisiana, by Laska (1973).

In contrast, in North Carolina, peak recruitment of southern flounder occurred later in the year from April-June (Ross and Carpenter 1983). Ross and Epperly (1985) proposed an April or May peak in Pamlico Sound, North Carolina, while Rozas and Hackney (1984) described a March peak in North Carolina oligohaline marshes. Recruits initially settled on high salinity intertidal flats followed by upstream movement toward the head of the estuary where they settled on shallow tidal flats with muddy substrates. Salinity affected distribution more than substrate (Burke et al. 1991), but habitat was also partitioned by two co-occurring paralichthyid species (summer and southern flounder). According to Powell and Schwartz (1977), advanced juvenile southern and summer flounders sought out nursery grounds in North Carolina estuaries characterized by low salinities and muddy substrates. In the northern area of Pamlico Sound, flounder utilized shallow tributaries through July, with decreasing numbers noted thereafter. Turner and Johnson (1973) reported similar findings from South Carolina when they found large numbers of small southern flounder in tidal streams, with most occurring in April; they stated these were all YOY moving into nursery areas.

Other studies indicated migration of postlarval and juvenile southern flounder toward freshwater or low salinity intertidal zones (Hildebrand and Cable 1930, Powell and Schwartz 1977, Weinstein 1979, Weinstein et al. 1980, Smith 1981, Ross et al. 1982, Rogers et al. 1984, and Rozas and Hackney 1984). In South Carolina, Wenner et al. (1990) noted distribution of YOY southern flounder (January-April) was nearly three times greater at the farthest upriver station than at the site nearest the ocean. Rogers et al. (1984) found the highest abundance of recruits to concentrate in northerly Georgia estuaries in freshwater conditions and to utilize the shallow nursery area on a size-specific basis. As residence time and growth increased, movement toward more saline waters began. Since less saline headwaters of the total distribution range are utilized first with subsequent movement to more saline waters occurring with growth, there is a 'filling up backward' of the nursery (Herke 1971, Weinstein 1979).

As with southern flounder, Gulf flounder larvae begin to move shoreward with the tides beginning in December. Larvae were reported offshore near Tampa Bay, Florida, from December through early March (Topp and Hoff 1972). Reid (1954) reported first collecting young fish, 10-15 mm, in January in the Cedar Key area of Florida. The periodicity of recruitment of young juvenile flounder into the bays and estuaries may be geographically variable. Preliminary data from the west coast of Florida (FWC/FWRI unpublished data) indicate that there may be a relationship between the latitude and/or mean temperature of the bays and the patterns of recruitment. Data from Charlotte Harbor, along the southwest Florida Coast, indicated recruitment of young fish (10-50 mm SL) reached a peak in February while recruitment in Tampa Bay peaked in March. In Choctawhatchee Bay along the Florida panhandle, juvenile recruitment did not peak until April.

Migration

Simmons and Hoese (1959) noted an intense seaward movement of these fish during fall months associated with declining water temperatures; by November/December all recorded movement was Gulf-ward. In seaward migrations during fall months, males appeared to leave estuaries earlier than females (Simmons 1957, Simmons and Hoese 1959, Stokes 1977). Stokes (1977) found adult southern flounder leaving Texas bays from mid-October to mid-December, peaking in mid-November. This seasonal movement was also associated with a 4°-5°C decrease in water temperature. Arnold et al. (1960) reported a 'fall run' of southern flounder in October and November at Galveston Island, Texas, which was thought to be associated with spawning activities. In contrast, moderate to warm winters can cause departure from bays to occur over an extended period rather than a mass exodus following a severe cold front (Hoese and Moore 1998). Other researchers describing a fall and early winter migration include Hildebrand and Cable (1930), Kelly (1965), and Shepard (1986). Some authors included older juveniles along with adults in this Gulf-ward movement (Ginsburg 1952, Fox and White 1969, Stokes 1973, Powell and Schwartz 1977, Randall and Vergara 1978); however, most YOY remain in estuaries and overwinter in deeper holes and channels (Gunter 1938, 1945). Ogren and Brusher (1977) and Stokes (1977) also noted some adults remained and utilized deeper portions of the estuary during winter. Smith (1981) stated YOY southern flounder remained in and utilized nurseries up to their second year of life. Analysis of length/frequency data for southern flounder led Devries and Harvell (1982) to suggest a higher proportion of age-2 or older fish migrated to the ocean in the fall than age-1 fish. Taylor et al. (2008) found in their otolith microchemistry analysis that most southern flounder in the coastal region of North Carolina emigrated offshore at two or three years of age and never migrated back to estuarine habitats.

Green (1986) accumulated 25 years of fisheries independent program tag and release data from coastal Texas waters. Results indicated the majority (58%) of southern flounder were recaptured within five km of the tagging location and 69% within the same bay system. Most recaptures were within 90 days of release. During a four-year study in coastal Georgia, the average time at large for tagged southern flounder was 215 days with normal movement of 54 km. Only 32% of all recoveries were within the estuary of release and occurred during summer and fall. Stokes (1977) found inconsistent movement patterns between and within bays and reported one tagged southern flounder recaptured 77.2 km northeast of the tag site. In North Carolina waters, Devries and Harvell (1982) received most southern flounder returns in less than 40 days within 6.4 km of the release site. Intermediate and long-term returns indicated a seaward movement. Similar results were noted by Monaghan (1992) in North Carolina waters and Wenner et al. (1990) in South Carolina waters. These studies reported some individuals traveled considerable distances: Music and Pafford (1984), 556 km; Monaghan (1992), 428 km; Wenner et al. (1990), 404.7 km in 472 days; Green (1986), 15.2% moved >40 km; and Devries and Harvell (1982), several in excess of 322 km with one at 740 km and another moving 645 km in 131 days, averaging 4.9 km/day.

Southern flounder have been found in large numbers as far as Fort Jackson, Louisiana, in the Mississippi River which is at least 29 km upriver from the nearest outlet to Breton Sound (P. Cooper, Jr. personal communication). Southern flounder have also routinely been captured at least 13 km upriver in the Atchafalaya River in Louisiana (G. Adkins personal communication). Tagatz (1967) reported collecting southern flounder in waters from 16-135 km from the mouth of the St. Johns River on the east coast of Florida and in salinities ranging from 0.0-30.2‰.

Lowe et al. (2011) found that 68% of the southern flounder juveniles exhibited high strontium and calcium concentrations (Sr/Ca) in the otolith core and declined rapidly to <1.71 mmol/mol for the remainder of the otolith width (i.e., juvenile life), indicating a prolonged period of freshwater residency after ingress from the marine environment; they suggest that the remaining 32% were hatched in or near a freshwater habitat in the Mobile-Tensaw River Delta, Alabama. They suggest, based on their results, that more low salinity habitat must be considered when defining nursery habitat for southern flounder. These results are contrary to previous work indicating 100% mortality of pre-metamorphosis larvae in waters below 10‰ (Daniels and Borski 1998, Smith et al. 1999).

Fisheries Independent Monitoring data from Florida suggest that some Gulf flounder adults may remain within bays and estuaries during winter months and not migrate offshore. A large number of Gulf flounder over 250 mm SL were collected in nearly every year sampled from Tampa Bay, Charlotte Harbor, and Choctawhatchee Bay/Santa Rosa Sound during October through January (FWC/FWRI unpublished data). In Texas, Stokes (1977) reported highest winter catches within bays at stations along or within the Gulf Intracoastal Waterway.

Fecundity

When reporting on flatfish in general, White and Stickney (1973) stated that females often release over 100,000 eggs per spawning season depending upon species. Arnold et al. (1977) observed three female southern flounder spawning 13 times producing a total of 1.2×10^5 eggs with a fertilization rate of 30%-50%. Lasswell et al. (1977) reported three spawning southern flounder females to produce approximately 40,000 eggs each. The fertilization percentage and hatching rate was similar to that reported by Arnold et al. (1977), averaging only 26% and 50% for each, respectively. In another study, Lasswell et al. (1978) found southern flounder females to produce approximately 5,000 eggs per spawn that were fertilized (a fertilization rate of approximately 80%). These eggs hatched within 40 hours at a water temperature of 22°C. Watanabe et al. (2001) demonstrated that photothermal conditioning without the use of hormones in North Carolina southern flounder broodstock, resulted in relatively high spawning success in terms of total egg production, egg quality, and the duration of the spawning period. Six females produced a total of 18.4 million eggs, with an overall fertilization rate of 28% and a hatching rate of 37.3%. With the use of gonadotropin releasing hormone implants and photothermal conditioning, three South Carolina female southern flounder broodstock produced 17,782,000 eggs with a mean fertility rate of 32.8% ± 25.25% (Smith et al. 1999).

Henderson-Arzapalo et al. (1988) reported relatively low batch fecundity for southern flounder of 24 egg releases consisting of 66 to 28,900 eggs occurring between December and February (Table 3.17). Based upon those data, they stated it was indicated that batch fecundity was inherently small when compared to most cultured flatfish species. Benson (1982) reported approximately 100,000 eggs during the entire spawning season for a single southern flounder. Fischer (1999) determined batch fecundity for southern flounder in Louisiana waters ranged from 14,046 to 68,829 ova per batch. He also reported spawning frequency ranged from once every 3.6 days (in 1991) to once every 6.4 days (in 1993). In two studies (Smith et al. 1999, Watanabe et al. 2001), North and South Carolina southern flounder female brood stock had an average of 3,064,301 and 5,927,333 eggs released over a 90-day period.

Fitzhugh et al. (2008) calculated the average batch fecundity for Gulf flounder to be 79,892 oocytes in northwest Florida. Hydrated ooycte density was greater during the month of November and lower during the months of October and December.

Incubation

Stokes (1977) reported sexually mature adults of both southern and Gulf flounder emigrating offshore during October-December and juveniles immigrating during January-February in Texas. This indicates a very short larval period of three or four months, assuming courtship and spawning behavior occur sporadically during the October-December period.

Lasswell et al. (1978), utilizing carp pituitary hormone to induce laboratory spawning of southern flounder, reported eggs hatched in 40 hours at water temperatures of 22°C. Arnold et al. (1977) stated laboratory-spawned eggs of southern flounder hatched in 61-76 hours at 16.5°-17.5°C**.** Benetti et al. (2001) used gonadotropin releasing hormone-analogue (GnRH-a) implants and human chorionic gonadotropin (HCG) for induced spawning on their Florida southern flounder broodstock. Fertilized eggs were incubated at 24-26°C and hatched within 24-28 hours. Southern flounder oocytes from South Carolina hatched between 55-61 hours at16ºC in Daniels et al. (1996).

Genetics

Previous genetics work on southern flounder has been focused on identifying the number and extent of populations occurring throughout the species range. The first study on southern flounder population genetics used allozyme (enzyme-based) markers and surveyed eight localities between Laguna Madre, Texas, and Core Sound, North Carolina (Blandon et al. 2001). The primary findings from this work were that: 1) there was a genetic discontinuity between Gulf of Mexico and Atlantic collections, coinciding with a break in the distribution between coasts, and 2) there was evidence for significant population structure between the northern Gulf of Mexico (represented by samples from Galveston Bay and Sabine Lake Texas), and the southern Texas coast (represented by samples from Matagorda Bay and Laguna Madre, Texas, Blandon et al. 2001). This study has subsequently been repeated using mitochondrial DNA markers (mtDNA, Anderson et al. 2012) and microsatellite markers (Anderson and Karel 2012). These latter studies have validated the finding of independent populations of southern flounder in the Gulf and Atlantic. Anderson et al. (2012) suggested that southern flounder in the Gulf and Atlantic represent independent evolutionarily significant units (ESU) based upon the ESU criteria of multiple authors (Moritz 1994, Crandall et al. 2000). Thus, these populations should be managed independently and treated as independent stocks for the purpose of stock assessment (Anderson and Karel 2012). All three genetic data sets indicate that migration between oceanic basins is insufficient to homogenize allele frequencies at neutral genetic loci, and the mtDNA data suggested that divergence among these populations has existed for thousands of years (Anderson et al. 2012).

The mtDNA and microsatellite data sets contrast with the allozyme data set of Blandon et al. (2001) in that they do not indicate genetic subdivision between northern and southern locales in Texas (Anderson et al. 2012, Anderson and Karel 2012). While there was evidence for significant population structure within the Gulf in both studies, the evidence was more consistent with genetic divergence among samples separated by wide geographic expanse (isolation-by-distance) than it was evidence for discreet populations. These results indicate that, while the southern flounder in the Gulf likely constitute a single stock for the purpose of stock assessment, localized (within-state) management strategies should account for upper limits to dispersal within the Gulf (Anderson and Karel 2012), and should take into account potential adaptive genetic differences of southern flounder on the coast of Texas (Blandon et al. 2001).

Parasites and Diseases

All fish harbor disease organisms, and the potential for outbreak of disease always exists, especially following periods of stress (White and Stickney 1973). There is one parasite (*Hysterothylacium* type MB), an ascaridoid nematode, reported as a potential threat to public health (Overstreet and Meyer 1981).

Christmas (1973) believed that human coastal population growth and industrial pollution was responsible for fish kills along the northern Gulf of Mexico. Sindermann (1979) cited pollution and habitat degradation associated with cases of vibriosus and fin erosion in summer flounder. Overstreet and Howse (1977) believed some types of 'fin rot syndrome', which described several non-specific hemorrhagic lesions usually found on fins, occurred on 10% of southern flounder during summer months and 5% on an annual basis. They believed at least some of the lesions could be attributed to pollutants. Overstreet and Howse (1977) explained that pollutants can affect animals directly by causing acute to chronic diseases or they can affect the animals indirectly by stressing them and thus allowing them to be vulnerable to parasites or other disease agents. The pollutants can also form synergistic or other type relationships between the pollutant and another chemical or disease-causing agent causing predators to become affected by feeding on exposed animals or destroying the environment so that animals can no longer live, grow, or reproduce. At least two juvenile ascaridoids (*Hysterothylacium*) have been found to infect southern flounder (Deardorff and Overstreet 1981).

Ectoparasites are fairly common on southern flounder; stress or even death can result from the presence of large numbers of these organisms (Etzold and Christmas 1979). Of 19 southern flounder (22.4-35.5 cm) examined by Williams (1979) from the Mobile Bay region, a single parasitic leech (*Myzobdella lugubris*) was reported from the right pectoral fin of one individual. Sawyer et al. (1975) considered the southern flounder the most common host for that leech in Mississippi, where they also reported the related *Calliobdella vivida*. Overstreet (1978) reported the presence of a non-permanently attached transparent copepod (*Caligus praetextus*) on southern flounder. Argulids, commonly called 'fish lice', can also cause host damage. Some species of parasites show species selectivity; *Argulus flavescens* commonly infests the skin of southern flounder and appear as small colored dots (Overstreet 1978).

Overstreet (1978) and Becker and Overstreet (1979) noted the trypanosome (*Trypanoplasma bullocki*) in blood of southern flounder and listed it as the most common blood flagellate in Mississippi estuaries. Another protozoan, a hemogregarine assumed to be *Haemogregarina platessae,* occurred in the red blood cells of the flounder (Becker and Overstreet 1979). Those authors suggested that both protozoans were transmitted to the flounder by *Calliobdella vivida*.

A nematode (round worm) of the family Philometridae was also found to infect the mouth of the southern flounder (Overstreet 1978). Members of this group appear reddish and release live larvae rather than eggs. This species was recently abundant in the flounder after not being observed for several years. Blaylock and Overstreet (1999) have described the new species as a member of a new genus. Other species appear in a variety of locations in fish including the body cavity, gonads, subdermally, in musculature, and between fin rays. Overstreet and Edwards (1976) described two benign pseudo encapsulated mesenchymal tumors beneath the gular membrane of a southern flounder and attributed the subcutaneous tumors to the presence of a philometrid nematode or a didymozoid trematode.

The literature for information on parasites and diseases of the Gulf flounder is sparse except for juvenile nematodes (e.g., Deardorff and Overstreet 1981).

Feeding, Prey, and Predators

Paralichthyid flounder appear well-adapted for feeding on quick moving prey such as fish and shrimp which occur throughout the water column. Development of large optic lobes, large mouths with strong teeth, and stomachs with large storage capacities enhance their predatory feeding abilities (DeGroot 1971). Southern flounder has been described as an estuarine-dependent carnivore at the top of the food chain (Wagner 1973) which feeds as an ambush predator (Minello et al. 1989) exhibiting a 'lay and wait' feeding behavior (Music and Pafford 1984).

In aquarium experiments of southern flounder (Henderson-Arzapalo et al. 1988), characteristic feeding activity was described as a normal, burrowing pattern. Small fish (84-94 mm TL) exhibited various patterns of feeding behavior including active searching on the bottom and in the water column (Minello et al. 1987). Prey stalking behavior for summer flounder was described by Olla et al. (1972), and similar behavior is likely to occur in both southern and Gulf flounder. Often the fish remained motionless on the bottom and waited for potential prey to come within striking distance before attacking (Minello et al. 1987). Paralichthyids have been classified as primarily visual feeders by DeGroot (1971). In southern flounder observed by Minello et al. (1987), all stalking activity was accompanied by active eye movements, tracking potential prey, which suggested the primary use of vision in prey detection. In addition to vision, the southern flounder may use sensory mechanisms such as the lateral line for prey detection at night. Minello et al. (1987) noted older southern flounder juveniles and adults fed actively day and night with highest feeding rates during the afternoon. Smaller flounder consumed approximately 7.6% of their live weight, and larger fish ate about 4.0% of their live weight each day. Music and Pafford (1984) found feeding activity was greatest at water temperatures of 16º-25ºC during the three-day period following a first quarter moon and the three-day period prior to a new moon. In pond studies, Wright et al. (1993) noted predation by southern flounder was a size-structuring force on the prey fish assemblage in the pond, and flounder respond to an increase in prey density by an increase in consumption (Holling 1959).

For southern flounder, early life stages reportedly fed primarily on plankton in Mississippi (Gilbert 1986, Etzold and Christmas 1979), and young southern flounder fed on bottom invertebrates in Lake Pontchartrain, Louisiana (Darnell 1958). Stokes (1977) found smaller fish (10-150 mm TL) fed primarily upon mysids. Overstreet and Heard (1982) concurred, specifically identifying the dominant mysid as *Mysidopsis almyra*. Stokes (1977) found larvae ate various forms of zooplankton, and juveniles fed largely on shrimp, crabs, menhaden, croaker, and other flounder. In North Carolina, Fitzhugh et al. (1996) found southern flounder less than 150 mm TL utilized invertebrates, primarily mysids such as *Mysidopsis bigelowi* and *Neomysis americana*. Individuals between 151-250 mm TL contained the greatest frequency of fish prey, most commonly bay anchovy (*Anchoa mitchilli*), spot (*Leiostomus xanthurus*), and Atlantic croaker

Table 3.18 Food preference of southern flounder derived from select literature. NA = not available or not reported.

State	Stomachs Examined	Number with Food	Flounder Size (mm)	Food Preference	Other Foods	Author(s)
Texas	16	8	240-490 TL	Mullet, *Anchoa mitchilli*, unidentified fish, *Penaeus setiferus* and *P. aztecus*	Pinfish, mojarra, and stone crab	Gunter 1945
	34	27	NA	Unidentified shrimps and fishes	*Penaeus* spp., *P. aztecus*, *Crangon* spp., *Palaemonetes* spp., *Squilla empusa*, *Lagodon rhomboides*	Kemp 1949
	24	NA	NA	Shrimp present in 50% of stomachs. Fishes (including menhaden) present in 40%	Miscellaneous invertebrates in <5%	Knapp 1950
	36	15	NA	Penaeid and unidentified shrimps	Crabs and unidentified fish	Miles 1949
	7	4	159-265 TL	75% fish, 25% shrimp	NA	Reid 1955
	4	NA	NA	Primarily fishes and shrimps	NA	Reid et al. 1956
	626	343	10-150 TL >150 TL	95% invertebrates (primarily mysids); 70% fish (*Anchoa* spp., *Brevoortia* spp., sciaenids, *Mugil* spp., and unidentified fish	Penaeid shrimp most frequently found invertebrate food item in larger flounder	Stokes 1977
	10	9	36-177 SL	Fish in 60% of stomachs including *Micropogonias undulatus* and *Archosargus probatocephalus*	Arthropods, polychaetes, and bivalves	Matlock and Garcia 1983
Louisiana	19	14	113-380	89% *A. mitchilli*, *Micropogon undulatus* (earlier name for *Micropogonias undulatus*), and unidentified fish remains	7% blue and mud crabs, 4% clams, gastropod, schizopods, and unidentified organic material	Darnell 1958
	305	171	60-602 TL	94% juvenile Mugil cephalus and Anchoa sp. (by volume)	6% crustaceans	Fox and White 1969
Mississippi	NA	NA	Larvae/early juveniles Late juveniles/ adults	Plankton/ Crustaceans (shrimp)/ small fish	NA	Etzold and Christmas 1979
	212	97	125-410 SL	A. mitchilli and penaeid shrimps	>20 various items	Overstreet and Heard 1982

State	Stomachs Examined	Number with Food	Flounder Size (mm)	Food Preference	Other Foods	Author(s)
Georgia	221	113	<200 TL 201-400 TL >400 SL TL	Nearly equal proportions of fish and crustaceans Increase in fish (bay anchovy and sea catfish) Fish preference dominated by sea catfish (mullet and menhaden also present)	NA	Music and Pafford 1984
North Carolina	1573	815	<150 TL 151-250 TL	62% mysids 85% fish (*A. mitchilli*, sciaenids, and other fishes)	NA	Fitzhugh et al. 1996
	160	NA	20-60 SL	Gammarid amphipods and mysid shrimp	Copepods, insects, fish and invertebrate parts	Burke 1995
	430	234	100-200 TL >200 TL	32% crustacean (mostly mysid shrimp) 96% fish (mostly engraulids and sciaenids)	NA	Powell and Schwartz 1979
South Carolina	345	NA	51-125 TL and 126-200 TL 201-400 TL 401-579 TL	Grass shrimp, *Palaemonetes pugio,* was the dominant prey Spot were most important Striped mullet became first and grass shrimp were virtually eliminated from diet	Overall, mummichog (*Fundulus heteroclitus*), spot (*Leiostomus xanthurus*), and striped mullet (*Mugil cephalus*) were the most important prey items	Wenner et al. 1990

(*Micropogonias undulatus*). They suggested consumption of fish prey within this size group was more variable among females than males.

Wilcox et al. (2006) tested diet effects on growth rate and survivability on larval southern flounder. The study found that a varied and mixed diet of copepods and rotifers had a significantly higher survival rate than larvae fed only S-type or SS-type rotifers; however, total length measurements were not generally greater with the mixed diet. Total height measurements were significantly different as was the total mean weight. This study suggests that a varied and mixed diet contributes to the overall health and survivability of southern flounder larvae.

Table 3.19 Food preference of Gulf flounder derived from available literature. NA = Not available or not reported.

State	Stomachs Examined	Number with Food	Flounder Size (mm)	Food Preference	Other Foods	Author(s)
Texas	626	242	10-150 TL >150 TL	84% invertebrates 72% fishes (mostly (*Anchoa* sp., clupeids, sciaenids, and *Mugil* sp.)	NR	Stokes 1977
Florida	27	NR	<45 SL 46-400 SL	Primarily amphipods Small crustaceans & fish (mainly *Orthop ristis chrysopterus*, earlier name for *Orthop ristis chrysoptera*)	NR	Reid 1954
	NR	NR	<45 SL 45-100 SL >100 SL	80% crustaceans 45% crustaceans & 55% fishes 100% contained fishes	NR	Springer and Woodburn 1960

Southern flounder consume a wide variety of food items (Table 3.18). Fish become the major component of the diet with increasing size (Stokes 1977, Powell and Schwartz 1979, Smith 1981, Overstreet and Heard 1982). In Texas waters, Stokes (1977) listed the common prey found in southern flounder larger than 150 mm SL as: anchovy (*Anchoa* spp.), mullet (*Mugil* spp.), shrimp (*Penaeus* spp.), menhaden (*Brevoortia* spp.), and Atlantic croaker (*Micropogonias undulatus*). Minello et al. (1989) reported southern flounder as the dominant fish predator on brown shrimp (*P. aztecus*) during spring in Galveston Bay. They fed on shrimp only until the prey reached 33%-50% of the total length of the predator. Minello et al. (1987) noted an increase in the predation rate of southern flounder from 84-94 mm SL on brown shrimp in turbid water and suggested it was related to feeding tactics of the predator and prey behavior. In a Texas estuary, Moffet (1975) found penaeid shrimp and portunid crabs in the stomachs of southern flounder that ranged from 105-255 mm TL.

In Mississippi Sound, southern flounder stomachs most frequently contained fish, with approximately one-third containing penaeid shrimp from spring through autumn. When penaeid shrimp availability was low in winter, they were replaced by mysidaceans. Of prey fish species reported, a high incidence of bay anchovy was noted (Overstreet and Heard 1982). While studying Lake Pontchartrain, Louisiana, Darnell (1958) examined 14 southern flounder (240-490 mm), and Levine (1980) examined four (102-300 mm), both reported a prevalence of bay anchovy in the stomachs. Fox and White (1969) reported approximately 94% (by volume) of southern flounder stomachs from Barataria Bay, Louisiana, contained juvenile striped mullet (*Mugil cephalus*) and anchovies.

Southern flounder utilized more individual prey of the same size class as flounder length increased rather than utilizing larger food items (Fox and White 1969). They found the same type of diet irrespective of an increase in flounder size and attributed it to seasonal availability of food in the bay system. Darnell

(1958) also stated the relative percentage of food utilized from one environment to another may be related to seasonal availability rather than prey selectivity. However, Rice et al. (1993) found a size-dependent predation rate between spot and southern flounder in North Carolina pond studies (i.e., small spot survived better when predator size was larger, and larger spot survived better when predator size was smaller). Wenner et al. (1990) described ontogenetic changes in southern flounder diet for four major prey species in South Carolina waters. The primary decapod crustaceans utilized for food were palaemonid shrimp, while more important fish species included mummichog (*Fundulus heteroclitus*), spot, and striped mullet. As flounder size increased, striped mullet became the most important prey species.

The food preference of Gulf flounder is similar to that of other paralichthyid flounders (including southern flounder) in that the young feed primarily on crustaceans and change to a more piscivorous diet as they grow larger (Table 3.19). Examination of stomach contents of Gulf flounder by Topp and Hoff (1972) revealed penaeid shrimp, portunid crabs, anchovies, striped killifish (*Fundulus similis*), pipefishes (*Syngnathus* spp.), grunts (*Haemulon* spp.), and code goby (*Gobiosoma robustum*). Springer and Woodburn (1960) reported the stomach contents of Gulf flounder from Tampa Bay. For fish under 45 mm SL, crustaceans were present in four out of six with one stomach being empty. Of 16 stomachs examined from fish 46 mm to 100 mm SL, six contained fishes, five contained crustaceans, and five were empty. All of the stomachs from fish over 100 mm SL contained fish or were empty. Reid (1954) stated that young Gulf flounder in the Cedar Key, Florida, area feed primarily on amphipods and other small crustaceans. At about 45 mm SL, they began feeding upon fish, and this becomes the main element of their diet as the flounder become larger. Stokes (1977) reported similar findings with Gulf flounder along the Aransas Bay, Texas, area; invertebrates accounted for 84% of the food in the stomachs of fish 10 to 150 mm TL, and 72% of the food in stomachs of fish larger than 150 mm TL were fish.

Chapter 4

Habitat of the Stock Comprising the Management Unit

Habitat is where an organism lives (Odum 1971, Whitaker and Levin 1975, Baltz 1990, Peters and Cross 1992, Ricklefs 1993, Minello 1999). The various life history stages of a species, more often than not, have different habitat requirements. The Paralichthyids are euryhaline and are distributed over most of the habitats occurring in the northern Gulf of Mexico. Depending on their life history stage, they include freshwater rivers and lakes, brackish estuaries, bayous, canals, saltwater bays, sounds, and lagoons as well as offshore areas (Deubler 1960, Gutherz 1967, Hoese and Moore 1998). There are many biotic and abiotic parameters that combine to create a suitable habitat for a particular species, such is true for the Gulf and southern flounders. An extensive description of the various habitats in the Gulf of Mexico can be found in Perry and VanderKooy (2015) and VanderKooy and Smith (2015).

Southern flounder is most common along the northwest Gulf of Mexico along the Texas and Louisiana coasts (Norden 1966, Perret et al. 1971, Adkins et al. 1979); Gulf flounder are more abundant in the northeast Gulf along the Florida coast (Hoese and Moore 1998, Gutherz 1967). Although some overlap occurs in the waters off eastern Louisiana, Mississippi, and Alabama, southern flounder is not abundant seaward of the barrier islands in the Tuscaloosa Trend (Darnell 1985) (Figure 3.1).

Powell and Schwartz (1977) believed that benthic substrate and salinity were the two most important factors affecting paralichthyids distribution. Adult southern flounder prefer muddy substrates and are relatively abundant in areas with silt and clay sediments (Norman 1934, Powell and Schwartz 1977, Hoese and Moore 1998, Randall and Vergara 1978, Etzold and Christmas 1979, Nall 1979, Phalen et al. 1989) and organic-rich mud substrates (Burke et al. 1991) while Gulf flounder prefer hard or sandy substrates (Ginsburg 1952, Stokes 1977, Nall 1979). Generally, adults of both southern and Gulf flounder migrate from estuarine habitats during the colder fall and winter months to spawn offshore in response to changing water temperatures.

Aquatic vegetation does not appear important to adult *Paralichthys* but is utilized by juveniles (Gilbert 1986, Burke et al. 1991). Juvenile southern flounder apparently select estuarine microhabitats based primarily on substrate type and salinity (Burke et al. 1991). Postlarval and juvenile southern flounder generally move to areas of lower salinities and become established in vegetated shallows of estuarine habitats (Gunter 1945, Deubler 1960). Gulf flounder were found on shallow flats in the Cedar Key area of Florida (Reid 1954) and in areas of dense patches of shoalgrass in Texas (Stokes 1977). Immature flounders of both species remain in the estuaries throughout the year and eventually mature in the estuary.

Spawning Habitat

Very little information describing spawning habitat for Gulf and southern flounder exists, with most studies dealing with spawning behavior and courtship in laboratory experiments with southern flounder (Arnold et al. 1977, White and Stickney 1973, Lasswell et al. 1978, Henderson-Arzapalo et al. 1988). Numerous authors have stated that both species migrate from estuarine habitats to spawn offshore in the Gulf during colder fall and winter months (Hildebrand and Cable 1930, Ginsburg 1952, Gunter 1945, Simmons 1951, Reid 1954, Topp and Hoff 1972, Stokes 1977, Etzold and Christmas 1979). These determinations are based primarily upon the paucity of ripe females and males in inshore waters during the winter and the gravid females caught along passes during the fall migration. Benson (1982) suggested southern flounder spawn in offshore Mississippi waters between 30-66 m. Topp and Hoff (1972) reported making determinations of spawning activity of Gulf flounder collected in water 18-37 m November through February. In Texas, six southern flounder tagged during a Gulf-ward spawning migration were recaptured in Gulf waters ranging from 2-66 m in depth (Stokes 1977).

Anecdotal information of Gulf flounder spawning aggregations exists from the west coast of Florida. During routine monitoring of artificial reef structures by University of Florida and Florida Sea Grant researchers from 1989-1991, Gulf flounder were observed to aggregate within close proximity of one another. These structures, approximately 37 km offshore Cedar Key, Florida, concrete rubble and culverts made up of 35-60 pieces located approximately 150 m apart and in water about 12 m in depth. Aggregations of up to 40 flounder were observed during routine monitoring on December 12, 1991, which consisted of smaller groups of three to six fish that were in physical contact with one another. Some groups (specimens collected) comprised of a female lying on top of, or near a concrete clump, with a male lying partially or entirely on top of her. Although no apparent spawning was observed, the collection of ten individuals (334-492 mm TL) indicated eggs were running ripe, and the gonadosomatic index of these specimens were substantially higher than that of flounder collected within estuaries and bays in Florida during the same time of year (F. Voss personal communication, FWC/FWRI unpublished data). These and other observations by researchers and scuba divers along the panhandle of Florida suggest that both species of flounder may utilize various types of structure as spawning aggregation sites during the winter months.

Other researchers have suggested similar spawning habitat (structure) for Gulf and southern flounder in the panhandle of Florida. A collection of 82 female Gulf flounder containing hydrated ova from offshore sites over artificial reefs and natural limestone outcroppings, in comparison to only one female from inshore (St. Andrews Bay) sites containing hydrated ova by researchers may support the use of this habitat type as Gulf and southern flounder spawning habitat (G. Fitzhugh personal communication).

In laboratory spawning of southern flounder spawning occurred at the water's surface, the female swam to the surface and released her eggs, the eggs where immediately fertilized by an attending male (Arnold et al. 1977). Observations indicated that only the large females (>2kg) spawned with each female spawning multiple times (Arnold et al. 1977).

Embryo and Larval Habitat

The transition from egg to embryo occurs when the egg membrane ruptures in offshore waters, therefore, embryos are adapted for seawater at salinities of 30‰-35‰ (Balon 1975). Embryonic nutrition is endogenous so prey availability is not a limiting factor and, with the possible exception of thermal shock, predation is probably the only factor limiting survival (Deubler 1960). As the flounder become larvae, they switch to exogenous feeding (Balon 1975) and like many other fish species with pelagic larvae, their transportation to the 'nursery grounds' is based on both prevailing winds and currents (Gilbert 1986). Therefore, it appears that there is very little habitat selection in pelagic, passively transported flounder larvae and it is not until they reach the estuaries as juveniles that they utilize demersal habitat types (Nañez-James et al. 2009).

The larval period of the southern flounder, and presumably the Gulf flounder, lasts less than two months (Arnold et al. 1977) and, as noted above, is spent in the offshore waters as the fish are passively transported toward inshore waters Sogard et al. (1987). Lyczkowski-Shultz et al. (1990) stressed the importance of current transportation for offshore spawners and their larvae survival.

Juvenile (Postlarvae) Habitat

The onset of metamorphosis to an adult form generally occurs in the estuary. Nañez-James et al. (2009) described southern flounder settling from their planktonic phase (larva) to the demersal habitat types (juvenile) at 8-12mm. Estuarine areas are consistently referred to as 'nursery areas' due to the abundance and variety of juvenile nekton species that utilize them. The abundance of habitat types such as intertidal marshes, seagrass, oyster reef and shell, and shallow non-vegetated bottom within estuaries is what enables such productivity (Carr and Adams 1973, Weinstein 1979, Rozas and Minello 1998). Rogers et al. (1984) found an abundance of southern flounder recruits did use shallow water nursery areas on a size-specific basis. As the fish grow, they move toward deeper, more saline waters. Shallow marsh lakes and blind bayous were believed to be prime habitat for early immigrating southern flounder in a Texas river delta (Conner and Truesdale 1972).

Salinity

Being euryhaline, juvenile southern flounder are able to adapt to a wide range of salinities and are likely able to adapt to a wider range of salinities than the Gulf flounder (Gilbert 1986). Gunter (1945) captured juvenile southern flounder (17-40 mm) in Texas estuaries at salinities of 19.6-30.0‰. In 2004/2005 Nañez-James et al. (2009) captured juvenile flounder in mean salinity ranges of 6.7-26.7‰ with the highest density of newly settled captured juvenile in more saline, vegetated habitats near Aransas Pass of Aransas Bay, Texas.

In North Carolina estuaries, Williams and Deubler (1968) collected juvenile southern flounder in salinities from 0.02-35‰. In areas <12‰, southern flounder dominated and as salinity increased, Gulf flounder replaced them (Powell and Schwartz 1977) (Tables 3.2 and 3.4). In Pamlico Sound, North Carolina, juvenile Gulf flounder were collected at salinities ranging from 6-35‰ but as they matured were most abundant near the estuary mouth where salinities were highest, however, never in large quantities compared to southern and summer flounder (Powell and Schwartz 1977). Williams and Deubler (1968) reported postlarvae Gulf flounder being captured near inlets in North Carolina in waters salinities ranging from 22-35‰.

In Barataria Bay, Louisiana, between October 1992 and September 1994, Allen and Baltz (1997) sampled various flatfish from a wide range of environmental conditions including salinity. Of the 58 southern flounder encountered, 23 were juveniles (≤30 mm) collected in salinities ranging from 9.0-11.6‰.

Temperature

Gunter (1945) captured juvenile (17-40 mm) southern flounder in Texas estuaries at water temperatures between 14.5°-21.6°C. Moffet (1975) sampled in Galveston and Trinity Bays and collected juvenile southern flounder in temperatures from 12.7°-39.0°C. In Aransas Bay, Texas, immigration of postlarval and early juvenile Gulf and southern flounder into the bays and estuaries begins in January at an average water temperature of 13.8°C and peaks in February with the average temperatures around 16.1°C (Stokes 1977). Nañez-James et al. (2009) sampled the Aransas-Copano Bay system in January and March of 2004 and January through March of 2005 capturing juvenile flounder in mean temperatures ranges of 16.4°-22.4°C. Juvenile Gulf flounder in Florida exhibit similar patterns to Aransas Bay. In Charlotte Harbor and Tampa and Choctawhatchee Bays, juvenile recruitment occurred in February, March, and April when average water temperatures neared 18°C (FWC/FWRI unpublished data). Allen and Baltz (1997) sampled Barataria Bay between October 1992 and September 1994 capturing juvenile southern flounder in mean temperatures ranges of 15.5°-16.4°C

Peters and Kjelson (1975) determined that the temperature for maximum conversion efficiency in juvenile southern flounder increases as salinities decrease. Therefore, temperature may indirectly affect flounder survival by shifting the duration of time that young flounder spend in a size class, potentially increasing their vulnerability to predation (Enge and Mulholland 1985).

Dissolved Oxygen (DO)

Nañez-James et al. (2009) measured mean dissolved oxygen (DO) levels ranging between 5.0-10.5 mg/L in Aransas-Copano Bay during their sampling efforts to determine the habitat and use patterns of juvenile southern. Allen and Baltz (1997) captured juvenile southern flounder within Barataria Bay in water with a mean DO of 9.0 mg/L.

Substrate

Juvenile flounder in the Gulf of Mexico commonly utilize mud habitats which is similar to that of adults. Moffet (1975) sampled the Chocolate Bayou estuary (part of the Galveston Bay system) from June 1969 through October 1971. Southern flounder were present year-round, and YOY were collected during the winter and spring in association with saltmarsh, mud and shell bottoms, and shoreline banks. Vick (1964) reported catching juvenile southern flounder over mud bottom from St. Andrews Bay, Florida. In Mississippi's fishery-independent sampling reported that juvenile southern flounder were most abundant in association within a natural inland bayou where mud bottom predominated (MDMR unpublished data).

In North Carolina, Powell and Schwartz (1977) that sediment type also appeared to influence the distribution on the young of year (YOY) southern flounder, with southern flounder preferring muddy substrate dominated by silt and clay with minimal sand content.

In contrast, Nañez-James et al. (2009) reported the highest densities of newly settled juvenile southern flounder in the Aransas-Copano Bay system were captured on sand bay bottoms which was interspersed with vegetation and minimal silt and clay. This association with sand bottoms in Aransas Bay is contrary to habitat preferences elsewhere. Nañez-James et al. (2009) suggest that benefits, such as protection from predation or increased food availability, of occupying vegetated habitats may outweigh negative effects of settling on the less coarse sediment and influence the distribution of flounder.

Vegetation

Stokes (1977) reported that in the Aransas Bay system (during spring months) juvenile southern flounder were most abundant in areas of the bay that were characterized by dense patches of shoal grass, *Halodule wrightii*, covering 30-60% of the total area. In the Cedar Key, Florida vicinity, Reid (1954) reported during warm weather, most Gulf flounder (>70 mm SL) were caught from sparsely vegetated channels or coves with muddy bottoms. However, during winter months they were collected over shallow flats devoid of thick plant growth. Juvenile Gulf flounder were also taken in areas of similar dense patches of shoal grass as well as areas of less dense stands of shoal grass (<30% of the total area) (Stokes 1977). Nañez-James et al. (2009) also collected the highest densities of newly settled juvenile southern flounder in the Aransas Bay system in association with seagrass beds and marsh edge rather than the non-vegetated, mud bottom suggesting a strong affinity for structure over sediment.

Adult Habitat

Juvenile southern flounder remain in the estuaries for the first two years of their lives before becoming sexually mature (Takade-Heumacher and Batsavage 2009). After maturing in the estuary, adult flounder migrate offshore from bays and estuaries in response to changing water temperatures during the fall and winter to spawn (Hildebrand and Cable 1930, Gunter 1945, Ginsburg 1952, Stokes 1977).

Along the Texas coast, tag returns indicate that after maturing in the estuary southern flounder migrate offshore to spawn, it was probable that older males do not return to the bays after emigration, remaining instead offshore for the duration of their lives (Stokes 1977). Fishery-independent monitoring data from Florida also suggests that some Gulf flounder adults may remain within bays and estuaries during winter months and not migrate offshore. A large number of Gulf flounder over 250 mm SL were collected in nearly every year sampled from Tampa Bay, Charlotte Harbor, and Choctawatchee Bay/Santa Rosa Sound during October through January (FWC/FWRI unpublished data).

In North Carolina, Watterson and Alexander (2004), Taylor et al. (2008), and Takade-Heumacher and Batsavage (2009) report evidence of adult southern flounder returning to the estuaries in the spring and summer subsequent to spawning offshore, and the presence of adult southern flounder remaining in the ocean off North Carolina after spawning.

Salinity

Paralichthyids are distributed over most of the habitats occurring in the northern Gulf of Mexico including freshwater rivers and lakes, brackish estuaries, bayous, canals, saltwater bays, sounds, and lagoons as well as offshore (Deubler 1960, Gutherz 1967, Hoese and Moore 1998). Both southern and Gulf flounder have been captured within a wide range of salinities, however, juvenile southern flounder are much more euryhaline and are likely able to adapt to a wider range of salinities than the Gulf flounder (Gilbert 1986). Where both species co-occur, Gulf flounder is more abundant than southern flounder in salinities over 20‰.

While there is a wide range of salinities (5-20‰) reported in the literature for southern flounder (Gunter 1945, Williams and Deubler 1968, Perret and Caillouet 1974, Tarver and Savoie 1976, Stokes 1977, Barrett et al. 1978), Gulf flounder seem to prefer salinities higher than 20‰ (Gunter 1945, Springer and Woodburn 1960, Topp and Hoff 1972). Seasonal changes in the southern flounder's osmoregulatory processes appear to correspond to spawning migrations between estuarine and offshore waters (Hickman 1968).

Simmons (1957) reported collecting both Gulf and southern flounder from the Texas coast in salinities up to 60‰ (Tables 3.2 and 3.4). In Aransas Bay, Texas, southern flounder were captured in all salinities from 6-36‰ and Gulf flounder generally occurred in salinities over 16‰ (Stokes 1977). One notable exception was Gunter (1945) who collected one Gulf flounder in Texas from 9.6‰. In the same study, Gunter (1945) collected southern flounder from 0.0-30.0^{+}‰. In a Louisiana estuary, Perret et al. (1971) found southern flounder distributed equally in salinities from 0-30^{+}‰.

Fishery-independent sampling by the ADCNR/MRD in Perdido Bay, Alabama, captured only southern flounder in the lower salinity, upper bay stations (8-18‰) (ADCNR/MRD unpublished data). At the mid-bay stations (13-20‰), southern and Gulf flounder were captured in approximately equal numbers and at the higher salinity, lower bay stations (19-28‰), Gulf flounder dominated the catch and southern flounder occurred in very low numbers.

Reid (1954) reported Gulf flounder were collected in salinities from 17.5‰-31.5‰ near Cedar Key, Florida (Table 3.4). Subrahmanyam and Drake (1975) collected Gulf and southern flounders in nearly equal numbers along salt marshes of Apalachee Bay, Florida. Comp (1985) characterized Gulf flounder as both a marine and estuarine species in his survey of fishes in Tampa Bay, Florida. Murdock (1957) reported a single specimen of Gulf flounder near the mouth of the Manatee River in 30.7‰. Gulf flounder were sampled from Tampa Bay by Springer and Woodburn (1960) in salinities from 13.7-33.7‰ and in St. Andrews Bay, Florida, by Vick (1964) in salinities from about 34-36‰. Gulf flounder were collected in several bay systems in Florida, including Tampa Bay, Charlotte Harbor, Choctawatchee Bay, and Florida Bay by the Fisheries Independent Monitoring Program (FWC/FWRI unpublished data). Although Gulf flounder were collected in salinities ranging from 1-38‰, the majority of fishes were from waters less than 20‰ (Table 3.4). Tagatz (1967) collected both Gulf and southern flounder from the St. Johns River, Florida although the Gulf flounder were never collected further than 40 km from the mouth of the river or in salinities <12.0‰. Comparatively, southern flounder were collected as far as 135 km upstream and in salinities as low as 0.0‰.

Temperature

Ambient water temperature is an important factor in an aquatic ecosystem because it contributes to an organisms biological activities and chemical processes. Most aquatic organisms depend upon the environment to regulate metabolic rates and have adapted to temperature ranges that occur in their habitat. In Gulf of Mexico populations of southern and Gulf flounders, adults emigrate to offshore waters during cooler months (September through April) which is likely a result of spawning patterns triggered by cold fronts and return to estuarine waters occurs in warmer months. Similar to salinity, flounder can be collected from a wide range of temperatures from 5.0°-34.9°C (Table 3.2). Gunter (1945) collected southern flounder in a Texas estuary at temperatures of 9.9°-30.5°C and Perret et al. (1971) collected adult southern flounder at temperatures of 5.0°-34.9°C in Louisiana. Springer and Woodburn (1960) collected flounder in the Tampa Bay, Florida at 11.2°-32.5°C.

In Aransas Bay, Texas, Stokes (1977) collected both southern and Gulf flounders at temperatures of 10.0°-31.0°C and noted that the adults left the bay and moved offshore when the mean water temperature dropped from 23.0°C in October to 14.1°C in December. Of seven peak periods of emigration from Aransas Bay, four occurred when cold fronts reduced water temperatures by 4°-5°C (Stokes 1977).

The upper thermal limit for Gulf and southern flounder is approximately 35°C (Tables 3.2 and 3.4). Gulf flounder were collected in temperatures ranging from 11°-33°C in several bay systems in Florida, including Tampa Bay, Charlotte Harbor, Choctawatchee Bay, and Florida Bay (FWC/FWRI unpublished data) (Table 3.4).

Dissolved Oxygen (DO)

Dissolved oxygen (DO) concentration usually reflects the ability of a water body to support a healthy, diverse aquatic population. The state of Texas recommendations certain limits to determine the 'quality' of the saltwater environment and defines environmental conditions as *exceptional* in the aquatic life subcategory at a minimum DO of 4.0-5.0 mg/L (TCEQ 2006). A minimum DO of 3.0-4.0 mg/L, on average, is rated *high* in the aquatic life subcategory.

Water temperature and DO concentrations are inversely related with period of smallest DO concentration occurring during the summer months when water temperatures are the highest. Temperature affects the amount of DO that is available to aquatic organisms, cool water is capable of retaining more oxygen than warm water. Therefore, as water temperatures increase, an organism's metabolic activities such as respiration also increases, but less dissolved oxygen is available for consumption.

Although the lower lethal limits of DO for southern and Gulf flounders are unknown, 3.0 ppm is typically stressful to other fish species (Hoss and Peters 1976). In Louisiana estuaries, southern flounder have been collected at DO concentrations of 4.0-10.5 ppm (Barrett et al. 1978). Flounder appear to be only moderately susceptible to gradually decreasing DO concentrations and being mobile generally move out of an area when DO levels get too low. Such movements result in displacement rather than mortality. Deubler and Posner (1963) noted that in a laboratory study, juvenile southern flounder moved out of areas when DO levels fell below 3.7mg/L.

Taylor and Miller (2001) examined the respiration rates of southern flounder in the laboratory and compared the available DO levels with growth and physiologic performance when exposed to periodic low DO situations. When juvenile flounder are forced into exposures of relatively low DO levels (2.75mg/L) such as may occur nocturnally in certain shallow-water environments, they will acclimate to the environment by compensating during the higher daytime DO periods (6.5mg/L). Taylor and Miller (2001) suggest this behavior is a 'repayment' for an oxygen debt. Low DO situations can occur at any time of the year. Some of the primary factors causing a low DO situation are algal blooms, biological oxygen demand (BOD), chemical oxygen demand (COD), decreased photosynthetic activity at night, and increased water temperature.

Along many nearshore areas of the northern Gulf of Mexico, a low DO condition known as 'jubilees' generally occur in late summer when estuarine waters are under very specific conditions, e.g., shallow, calm water with high water temperatures. Very little scientific data has been collected during jubilee events, although Gunter and Lyles (1979) attributed plankton blooms for their occurrence. C. Moncreiff (personal communication) attributed the cause more precisely to a monospecific dinoflagellate bloom where DO may range between 0-2 ppm. Blue crabs and flounder, as well as many other species, are often impacted by these events resulting in death of organisms in the affected area by either asphyxiation or harvest.

Depth

Gulf and southern flounder can be found in a wide range of depths from less than one meter inshore to over 120 m offshore (Table 3.1). In general, depth preference is a function of both life history stage and season. In the warm summer months, flounder are found throughout inshore estuaries in waters less than 40 m in depth (Hildebrand 1954). In the winter months, cold fronts trigger mass migrations of adult flounder to offshore waters. These migrations have led to reports of southern flounder being collected in as much as 66 m of water (Stokes 1977) Gulf flounder being collected in as much as 128 m of water (Gutherz 1967).

In a tagging study, Stokes (1977) tagged 1,298 southern flounder in the Lydia Anne Channel and Corpus Christi Channel during a spawning migration. Four flounder were recaptured in the Gulf at 1.8 m, 32.9 m, 62.2 m, and 65.8 m depths.

Substrate

Powell and Schwartz (1977) believed benthic substrate and salinity to be the two most important factors affecting paralichthyid distribution. Enge and Mulholland (1985) suggested that since Gulf and southern flounder are morphologically similar and prey upon similar food items, salinity preference probably contributes more to the observed difference in substrate preference. They also suggest that the amount of flushing that occurs in an estuary results in varying substrate compositions and species composition. In the case of southern flounder, a high inflow of freshwater into an estuary results in low salinities, and high sediment loads from rivers result in high turbidity and muddy substrates. For Gulf flounder, estuaries with low freshwater inflow and correspondingly high salinity are usually characterized by low turbidity and firmer substrates (Enge and Mulholland 1985).

Ginsburg (1952) reported that southern flounder prefer mud bottom and Gulf flounder prefer hard/sand bottom. Nall (1979) confirmed this by collected 85% (152 individuals) of all southern flounder in the study area from areas dominated by mud, 15% from combination mud and sand, and none (zero) from sand. In the same study, Nall collected 85% (28 individuals) of all the Gulf flounder from sand or a combination of mud and sand bottoms, and only 15% (five individuals) from mud alone. In Aransas Bay, Texas, the greatest numbers of southern flounder were taken by gig at a station with finer sediments whereas most Gulf flounder were taken at a station with coarser sediments (Stokes 1977). Despite this, Texas anglers are known to successfully take adult southern flounder on the shells reefs with gigs in West Galveston Bay (O'Brien personnel communication).

Springer and Woodburn (1960) reported collecting several Gulf flounder while pushnetting and seining over grass beds but suggested they may have been picked up from sandy areas adjacent to the grass. They reported Gulf flounder from all habitats in the Tampa Bay area of Florida except freshwater and rocky reefs offshore, however, Moe and Martin (1965) reported collecting a few Gulf flounder near offshore reefs adjacent to Tampa Bay off Clearwater Beach, Florida. Springer and McErlean (1962) reported Gulf flounder on a grass flat in the Florida Keys. Naughton and Saloman (1978) collected several Gulf flounder in the St. Andrews Bay, Florida, area and did not report any southern flounder in their study of this sandy, north Florida estuary.

Vegetation

In the northern Gulf, southern flounder are typically collected in highly turbid bays with little rooted vegetation, brackish or saltwater marshes, and small tidal creeks dominated by cordgrass (*Spartina* *alterniflora*), needlerush (*Juncus roemerianus*), wiregrass (*Spartina patens*), and three-square grass (*Schoenoplectus americanus*) (Reid 1955, Darnell 1958, Fox and White 1969, Perret et al. 1971, Livingston 1976, Subrahmanyam and Coultas 1980). Of the two gigging sites chosen by Stokes (1977) in Aransas Bay, Texas, southern flounder were taken more frequently at the site where cordgrass lined the shore and extended out into the water; Gulf flounder were taken more frequently at the site with an un-vegetated shoreline. Springer and Woodburn (1960) reported Gulf flounder inhabited sandy areas of marine grass beds in Tampa Bay, Florida.

Threats to Survival

In the simplest terms, 'habitat' is where an organism lives (Odum 1971, Whitaker and Levin 1975, Baltz 1991, Peters and Cross 1992, Ricklefs 1993, Minello 1999) and the various life history stages of a species, more often than not, have different habitat requirements. The Paralichthyids are distributed over most of the US Gulf of Mexico in a variety of habitats including freshwater rivers and lakes, brackish estuaries, bayous, canals, saltwater bays, sounds, and lagoons as well as offshore (Deubler 1960, Gutherz 1967, Hoese and Moore 1998). Estuarine areas are consistently referred to as 'nursery areas' due to the abundance and variety of juvenile nekton species that utilize these them. The abundance of habitat types such as intertidal marshes, seagrass, oyster reef and shell, and shallow non-vegetated bottom within estuaries is what enables such productivity (Carr and Adams 1973, Weinstein 1979, Rozas and Minello 1998). The biotic and abiotic parameters of the habitat also determine the suitability of that habitat to a particular species, such is true for the Gulf and southern flounders. The conversion, loss, and degradation of a coastal habitats are likely to impact flounder because of the wide distribution of Paralichthyids throughout the Gulf and includes natural processes like hypoxia, harmful algal blooms, global climate change and climate regime shifts, as well as man-made changes such as habitat alteration, freshwater diversions, pollution, and the introduction of non-native flora and fauna.

Chapter 5

Fishery Management Jurisdictions, Laws, and Policies Affecting the Stock

Flounder are somewhat unusual among the more important marine fish species in the Gulf because they are not highly migratory. They are usually associated with estuaries and Gulf waters and are "euryhaline, estuarine-dependent bottom fish" (Benson 1982). Although the range of individuals is more limited than other Gulf species, flounder are directly and indirectly affected by numerous state and federal management institutions because of their wide-spread distribution. The following is a partial list of some of the most important agencies and a brief description of the laws and regulations that could potentially affect flounder and their habitat. Individual Gulf states and federal agencies should be contacted for specific and up-to-date state laws and regulations, which are subject to change on a state-by-state basis. An extensive list of federal laws and acts that impact marine waters in the Gulf of Mexico can be found in Perry and VanderKooy (2015) and VanderKooy and Smith (2015).

Federal

Management Institutions

Flounder are found in the exclusive economic zone (EEZ) of the Gulf of Mexico, but they are most abundant in state waters. The commercial and recreational fisheries are almost exclusively conducted within the jurisdictions of the states; consequently, federal regulations primarily affect flounder populations by maintaining and enhancing habitat, preserving water quality and food supplies, and abating pollution. Federal laws may also be adopted to protect consumers through the development of regulations to maintain the quality of flounder as seafood.

With the passage of the Magnuson Fishery Conservation and Management Act (MFCMA) and the subsequent Magnuson-Stevens Conservation and Management Act (Mag-Stevens) of 1996, the federal government assumed responsibility for fishery management within the EEZ, a zone contiguous to the territorial sea and whose inner boundary is the outer boundary of each coastal state. The outer boundary of the EEZ is a line 200 nautical miles from the (inner) baseline of the territorial sea. Management of fisheries in the EEZ is based on fishery management plans (FMPs) developed by regional fishery management councils. Each council prepares plans for each fishery requiring management within its geographical area of authority and amends such plans as necessary. Plans are implemented as federal regulation through the U.S. Department of Commerce (USDOC).

The councils must operate under a set of National Standards and guidelines laid out in the Mag-Stevens, and to the extent practicable, an individual stock of fish must be managed as a unit throughout its range. Management must, where practicable, promote efficiency, minimize costs, and avoid unnecessary duplication (MFCMA Section 301a).

There is no significant fishery for flounder in the EEZ of the U.S. Gulf of Mexico. Consequently, the GMFMC has not developed a management plan for flounder.

National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (USDOC)

The Secretary of Commerce, acting through the NMFS, has the ultimate authority to approve or disapprove all FMPs prepared by regional fishery management councils. Where a council fails to develop a plan, or to correct an unacceptable plan, the Secretary may do so. The NMFS also collects data and statistics on fisheries and fishermen. It performs research and conducts management authorized by international treaties. The NMFS has the authority to enforce the Mag-Stevens and the Lacey Act and other federal laws protecting marine organisms, including the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) and is the federal trustee for living and nonliving natural resources in coastal and marine areas.

The NMFS exercises no management jurisdiction other than enforcement with regard to flounder in the Gulf of Mexico. It conducts some research and data collection programs and comments on all projects that affect marine fishery habitats.

The USDOC, in conjunction with coastal states, administers the National Estuarine Research Reserve and National Marine Sanctuaries Programs as authorized under Section 315 of the Coastal Management Act of 1972. Those protected areas serve to provide suitable habitat for a multitude of estuarine and marine species and serve as sites for research and education activities relating to coastal management issues.

Treaties and Other International Agreements

There are no treaties or other international agreements that affect the harvesting or processing of flounder. No foreign fishing applications to harvest flounder have been submitted to the United States.

Federal Laws, Regulations, and Policies

The following federal laws, regulations, and policies may directly and indirectly influence the quality, abundance, and ultimately the management of flounder.

Magnuson Fishery Conservation and Management Act of 1976 (MFCMA); Magnuson-Stevens Fishery Conservation and Management Act of 1996 (Mag-Stevens) also called the Sustainable Fisheries Act (P.L. 104-297)

The MFCMA mandates the preparation of FMPs for important fishery resources within the EEZ. It sets national standards to be met by such plans. Each plan attempts to define, establish, and maintain the optimum yield for a given fishery. The 1996 Mag-Stevens reauthorization included three additional national standards (eight through ten) to the original seven for fishery conservation and management, included a rewording of standard number five, and added a requirement for the description of essential fish habitat and definitions of overfishing.

1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry;
2. Conservation and management measures shall be based on the best scientific information available;
3. To the extent practicable, an individual stock shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or close coordination;
4. Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various U.S. fishermen, such allocations shall be:
   - fair and equitable to all such fishermen;
   - reasonably calculated to promote conservation; and
   - carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.
5. Conservation and management measures shall, where practicable, consider efficiency in the utilization of the resources; except that no such measures shall have economic allocation as its sole purpose.
6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fisheries resources, and catches.
7. Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

8. Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to:
   - provide for the sustained participation of such communities, and
   - to the extent practicable, minimize adverse economic impacts on such communities.
9. Conservation and management measures shall, to the extent practicable,
   - minimize bycatch and
   - to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.
10. Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

The 2006 reauthorization builds on the country's progress to implement the 2004 Ocean Action Plan which established a date to end over-fishing in America by 2011, use market-based incentives to replenish America's fish stocks, strengthen enforcement of America's fishing laws, and improve information and decisions about the state of ocean ecosystems.

Interjurisdictional Fisheries Act (IFA) of 1986 (P.L. 99-659, Title III)

The IFA of 1986 established a program to promote and encourage state activities in the support of management plans and to promote and encourage regional management of state fishery resources throughout their range. The enactment of this legislation repealed the Commercial Fisheries Research and Development Act (P.L. 88-309).

Federal Aid in Sport Fish Restoration Act (SFRA); the Wallop-Breaux Amendment of 1984 (P.L. 98-369)

The SFRA, passed in 1950, provides funds to states, the USFWS, and the Gulf States Marine Fisheries Commission to conduct research, planning, and other programs geared at enhancing and restoring marine sportfish populations. The 1984 amendment created the Aquatic Resources Trust Fund which is a 'user pays/user benefits' program. The amendment allows transfer of fishing and boating excise taxes and motorboat gas taxes (user pays) to the improvement of boating and fishing programs (user benefits) and provides equitable distribution of funds between freshwater and saltwater projects in coastal states.

State

Table 5.1 outlines the various state management institutions and authorities and Table 5.2 compares the commercial and recreational size and bags limits by state.

Florida

Florida Fish and Wildlife Conservation Commission (FWC)

Florida Fish and Wildlife Conservation Commission
620 South Meridian Street
Tallahassee, FL 32399
Telephone: (850) 487-0554
www.myfwc.com

The agency charged with the administration, supervision, development, and conservation of natural resources in Florida is the FWC. This commission is not subordinate to any other agency or authority of the state's executive branch. The administrative head of the FWC is the executive director. Within the FWC, the Division of Marine Fisheries is empowered to manage marine and anadromous fisheries in the interest of all people of Florida. The Division of Law Enforcement is responsible for enforcement of all marine, resource-related laws, rules, and regulations of the state.

Table 5.1 State management institutions - Gulf of Mexico.

STATE	ADMINISTRATIVE BODY AND ITS RESPONSIBILITIES	ADMINISTRATIVE POLICY-MAKING BODY AND DECISION RULE	LEGISLATIVE INVOLVEMENT IN MANAGEMENT REGULATIONS
Florida	**FWC**		
	-administers management programs -enforcement -conducts research	-creates rules in conjunction with management plans -ten member commission	-responsible for setting fees, licensing, and penalties.
Alabama	**ADCNR**		
	-administers management programs -enforcement -conducts research	-Commissioner of department has authority to establish management regulation -Conservation Advisory Board is a thirteen- member board and advises the commissioner -has authority to amend and promulgate regulations	-authority for detailed management regulations delegated to commissioner -statutes concerned primarily with licensing
Mississippi	**MDMR**	**COMMISSION ON MARINE RESOURCES**	
	-administers management programs -conducts research -enforcement	-five-member board establishes regulations on recommendation of executive director (MDMR)	- authority for detailed management regulations delegated to commission statutes concern licenses, taxes and some specific fisheries laws
Louisiana	**LDWF**	**WILDLIFE AND FISHERIES COMMISSION**	
	-administers management programs -enforcement -conducts research -makes recommendations to legislature	-seven-member board establishes policies and regulations based on majority vote of a quorum (four members constitute a quorum) consistent with statutes	-detailed regulations contained in statutes -authority for detailed management regulations delegated to commission
Texas	**TPWD**	**PARKS AND WILDLIFE COMMISSION**	
	-administers management programs -enforcement -conducts research -makes recommendations to Texas Parks & Wildlife Commission (TPWC)	-nine-member body establishes regulations based on majority vote of quorum (five members constitute a quorum) -granted authority to regulate means and methods for taking, seasons, bag limits, size limits and possession	-licensing requirements and penalties are set by legislation

The FWC, a seven-member board appointed by the governor and confirmed by the senate, was created by constitutional amendment in November 1998, effective July 1, 1999. This Commission was delegated rule-making authority over all aspects of rule-making concerning marine life with the exception of requiring fees.

Florida has habitat protection and permitting programs, and a federally-approved CZM program.

Table 5.2 Comparison of commercial and recreational size and bag limits for flounder in the Gulf of Mexico.

STATE	SPECIES	COMMERCIAL		RECREATIONAL	
		MIN LENGTH	BAG/POSSESSION	MIN LENGTH	BAG/POSSESSION
Florida	Flounder Gulf Southern Summer Fringed	12 TL	Incidental bycatch - 50lb/day	12 TL	10/10
Alabama	Flounder	12 TL		12 TL	10/10
Mississippi	Flounder	12 TL	QUOTA	12 TL	15/15
Louisiana	Flounder	NONE	10/licensed commercial fishermen/day (Does not apply to shrimp boats – incidental percentages apply)	NONE	10/10
Texas	Flounder (All Species)	14	30/person with commercial finfish license 5/licensed shrimp boat captain November pole and line only and limit 2	14	5/person/day (Jan-Oct, Dec) 2/person/day pole & line only (Nov)

Legislative Authorization

Prior to 1983, the Florida Legislature was the primary body that enacted laws regarding management of flounder in state waters. Chapter 370 of the Florida Statutes, annotated, contained the specific laws directly related to harvesting, processing, etc. both statewide and in specific areas or counties. In 1983, the Florida Legislature established the Florida Marine Fisheries Commission (MFC) and provided the MFC with various duties, powers, and authorities to promulgate regulations affecting marine fisheries. Title 46, Chapters 46-48 contained regulations regarding flounder. On July 1, 1999, the MFC, parts of the Florida Department of Environmental Protection (DEP) including the Florida Marine Patrol, and the Florida Game and Freshwater Fisheries Commission (GFC) were merged into one commission, the FWC. Marine fisheries rules of the FWC are now codified under Chapter 68B, Florida Administrative Code.

Reciprocal Agreements and Limited Entry Provisions

Reciprocal Agreements

Florida statutory authority provides for reciprocal agreements related to fishery access and licenses. Florida has no statutory authority to enter into reciprocal management agreements.

Limited Entry

Florida has no provisions for limited entry in the flounder fishery with the exception of a $5,000/year restricted species license endorsement.

Commercial Landings Data Reporting Requirements

Florida requires wholesale dealers to maintain records of each purchase of saltwater products by filling out a Marine Fisheries Trip Ticket (Chapter 379.361 of the Florida Statutes grants rule making authority and Chapter 68E-5.002 of the Administrative Code specifies the requirements). Information to be supplied for each trip includes Saltwater Products License number; vessel identification; wholesale dealer number; date; time fished; area fished; county landed; depth fished; gear fished; number of sets; whether a head boat, guide, or charter boat; number of traps; aquaculture or lease number; species code; species size; amount of catch; unit price; and total dollar value which is optional. The wholesale dealer is required to submit trip tickets weekly if the tickets contain quota-managed species such as Spanish mackerel; otherwise trip tickets must be submitted every month.

Penalties for Violations

Penalties for violations of Florida laws and regulations are established in Florida Statutes, Section 379.407. Additionally, upon the arrest and conviction of any license holder for violation of such laws or regulations, the license holder is required to show just cause why their saltwater license should not be suspended or revoked.

License Requirements

Contact the FWC for current license requirements for commercial and recreational harvest of flounder.

Laws and Regulations

Florida's laws and regulations regarding the harvest of flounder are statewide. The following discussions are general summaries of laws and regulations, and the FWC should be contacted for more specific information. *The restrictions discussed in this section are current through the end of December, 2011, and are subject to change at any time thereafter.*

Size Limits

A minimum size limit of 12 inches TL.

Gear Restrictions

Flounder may be harvested with a beach or haul seine (under 500 ft^2), cast net (less than 14feet in length; fishing with more than two cast nets per vessel is prohibited in state waters), hook and line gear, gig, and spear or lance. Purse seines, gill nets, trammel nets, pound nets, and other entangling nets) are prohibited throughout Florida territorial waters. Additionally, possession of flounder aboard any vessel carrying gill nets or other entangling nets is prohibited. Flounder may be harvested as an incidental bycatch by gears not specifically authorized for the harvest of flounder (e.g., trawls), provided that the number of flounder so harvested and in possession does not exceed 50 lbs.

Closed Areas and Seasons

There are no closed areas for the harvest of flounder in Florida with the exception of Everglades National Park, the sanctuary preservation areas (SPA) within the Florida Keys National Marine Sanctuary, and other state and national parks and reserves.

Quotas and Bag/Possession Limits

No recreational harvester shall harvest in or from state waters more than a total of ten flounder per day, nor possess while in or on state waters more than ten such fish. Licensed commercial harvesters are not limited by bag or possession limits when fishing with allowable gears.

Other Restrictions

Flounder must be landed in a whole condition. The use of any multiple hook (e.g., treble hook) with live or dead natural bait and snagging (snatch hooking) to catch flounder is prohibited.

Historical Changes to Flounder Regulations in Florida

The following regulatory changes may have notably influenced the landings during a particular year and are summarized here for informational purposes.

1991: Prohibited to use gill or trammel nets with a total length greater than 600 yards. No more than two nets to be possessed aboard a boat. No more than one net to be used from a single boat. Required net to be tended and marked according to certain specifications in the waters of Brevard through Palm Beach counties. Prohibited to use gill nets in state waters with a mesh size greater than six inches stretched mesh.

1993: Set a maximum mesh size for seines at two inches stretched mesh, excluding wings. Set a minimum mesh size for gill and trammel nets at three inches stretched mesh beginning.

1995: Set a maximum length of 600 yards for all gill and trammel nets and seines. Allowed only a single net to be fished by any vessel or individual at any time. Prohibited the use of longline gear.

1993: Prohibited the use of gill and trammel nets in any bayou, river, creek, or tributary of waters between Collier and Pinellas counties from November 1 - January 31 each year.

1994: Prohibited the use of gill and trammel nets and seines in state waters of Martin County.

1995: Prohibited the use of any gill or entangling net in Florida waters. Prohibited the use of any net with a mesh area greater than 500 square feet.

1996: 12 inch TL minimum size for all flounders (commercial and recreational fishermen). Ten fish daily limit (recreational fishermen only). Allowed only hook and line, cast net, beach, haul seine, spears and gigs. 50 lbs commercial daily vessel bycatch allowed. Requires flounder to be landed in whole condition. Prohibited use of multiple (treble) hook in conjunction with natural bait and snagging. Restricted species license endorsement required in addition to a Saltwater Product. License for commercial harvest. Establishes an exemption to the bag limit for aquaculture operators.

1998: Prohibits sale of flounder harvested in or from state waters that are less than 12 inches.

2006: Defines total length as the straight-line distance from the most forward point of the head with the mouth closed to the farthest tip of the tail compressed or squeezed while the fish is lying on its side.

Alabama

Alabama Department of Conservation and Natural Resources (ADCNR); Alabama Marine Resources Division (AMRD)

Alabama Department of Conservation and Natural Resources
Marine Resources Division
P.O. Box 189
Dauphin Island, Alabama 36528
(251) 861-2882
www.outdooralabama.com

Management authority of fishery resources in Alabama is held by the Commissioner of the ADCNR. The Commissioner may promulgate rules or regulations designed for the protection, propagation, and conservation of all seafood. He may prescribe the manner of taking, times when fishing may occur, and designate areas where fish may or may not be caught; however, all regulations are to be directed at the best interest of the seafood industry.

Most regulations are promulgated through the Administrative Procedures Act approved by the Alabama Legislature in 1983; however, bag limits and seasons are not subject to this act. The Administrative Procedures Act outlines a series of events that must precede the enactment of any regulations other than those of an emergency nature. Among this series of events are: (a) the advertisement of the intent of the regulation; (b) a public hearing for the regulation; (c) a 35-day waiting period following the public hearing to address comments from the hearing; and (d) a final review of the regulation by a Joint House and Senate Review Committee.

Alabama also has the Alabama Conservation Advisory Board (ACAB) that is endowed with the responsibility to provide advice on policies and regulations of the ADCNR. The board consists of 10 members appointed by the Governor for alternating terms of six years, and three ex-officio members in the persons of the Governor, the Commissioner of Agriculture and Industries, and the Director of the Alabama Cooperative Extension System. The Commissioner of the Department of Conservation and Natural Resources serves as the ex-officio secretary to the board.

The Marine Resources Division (MRD) has responsibility for enforcing state laws and regulations, for conducting marine biological research, and for serving as the administrative arm of the commissioner with respect to marine resources. The Division recommends regulations to the Commissioner.

Alabama has a habitat protection and permitting program and a federally-approved CZM program.

Legislative Authorization

Chapters 2 and 12 of Title 9, Code of Alabama, contain statutes that affect marine fisheries.

Reciprocal Agreements and Limited Entry Provisions

Reciprocal Agreements

Alabama statutory authority provides for reciprocal agreements with regard to access and licenses. Alabama has no statutory authority to enter into reciprocal management agreements.

Limited Entry

Alabama law provides that commercial net and seine permits shall only be issued to applicants who purchased such licenses in two of five years from 1989 through 1993 and who show proof (in the form of Alabama state income tax returns) that they derived at least 50% of their gross income from the capture and sale of seafood species in two of the five years; or applicants that purchased such licenses in all five years and who (unless exempt from filing Alabama income tax) filed Alabama income tax returns in all five years. Furthermore; beginning June 1, 2008 resident gillnet licenses were no longer available to anyone other than a current license holder. Each license holder must renew the license annually or the license becomes void. In addition, non-resident gill net licenses were no longer available for purchase therefore eliminating the non-resident fishery. Other restrictions are applicable, and the ADCNR, MRD should be contacted for details.

Commercial Landings Data Reporting Requirements

Alabama law requires that wholesale seafood dealers file monthly reports by the tenth of each month for the preceding month. Under a cooperative agreement, records of sales of seafood products are now collected jointly by NMFS and ADCNR port agents.

Penalties for Violations

Violations of the provisions of any statute or regulation are considered Class A, Class B, or Class C misdemeanors and are punishable by fines up to $6,000 and up to one year in jail.

License Requirements

Contact the ADCNR for current license requirements for commercial and recreational harvest of flounder. Nonresident fees for commercial hook and line licenses, recreational licenses, and seafood dealers licenses may vary based on the charge for similar fishing activities in the applicant's resident state.

Laws and Regulations

Alabama laws and regulations regarding the harvest of flounder primarily address the type of gear used and seasons for the commercial fishery. The following is a general summary of these laws and regulations. They are current through the end of December, 2011, and are subject to change at any time thereafter. The ADCNR MRD should be contacted for specific and up-to-date information.

Size Limits

Alabama has a 12 inch TL minimum size limit for recreationally and commercially caught flounder.

Gear Restrictions

Gill nets must be marked every 100 feet with a color-contrasting float and every 300 feet with the fisherman's permit number. Recreational nets may not exceed 300 feet in length and must be marked with the licensee's name and license number. Commercial gill nets, trammel nets, and other entangling nets may not exceed 2,400 feet in length; however, depth may vary by area.

During the period January 1st through October 23rd of each year, gill nets, trammel nets, and other entangling nets used to catch any fish in Alabama coastal waters under the jurisdiction of the MRD must have a minimum mesh size of 1.5 inch bar (knot to knot). A minimum mesh size of two inch bar is required for such nets used to take mullet during the period October 24 through December 31 of each year for all Alabama coastal waters under the jurisdiction of the MRD as provided in Rule 220-2-42 and defined in Rule 220-3-04(1), and any person using a two inch or larger bar net during the period October 24 through December 31 of each year shall be considered a roe mullet fisherman and must possess a roe mullet permit. These net-size restrictions do not apply to coastal rivers, bayous, creeks, or streams. In these areas, the minimum mesh size shall be six inch stretch mesh.

The use of purse seines to catch flounder is prohibited. Commercial and recreational gill net fishermen may use only one net at any time; however, commercial fishermen may possess more than one such net. No hook and line device may contain more than five hooks when used in Alabama coastal waters under the jurisdiction of the MRD.

Flounder may also be taken by ordinary hook and line, cast net, gig, and spear.

Closed Areas and Seasons

Gill nets, trammel nets, seines, purse seines, and other entangling nets are prohibited in any marked navigational channel, Theodore Industrial Canal, Little Lagoon Pass, or any man-made canal; within 300 feet of any man-made canal or the mouth of any river, stream, bayou, or creek; and within 300 feet of any pier, marina, dock, boat launching ramp, or certain 'relic' piers. Recreational gill nets may not be used beyond 300 feet of any shoreline, and they may not extend into the water beyond the end of any adjacent pier or block ingress or egress from any of the aforementioned structures.

From October 24 through December 31 of each year, it shall be unlawful to use any set nets (gill nets, trammel nets, or other entangling nets, etc.) in the waters of Bon Secour Bay south of the Gulf Intracoastal Waterway from Oyster Bay west to the last Waterway navigational marker and from that point southwestward to the northwestern tip of the Fort Morgan Peninsula. During this time period, this area shall be open to strike nets but these nets cannot be used within 300 feet of any pier, wharf, dock, or boat launching ramp in this area. 'Strike net' means a gill net, trammel net, or other entangling net, that is set and used from a boat in a circular pattern and is not anchored or secured to the water bottom or shore and which is immediately and actively retrieved. This is to protect the flounder spawning area.

From January 1 through the day after Labor Day of each year, entangling nets are prohibited in certain waters in and around Dauphin Island.

For other seasonal closures, contact ADCNR, AMRD.

Quotas and Bag/Possession Limits

There is a bag/possession limit of 10 fish/person for the recreational flounder fishery.

Other Restrictions

All nets must be constantly attended by the licensee, and no dead fish or other dead seafood may be discarded within 500 feet of any shoreline; or into any river, stream, bayou, or creek. Commercial shrimp boats may not discard their bycatch within three miles of the Gulf beaches.

Historical Changes

The following regulatory changes may have notably influenced the landings during a particular year and are summarized here for informative purposes.

2001: A 12 inch TL regulation enacted.

2008: A 10/person bag/possession limit enacted.

Mississippi

Mississippi Department of Marine Resources (MDMR)

Mississippi Department of Marine Resources
1141 Bayview Avenue
Biloxi, Mississippi 39530
(228) 374-5000
www.dmr.ms.gov

The MDMR administers coastal fisheries and habitat protection programs. Authority to promulgate regulations and policies is vested in the Mississippi Commission on Marine Resources (MCMR), the controlling body of the MDMR. The commission consists of seven members appointed by the Governor. One member is also a member of the Mississippi Commission on Wildlife, Fisheries and Parks (MCWFP) and serves as a liaison between the two agencies. The MCMR has full power to "manage, control, supervise and direct any matters pertaining to all saltwater aquatic life not otherwise delegated to another agency" (Mississippi Code Annotated 49-15-11).

Mississippi has a habitat protection and permitting program and a federally-approved CZM program. The MCMR is charged with administration of the Mississippi Coastal Program (MCP) which requires authorization for all activities that impact coastal wetlands. Furthermore, the state has an established Coastal Zone Management Program (CZMP) approved by NOAA. The CZMP reviews activities which would potentially and cumulatively impact coastal wetlands located above tidal areas. The Executive Director of the MDMR is charged with administration of the CZMP.

Legislative Authorization

Title 49, Chapter 15 of the Mississippi Code of 1972, annotated, contains the legislative regulations as related to the harvest of marine species in Mississippi. Chapter 15 also describes the regulatory duties of the MCMR and the MDMR regarding the management of marine fisheries. Title 49, Chapter 27 involves the utilization of wetlands through the Wetlands Protection Act and is also administered by the MDMR.

Title 49, Chapter 15 of the Mississippi Code of 1972 §49-15-2 "Standards for fishery conservation and management; fishery management plans," was implemented by the Mississippi Legislature on July 1, 1997 and sets standards for fishery management as related to Mag-Stevens (1996).

In 1993 the Mississippi Commission on Wildlife, Fisheries and Parks, pursuant to the authority in Miss. Code Ann. §25-43-9 (1972), adopted Public Notice No. 3306 (re-codified as Miss. Admin. Code 40-4:2.5) and established the dividing line between marine and fresh waters. Specifically, Public Notice No. 3306 provides: "Be it ordered that the southern boundary of Interstate 10 extending from the Alabama state line to the Louisiana state line is hereby declared to be the boundary line between salt and fresh waters for the purposes of the game and fish laws of this state. Be it further ordered that on all waters south of I-10 and north of U.S. Highway 90, either a salt or fresh water sportfishing license will be valid for the purpose of recreational fishing." This adopted Public Notice became effective on September 24, 1993.

Reciprocal Agreements and Limited Entry

Reciprocal Agreements

Section §49-15-15 (h) provides statutory authority to the MDMR to enter into or continue any existing interstate and intrastate agreements, in order to protect, propagate, and conserve seafood in the state of Mississippi.

Section §49-15-30 (1) gives the MCMR the statutory authority to regulate nonresident licenses in order to promote reciprocal agreements with other states.

Limited Entry

Section §49-15-16 gives the MCMR authority to develop a limited entry fisheries management program for all resource groups.

Section §49-15-29 (3), when applying for a license of any kind, the MCMR will determine whether the vessel or its owner is in compliance with all applicable federal and/or state regulations. If it is determined that a vessel or its owner is not in compliance with applicable federal and/or state regulations, no license will be issued for a period of one year.

Section §49-15-80, no nonresident will be issued a commercial fishing license for the taking of fish using any type of net, if the nonresident state of domicile prohibits the sale of the same commercial net license to a Mississippi resident.

Commercial Landings Data Reporting Requirements

Ordinance Number 9.001 of the MDMR establishes data reporting requirements for marine fisheries' operations, including confidentiality of data and penalties for falsifying or refusing to make the information available to the MDMR. Furthermore, Ordinance Number 9 Chapter 6.100 states that each seafood dealer/processor is hereby required to complete Mississippi trip tickets provided by the MDMR. Commercial fishermen, who sell their catch to individuals other than a Mississippi dealer/processor, are hereby required to complete Mississippi trip tickets provided by the MDMR and be in possession of a fresh product permit. Commercial fishermen who sell their catch to anyone other than a Mississippi licensed dealer/processor or transport their catch out-of-state are required to purchase and possess a Dealer/Processor License and are required to comply with all regulations governing Mississippi dealers/processors.

Mississippi implemented a trip ticket program under these guidelines beginning January 1, 2012. Under this rule, fishermen and Dealer/Processors must submit their completed trip tickets as well as a monthly summary form to the MDMR by the tenth of the following month.

Penalties for Violations

Section §49-15-63 provides penalties for violations of Mississippi laws and regulations regarding flounder in Mississippi.

License Requirements

The license fees which are required for the resident commercial harvest and sale of flounder in Mississippi marine waters are listed below. Also included are the fees for the recreational harvest of flounder. Nonresident fees may vary based on the charge for similar fishing activities in the applicant's state of residence. Contact the MDMR for current license requirements for commercial and recreational harvest of flounder.

Laws and Regulations

Mississippi laws which regulate the harvest of flounder are primarily limited to size and creel as well as geographical locations.

Mississippi Title 22 Part 7 provides regulations related to the flounder fishery in Mississippi marine waters. The following is a general summary of regulations which apply to the harvest of flounder, *is current through the end of December 2011, and is subject to change at any time thereafter.* The MDMR should be contacted for the most current regulations.

Title 49, Chapter 15 of the Mississippi Code of 1972 section §49-15-96 allows licensed shrimpers to retain, clean, or filet for personal consumption only flounder which are caught in shrimp trawls.

Size limits

Commercial-12 inch minimum TL
Recreational-12 inch minimum TL

Closed Areas and Seasons

All commercial fishing is prohibited north of the CSX railroad track in coastal Mississippi. Gill nets, trammel nets, purse seines, and other commercial nets may not be used within 1,200 feet of any public pier or hotel/motel pier, and they are prohibited within 300 feet of any private piers that are at least 75 feet in length. These nets are also prohibited within 1,200 feet of the shoreline of Deer Island and within 1,500 feet of the shoreline between the U.S. Highway 90 bridge and the north shore of Bayou Caddy in Hancock County. These aforementioned nets are prohibited within 100 feet of the mouth of rivers, bays, bayous, streams, lakes, and other tributaries to Mississippi marine waters: Point aux Chenes Bay, Middle Bay, Jose Bay, L'Isle Chaude, Heron Bay, Pascagoula Bay (south of the CSX railroad bridge), and Biloxi Bay (south of a line between Marsh point and Grand Bayou). The nets must not be used in a manner to block any of these bays, bayous, rivers, streams, or other tributaries.

No gill or trammel nets, seines, or like contrivance may be used within an area formed by a line running 1.85 km from the shoreline of Cat, Ship, Horn, Petit Bois, and Round islands, or from the shoals of Telegraph Keys and Telegraph Reef (Merrill Coquille) during the period from May 15 to September 15 of each year.

There are no closed seasons for the harvest of flounder. However, gear restrictions include: from 6:00 a.m. to 6:00 p.m., no trammel nets shall be set or otherwise used for the taking of aquatic life within 0.93 km of the shoreline or any manmade structure attached to the shoreline from Bayou Caddy in Hancock County to Marsh Point in Ocean Springs, Jackson County. From 6:00 p.m. to 6:00 a.m., no trammel nets shall be set or otherwise used for the taking of aquatic life within 0.46 km of the shoreline or any manmade structure attached to the shoreline from Bayou Caddy in Hancock County to Marsh Point in Ocean Springs, Jackson County.

Section 49-15-78 states gill nets cannot be set within 0.93 km of shoreline in the state of Mississippi.

It is illegal to use a gill or trammel net in the marine waters of Mississippi or to possess fish in, or in contact with, a gill or trammel net in a boat in the marine waters of Mississippi between 6:00 a.m. on Saturday mornings and 6:00 p.m. on Sunday evenings or on any legal holidays established by the Mississippi Legislature and as set forth in Mississippi Code Annotated §3-3-7. No gill or trammel net shall be set within 0.46 km of another gill or trammel net. Gill and trammel nets must be attended at all times from a distance of no greater than the length of the boat in use. All gill and trammel nets must be constructed of an approved degradable material. All degradable materials must be approved by a MDMR biologist. Any net deemed approved must be tagged on both ends with a MDMR tag. An approved degradable materials list will be on file with the Executive Director of the MDMR or his designee.

Quota and Bag/Possession Limits

Commercial –Season based on annual catch quota currently set at 74,000 lbs. Season runs from January 1 through December 31 unless quota is met.

Recreational – 15/person in possession

Historical Changes to the Regulations

The following regulatory changes may have notably influenced the landings during a particular year and are summarized here for informative purposes.

1993: The Mississippi Legislature established a recreational saltwater fishing license which at the time only applied to hook and line fishermen and by omission, exempted gig fishermen from any recreational licensing requirements.

2001: Gigging was added to the commercial hook and line license by Mississippi State Statute §Title 49, Chapter 15, Section 80.

2002: Mississippi enacted commercial quota and size regulations. The commercial quota was set at 74,000 lbs and the minimum size for both recreational and commercial was set at 12 inches.

Louisiana

Louisiana Department of Wildlife and Fisheries

Louisiana Department of Wildlife and Fisheries
P.O. Box 98000

Baton Rouge, Louisiana 70898-9000
(800) 256-2749
www.wlf.la.gov

The LDWF is one of 21 major administrative units of the Louisiana government. A seven-member board, the Louisiana Wildlife and Fisheries Commission (LWFC), is appointed by the Governor. Six of the members serve overlapping terms of six years, and one serves a term concurrent with the Governor. The commission is a policy-making and budgetary-control board with no administrative functions. The legislature has authority to establish management programs and policies; however, the legislature has delegated certain authority and responsibility to the LWFC and the LDWF. The LWFC may set possession limits, quotas, places, seasons, size limits, and daily take limits based on biological and technical data. The Secretary of the LDWF is the executive head and chief administrative officer of the department and is responsible for the administration, control, and operation of the functions, programs, and affairs of the department. The Secretary is appointed by the Governor with consent of the Senate.

Within the administrative system, an Assistant Secretary is in charge of the Office of Fisheries. In this office, a Marine Fisheries Section (headed by the Section Director) performs:

> "the functions of the state relating to the administration and operation of programs, including research relating to oysters, water bottoms and seafood including, but not limited to, the regulation of oyster, shrimp, and marine fishing industries." (Louisiana Revised Statutes 36:609).

The Enforcement Division, in the Office of the Secretary, is responsible for enforcing all marine fishery statutes and regulations.

Louisiana has habitat protection and permitting programs and a federally-approved CZM program. The Department of Natural Resources is the state agency which monitors compliance of the state Coastal Zone Management Plan and reviews federal regulations for consistency with that plan.

Legislative Authorization

Title 56, Louisiana Revised Statutes (L.R.S.) contains statutes adopted by the Legislature that govern marine fisheries in the state and that empower the LWFC to promulgate rules and regulations regarding fish and wildlife resources of the state. Title 36, L.R.S. creates the LDWF and designates the powers and duties of the department. Title 76 of the Louisiana Administrative Code contains the rules and regulations adopted by the LWFC and the LDWF that govern marine fisheries.

Sections 320, 325.4, and 326.3 of Title 56 (L.R.S.) authorize the LWFC to promulgate rules for the harvest of flounder including seasons, daily take and possession limits, permits, and other aspects of harvest, and provide authority to adopt interim rules until the LWFC can implement permanent rules. Additionally, Sections 325.4 and 326.3 of Title 56 (L.R.S.) give the LWFC the legislative authority to set possession limits, quotas, places, season, size limits, and daily take limits for all freshwater and saltwater finfishes based upon biological and technical data. However, section 492 of Title 56 (L.R.S.) establishes that all southern flounder harvested by any commercial shrimping vessel as bycatch may be retained and sold.

Reciprocal Agreements and Limited Entry Provisions

Reciprocal Agreements

The LWFC is authorized to enter into reciprocal management agreements with the states of Arkansas, Mississippi, and Texas on matters pertaining to aquatic life in bodies of water that form a common boundary. The LWFC is also authorized to enter into reciprocal licensing agreements.

Residents of Texas 65 years of age or under 17 years of age may fish in all Louisiana/Texas border waters without a fishing license. Reciprocally, Louisiana residents 65 years of age or older or those who are 16 years of age or younger may fish in all Texas/Louisiana border waters, excluding the Gulf of Mexico, without a fishing license.

Limited Entry

Louisiana has adopted limited access restriction for the commercial taking of flounder with rod and reel. Sections 325.4 and 305 B(14) of Title 56 (L.R.S.) as amended in 1995 provide that rod and reel licenses may only be issued to a person who has derived 50% or more of his income from the capture and sale of seafood species in at least two of the years 1993, 1994, and 1995 and has not applied for economic assistance for training under 56:13.1(C). Additionally, any person previously convicted of a Class 3 or greater violation cannot be issued a commercial rod and reel license. A person must meet these requirements in order to commercially take flounder with a rod and reel. No limited entry exists to commercially take flounder with other legal commercial gear.

Commercial Landings Data Reporting Requirements

Wholesale/retail seafood dealers who purchase flounder from fishermen are required to report those purchases by the tenth of the following month. Commercial fishermen who sell flounder directly to consumers must be licensed as a wholesale/retail seafood dealer and comply with the same reporting requirements.

Penalties for Violations

Violations of Louisiana laws or regulations concerning the commercial or recreational taking of flounder by legal commercial gear shall constitute a Class 3 violation which is punishable by a fine from $250 to $500 or imprisonment for not more than 90 days or both. Second offenses carry fines of not less than $500 or more than $800 and imprisonment of not less than 60 days or more than 90 days and forfeiture to the LWFC of any equipment seized in connection with the violation. Third and subsequent offenses have fines of not less than $750 or more than $1,000 and imprisonment for not less than 90 days or more than 120 days and forfeiture of all equipment involved with the violation. Civil penalties may also be imposed.

In addition to any other penalty, for a second or subsequent violation of the same provision of law, the penalty imposed may include revocation of the permit or license under which the violation occurred for the period for which it was issued and barring the issuance of another permit or license for that same period.

License Requirements

Contact the LDWF for current license requirements for commercial and recreational harvest of flounder. Nonresidents may not purchase any gear license for Louisiana if their resident state prohibits the use of that particular gear.

Laws and Regulations

Louisiana laws and regulations regarding the harvest of flounder include gear restrictions, season, and other provisions. The following is a general summary of these laws and regulations and *are current through the end of December, 2011 and subject to change at any time thereafter.* The LDWF should be contacted for specific and up-to-date information.

Size Limits

No size limits currently exist on flounder taken either commercially or recreationally.

Gear Restrictions

Licensed commercial fishermen may take flounder commercially with a pole, line, yo-yo, hand line, gig, trotline wherein hooks are not less than 24 inches apart, trawl, skimmer, butterfly net, cast net, scuba gear using standard spearing equipment, and rod and reel (if permitted). It is also legal to harvest flounder with hoop nets with the proper gear license.

Licensed recreational fishermen may take flounder recreationally with a bow and arrow, barbless spear, gig, scuba gear, hook and line, and rod and reel.

Closed Areas and Seasons

Commercial activities including harvest of flounder are prohibited on designated refuges and state wildlife management areas.

Quotas and Bag/Possession Limits

There is no quota on flounder. The daily bag limit for recreational is ten fish per day and in possession. The daily commercial limit is ten fish per day per licensed commercial fisherman on the vessel. Additionally, any commercial shrimping vessel may retain and any commercial fisherman may sell all southern flounder caught as bycatch.

Other Restrictions

The use of aircraft to assist fishing operations is prohibited. Flounder must be landed 'whole' with heads and tails attached; however, they may be eviscerated and/or have the gills removed. For the purpose of consumption at sea aboard the harvesting vessel, a person shall have no more than two pounds of finfish parts per person on board the vessel, provided that the vessel is equipped to cook such finfish. The provisions shall not apply to bait species.

Historical Changes in Regulations

The decline in Louisiana southern flounder landings can be attributed, at least in part, to the following chronology of legislative events.

1995: The Louisiana Legislature eliminated the use of all set nets and provided for the use of strike nets only during specified seasons through 1997. Southern flounder was designated a 'restricted' species and could only be harvested during the strike net season, eliminating a gill net fishery. Permit criteria were established requiring that 50% of the applicant's income over two of the previous three years had to be derived from commercial fishing to qualify. In addition, possession of a saltwater gill net license and no Class 3 or greater fisheries violations were required. Net fishing was restricted to daylight, weekday hours.

1996: From May 1996 to May 1997, the commercial harvest of flounder was closed due to low SPR estimates. The closure was later modified and allowed the current daily possession limit of ten fish per person per day. The same bag limit was applied to recreational anglers.

In November, the declaration of emergency closure was followed by a permanent rule which continued the original closure.

1997: The Legislature provided for the incidental bycatch of flounder on commercial vessels not to exceed 100 lbs per trip. This action also reopened the flounder season at the current bag and possession limits and added a reporting requirement for all transactions including flounder.

1999: The Legislature changed the incidental bycatch of flounder on commercial vessels to read that any commercial shrimping vessel may retain and any commercial fisherman may sell all southern flounder caught as bycatch.

2004: The Legislature changed recreational regulations to allow for the harvest of southern flounder with barbed gigs.

Texas

Texas Parks and Wildlife Department (TPWD)

Texas Parks and Wildlife Department
Coastal Fisheries Division
4200 Smith School Road
Austin, Texas 78744
(512) 389-4863
www.tpwd.state.tx.us

The TPWD is the administrative unit of the state charged with management of the coastal fishery resources and enforcement of legislative and regulatory procedures under the policy direction of the Texas Parks and Wildlife Commission (TPWC). The commission consists of nine members appointed by the Governor for six-year terms. The commission selects an Executive Director who serves as the administrative officer of the department. The Executive Director selects a Deputy Executive Director for Natural Resources who, in turn, selects the Director of Coastal Fisheries, Inland Fisheries, Wildlife, and Law Enforcement Divisions. The Coastal Fisheries Division, headed by a Division Director, is under the supervision of the Deputy Executive Director for Natural Resources.

Texas has habitat protection and permitting programs and a federally-approved Coastal Zone Management (CZM) program. The Texas General Land Office (TGLO) is the lead agency for the Texas CZM. The Coastal Coordination Council monitors compliance of the state Coastal Management Program and reviews federal regulations for consistency with that plan. The Coastal Coordination Council is an eleven-member group whose members consist of a chairman (the head of TGLO) and representatives from Texas Natural Resource Conservation Commission, TPWC, the Railroad Commission, Texas Water Development Board, Texas Transportation Commission, and the Texas Soil and Water Conservation Board. The remaining four places of the council are appointed by the governor and are comprised of an elected city or county official, a business owner, someone involved in agriculture, and a citizen. All must live in the coastal zone.

Legislative Authorization

Chapter 11, Texas Parks and Wildlife Code, established the TPWC and provided for its make-up and appointment. Chapter 12, Texas Parks and Wildlife Code, established the powers and duties of the TPWC, and Chapter 61, Texas Parks and Wildlife Code, provided the commission with responsibility for marine fishery management and authority to promulgate regulations. Chapter 47, Texas Parks and Wildlife Code, provided for the commercial licenses required to catch, sell, and transport finfish commercially, and Chapter 66, Texas Parks and Wildlife Code, provided for the sale, purchase, and transportation of protected fish in Texas. All regulations pertaining to size limits, bag and possession limits, and means and methods pertaining to finfish are adopted by the TPWC and included in the Texas Statewide Hunting and Fishing Proclamations.

Reciprocal Agreements and Limited Entry Provisions

Reciprocal Agreements

Texas statutory authority allows the TPWC to enter into reciprocal licensing agreements in waters that form a common boundary, i.e., the Sabine River area between Texas and Louisiana. Texas has no statutory authority to enter into reciprocal management agreements.

Limited Entry

Chapter 47, Texas Parks and Wildlife Code, provides that no person may engage in business as a commercial finfish fisherman unless a commercial finfish fisherman's license has been obtained. Beginning September 1, 2000, a commercial finfish license could only be sold to a person who documented, in a manner acceptable to the department, that the person held a commercial finfish license during the period after September 1, 1997 through April 20, 1999. In order to qualify for entry into the finfish license management program, the person was required to file an affidavit with the department at the time the license was applied for that stated:

1) the applicant was not employed at any full-time occupation other than commercial fishing; and,
2) during the period of validity of the commercial finfish fisherman's license, the applicant did not intend to engage in any full-time occupation other than commercial fishing.

Commercial Landings Data Reporting Requirements

Section 66.019, Chapter 66, Texas Parks and Wildlife Code, provides:

a) The department shall gather statistical information on the harvest of aquatic products of this state.
b) The department shall prescribe the method or methods used to gather information and shall produce and distribute any applicable report forms.
c) Unless otherwise required by the department, no dealer who purchases or receives aquatic products directly from any person other than a licensed dealer may fail to file the report with the department each month on or before the tenth day of the month following the month in which the reportable activity occurred. The report must be filed even if no reportable activity occurs in the month covered by the report. No dealer required to report may file an incorrect or false report. A culpable mental state is not required to establish an offense under this section.
d) Unless otherwise required by the department, no dealer who purchases, receives, or handles aquatic products (other than oysters) from any person except another dealer may fail to:
    i) maintain cash sale tickets in the form required by this section as records of cash sale transactions; or
    ii) make the cash sale tickets available for examination by authorized employees of the department for statistical purposes or as a part of an ongoing investigation of a criminal violation during reasonable business hours of the dealer.
e) All cash sale tickets must be maintained at the place of business for at least one year from the date of the sale.
f) A cash sale ticket must include:
    i) name of the seller;
    ii) the general commercial fisherman's license number and the commercial finfish fisherman's license number or the general commercial fisherman's license number and the commercial crab fisherman's license number, as applicable, if the holder of the general fisherman's license is selling finfish or crabs;
    iii) the general commercial fisherman's license number, the commercial crab fisherman's license number, the commercial finfish fisherman's license number, the commercial shrimp boat

captain's license number, or the commercial fishing boat license number of the seller or of the vessel used to take the aquatic product, as applicable;

iv) the number of pounds sold by species;

v) date of sale;

vi) water body or bay system from which the aquatic products were taken; and

vii) price paid per pound per species.

g) Any person who violates subsection (c) or (d) of this section is guilty of a Class C misdemeanor

Penalties for Violations

Penalties for violations of Texas' proclamations regarding flounder are provided in Chapter 61, Texas Parks and Wildlife Code, and most are Class C misdemeanors punishable by fines ranging from $25 to $500. Under certain circumstances, a violation can be enhanced to a Class B misdemeanor punishable by fines ranging from $200 to $2,000; confinement in jail not to exceed 180 days; or both.

License Requirements

Senate Bill 1303 authorizes the Texas Parks and Wildlife Commission under Parks and Wildlife Code 47, to establish a license limitation plan for the Texas commercial finfish fishery. The Finfish License Management Program became effective September 1, 2000. Contact the TPWD for current license requirements for commercial and recreational harvest of flounder.

Laws and Regulations

Various provisions of the Statewide Hunting and Fishing Proclamation adopted by the TPWC affect the harvest of flounder in Texas. The following is a general summary of these laws and regulations. *It is current through the end of December, 2011, and is subject to change at any time thereafter.* The TPWD should be contacted for specific and up-to-date information.

Size Limits

A minimum size limit of 14 inches TL has been established for flounder in Texas.

Gear Restrictions

Gill nets, trammel nets, seines, purse seines, and any other type of net or fish trap are prohibited in the coastal waters of Texas. Flounder may be legally taken by pole and line, trotline, sail line, and gig. Daily bag limit is five fish except for the period of November 1-30 when the daily bag is two fish and flounder may be taken only by pole and line. Possession limit is equal to the daily bag limit. The daily bag and possession limit of flounder for the holder of a valid commercial finfish fisherman's license is 30 fish, except on board a licensed commercial shrimp boat the limit is five per person with a current shrimp boat captain's license and is subject to the 50% bycatch rule. For the period November 1-30, flounder may be taken using hook and line only. Possession limit during the period November 1-30 is two fish.

Closed Areas and Seasons

There are no closed areas or seasons for the taking of flounder in Texas.

Quotas and Bag/Possession Limits

Recreational

Bag limit – ten

Possession limit – same as the daily bag limit

Commercial

The daily bag and possession limit for the holder of a valid Commercial Finfish Fisherman's License is 30 flounder. Non-game fish and other aquatic products taken incidental to legal shrimp trawling operations may be retained provided the total weight of aquatic products retained, in any combination, does not exceed 50% by weight of shrimp on a shrimping vessel. The bag limit for flounder retained incidental to a legal shrimping operation is equal to a recreational bag limit except for the period of November 1-30 when the daily bag limit is two fish and flounder may only be taken by pole and line. Possession limit is equal to daily bag limit.

Other Restrictions

Flounder must be kept in a 'whole' condition with heads and tails attached until landed on a barrier island or the mainland; however, viscera and gills may be removed.

Historical Changes to Regulations

The following regulatory changes may have notably influenced the landings during a particular year and are summarized here for informative purposes.

1981: House Bill 1000, prohibition of red drum and spotted seatrout sale (game fish status), therefore commercial pressure on flounder would have been increased.

1988: Net ban, affecting immediate commercial as well as future commercial and recreational landings.

1988: Size restrictions were previously implemented on flounder in some counties in Texas (i.e., 1983, Cameron County, 12-inch minimum); however, the first coast-wide size and bag limits were passed for flounder September 1, 1988. The minimum size for recreational and commercial anglers was 12 inches. Recreational anglers were also restricted to a 20-fish bag limit, 40-fish possession on flounder. No bag limit on commercial finfish fishermen, other than those landed by shrimp trawls, where the bag limit was the same as for recreational fisherman.

1995: Senate Bill 750, limited entry for shrimpers may have redistributed commercial pressure.

1996: On September 1, 1996, the minimum size of flounder increased from 12 to 14 inches for both recreational and commercial fishermen. The bag/possession limit for recreational fisherman decreased from 20 fish bag/40 fish possession to 10 fish bag/20 fish possession limit. A bag limit of 60 flounder was established for commercial fisherman. (Flounder taken from commercial trawls are subjected to same restrictions as recreational anglers, 14 inch size and 10 fish bag/20 fish possession.)

1999: On June 18, 1999, Senate Bill 1303 authorized the TPWC under Parks and Wildlife Code 47, to establish a license limitation plan for the Texas commercial finfish fishery with the goal of improving the economic stability of the commercial finfish fishery while providing long-term sustainability of finfish stocks. The Finfish License Management Program became effective September 1, 2000.

2006: On September 1, 2006, the bag/possession limit for recreational fisherman decreased from 20 fish bag/40 fish possession limit to 10 fish bag/10 fish possession limit.

2010: On September 1, 2010, the bag limit for recreational fisherman decreased from 10 fish bag/10 fish possession to five fish/two fish bag limit. During the period of Nov. 1-30 the daily bag limit is two fish by pole and line only. The possession limit is equal to the daily bag. The bag limit for commercial fishermen decreased from 60 flounder to 30 fish/two fish bag limit except on board a licensed commercial shrimp boat the limit is five fish per person with a current shrimp boat captain's license and is subject to the 50% bycatch rule. For the period November 1-30, flounder may be taken using hook and line only. Possession limit during the period November 1-30 is two fish.

Regional/Interstate

Gulf States Marine Fisheries Compact (P.L. 81-66)

The Gulf States Marine Fisheries Commission (Commission) was established by an act of Congress (P.L. 81-66) in 1949 as a compact of the five Gulf states. Its charge is

> "to promote better utilization of the fisheries, marine, shell and anadromous, of the seaboard of the Gulf of Mexico, by the development of a joint program for the promotion and protection of such fisheries and the prevention of the physical waste of the fisheries from any cause."

The Commission is composed of three members from each of the five Gulf states. The head of the marine resource agency of each state is an ex-officio member, the second is a member of the legislature, and the third, a citizen who shall have knowledge of and interest in marine fisheries, is appointed by the governor. The chairman, vice chairman, and second vice chairman of the Commission are rotated annually among the states.

The Commission is empowered to make recommendations to the governors and legislatures of the five Gulf states on action regarding programs helpful to the management of the fisheries. The states do not relinquish any of their rights or responsibilities in regulating their own fisheries by being members of the Commission.

Recommendations to the states are based on scientific studies made by experts employed by state and federal resource agencies and advice from law enforcement officials and the commercial and recreational fishing industries. The Commission is also authorized to consult with and advise the proper administrative agencies of the member states regarding fishery conservation problems. In addition, the Commission advises the U.S. Congress and may testify on legislation and marine policies that affect the Gulf states. One of the most important functions of the Commission is to serve as a forum for the discussion of various problems, issues, and programs concerning marine management.

Flounder Technical Task Force

The Flounder Technical Task Force (TTF) is organized with one scientific representative from each of the five Gulf states who are appointed by each state's director serving on the State-Federal Fisheries Management Committee (SFFMC). In addition, a representative from each of the Commission's Commercial Fisheries and Recreational Fisheries Advisory Panels, the Law Enforcement Committee, and the Habitat Subcommittee (the representative is chosen by action of the respective committees). In additional, other experts from other disciplines may be included on the TTF as needed (i.e., public health, economics, sociology, etc.). As with all of the Commission's TTF's, the committee becomes inactive until there is a need for revision of a profile or work on specific issues related to flounder in the region. The members of the TTF may be called upon to advise the Technical Coordinating Committee (TCC), the SFFMC, or the Commission on flounder issues in the Gulf of Mexico.

Interjurisdictional Fisheries Act (IFA) of 1986 (P.L. 99-659, Title III)

The IFA of 1986 established a program to promote and encourage state activities in the support of management plans and to promote and encourage regional management of state fishery resources throughout their range. The enactment of this legislation repealed the Commercial Fisheries Research and Development Act (P.L. 88-309).

Development of Biological and Management Profiles and Management Plans for Fisheries (Title III, Section 308(c))

Through P.L. 99-659, Congress authorized the USDOC to appropriate funding in support of state research and management projects that were consistent with the intent of the IFA. Additional funds were authorized to support the development of interstate management plans by the Gulf, Atlantic, and Pacific States Marine Fisheries Commissions.

Chapter 6

Description of the Fishery

The relative importance of flounders in the commercial catch has declined since the height of the fishery in the 1980s and early 1990s. Regulatory changes throughout the Gulf of Mexico related to bycatch and gill/entangling gear has greatly reduced the landings for Gulf and southern flounder from an average of about 1.5M lbs in the 1980s to 1.1M lbs in the 1990s to under 500,000 lbs in the 2000s. Net limitations were established in Texas waters in 1988 in response to concerns over red drum followed by Louisiana and Florida in 1995, the last year that the Gulf-wide catch was over a million pounds.

While two distinct species make up the 'flounder fishery' in the Gulf of Mexico, the NMFS classified all species of flounder landed in the Gulf of Mexico as 'flatfish' until 2000. After 2000, NMFS began reporting all Louisiana flounders as 'southern flounder' while the other four Gulf states are still reporting flounders as 'flatfish'.

Despite differences in their ranges and life histories, Gulf and southern flounder are not differentiated in the market place in part because they have the same value regardless of species. Therefore, there is no incentive to better identify the two species by dealers and processors when reporting on trip tickets or product reports.

The Gulf and southern flounder are valuable recreational species on the Gulf Coast where they are harvested mainly by hook and line and gigs (Reagan and Wingo 1985). Flounder gigging occurs mainly at night, with fishermen wading in shallow water using a bright light to illuminate the bottom. According to Warlen (1975), this technique has been used since the time of the ancient Greeks and Romans and could go back 10,000 years to a time when early humans used spears for self-protection, hunting, and fishing.

Commercial Fishery

History

There are more than four dozen species of flatfish in the family Paralichthyidae of which approximately two dozen are found in the Gulf of Mexico, many of which are captured by commercial shrimp trawlers (Reagan and Wingo 1985). However, most flatfishes have little or no commercial value. In addition, flatfishes make up a small component of the industrial bottomfish catches in the Gulf of Mexico. Commercially-valuable flatfishes (Gulf and southern flounder) are typically removed from these catches and sold separately, rather than leaving them in the groundfish catch to be processed as pet food or fish meal, or discarded as bycatch.

Twelve species of flatfish (Paralichthyidae) are regularly captured in the annual SEAMAP sampling program in the Gulf of Mexico. They include the southern, ocellated (*Ancylopsetta quadrocellata*), three-eye (*Ancylopsetta dilecta*), Mexican *(Cyclopsetta chittendeni*, shelf (*Etropus cyclosquamus*), fringed (*Etropus crossotus*), shoal (*Syacium gunteri*), dusky *(Syacium papillosum*), broad (*Paralichthys squamilentus*), and Gulf flounders, as well as the spotted whiff (*Citharichthys macrops*) and bay whiff (*Citharichthys spilopterus*).

Gear types used to incidentally harvest flounders are the same as those used to commercially harvest other marine species and include butterfly nets, shrimp trawls, gill nets, trammel nets, handlines, longlines, and haul seines. Although spears and/or spearing are primarily associated with the harvest of flounders, commercial landings for flounders attributed to this method are rarely reported for most states. Gulf-wide, harvest methods have shifted over the years due to gear restrictions or efficiency. Prior to 1986, trawling (all types) accounted for almost 80% of landings and gigs/spears represented only 10%, however, since 1986 landings have shifted dramatically with trawling accounting for 41% and spears/gigs accounting for approximately 29% (NOAA personal communication). Part of this shift in gear contributions can be attributed to closure of the groundfish fishery in the mid-1980s, a decline in effort due to competition with foreign shrimp products, regulations banning the use of nets, and tighter regulations on bycatch in trawls. With the implementation of trip tickets in the five Gulf states, more detailed gear data is now available than was previously estimated by the NOAA port agents.

Trammel nets are a gear used for harvesting commercial marine species during cooler months along beaches or inshore waters. Trammel nets are normally fished by one or two fishermen in small to moderate sized vessels up to 12 m in length. In the last ten years, however, most entanglement type nets (gill and trammel) have been banned or greatly restricted in the Gulf states.

Handlines and longlines are normally fished in offshore waters from 36.5-71.3 m near offshore oil platforms (Gutherz et al. 1975). Handlines employ a weighted cord with hooks spaced along its length and can be fished near the bottom or at any depth fish are encountered. They are usually operated by hand or with the use of downriggers. Longlines may reach 1-3 km long and have several floats, weights, and hooks attached periodically along its length. This gear is used to fish waters of any depth, up to approximately 330 m, depending on the target species (Horst and Bankston 1987). Only a small percentage of commercially harvested flounders are landed with handlines or longlines. Butterfly nets generally harvest flounders incidentally to the targeted shrimp catch. However, butterfly nets have been used to target flounders when large flounder runs occur, normally during the fall months of October and November.

Butterfly nets are used mainly in bayous, channels, and passes to harvest shrimp along with incidental species during periods of strong falling tides and during declining temperatures. In the Gulf of Mexico; October, November, and December are the months during which most flounders are commercially landed due to the flounder's habit of moving to offshore areas as water temperatures decline.

Based on the available commercial landings data from NOAA (personal communication), landings for flounder, or flatfish, increased rapidly in the late 1960s to an all-time high in 1972 of 2.59M lbs (Table 6.1). Gulf-wide landings then began to decline through the early 1980s before there was another surge in landings from 1982-1987. Flounder landings dropped rapidly in 1988, 1989, and 1990, then again increased from 1991-1995 and again quickly declined in 1996 and continued to decline slightly until present (Figure 6.1). Most of the abrupt changes in landings are attributed to various state regulatory actions which are highlighted in the following sections. For example, the drop in landings between 1995 and 1996 (from 1.3M lbs to 550,000 lbs Gulf-wide) was primarily due to the ban of entanglement nets in Louisiana which went into effect in 1995. Likewise, the increase in flounder landings from 1981-1982 was primarily due to commercial net fishermen switching to other species such as flounder, following the year that Texas declared red drum and spotted seatrout as sportfish.

State Commercial Fisheries

The flounder commercial fishery varies widely among Gulf states in historical landings, gear, vessels, and traditions. Table 6.1 provides flounder landings for the Gulf states from 1965 to 2011. Because identification of flounder to species has not been a high priority for most fishermen and dealers, most of the landings are generally lumped into 'flatfish' and are not broken out by species with the exception of Louisiana which only reports 'southern flounder' in the NOAA commercial landings data. Several of the states have some of their data separated by species thanks to trip tickets and improved reporting, however, NOAA still aggregates most of the flounder species in the Gulf of Mexico (Figure 6.1).

Table 6.1 Total commercial landings (X 1,000 lbs) of flounders (1965-1985 data derived from NOAA personal communication; Florida's 1986-2011 data derived from FWC/FWRI unpublished data).

Year	Florida (Gulf Coast)	Alabama	Mississippi	Louisiana	Texas	Gulf-Wide
1965	272.5	300.8	69.4	261.7	292.5	1,196.9
1966	209.1	483.4	105.9	274.5	188.1	1,261.0
1967	182.8	479.5	138.0	350.0	456.0	1,606.3
1968	222.6	533.0	137.8	271.0	365.8	1,530.2
1969	268.7	539.8	123.4	306.8	288.2	1,526.9
1970	290.2	780.7	152.5	480.3	131.2	2,001.0
1971	296.5	950.8	172.0	463.4	163.9	2,202.0
1972	304.0	1,169.8	153.1	507.3	453.8	2,587.8
1973	263.2	709.0	97.2	281.4	341.9	1,691.9
1974	226.5	916.5	97.7	315.4	507.1	2,064.1
1975	219.3	832.0	104.8	242.5	492.6	1,891.6
1976	232.5	803.4	80.7	327.3	434.5	1,878.5
1977	270.9	598.5	81.4	292.5	310.9	1,360.9
1978	298.3	638.5	80.0	305.9	237.2	1,560.2
1979	322.4	671.3	53.5	193.7	232.4	1,556.4
1980	355.6	501.2	42.1	158.7	194.9	1,254.9
1981	313.1	588.3	28.6	136.5	130.4	1,197.4
1982	395.7	624.5	50.6	193.1	535.9	1,807.9
1983	322.4	509.9	49.7	275.4	474.3	1,632.3
1984	224.6	308.6	43.5	353.0	380.1	1,311.1
1985	184.8	379.5	88.2	523.9	443.5	1,625.5
1986	174.2	386.2	28.1	804.9	560.3	1,973.3
1987	180.3	288.3	57.3	927.3	551.3	2,014.3
1988	152.9	154.4	34.0	507.3	273.8	1,124.8
1989	169.7	189.2	77.8	479.3	166.7	1,096.7
1990	192.7	167.2	62.4	454.7	151.0	1,029.0
1991	235.9	228.8	85.0	692.3	314.5	1,556.5
1992	185.2	170.5	40.5	784.6	311.5	1,492.5
1993	173.2	175.4	44.7	898.9	241.7	1,533.7
1994	152.2	198.1	40.8	974.7	232.0	1,598.0
1995	136.2	207.5	56.9	533.2	299.1	1,233.1
1996	84.0	148.8	37.2	61.8	242.8	574.8
1997	125.6	146.9	37.5	94.9	187.4	593.4
1998	95.4	147.9	53.5	139.9	217.9	654.9
1999	112.9	155.2	93.4	140.7	287.8	789.8
2000	91.1	159.4	109.6	177.1	159.5	696.5
2001	125.9	137.1	83.8	90.1	121.2	558.2
2002	111.6	176.2	46.4	66.9	173.3	589.3
2003	120.0	118.0	30.9	62.9	156.0	489.0
2004	108.1	138.1	18.2	71.5	151.1	489.1
2005	104.4	129.7	10.4	18.0	107.0	373.0
2006	78.5	118.4	16.0	83.6	67.7	364.7
2007	70.2	132.7	24.5	76.1	24.3	330.3
2008	76.1	106.9	16.8	75.7	58.1	337.1
2009	100.1	97.0	24.7	77.1	31.7	384.7
2010	89.2	47.5	27.6	80.6	20.1	266.1
2011	111.4	110.9	55.2	151.3	74.6	504.6

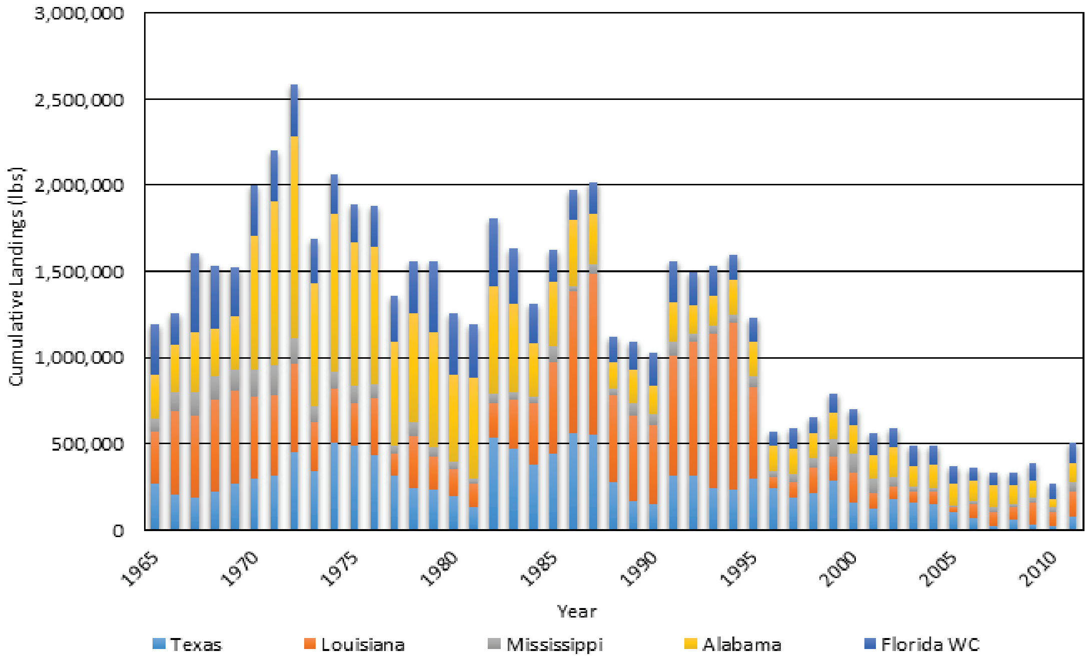


Figure 6.1 Total commercial flounder (flatfish) landings (lbs) by state from 1965-2011 (NOAA personal communication). Combines Gulf and southern flounder plus any other 'flatfish' species in the NOAA database.

Florida (West Coast)

Commercial harvesters are required to have a Saltwater Products License (SPL; Florida's commercial fishing license) and a Restricted Species (RS) endorsement to commercially harvest or sell flounder in Florida and must sell to a state licensed wholesale dealer. Florida wholesale dealers are required to report the purchase of saltwater products from commercial harvesters to the Florida Fish and Wildlife Conservation Commission (FWC) using the Marine Fisheries Information System (MFIS; Trip Ticket Program). The MFIS was implemented in 1984 and became the sole source of Florida's commercial fisheries statistics in 1986 (Murphy et al. 1994).

Figure 6.2 shows the trend for the number of RS endorsements held by Florida fishermen statewide for calendar years 1991 through 2011. The number of RS endorsement holders has generally declined since 1991. One possible contributing factor for the overall decline in RS endorsements may be the stricter policies that have been enacted in some Florida fisheries (e.g., blue crab) that limit the number of participants in the fishery, hence fewer RS endorsements are being used throughout Florida.

Identification of flounders at the species level in the Florida commercial landings data is not reliable due to several factors including misidentification. However, based on FWC's MFIS database and commercial port sampler data, the majority of Florida West Coast landings of flounder are Gulf flounder harvested from inland (i.e. bays and sounds) and offshore waters (Bradshaw personal communication) (Figures 6.3A, 6.3B, and 6.3C). Generally, commercial landings of flounder in Florida have been higher on the Atlantic Coast, than on the Florida West Coast. Atlantic Coast annual landings averaged 266,393 lbs compared to 175,247 lbs on the Florida West Coast between 1986 and 1995 (FWC 2012). The Net Limitation Amendment to the Florida Constitution, implemented in 1995, banned the use of entangling nets in state waters and limited the use of all nets in nearshore waters to no more than 500 square feet. In 1996, the minimum size limit for flounders increased from 11 to 12 inches for all harvesters and a daily incidental bycatch limit of 50 lbs was implemented for vessels harvesting flounder using gears not allowed for use in the directed fishery (such as shrimp trawls). These actions contributed to declines in commercial flounder landings on both coasts. Average annual landings on the Atlantic Coast decreased

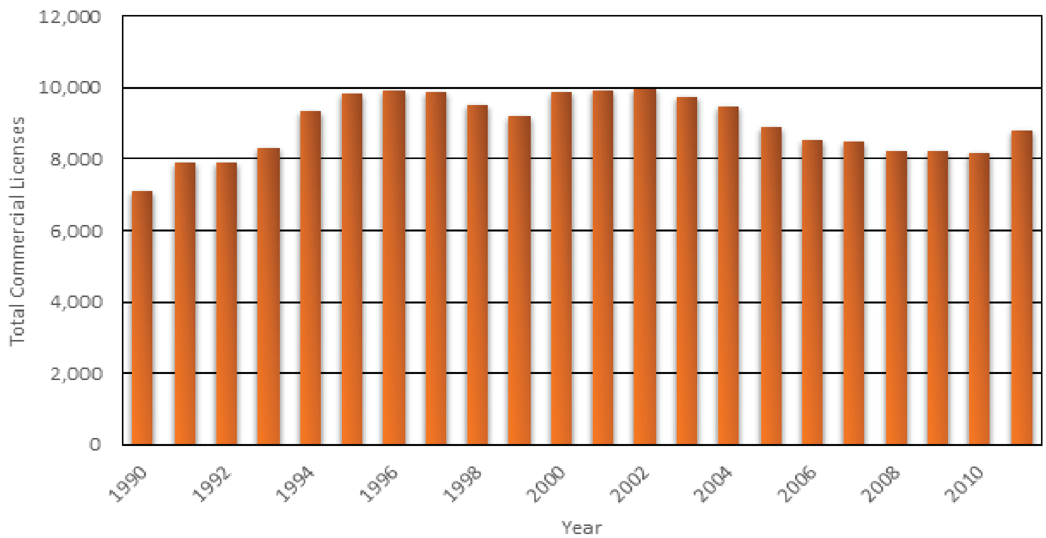


Figure 6.2 Annual resident and nonresident RS endorsements held by commercial fishermen in Florida which allow harvest of flounder from 1991-2011 (FWC/FWRI unpublished data).

to 163,858 lbs, and average annual landings on the Florida West Coast decreased to 100,271 lbs for the period of 1996-2011 (Figure 6.4) (FWC 2012).

Flounder commercial landings from the Florida West Coast remained fairly stable between 1965 and 1984, averaging 275,000 lbs/year (Table 6.1), before beginning to decline in 1985 to 184,844 lbs (Murphy et al. 1994) through to 1995 when 136,183 lbs were landed (FWC 2012). The Net Limitation Amendment of 1995 and the regulatory changes of 1996 further reduced commercial flounder landings on the Florida West coast, which fell below 100,000 lbs in 1996. From 1997 through 2011, annual landings stabilized once again, averaging 100,271 lbs (Table 6.1 and Figure 6.4).

Commercial fishing effort on the Florida West Coast steadily increased between 1986 and 1991, peaking at 19,548 trips in 1991 (FWC 2012). The number of trips declined steadily beginning in 1992, bottoming out at 1,525 trips in 2007, but increased to over 2,000 trips from 2009 through 2011 (Figure 6.4). The lowest landings (1965-2011) and effort (1986-2011) for the Gulf Coast were reported in 2007, with 70,239 lbs and 1,525 trips, respectively (Figures 6.4).

In the last decade (2000-2011), Florida commercial flounder landings and effort peaked in spring and were lowest in winter (FWC 2012; Table 6.2 and Figure 6.5). In 2010, Florida had record setting low temperatures from January through March. Thus, flounder landings and trips hit record lows during these three months (Tables 6.2 and 6.3, and Figure 6.5).

The Florida panhandle dominated commercial flounder landings on the Florida West Coast over the last decade (2000-2011). Franklin County accounted for 37% of the overall Florida West Coast landings followed by Bay County (18%) and Escambia County (17%) (Figure 6.6). All other Florida West Coast counties landed less than 6,000 lbs per year on average, while Franklin County landed an average of 36,668 lbs annually (Figure 6.6). Franklin County averaged the greatest number of trips per year at 493 followed by Bay County averaging 351 (Figure 6.7). Lee County averaged the third greatest number of trips per year at 297 though they only landed 1% of the average total landings for the Florida West Coast (FWC 2012).

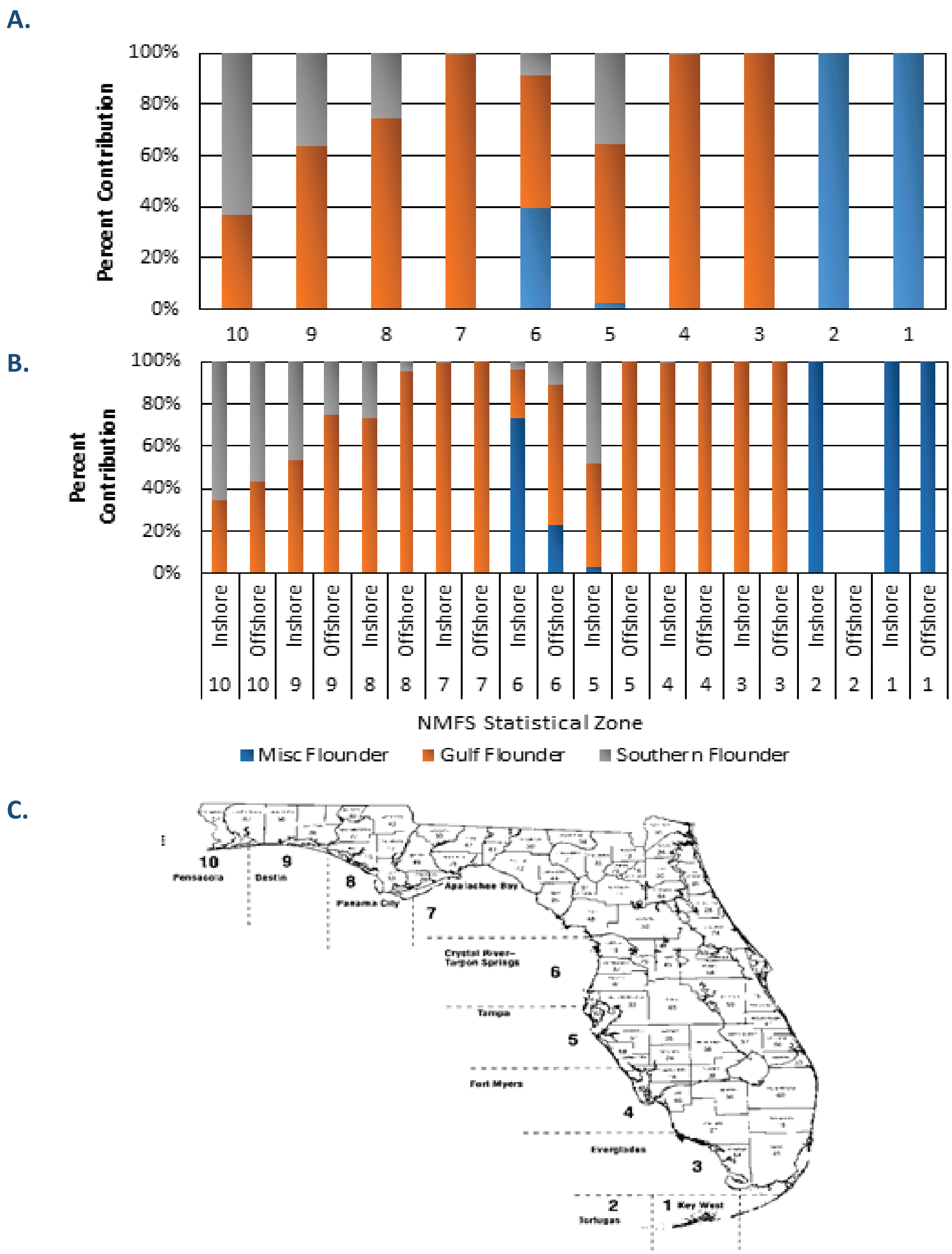


Figure 6.3 Total proportion (A.) of flounder species landed (B.) inshore and offshore in NMFS Statistical Zones (West to South) pictured in (C.) on the Florida West coast from 2007-2011. Misc. flounder are flounder reported on trip tickets that were not identified to species. Inshore encompasses inland areas such as bays and sounds, offshore encompasses waters adjacent to the shoreline and federal waters (Bradshaw personal communication; FWC/FWRI unpublished data).

Tables 6.4 and 6.5 provide landings and effort for flounder caught on Florida's west coast with various gear types. The most common gears used between 1991 and 1995, when the Net Limitation Amendment went into effect, were gig/spears, gill/trammel nets, trawls, and hook and line. The 'missing' category represents trip tickets that omitted reporting the gear type used and was a common problem in the early 1990s but declined through the mid-2000s. Since 2005, fishermen have consistently reported their gear type on their trip tickets (Table 6.4).

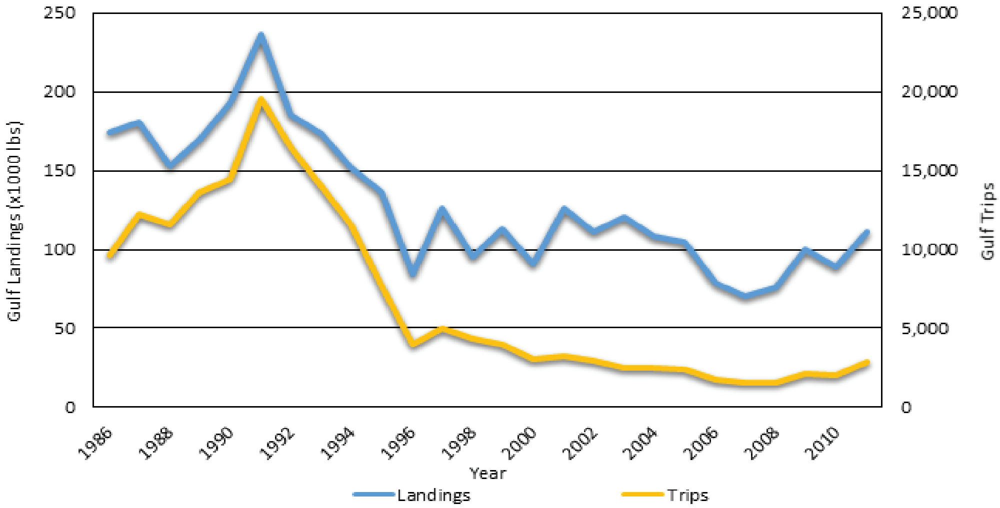


Figure 6.4. Florida (West Coast) commercial flounder landings and trips 1986-2011 (FWC/FWRI unpublished data).

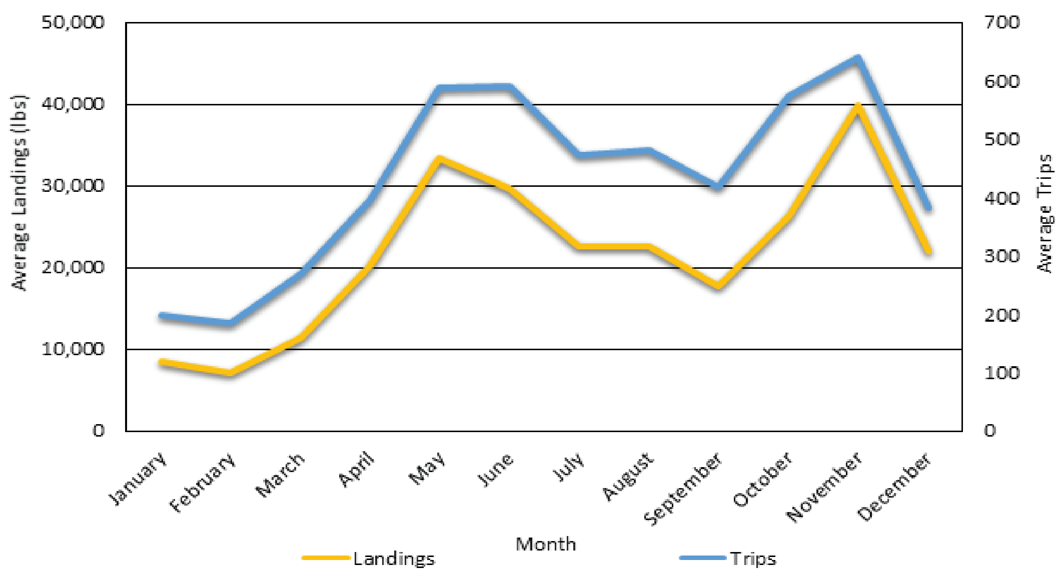


Figure 6.5 Monthly average Florida (statewide) commercial flounder landings (lbs) and trips that landed flounder 2000-2011 (FWC/FWRI unpublished data).

Florida's 1995 Net Limitation Amendment made any gill or entangling net and any net with a mesh area greater than 500 square feet illegal to use in state inshore and nearshore waters, which encompasses Florida West Coast waters seaward through the first three miles of the nine miles of state waters. Florida West Coast flounder landings reflect a shift in gears from newly restricted gears to legal gears such as gigs, spears, and cast nets. Annual gill/trammel net landings on Florida's west coast (1991-2011) peaked in 1992 at 67,264 lbs before declining to 19,489 lbs in 1995 when the Net Limitation Amendment went into effect (Table 6.4). In 1996, Florida's west coast landings by gill/trammel nets dropped to 151 lbs and have remained under 100 lbs since 2001 (entangling nets are legal in federal waters and flounder caught with gill nets from federal waters may be landed and sold in Florida as long as the boat transits state waters in a direct and continuous manner and the nets are properly stowed). Concurrently, the landings by cast nets and gig/spears on Florida's west coast increased in 1995. Cast net annual landings averaged 165 lbs between 1991 and 1994, and then rose sharply to 1,225 lbs in 1995; 4,730 lbs in 1996, and 8,380 lbs in 1997. Annual cast net landings leveled off on the Florida West Coast in the last decade (2000-2011)

Table 6.2 Florida monthly commercial flounder landings (lbs) 2000-2011 (FWC/FWRI unpublished data).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2000	12,655	8,060	11,872	17,404	38,321	26,124	21,245	20,343	14,057	37,192	61,891	19,613
2001	6,122	8,305	14,903	19,905	30,668	22,873	16,342	19,293	27,149	32,315	41,541	26,942
2002	12,980	8,439	13,166	23,027	38,948	26,591	19,974	17,233	13,602	24,372	50,632	24,582
2003	4,101	6,289	11,593	26,810	36,762	24,249	20,247	21,037	24,645	23,488	36,822	20,966
2004	9,630	6,281	14,276	22,561	39,373	32,839	29,798	22,747	11,953	31,335	36,173	30,525
2005	4,776	4,516	12,435	13,779	33,587	34,003	35,640	34,346	25,069	20,910	33,614	15,507
2006	5,933	6,629	7,880	17,199	34,733	33,113	24,530	17,552	15,377	29,784	47,960	19,873
2007	8,208	7,963	12,960	24,110	30,019	24,720	17,125	22,126	16,100	17,431	37,658	36,086
2008	17,859	10,992	9,228	12,693	28,642	29,125	16,134	14,686	11,421	20,108	32,401	12,402
2009	8,901	5,327	9,857	15,614	23,447	27,064	21,918	23,217	16,329	23,011	20,222	9,721
2010	1,332	1,890	3,263	19,878	24,764	32,036	19,387	16,523	18,675	21,558	19,556	13,909
2011	9,490	10,932	14,539	28,637	41,096	43,633	28,173	41,723	16,948	34,169	59,567	34,059

Table 6.3 Florida monthly commercial flounder trips 2000-2011 (FWC/FWRI unpublished data).

Year	January	February	March	April	May	June	July	August	September	October	November	December
2000	323	327	501	528	741	650	476	618	548	801	933	429
2001	237	253	350	476	633	658	555	546	586	714	767	494
2002	291	254	308	511	699	578	475	476	456	609	790	435
2003	178	192	261	484	764	578	464	497	480	582	635	403
2004	219	168	310	418	693	660	548	461	252	478	594	415
2005	164	154	259	294	595	611	558	606	466	485	554	302
2006	159	144	185	289	493	580	441	409	357	558	627	323
2007	199	183	250	342	439	506	416	486	372	450	622	504
2008	185	165	187	237	437	517	413	338	291	481	510	233
2009	161	106	194	303	389	500	482	472	379	537	414	291
2010	73	88	127	356	514	527	355	347	363	517	496	296
2011	175	175	297	496	650	734	500	514	466	676	723	465

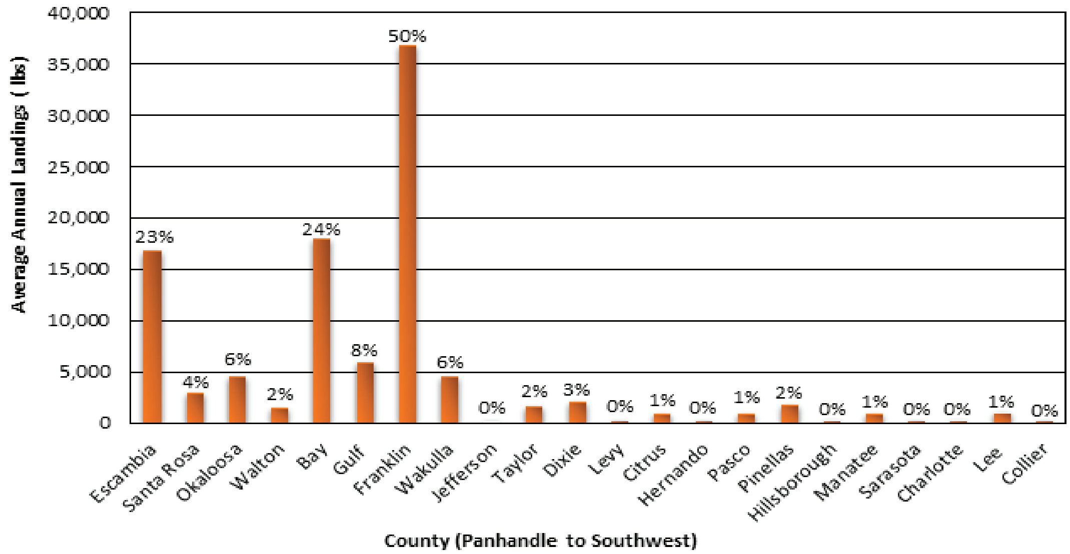


Figure 6.6 Average commercial flounder landings and percent contribution for Florida's west coast counties 2000-2011 (FWC/FWRI unpublished data).

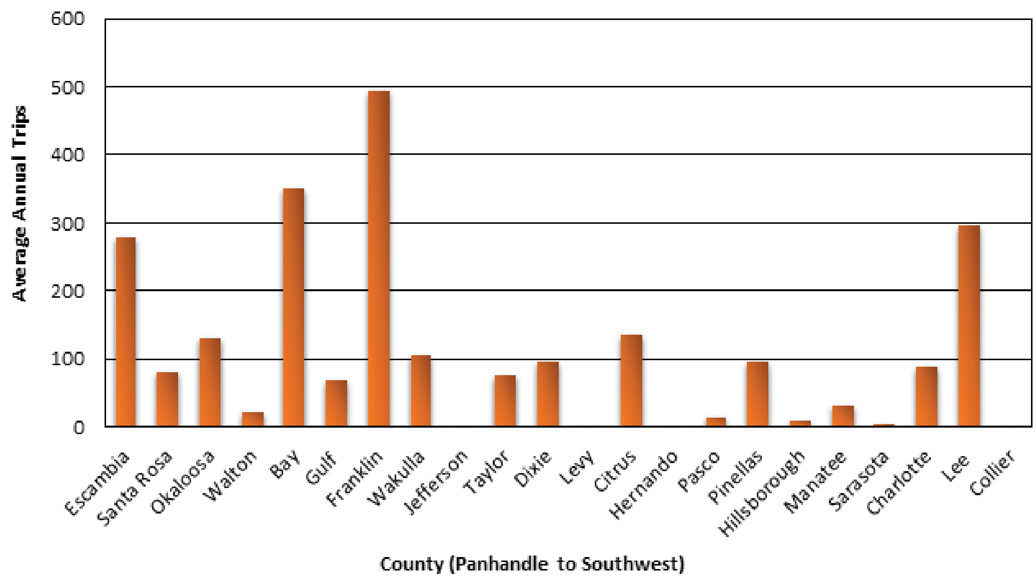


Figure 6.7 Average commercial trips taken in Florida's west coast counties that landed flounder 2000-2011 (FWC/FWRI unpublished data).

averaging 3,000 lbs. Florida West Coast gig/spear annual landings averaged 31,055 lbs from 1991 to 1994 then increased to 68,510 lbs in 1995 and have averaged 67,677 lbs since then. In 2011, 90,542 lbs of flounder were landed on Florida's west coast by gig/spears. Landings by trawl gear increased nearly twofold in the early 1990s on Florida's west coast, increasing from 15,868 lbs in 1991 to 30,708 lbs in 1992 and remained high until 1995, before falling to 17,150 lbs in 1996. Landings on the Florida West Coast by trawl gear peaked again in 2001 at 28,138 lbs, but steadily declined through 2011 when only 2,748 lbs were landed (FWC 2012). Turtle excluder devices (TED) and bycatch reduction devices (BRD) are required in all shrimp trawls fishing in the Exclusive Economic Zone (EEZ) of the Gulf of Mexico or in Florida state waters. The design of these devices have become more efficient at excluding larger flounder from shrimp trawls and the enforcement of these devices has increased over the past decade which may be a contributing factor to the drastic decrease in flounder landings from 2001 to 2011 (Thomas personal communication). Longline gear was prohibited in Florida state waters in 1993 which is reflected by a decrease in flounder landings from this gear on the Florida West Coast from 7,362 lbs in 1993 to 382 lbs

Table 6.4 Total landings (lbs) for Florida's west coast 1991-2011 for all flounder species combined (FWC/FWRI unpublished data, Bradshaw personal communication). Scuba/Tropicals category includes all underwater methods of take (i.e. hand nets, marine life collectors, etc.) other than spearfishing which is included in the gig/spear category.

Year	Gear Type												
	Gig/ Spear	Gill/ Trammel Net	Trawls	Hook and Line	Scuba/ Tropicals	Traps	Longline	Cast Net	Beach/ Haul Seine	Purse/ Lampara Net	Missing	Other	Total
1991	17,089	51,656	15,868	11,059	1,694	3,091	7,356	65	4,091	143	123,788	0	235,900
1992	30,790	67,264	30,708	12,806	2,854	2,254	1,495	128	61	0	36,882	0	185,242
1993	37,935	57,360	28,872	11,537	7,633	7,750	7,362	274	562	2	13,865	0	173,152
1994	38,407	49,902	32,992	14,098	6,794	3,641	382	191	73	153	5,602	0	152,235
1995	68,510	19,489	24,091	10,325	711	5,638	645	1,225	640	5	4,904	0	136,183
1996	44,252	151	17,150	7,427	5,211	3,202	20	4,730	56	0	1,768	0	83,967
1997	67,698	153	18,418	19,017	4,704	3,098	491	8,380	971	2	2,646	0	125,578
1998	49,079	546	19,839	10,412	2,457	2,620	57	4,409	1,337	49	4,557	3	95,365
1999	65,154	456	17,896	7,988	7,640	2,418	67	6,309	1,177	17	3,729	5	112,856
2000	58,734	120	9,313	5,675	8,235	2,461	162	3,888	295	1	2,206	0	91,090
2001	73,210	80	28,138	9,842	6,698	2,642	37	4,115	310	1	790	0	125,862
2002	76,095	40	15,669	6,341	4,828	4,114	243	3,944	288	6	0	0	111,568
2003	88,991	12	12,027	7,785	5,087	3,494	87	2,116	141	3	231	0	119,973
2004	75,010	2	20,831	4,636	2,980	1,514	328	2,380	294	3	160	0	108,138
2005	83,682	6	8,528	4,944	2,755	1,867	40	2,256	290	0	0	0	104,367
2006	62,234	7	4,686	4,540	3,521	1,399	54	1,942	137	0	0	0	78,519
2007	50,713	9	4,914	4,062	4,343	2,704	32	2,916	307	0	0	241	70,239
2008	55,203	8	3,998	7,524	4,208	2,024	26	2,962	173	1	0	0	76,126
2009	72,498	48	3,965	11,400	4,299	5,079	0	2,560	230	2	0	0	100,083
2010	69,737	0	3,289	7,906	1,555	4,952	92	1,419	253	1	0	37	89,241
2011	90,542	57	2,748	4,901	96	8,942	264	3,141	679	0	0	0	111,370

Table 6.5 Total number of trips for Florida's west coast 1991-2011 for all flounder species combined (FWC/FWRI unpublished data, Bradshaw personal communication). Scuba/Tropicals category includes all underwater methods of take (i.e. hand nets, marine life collectors, etc.) other than spearfishing which is included in the gig/spear category.

Year	Gear Type												
	Gig/ Spear	Gill/ Trammel Net	Trawls	Hook and Line	Scuba/ Tropicals	Traps	Longline	Cast Net	Beach/ Haul Seine	Purse/ Lampara Net	Missing	Other	Total
1991	346	6,991	943	391	37	486	7	7	54	23	10,263	0	19,548
1992	482	11,521	1,456	473	50	431	8	31	23	0	2,056	0	16,531
1993	643	9,906	1,524	582	85	653	11	26	14	1	512	0	13,957
1994	553	7,747	1,758	525	81	653	10	25	16	3	164	0	11,535
1995	919	2,744	1,785	618	26	1,125	7	233	39	2	153	0	7,651
1996	606	61	1,552	438	45	581	9	614	2	0	44	0	3,952
1997	1,022	50	1,616	485	31	644	4	934	139	1	56	0	4,982
1998	752	158	1,213	490	30	607	8	809	192	18	93	1	4,371
1999	971	76	935	498	86	398	5	730	175	9	86	1	3,970
2000	915	57	716	329	73	347	8	494	67	1	49	0	3,056
2001	993	19	717	487	81	301	11	561	65	1	23	0	3,259
2002	1,106	19	477	291	66	394	12	504	98	1	0	0	2,968
2003	1,110	8	371	321	64	240	17	289	65	2	1	0	2,488
2004	1,097	1	459	195	54	306	25	292	98	2	2	0	2,531
2005	1,074	4	398	200	37	355	6	261	71	0	0	0	2,406
2006	870	2	144	134	40	222	8	271	51	0	0	0	1,742
2007	692	3	153	141	44	138	4	285	59	0	0	6	1,525
2008	844	2	148	213	34	79	5	177	82	1	0	0	1,585
2009	1,068	2	154	316	34	252	0	228	87	1	0	0	2,142
2010	1,051	0	130	269	20	309	3	193	81	1	0	1	2,058
2011	1,382	7	103	191	5	586	2	459	112	0	0	0	2,847

Table 6.6 Annual landings (X1000 lbs) of flounder (flatfish) in Alabama waters by gear from 1991-2011 (NOAA personal communication) (--- indicates no reported gear landings).

Year	Entanglement Nets (combined)	Spears	Trawls, Combined	Other Gear
1991	65.6	11.4	151.8	---
1992	59.8	7.0	103.3	---
1993	93.3	9.2	62.5	---
1994	76.7	10.4	99.3	---
1995	89.5	21.0	89.1	---
1996	93.5	19.4	29.9	---
1997	87.4	28.6	27.0	---
1998	99.8	22.2	22.9	---
1999	102.8	26.6	24.9	0.1
2000	124.2	7.3	27.9	0.1
2001	109.4	---	12.8	0.1
2002	130.2	23.3	13.6	5.8
2003	90.9	12.4	10.9	2.5
2004	84.7	26.5	15.2	6.7
2005	78.0	35.3	6.7	1.4
2006	84.9	21.7	5.6	3.0
2007	111.7	12.7	7.8	0.3
2008	85.5	9.5	10.2	1.0
2009	76.8	6.8	10.9	1.9
2010	30.6	13.4	2.6	0.7
2011	82.7	15.1	9.2	3.5

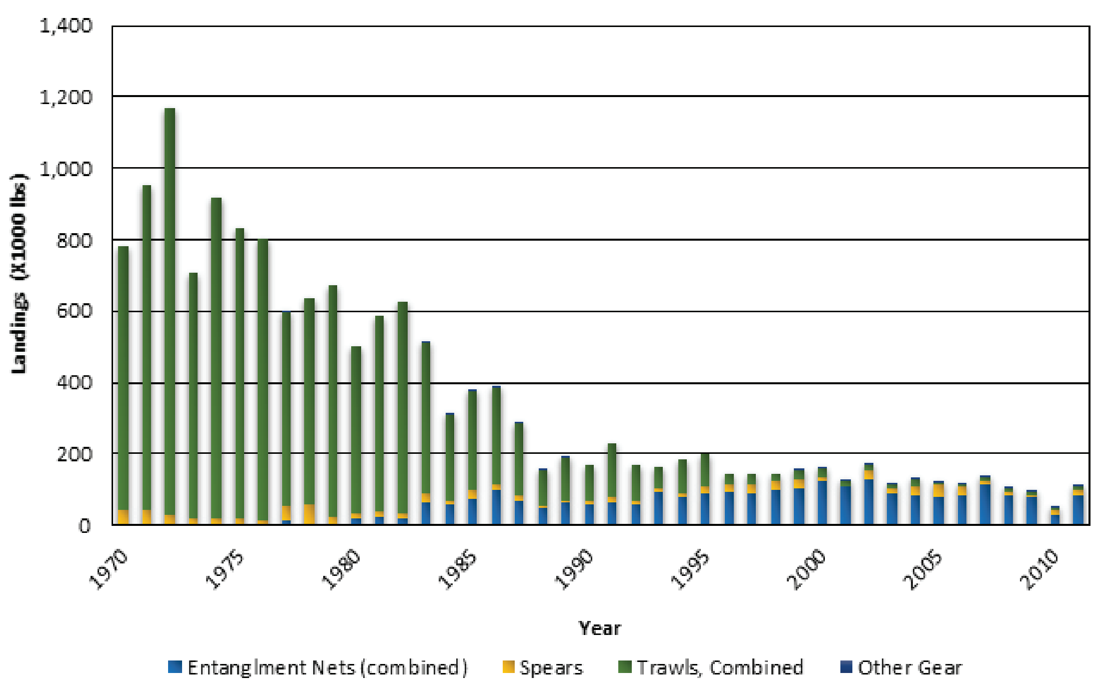


Figure 6.8 Total cumulative annual commercial flounder (flatfish) landings (lbs) by gear in Alabama from 1970-2011 (NOAA personal communication).

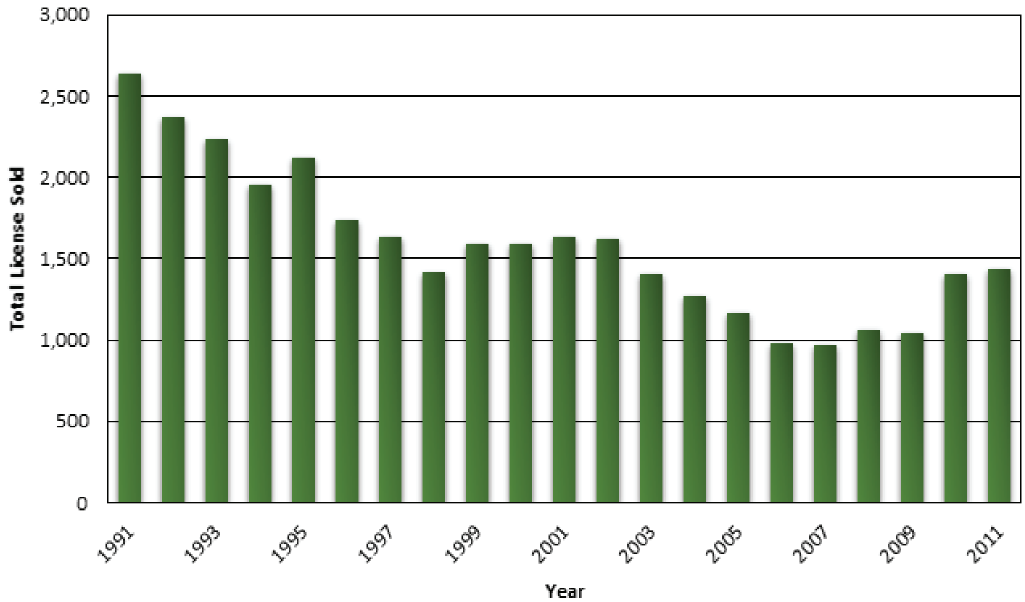


Figure 6.9 Annual commercial resident and nonresident license sales in Alabama which allow harvest of flounder from 1991-2011 (ADCNR unpublished data).

in 1994. Since 1994, landings with longlines have remained low (longlines are legal in federal waters; the same transit provision for entangling nets is in place for longlines enabling commercial fishermen who legally caught flounder in federal waters by longline gear to land and sell those flounder in the state of Florida) (FWC 2012; Table 6.4).

Alabama

The minimum size for commercially caught flounder is 12 inches. A summary of commercial landings in Alabama is provided in Table 6.1 and Figure 6.1. It should be noted that landings for Alabama are not broken down into individual species and are lumped as 'flatfish'. Swingle (1976) reported more than 95% of the flounder harvested in Alabama were caught in shrimp trawls offshore, 4-5% were taken with gigs and spears, and only a negligible amount was caught in gill and trammel nets (Table 6.6 and Figure 6.8). Overall landings of flounder declined steadily from the early 1970s to the late 1980s as trawls landed fewer flounder commercially.

Despite the closure to nets on the south shore of Bon Secour Bay in 1988, the entanglement net landings (gill and trammel) have made up the majority of the landings since the mid-1990s when trawl landings became almost negligible. Gig/spear landings have remained relatively steady over the 40 years of landings presented in Figure 6.8. From 1991 to present, gig/spear landings have averaged around 170,000 lbs annually, although there is a wide fluctuation around the mean.

Participation in the flounder fishery is difficult to determine since there is not a specific endorsement for flounder. However, general license sales which allow for the commercial harvest of flounder has declined since 1991 (Figure 6.9). Around 2,600 resident and non-resident licenses were sold in 1991, dropping to 969 licenses in 2007, the year the lowest number of licenses were sold (Table 6.7). License sales did not change much through 2009, but jumped by about 400 additional licenses in 2010 and 2011 to just over 1,400 total.

Table 6.7 Total commercial license sales (resident and non-resident) in Alabama from 1991-2011 (ADCNR unpublished data).

Year	License			
	Shrimp	Gill Net	Hook & Line	Total
1991	1,974	579	84	2,637
1992	1,690	556	119	2,365
1993	1,576	542	112	2,230
1994	1,303	582	71	1,956
1995	1,423	638	60	2,121
1996	1,443	206	88	1,737
1997	1,366	199	69	1,634
1998	1,190	172	50	1,412
1999	1,382	147	62	1,591
2000	1,387	145	64	1,596
2001	1,390	156	83	1,629
2002	1,350	153	120	1,623
2003	1,166	139	103	1,408
2004	1,029	130	112	1,271
2005	942	126	97	1,165
2006	782	113	85	980
2007	748	119	102	969
2008	793	141	130	1,064
2009	697	128	214	1,039
2010	907	86	412	1,405
2011	927	84	429	1,440

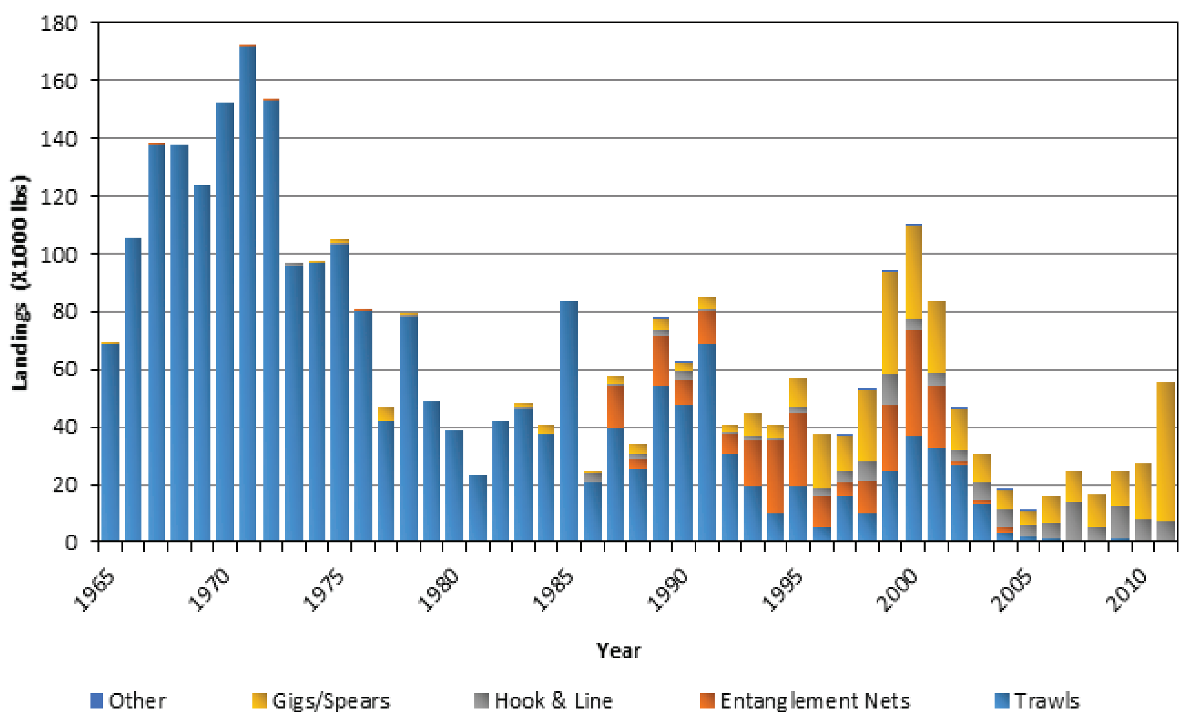


Figure 6.10 Mississippi commercial flounder landings (lbs) from 1965-2011 for flounder (NOAA personal communication).

Mississippi

The commercial harvest of flounder in Mississippi has traditionally been as bycatch in the shrimp trawl fishery. Southern flounder is the predominate species of flounder landed in Mississippi. Landings information (collected by port agents from local seafood dealers) is not collected by species; Gulf flounder do occur in Mississippi but not in large numbers. Total landings in Mississippi have fluctuated from a high of 172,000 lbs in 1971 to a low of 10,445 lbs in 2005 (Table 6.1 and Figure 6.10). From 2000 to 2011 landings averaged approximately 38,000 lbs per year. From 2000-2005 landings declined steadily. This was due to further reduction of the entanglement fishery and the implementation of the commercial quota; however, from 2006-2011 landings have increased each year due to the increase in the gig fishery. This could be attributed to commercial seasonal closures of other species such as spotted seatrout (*Cynoscion nebulosus*) and red drum (*Sciaenops ocellatus*). Although the majority of flounder harvested from 1988-2011 were caught in shrimp trawls (40%), the percentage has declined dramatically from 81% in 1991 to less than 1% in 2011. During this same time period, gigging totals rose from 5% in 1991 to 86% in 2011 (Table 6.8 and Figure 6.10). A federal law implemented in December 1992 required most shrimp vessels fishing in the EEZ and state waters to have turtle excluder devices (TEDs) installed in their nets. Use of TEDs in shrimp trawls is one possible explanation for the reduced number of flounder landed as bycatch. According to Burrage (1997), the mean finfish exclusion rates of five TEDs tested ranged from 7.33% to 43.56%. In May 1998, a law which requires bycatch reduction devices (BRDs) be installed in

Table 6.8 Total commercial flounder landings (lbs) in Mississippi by gear, 1988-2011 (NOAA personal communication).

Year	Trawls	Entanglement Nets	Hook & Line	Gigs/Spears	Other	Totals
1988	25,197	3,821	1,567	3,494	0	34,079
1989	54,093	17,551	2,038	4,130	2	77,814
1990	47,126	8,716	3,903	2,709	22	62,476
1991	69,126	10,787	1,062	4,052	0	85,027
1992	31,022	6,084	1,108	2,305	0	40,519
1993	19,161	16,305	1,171	8,133	0	44,770
1994	9,963	25,493	421	4,876	0	40,753
1995	19,610	25,333	2,151	9,853	0	56,947
1996	5,422	10,910	2,313	18,590	0	37,235
1997	15,813	4,816	4,327	12,104	508	37,568
1998	9,874	11,801	6,170	25,264	422	53,531
1999	24,642	22,477	11,088	35,138	45	93,390
2000	36,882	36,773	4,163	31,697	92	109,607
2001	32,970	21,052	4,758	25,013	0	83,793
2002	26,469	1,893	3,765	14,229	50	46,406
2003	13,284	1,431	6,068	10,139	0	30,922
2004	3,393	1,649	6,602	6,443	99	18,186
2005	1,663	85	4,275	4,419	3	10,445
2006	1,133	2	5,690	9,225	0	16,050
2007	649	0	13,053	10,841	0	24,543
2008	886	0	4,246	11,661	0	16,793
2009	1,538	0	10,811	12,346	0	24,695
2010	267	0	7,774	19,524	0	27,565
2011	189	11	7,367	47,634	0	55,201

shrimp trawls was enacted for all waters of the EEZ. Although not currently required in state waters, this device could further decrease flounder catches.

On January 1, 1997, a regulation was instituted requiring that all gill and trammel nets used in state waters must be constructed of a degradable material (currently cotton or linen). The definition of degradable material as specified in the ordinance is a material which after one year of immersion in water loses at least 50% of its tensile strength. There is very limited availability of cotton or linen entanglement nets, and this regulation has greatly reduced the number of commercial net fishermen in Mississippi from 222 in 1988 to 37 in 1997 (Table 6.9). The overall use and availability of legal gill and trammel nets are steadily decreasing in the state with only five registered gillnets on file (MDMR unpublished data). However, net license sales have been on the increase because cast-netting for fish in Mississippi waters requires the same license. Gill and trammel nets have accounted for an average of 15% of the flounder landed in Mississippi since 1999. The requirement for a degradable material has resulted in a change in the types of gear used to harvest flounder, and as such, the use of gigs to harvest flounder has been increasing, with a 13-year average (1999 and 2011) of 43% of the flounder landed in Mississippi being

Table 6.9 Number of Mississippi resident commercial license issued by gear from 1987-2011 (MDMR unpublished data). Mississippi commercial license year is May 1 through April 30 of the following year. NA indicates the license was not available. 'Shrimp Trawl' includes cumulative total of all vessel size licenses. All nets includes gill, trammel, haul seine, and cast nets.

Year	Shrimp Trawl	All Nets	Commercial Hook & Line/Gig	Total
1986	1,677	153	NA	1,830
1987	1,853	194	NA	2,047
1988	2,093	213	NA	2,306
1989	2,014	222	NA	2,236
1990	1,810	185	51	2,046
1991	1,520	182	89	1,791
1992	1,349	190	64	1,603
1993	1,334	233	73	1,640
1994	1,185	220	86	1,491
1995	1,181	168	90	1,439
1996	1,098	58	85	1,241
1997	1,038	37	103	1,178
1998	1,031	57	86	1,174
1999	980	57	90	1,127
2000	1,069	170	62	1,301
2001	1,101	181	37	1,319
2002	1,000	204	63	1,267
2003	673	183	55	911
2004	591	152	35	778
2005	412	104	69	585
2006	457	137	109	703
2007	511	133	138	782
2008	457	153	195	805
2009	647	163	408	1,218
2010	545	145	312	1,002
2011	483	154	246	883

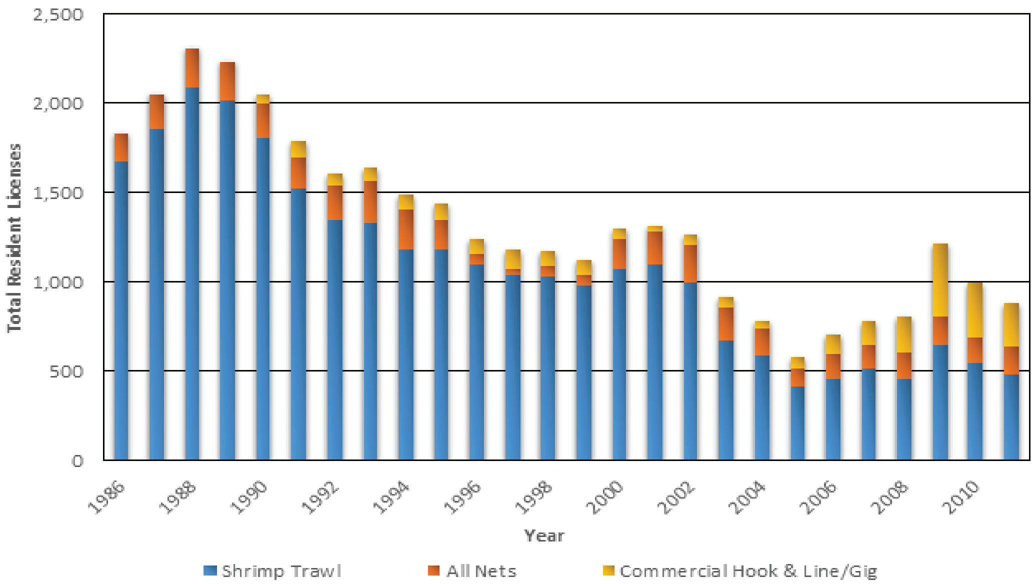


Figure 6.11 Annual Mississippi resident commercial license sales from 1987-2011. 'Shrimp Trawl' includes cumulative total of all vessel size licenses. 'All nets' includes gill, trammel, haul seine, and cast nets (MDMR unpublished data).

gigged. Mississippi does not require a specific license for gigs, and there is no information as to the number of commercial gig fishermen in the state, however beginning on July 1, 2001 gigging was added to the commercial hook and line license by Mississippi State Statute §Title 49, Chapter 15, Section 80. The percentage of flounder caught by commercial hook and line fishermen in Mississippi have increased over the last 13 years and now account for 16% of the total harvest. This trend can be seen in the total number of license sold each year (Figure 6.11).

Louisiana

Commercial flounder landings in Louisiana are primarily southern flounder and were relatively stable from 1965-1984. Beginning in 1985, Louisiana led the Gulf states in total commercial landings for flounder through 1995, when a ban on entangling nets was enacted (Table 6.1). Since the 1995 ban on entangling nets in Louisiana, commercial landings of flounder have averaged approximately 91,000 lbs. Southern flounder landings have been relatively stable since 2001 after a small increase during the late 1990s. An increase in 2011 is most likely the result of increased landings from trawls. In Louisiana, during the 12-year period from 2000-2011, an average of 82.5% of flounders were landed from trawls, skimmer nets, or butterfly nets (Table 6.10 and Figure 6.12). Flounder landings bottomed out in 2005 following the impacts associated with Hurricanes Katrina and Rita primarily due to damages to boats, infrastructure, and the associated debris on the fishing grounds hampering the ability to commercially fish at all.

In a Louisiana diel trawling study, Dugas (1975) found 89% of southern flounder were caught at night. Based on a tank study conducted by Dugas (1975), southern flounder were more active at night and as a result more vulnerable to trawling activity. Flounder caught in shrimp trawls are normally part of the incidental catch and are rarely targeted by trawlers. During the 12-year period from 2000-2011, shrimp trawls accounted for 42.6% of Louisiana commercial flounder landings, while all trawl, butterfly, and skimmer nets accounted for 82.5% of commercial landings during the same period (Table 6.10). However, in last five years, shrimp trawls have only averaged 24.1% of commercial flounder landings.

Historically, the commercial fishery for southern flounder in Louisiana has been an incidental catch fishery, especially during fall migrations towards the Gulf of Mexico (Adkins et al. 1998). Haul seines

Table 6.10 Total annual landings (lbs) of flounder in Louisiana by gear, 2000-2011 (NOAA personal communication).

Year	Butterfly Nets	Gill Nets[1]	Hand Lines	Fish Trawls	Shrimp Trawls	Fyke and Hoop Nets	Pots and Traps	Hydraulic or Electric Reels	Skimmer Trawls
2000	37,216	16540	23,197	1,382	76,529	16,639	4,674	73	0
2001	4,031	7851	5,905	1,475	60,013	9,705	1,120	20	0
2002	5,339	0	4,966	411	54,357	0	1,656	134	0
2003	12,390	0	5,473	190	43,377	0	1,419	35	0
2004	26,589	0	5,433	43	37,068	0	2,381	31	0
2005	0	0	3,430	0	9,681	1,480	1,177	12	2,185
2006	41,554	0	5,002	0	20,816	3,209	4,060	70	8,936
2007	23,911	0	6,500	0	15,521	0	5,317	0	24,879
2008	33,272	0	6,176	288	20,644	0	2,209	0	13,134
2009	20,426	0	2,898	2,842	33,891	0	3,714	0	13,328
2010	50,281	0	7,053	171	14,503	0	3,201	0	5,346
2011	79,421	0	24,486	470	16,732	0	4,422	0	22,682
Total Catch	32.56%	2.37%	9.79%	0.71%	39.25%	3.02%	3.44%	0.04%	8.81%

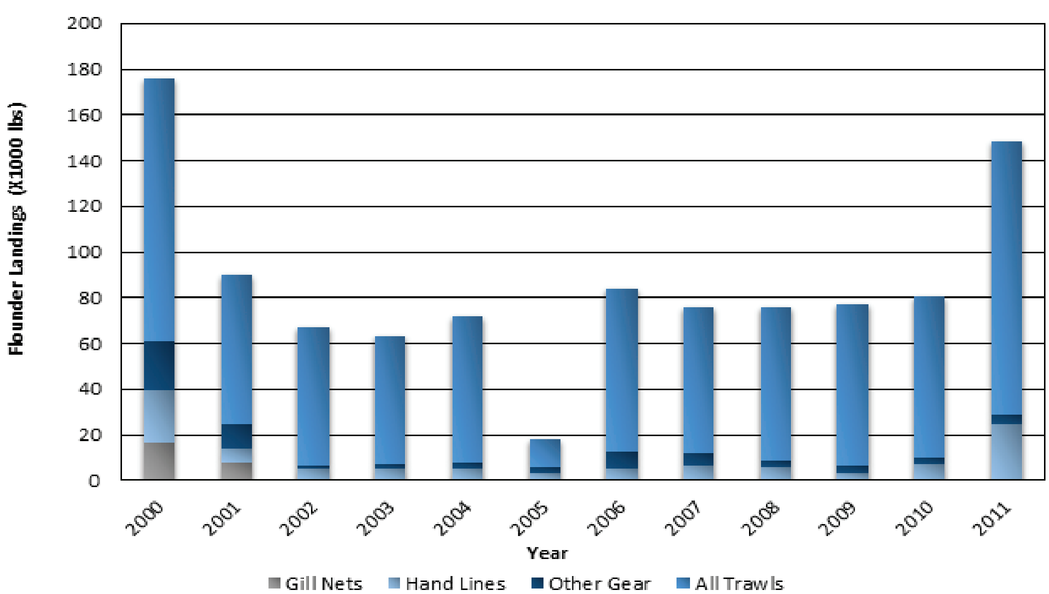


Figure 6.12 Total annual landings (lbs) of flounder in Louisiana by gear, 2000-2011 (NOAA personal communication).

and trammel nets were two other less important gear types used to commercially harvest flounders in Louisiana state waters prior to 1978. Haul seines were used in near offshore and inshore waters to surround schools of fish to be harvested and were also used in conjunction with spotter planes. They were usually deployed from small to medium-sized boats and normally targeted species such as black drum and sheepshead (Luquet et al. 1998). Trammel nets were utilized in other finfish fisheries such as those for spotted seatrout and black drum mainly during the cooler months in inshore waters and along beaches (Adkins et al. 1998). Haul seine and trammel net landings declined to zero by 1979, most likely due to factors such as the increased popularity of gill nets and trawling. Haul seines and trammel nets were included as 'entangling gear' and prohibited by the 1995 legislation described under gill nets. From 2000-2011, butterfly nets averaged 32.6% of the annual flounder harvest in Louisiana (Table 6.10). Butterfly nets, while mainly used to target shrimp, have been used to target flounder during the fall migrations of flounder (Adkins et al. 1998). Flounder catches peak during the fall; however Russell et al. (1986) reported that flounder did comprise a major component of the bycatch kept and sold from the commercial black drum gill net fishery in Louisiana from April - June. In 1987, gill nets accounted for 30.1% of the total flounder landings in Louisiana. Since gill nets were prohibited, the majority of flounder landed in Louisiana are now caught incidentally in commercial fisheries utilizing hand line and trawl gear, such as the black drum and shrimp fisheries. Louisiana's commercial flounder landings increased almost 200% in 2011 when compared to the average of the previous five years. Landings of flounder in 2011 noticeably increased from the skimmer trawl, butterfly net, and baited hand line gear categories. Increased flounder landings, for 2011, are most likely attributed to increased incidental landings from the commercial trawl fishery (Adriance personal communication). Trawl effort was not necessarily higher in 2011 but instead flounder, which in the past may have been kept for personal consumption by shrimpers and their families, may have been sold to provide extra income (Bourgeois personal communication).

Since 1988, a commercial gear license has been required for flounder gigs and spears in Louisiana as well as other legal gear types not previously requiring a license. No resident commercial flounder gig licenses were sold in 1989, and only 214 have been sold since 1989. The number of commercial licenses by gear sold to Louisiana commercial fishermen from 1980 through 2011 is shown in Table 6.11. In Louisiana, the majority of flounder landed commercially were harvested from inshore waters seaward to 5.6 km from shore (LDWF unpublished data).

Texas

Commercial flounder landings in Texas have declined over the last 39 years with a range of 560,300 lbs (1986) to 24,300 lbs (2007). Texas separates their landings based on two regions for which trawl licenses are sold: 'bay' waters are nearshore and 'Gulf of Mexico' refers to offshore trawling. Only four years (1974, 1982, 1986, and 1987) had more than 500,000 lbs of flounder landed (Table 6.1 and Figure 6.13). Bay landings represent the largest proportion of total commercial flounder landings over the last 39 years in Texas, ranging from 493,300 lbs in 1986 to 23,800 lbs in 2010. The offshore Gulf of Mexico landings represent a smaller portion of the total commercial flounder landings, with a range of 96,500 lbs in 1982 to 100 lbs. in 2010. Since the mid-1970s, offshore landings represented the highest proportion of total Texas flounder landings (43.3%) in 1990 (Figure 6.13).

A decline in flounder abundance, reduced effort, and regulatory measures account for the decline in commercial landings. The commercial ban on native red drum and spotted seatrout sales in 1981, the net ban and minimum size limits imposed in 1988, limited entry for shrimpers in 1995, and the bag and size limits in 1996 and 2010 coincide with the declines in 1981, 1988-1989, 1997, and 2010 (Table 6.1 and Figure 6.13). A redirected effort of the red drum and spotted seatrout commercial fishermen toward flounder is suggested by the increase in 1982 flounder landings. After the prohibition on sales of red drum and spotted seatrout (1981) and prior to the net ban (1988), total flounder landings for Texas averaged 473,000 lbs annually. Along with a change in size and bag limits and reduced fishing effort from declining license sales, the average flounder landings dropped 61% (average 290,000 lbs) from 1989-2010. Additional fluctuations may be due to market variations but are difficult to discern with the major regulatory changes that took place during this time period.

Prior to 1988, Texas had limited regulation on flounder harvest. Kenedy, Willacy, and Cameron counties had a 12-inch minimum size limit imposed in 1955. In 1988, Texas instituted a coast-wide net ban and a 12-inch minimum size limit on flounder. In 1996, the minimum size limit was increased to 14

Table 6.11 Number of resident commercial licenses issued from 1980-2011 in Louisiana (LDWF unpublished data). NA indicates license not available.

Year	Shrimp Trawl	Gill Net	Butterfly Net	Trammel Net	Set Lines	Haul Seine	Purse Seine	Gig
1980	16,307	1,602 [1]	NA	319	NA	445	0	NA
1981	19,280	1,786 [1]	NA	334	NA	425	4	NA
1982	19,648	2,552 [1]	NA	429	NA	472	18	NA
1983	19,163	2,780 [1]	NA	483	NA	596	40	NA
1984	17,843	2,252 [1]	123	414	NA	609	33	NA
1985	15,927	2,031 [1]	3,941	423	NA	442	34	NA
1986	16,308	2,116 [1]	5,094	377	NA	344	26	NA
1987	21,565	2,956 [1]	10,046	826	NA	247	71	NA
1988	20,582	2,492 [1]	9,812	605	NA	236	68	NA
1989	18,743	2,714 [1]	8,344	619	180	265	73	0
1990	16,735	2,566 [1]	8,140	594	1,055	257	71	9
1991	14,959	3,476 [1]	7,982	536	1,012	249	63	8
1992	13,866	2,029 [1]	4,746	493	995	218	53	9
1993	11,349	2,070 [1]	3,809	486	1,016	184	53	7
1994	10,231	1,823 [1]	3,294	489	1,053	196	58	8
1995	10,095	1,788 [2]	3,050	467	1,185	162	57	25
1996	9,847	2,089 [3]	2,776	NA	1,369	NA	54	14
1997	9,048	1,853 [3]	2,442	NA	1,456	NA	53	9
1998	9,182	1,372 [3]	2,473	NA	1,455	NA	59	7
1999	9,397	1,380 [3]	2,455	NA	1,577	NA	58	9
2000	9,591	1,368 [3]	2,566	NA	1,617	NA	49	10
2001	9,311	1,266 [3]	2,305	NA	1,605	NA	47	8
2002	8,767	1,163 [3]	1,991	NA	1,553	NA	44	8
2003	7,745	1,171 [3]	1,697	NA	1,420	NA	35	9
2004	6,642	1,071 [3]	1,464	NA	1,489	NA	33	10
2005	4,167	823 [3]	887	NA	1,420	NA	34	6
2006	4,860	875 [3]	1,156	NA	1,285	NA	33	7
2007	4,271	846 [3]	1,145	NA	1,221	NA	33	9
2008	3,755	779 [3]	1,105	NA	1,206	NA	32	8
2009	3,755	765 [3]	1,208	NA	1,376	NA	32	10
2010	3,831	695 [3]	1,253	NA	1,552	NA	31	10
2011	3,785	775 [3]	1,169	NA	1,768	NA	32	14

[1] Includes freshwater and saltwater gill net licenses from 1980 through 1994.
[2] Includes freshwater gill net, saltwater gill net, saltwater mullet strike net, and pompano strike net licenses.
[3] Includes freshwater gill net, saltwater mullet strike net and pompano strike net licenses.

inches with a 60-fish bag limit. Flounder captured with a commercial trawl were restricted to recreational limits of 10 bag/20 possession limit. In 2010, the commercial bag limit was reduced again to 30 bag/2 possession except on board a licensed commercial shrimp boat. The limit is five flounder per person with a current shrimp boat captain's license and is subject to the 50% bycatch rule that the number retained cannot exceed 50% by weight of shrimp. For the period November 1-30, flounder may be taken using hook and line only. Daily bag and possession limits during the period November 1-30 are two fish per person.

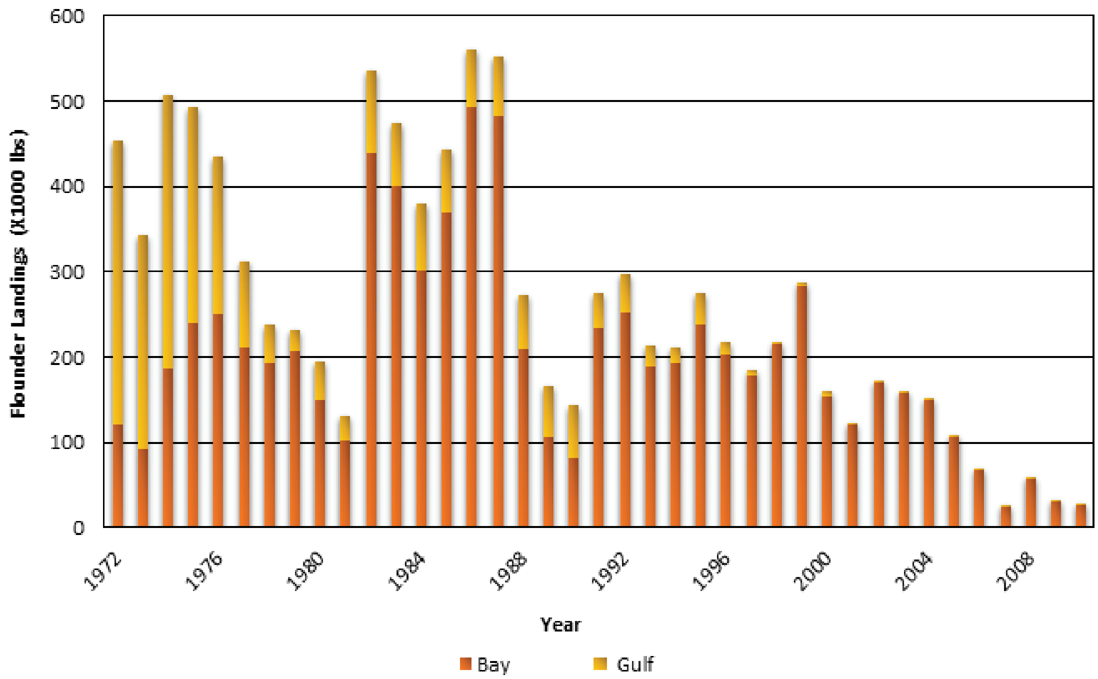


Figure 6.13 Texas commercial landings (lbs) for all flounder species and gears combined for Texas Bay systems and the Gulf of Mexico from 1972-2011 (TPWD unpublished data).

Commercial landings are reported as 'flounder', but at least 90% of these landings are southern flounder (TPWD unpublished data). It is also important to note that during a 1974-1975 study by Stokes (1977), 74% of the Texas commercial flounder catch consisted of age-2 and age-3 female southern flounder.

Prior to the net ban in 1988, commercial fishermen used a variety of entangling nets to target flounder during the fall and winter. Before 1984, nets with mesh greater than three inches were legal. After 1984, net mesh had to be greater than six inches. From 1980 to 1987, landings from legal nets were estimated to range from 56,000-384,400 lbs, and illegal net landings were estimated from 800-13,200 lbs (Weixelman et al. 1992). Currently, flounder are landed by commercial fishermen using a number of gears (i.e., shrimp trawls, trotlines, hook and line, and gig).

Flounder are sold primarily to fish markets, restaurants, or other retail outlets. Seventy percent of the commercial gig fishermen interviewed during a 1991 TPWD flounder gig study sold at least some of their catch to a fish house: 65% sold 95-100% of their catch and 5% sold 25% of their catch. The remaining 30% sold their catch to other retail outlets and may not have been reported. Commercial landings are underestimated because restaurant and other outlet purchases are not recorded on the Trip Ticket Program.

Several types of licenses allow commercial fishermen to land flounder in Texas. The commercial finfish fisherman's license is required for catches of finfish from coastal areas including harvest by gig and trotline. Other commercial licenses are specific to the gear types used (e.g., shrimp trawls) and whether vessels are used. The number of commercial licenses sold in Texas is shown in Table 6.12. No division was made to the general commercial fishing license until 1980, but this license was subdivided to include a commercial finfish license. The number of residential and nonresidential finfish licenses sold has declined since 1980. The highest and lowest number of licenses sold was 2,122 in 1981 and 254 in 2010. This decline followed the 1981 legislation banning native red drum and spotted seatrout sales. Even after

Table 6.12 Texas commercial license sales from 1980-2011 (TPWD unpublished data). Blanks indicate license was not available; N and R indicate nonresident and resident licenses respectively. All commercial netting was prohibited September 1988. Total annual sales are not additive due to multiple license holders. No division was made in the General license prior to 1980. Seine tags include both fresh and saltwater privileges.

Year	General		Finfish		Saltwater Trotline Tags	Seine Tags	Fishing Boat		Shrimp Trawl[1]	
	Res	Non	Res	Non			Res	Non	Res	Non
1980	19,660	2,291	1,989	46	16,866	13,971	1,504		9,996	
1981	14,205	3,581	1,678	444	17,947	9,510	1,254		11,230	
1982	13,427	3,870	632	16	16,702	8,096	787		11,228	
1983	13,591	4,775	670	31	15,943	8,498	1,095		11,747	
1984	12,357	5,503	452	11	9,323	6,325	1,100		11,261	
1985	11,244	5,352	466	28	7,818	7,164	917		10,531	
1986	10,803	1,742	486	46	8,318	7,184	947		10,060	
1987	10,885	1,725	479	24	8,849	6,528	1,042		8,799	
1988	10,429	1,348	596	20	9,841	7,264	1,233	68	7,599	548
1989	9,036	1,309	506	54	9,538	2,859	1,181	71	6,894	519
1990	8,018	1,008	619	67	10,587	2,545	994	7	6,380	595
1991	7,446	309	637	7	9,930	2,060	879	2	5,895	575
1992	6,410	316	825	2	9,692		1,252	92	5,324	708
1993	5,829	124	803	3	9,170		1,242	12	4,902	478
1994	4,733	43	1282	6	9,796		1,459	27	4,797	403
1995	4,564	45	1525	11	10,795		1,561	35	4,805	466
1996	3,201	61	986	4	12,575		1,681	59	4,486	498
1997	2,621	31	876	6	12,586		1,488	37	4,320	489
1998	2,312	32	784	5	12,196		1,332	24	4,065	385
1999	1,887	34	800	5	11,974		959	21	3,952	402
2000	1,611	21	734	2	10,966		876	17	3,797	428
2001	1,148	15	548	1	5,381		315	15	3,804	470
2002	1,022	22	495	1	5,532		326	13	3,547	480
2003	768	22	502	1	5,182		285	14	3,087	361
2004	778	19	432	1	5,019		279	11	2,959	254
2005	700	18	386	0	4,518		257	12	2,877	270
2006	640	24	365	0	4,171		242	11	2,521	135
2007	599	17	329	0	4,308		233	10	2,234	158
2008	615	31	321	0	4,290		262	12	1,880	143
2009	646	19	302	0	4,018		244	11	1,731	146
2010	603	27	275	1	3,719		230	21	1,688	158
2011	604	16	254	0	3,846		211	13	1,113	160

[1] Shrimp Trawl includes Gulf, Bay, and Bait trawl licenses.

the net ban in 1988, the number of finfish licenses sold remained around 500-800 until 1994 and 1995 when the sales rose to 1,288 and 1,536, respectively. These increases were probably due to the increased number of commercial trotline fishermen during this time and not to the number of fishermen targeting flounder with gigs. Figure 6.14 provides the resident license sales in Texas waters which can legally land flounder for commercial sale. With the exception of the General License and Gulf Trawl License, non-

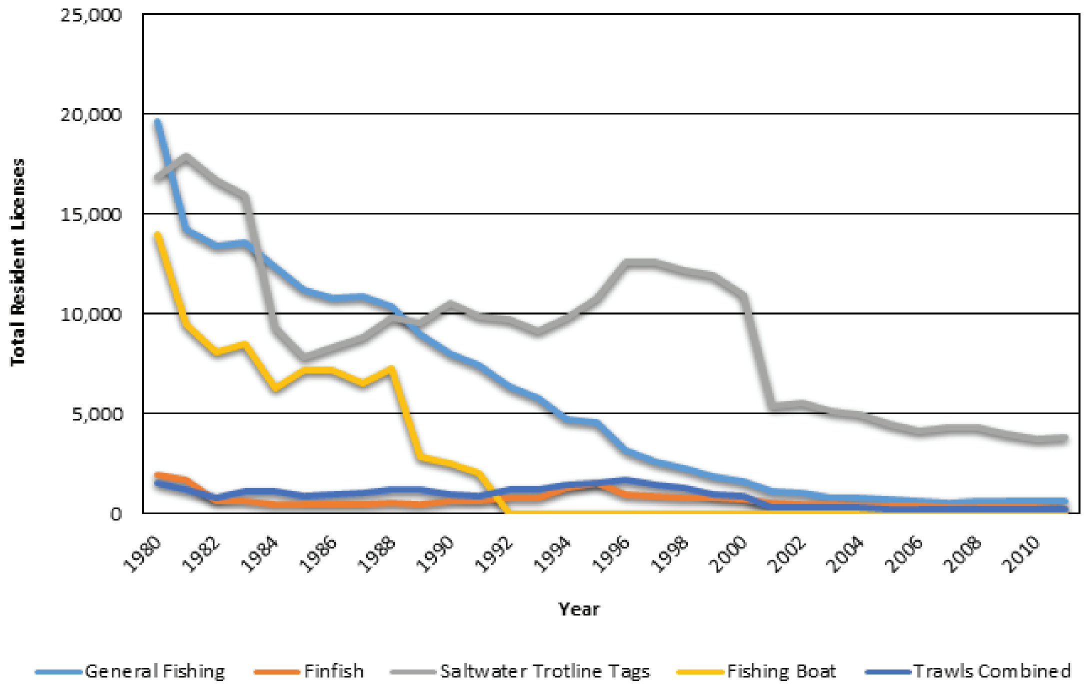


Figure 6.14 Annual Texas resident commercial fishing license sales from 1980-2011 (TPWD unpublished data). Combine trawls include Bay, Gulf, and Bait licenses. No division was made in the General license prior to 1980.

resident sales have generally been below 100 per year and in the last decade only a few dozen, total, have been sold (Table 6.12). The non-resident General License was first required by non-resident fishermen in 1980 and the total sold ranged from 1,000 to 5,500 annually. After 1990, the totals declined significantly to around 300 and quickly fell to an average of about 20 per year. Commercial shrimp trawl licenses were required in 1988 and the state sold between 400-700 non-resident Gulf Trawl Licenses through the early 2000s. Only about 150 non-resident Gulf Trawl Licenses have been sold annually since 2006. Overall, the number of annual all shrimping vessel licenses sold (resident and nonresident as well as Gulf, Bay, and Bait) has steadily declined over time and continues to decline through 2011 (Table 6.12).

Recreational Fishery

Flounder are a very popular recreational species because of the quality of the flesh and its accessibility due to its preferred habitats. Being euryhaline, flounders are commonly taken along beaches and barrier islands, inshore lakes and bays, and even in some freshwater areas. Southern flounder ranked ninth in percent composition of the 81 total species caught by Louisiana recreational anglers (Adkins et al. 1990). They were surpassed by red drum; hardhead catfish; spotted seatrout; 'silver' seatrout (combined *Cynoscion arenarius*, sand seatrout and *C. nothus*, silver seatrout); Atlantic croaker; sheepshead; black drum; and largemouth bass (*Micropterus salmoides*). These 10 species (including southern flounder) accounted for more than 90% of the catch. From the survey, southern flounder (when caught) were kept more than 85% of the time. For Texas waters, Ditton and Hunt (1996) determined that licensed anglers preferred red drum and spotted seatrout (51%), but 11% of those surveyed preferred hook-and-line fishing for flounder. In addition, about 19% of respondents indicated that they had gigged flounder in the last year.

A study in Barataria Bay, Louisiana, revealed the most productive baits included live bait, dead/cut bait, and a combination of artificial and dead/cut baits (Guillory and Hutton 1990). Small artificial grubs are commonly fished near the bottom or jigged around pilings, bulkheads, piers, and rock jetties to catch flounder. Small spoons and plastic jigs fished over shallow, sandy bottoms catch flounder buried in sand waiting to ambush their prey. Usually, the most productive fishing times are during ebb tides, which drain shallow flats and force prey species through channels into the surf zone and along beaches. The peak catches of flounder with rod and reel were recorded from September to November (Horst and Lane 2006).

Jackson and Timmer (1976) suggested October and November were also the best months for flounder gigging. Probably the most commonly used gear for flounder fishing is the gig. Warlen (1975) gave a comprehensive description of conditions and equipment necessary for a successful night of flounder gigging and pointed out that tide, wind, moon phase, water clarity, and bottom type play an important role in gigging success. Horst (2003) noted that firm sandy bottoms are the preferred habitats for gigging flounder on a rising tide with clear water.

Flounder gigs are often made by the angler and range from a simple sawed-off mop handle with a sharpened nail in the end to an aluminum or steel rod sharpened at one end for stabbing the flounder. Often, a hole drilled at the opposite end allows attaching a stringer. The flounder can then be slid along the pole onto the string, reducing handling and minimizing loss. Although barbless gigs are required in Louisiana, other states allow the use of single or multi-pronged gigs which have barbs. Multi-pronged gigs may cause more damage to fish but decrease the chance of loss. Anglers have been known to gig 100 fish or more per night, especially during late summer to early fall.

History

Southern and Gulf flounders dominate the marine recreational catch of flounder in the Gulf of Mexico. Texas and Louisiana have historically yielded the majority of southern flounder landed by marine recreational fishermen in the Gulf of Mexico. The IGFA all-tackle world record southern flounder as of 1990 weighed 20 lbs 9 oz and was caught in 1983 at Nassau Sound, Florida (IGFA 2013). The Texas state record for southern flounder on rod and reel was 28 inches, weighed 13 lbs, and was caught in Sabine Lake in February of 1976. Although not recognized by the IGFA all-tackle world records for Gulf flounder, the largest was 20.9 inches TL (7.5 lbs) and was caught in 1996 on Dauphin Island (ADCNR/MRD personal communication). The state records for Gulf and southern flounder are summarized in Table 6.13.

State Recreational Fisheries

Recreational fishing data for landings and effort are derived using the NMFS Marine Recreational Information Program (MRIP), its predecessor, the Marine Recreational Fisheries Statistics Survey (MRFSS), and the Texas Recreational Harvest Monitoring Program. The Texas program has been in place since 1974 while the MRFSS was used to sample anglers from Florida to Louisiana from 1979 until 2011. With the implementation of MRIP, the MRFSS landings since 1994 have been revised using the new protocols and

Table 6.13 State records (lbs and inches) for Gulf and southern flounder, where applicable. Bold indicates current world record (IGFA 2013, TPWD unpublished data, LDWF unpublished data, MDMR unpublished data, ADCNR/MRD unpublished data, FWC/FWRI unpublished data). NA indicates not available.

State	Gulf Flounder				Southern Flounder			
	Weight	TL	Year	Location	Weight	TL	Year	Location
FL	NA	NA	NA	NA	20.56	NA	1983	Nassau Sound
AL	7.51	20.9	1996	Dauphin Island	13.25	NA	1975	Dog River
MS	NA	NA	NA	NA	10.29	23.43	2007	Pascagoula River
LA					12.13	NA	1969	Lake of Second Trees
TX	NA	NA	NA	NA	14.5	34.5	2002	Gulf of Mexico

are reported below. Together, these three programs provide the best estimates of landings and effort by recreational anglers in the five Gulf states.

Unlike commercial landings information, the reported recreational landings in the MRFSS/MRIP include both retained (type 'A' and 'B1' that are the fish observed and reported catch not observed by samplers) and released fish (type 'B2'). The recreational landings presented in the recreational Figures and Tables are type A+B1 and actually represents total harvest, as designated by the NMFS.

Table 6.14 Recreational landings (lbs) for the Gulf states from 1981-2011 for Gulf flounder (NOAA personal communication). Texas landings are provided by TPWD (unpublished data) and are not based on calendar year. Dashes (---) indicate that no fish were intercepted by samplers in those years; landings enclosed in parenthesis ( ) are likely misidentified or were caught elsewhere (Gulf flounder ranges do not extend into Mississippi and Louisiana inshore waters (Section 3.1)).

Year	Florida (West Coast)	Alabama	Mississippi	Louisiana	Texas[1]
1981	37,043	---	(1,074)	(20,229)	0
1982	47,165	40,011	---	(123,477)	0
1983	121,015	6,762	---	(11,030)	6,283
1984	209,343	---	---	(21,621)	1,631
1985	166,596	---	---	(7,013)	1,695
1986	451,267	6,192	---	(66,506)	5,673
1987	238,147	26,189	(7,180)	(12,352)	13,320
1988	336,368	26,991	(4,147)	(25,895)	7,269
1989	218,068	34,445	(4,912)	(32,853)	4,120
1990	112,303	26,238	(1,739)	(2,154)	3,096
1991	315,487	34,244	(6,861)	(11,363)	10,365
1992	182,317	6,124	(2,809)	(1,810)	10,527
1993	148,721	19,043	---	(6,314)	3,290
1994	161,412	14,344	(780)	(4,985)	5,927
1995	102,848	3,895	---	(4,228)	5,060
1996	147,576	23,724	(679)	(824)	4,673
1997	134,324	10,368	(4,817)	(7,161)	4,661
1998	136,132	59,369	---	(24,526)	2,249
1999	201,859	6,878	---	(389)	5,846
2000	188,795	10,040	(745)	---	2,068
2001	236,968	30,927	(63)	---	2,575
2002	185,959	29,783	(723)	---	1,591
2003	219,131	7,508	---	---	1,002
2004	314,520	5,025	---	---	407
2005	172,053	7,280	---	---	347
2006	98,782	12,698	---	---	309
2007	333,925	4,909	---	---	362
2008	160,416	24,045	---	---	441
2009	193,416	15,468	---	---	206
2010	197,180	62,266	---	---	752
2011	229,278	7,396	---	---	158

[1] Weights for Texas were extrapolated using Florida's TL-weight formula. Data source: TPWD (Green and Campbell 2010 (1981-2007) and TPWD unpublished data (2008-2011).

Table 6.15 Recreational landings (lbs) for the Gulf states from 1981-2011 for southern flounder (NOAA personal communication). Texas landings are provided by TPWD (unpublished data) and are not based on calendar year.

Year	Florida (West Coast)	Alabama	Mississippi	Louisiana	Texas [1]
1981	120,610	287,081	201,730	213,075	195,570
1982	154,942	172,470	16,153	464,364	243,320
1983	132,229	132,113	8,587	2,714,729	180,846
1984	104,980	52,004	7,366	182,759	157,162
1985	70,214	65,682	14,328	664,973	194,831
1986	271,200	54,284	159,875	2,115,391	195,141
1987	98,245	10,745	104,172	179,860	256,719
1988	214,393	3,856	75,763	559,426	187,141
1989	37,881	7,077	115,032	336,259	153,394
1990	84,418	95,309	218,657	450,062	176,989
1991	109,477	25,924	171,915	598,974	235,238
1992	26,980	45,790	171,013	563,447	265,529
1993	63,891	91,711	102,214	387,161	249,382
1994	18,913	63,038	140,867	441,205	203,739
1995	30,317	167,179	241,592	328,592	190,370
1996	43,828	124,723	307,565	422,464	190,728
1997	48,797	57,108	193,448	398,882	155,454
1998	23,973	79,273	193,196	271,310	239,110
1999	18,709	171,688	157,976	498,484	260,910
2000	25,727	97,163	127,664	606,090	208,699
2001	30,399	344,753	326,723	380,983	176,996
2002	13,380	132,384	167,206	317,960	161,730
2003	27,404	194,754	146,540	454,384	231,996
2004	53,027	143,118	112,914	540,185	174,357
2005	47,223	170,278	93,533	340,076	115,760
2006	18,144	177,609	57,171	403,817	99,612
2007	197,154	162,579	151,588	462,296	86,992
2008	87,899	123,054	150,566	321,424	123,917
2009	13,886	230,914	263,229	402,168	80,312
2010	7,251	434,957	243,531	418,986	88,856
2011	52,274	258,204	243,014	567,163	214,226

[1] Weights for Texas were extrapolated from the length to weight conversion found in Hamilton (1981). Data sources: TPWD MDS 257 (1980-1981 through 2007-2008) and TPWD unpublished data (2008-2009 through 2011-2012).

Identification of flounders by species is better for the recreational landings than the commercial landings. While some errors likely occurred in earlier years, most of the state landings are designated by species and are discussed by species where appropriate (Tables 6.14 and 6.15).

Florida (West Coast)

The distribution of Gulf and southern flounder in the recreational landings from Florida's west coast is similar to that of the commercial landings, in that the majority are Gulf flounder (Murphy et al. 1994). Gulf and southern flounder recreational landings from the Florida West Coast have fluctuated without any apparent trends between 1982 and 2011 (NOAA personal communication) (Tables 6.14 and 6.15;

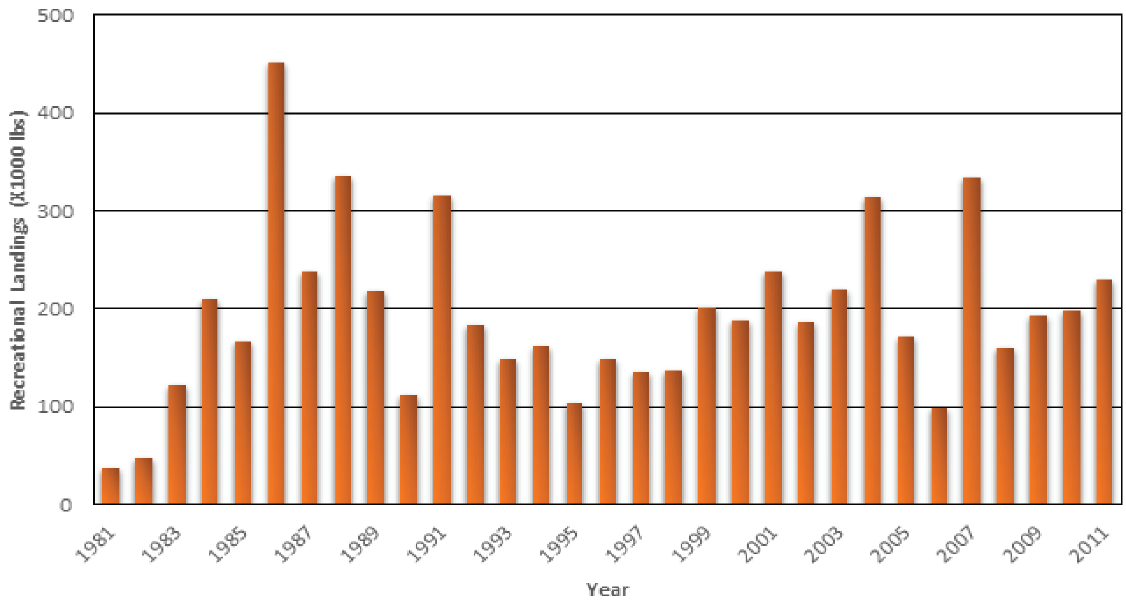


Figure 6.15 Gulf flounder landings (lbs) in Florida (West Coast) from 1981-2011 (NOAA personal communication).

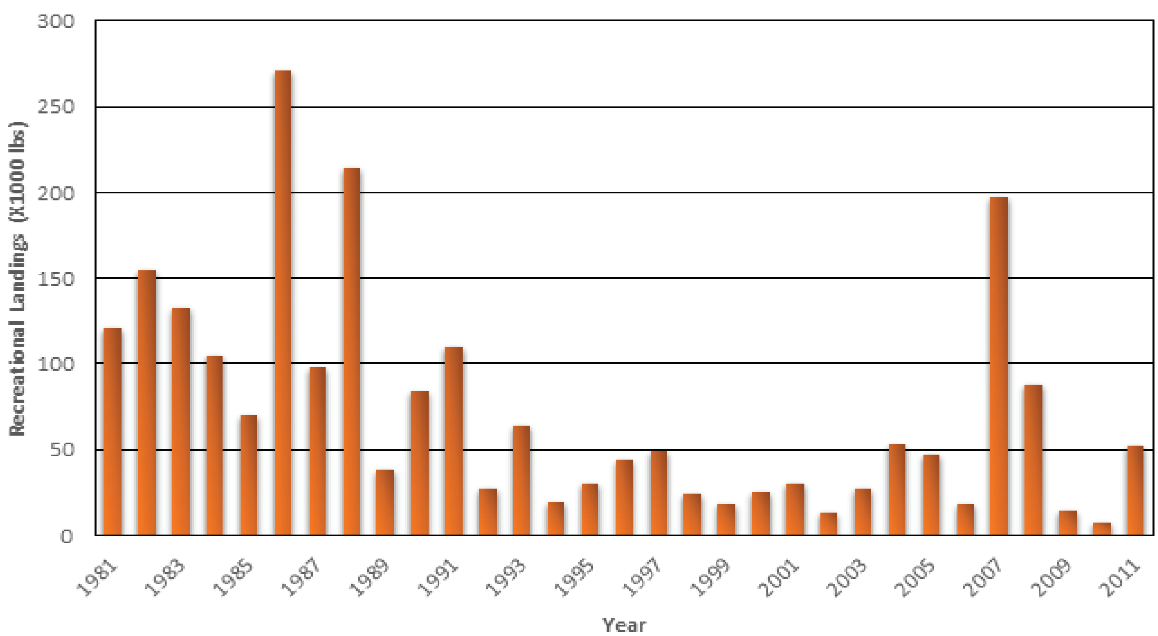


Figure 6.16 Southern flounder landings (lbs) in Florida (West Coast) from 1981-2011 (NOAA personal communication).

Figures 6.15 and 6.16). Gulf flounder landings along the Florida West Coast between 1981 and 2011 were highest in 1986 at 451,267 lbs, and lowest in 1981 at 37,043 lbs. Within the last decade (2000-2011), Gulf flounder landings were highest in 2007 at 333,925 lbs and lowest in 2006 at 98,782 lbs (Figure 6.15). In 2005, a massive red tide event occurred in southwest Florida that began in early January and ended in mid-December (Barbieri and Landsberg 2006). Flounder were one of the many species affected which may have contributed to the low landings in 2006. Southern flounder landings between 1981 and 2011 along the Florida West Coast were highest in 1986 at 271,200 lbs, and within the last decade, were highest in 2007 at 197,154 lbs. The lowest landings for southern flounder occurred in 2010 at 7,251 lbs, which coincided with the DWH disaster (Figure 6.16). In response to the presence of oil, FWC closed state waters offshore of Escambia County to all harvest of saltwater fish, crabs, and shrimp for a total of 47 days in June and July, 2010, encompassing approximately 23 miles of Florida's coastline (FWC/FWRI 2010). Since the majority of Florida southern flounder are landed in the panhandle (Bradshaw personal communication), this closure, along with closures in federal waters and increased public concern about the safety of consuming Gulf seafood following the event, may have contributed to the low landings recorded for 2010 (Figures 6.15 and 6.16).

The number of participants in Florida's recreational fishery and the number of fishing trips (Table 6.16) that were taken on the Florida West Coast increased over the last decade (2000-2011) compared to the 1990s. Total participation in the 1990s averaged between 2-3M anglers per year while in 2000, the number of participants increased to 4M anglers (Figure 6.17). The number of participants topped out at about 4.4M in 2001 and then began to decline to around 3M anglers in 2009 through 2011. The number of fishing trips taken between 2000 and 2011 was also higher than the number of trips that were taken in the 1990s (Figure 6.18). During the 1990s, the number of recreational fishing trips taken on the west coast of Florida averaged between 10-14M. In 2000, the number of trips increased to over 15M and topped out in 2004 at about 17.8M. The number of trips stayed between 16.5-17.5M from 2005-2008, but began to decline in 2009. In 2011, about 13.9M recreational fishing trips were taken from the Florida West Coast. A number of factors may have influenced the decrease in participation and number of recreational fishing trips that were taken on Florida's west coast between 2009 and 2011 which include stricter regulations in both state and federal waters, record-setting low temperatures, and the DWH oil spill (Figure 6.18).

On Florida's west coast over the last two decades (1990-2011), more out-of-state anglers participated in the recreational fishery than Florida residents (Figure 6.18). In only three of those years (1995, 2005, and 2006), more Florida residents participated in the recreational fishery than out-of-state anglers. The number of out-of-state anglers peaked in 2001 (1990-2011) at about 2.5M, but decreased to between 1.4-1.6M from 2009 to 2011. The trend for Florida residents follows this trend except that Florida resident participation topped out in 2005 and 2006 at just over 2M before decreasing to around 1.5M in 2009 to 2011 (Figure 6.18).

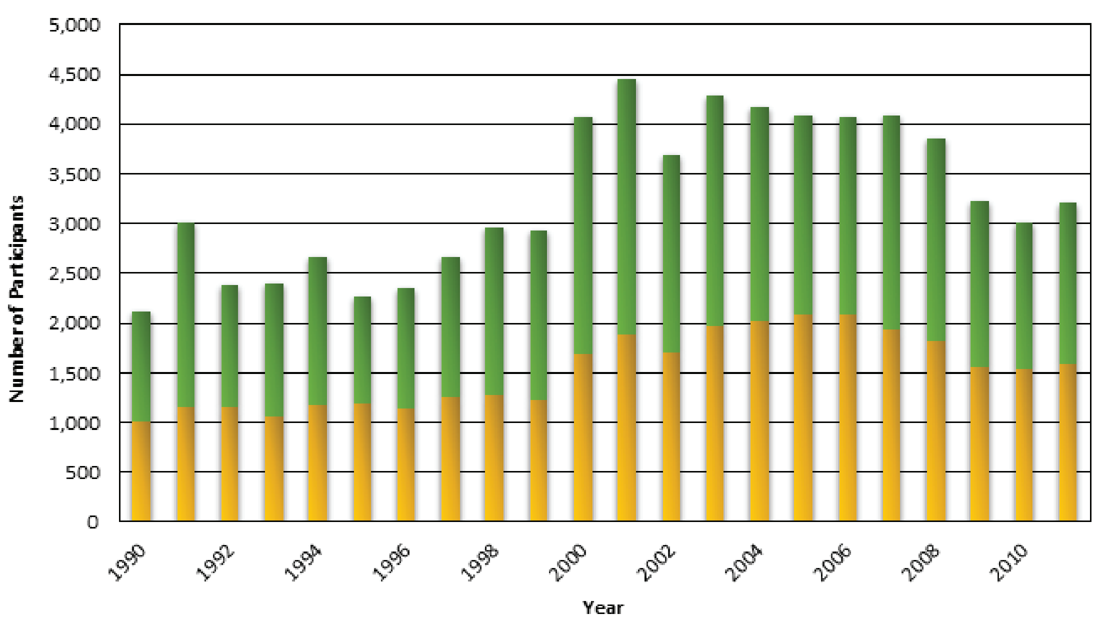


Figure 6.17 Number of Florida residents (yellow) and out-of-state anglers (green) who participated in Florida's recreational fishery on the Florida West Coast (NOAA personal communication).

Table 6.16 Florida resident and non-resident recreational fishing participation and total number of saltwater fishing trips along the Florida West Coast from 1990-2011 (NOAA personal communication).

Year	Coastal	Out-of-State	Total	Angler Trips
1990	1,009,284	1,104,893	2,114,177	9,922,602
1991	1,152,054	1,852,256	3,004,310	14,261,115
1992	1,162,068	1,216,799	2,378,867	13,763,989
1993	1,052,671	1,349,066	2,401,737	12,928,092
1994	1,173,291	1,491,514	2,664,805	13,166,982
1995	1,195,416	1,069,196	2,264,612	12,396,870
1996	1,143,775	1,207,191	2,350,967	12,331,873
1997	1,249,569	1,411,333	2,660,903	13,384,436
1998	1,266,487	1,696,492	2,962,980	12,234,580
1999	1,217,624	1,708,012	2,925,637	11,296,851
2000	1,683,222	2,387,389	4,070,610	15,086,213
2001	1,894,415	2,552,283	4,446,699	16,388,611
2002	1,702,807	1,989,785	3,692,592	14,418,275
2003	1,965,124	2,317,524	4,282,648	16,008,974
2004	2,023,259	2,141,324	4,164,583	17,795,711
2005	2,088,443	2,007,817	4,096,260	16,694,805
2006	2,083,835	1,988,445	4,072,281	16,667,410
2007	1,933,825	2,151,432	4,085,258	16,935,514
2008	1,820,194	2,028,977	3,849,172	17,497,165
2009	1,551,478	1,670,603	3,222,081	15,677,320
2010	1,538,143	1,469,996	3,008,139	14,266,196
2011	1,591,899	1,623,753	3,215,652	13,900,677

Alabama

Alabama's recreational flounder fishery is driven by hook and line anglers with the highest landings occurring in the shore mode as determined through MRFSS surveys dating back to 1981. A 1985-1986 recreational creel survey in Alabama found only 3.5% of those interviewed were specifically targeting flounder. However, this percentage was exceeded only by spotted seatrout, sand seatrout, king mackerel (*Scomberimorus cavalla*), and Spanish mackerel (*Scombermorus maculatus*) among marine fish recreationally targeted (ADCNR/MRD unpublished data), suggesting that much recreational fishing effort is not directed at a particular species, but is more opportunistic. The number of anglers purchasing recreational licenses has increased three-fold over time (Table 6.17). Landings have not experienced the same increase, but have fluctuated over time (Tables 6.14 and 6.15). Results from the AMRD inshore roving creel survey indicates that from 1998-2001 6.2 %, 2001-2004 8.6%, 2004-2007 9.3% and 2008-2009 8.6% of anglers were targeting flounder. The long-term targeting of flounder species recorded from the roving creel surveys is 8.8% from 1995-2010.

Results from the MRFSS survey during the same time period indicates more variation: 2001-2004 6.9%, 2004-2007 6.3% and 2007-2010 8.3% of anglers stated that they had targeted flounder. The variation may be due to the timing of the angler intercept; the ADCNR/MRD creel survey was given to anglers at all stages of their fishing trips while the MRFSS survey was asked of anglers who had completed their fishing trip for the day. Anglers are more likely to state target species as species that they have already landed. Some variation in target may be an effect of fishing site access; the creel survey included anglers who

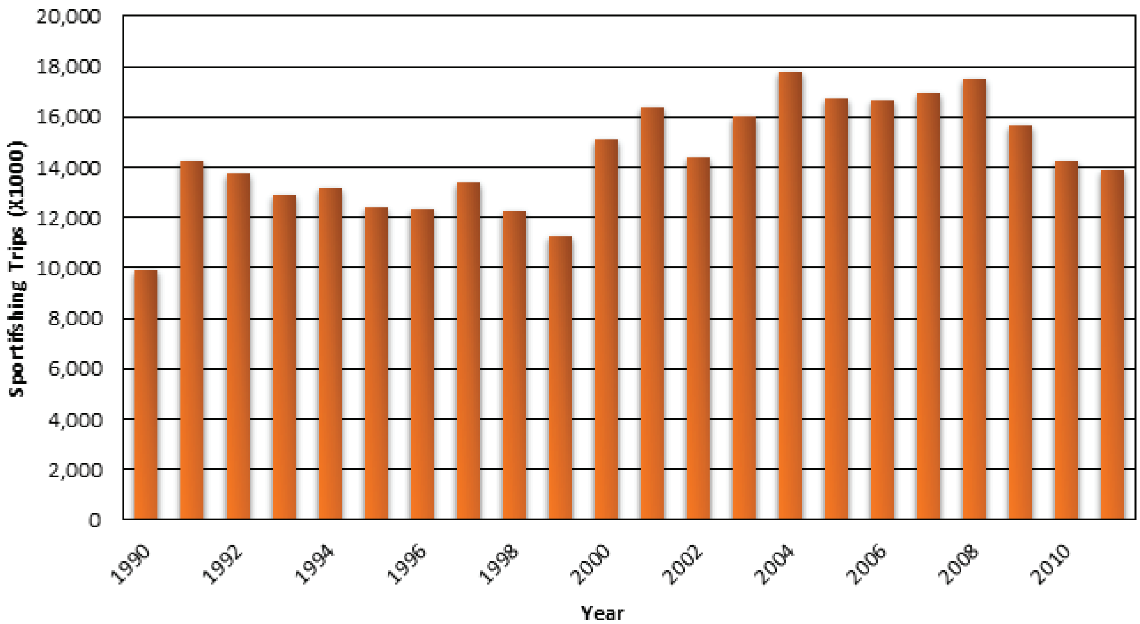


Figure 6.18 Total number of recreational fishing trips that were taken on Florida's west coast (NOAA personal communication).

had launched from both public and private boating access sites while the MRFSS survey was given only to anglers at public fishing sites. The long term targeting of flounder species recorded from the MRFSS survey is 7.5% from 2000-2011.

Both southern and Gulf flounder are commonly captured in the Alabama recreational fishery, with southern flounder being more abundant in the catch. Estimates of southern flounder catch-per-unit-effort (CPUE) of southern flounder from MRFSS/MRIP are depicted in Figure 6.19. Gulf flounder are more common along the Gulf beaches and barrier islands, while southern flounder are found from the coast to miles upstream of the major rivers.

The average size southern flounder measured from the combined ADCNR/MRD creel and the MRIP/MRFSS surveys has increased over time (1990-2011; Figure 6.20). Prior to 2001, recreationally caught flounder were not regulated by size, creel limit, or season. In the fall of 2000, a regulation was passed limiting the harvestable size of flounder to 12 inch TL (2000-MR-16, effective January 1, 2001). Continued concern led to implementing a regulation restricting the creel limit to 10 flounder/person/day (2008-MR-13, effective Sept. 23, 2008).

Flounder can also be harvested by gig or a recreational gillnet. According to Swingle (1976), 57% of the total recreational catch of flounder from 1965-1975 in Alabama was taken by gigging in shallow bays at night. Through 2011, no other nighttime survey has been initialized to characterize the recreational gig harvest of flounder in Alabama as current surveys are conducted from dawn to dusk. However, with the implementation of night sampling through MRIP protocol (March 2013), it is possible that the gig fishery may be better characterized. Obtaining estimates of gigging effort and harvest rates continues to be a data need.

Likewise, recreational gillnets are another type of gear for which it is difficult to assess effort and catch. Recreational gillnets are principally used by residents with direct access to the water's edge and are used during twilight hours. License sales (resident and non-resident) have remained stable until 2008, when legislation was proposed to limit their sale (Table 6.17 and Figure 6.21). At that time, recreational

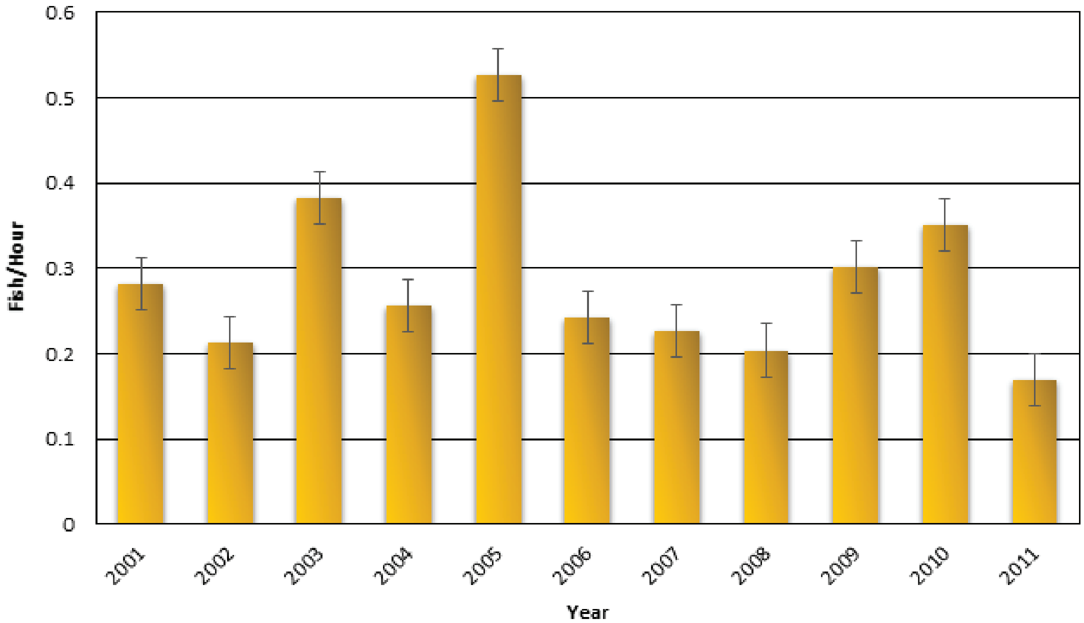


Figure 6.19 Alabama recreational southern flounder estimates of catch per unit effort (CPUE) for private boat mode from MRFSS/MRIP 2001-2011 (NOAA personal communication).

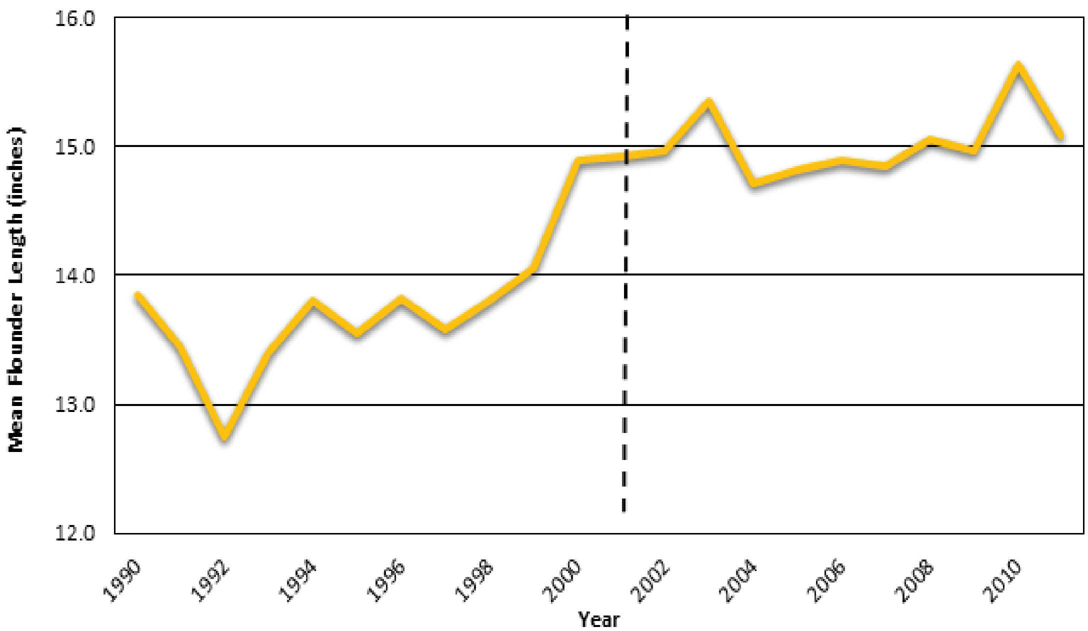


Figure 6.20 Alabama mean length of southern flounder by year collected during Alabama roving creels and MRFSS/MRIP surveys from 1990-2011 (ADCNR/MRD unpublished data and NOAA personal communication). Vertical line indicates implementation of the recreational 12 inch minimum size limit for both Gulf and southern flounder in Alabama waters.

gillnet license sales jumped to over 1,000 and subsequently have decreased to below 700 as of October 2011. The legislation that was passed required that current licenses be renewed annually or else the licenses would permanently expire. No new recreational gillnet licenses may be issued, and licenses may not be transferred. Although the impact made by this group of fishermen is difficult to ascertain, annual harvest of flounder in the past may be assumed to be consistent from year to year based on the relative stability of recreational license sales.

Table 6.17 Alabama recreational annual saltwater fishing license and recreational gillnet license sales from 1993-2011. Annual fishing includes all combination licenses which include saltwater fishing privileges (ADCNR/MRD unpublished data).

Year	Resident Annual	Resident Trip	Non-Resident Annual	Non-Resident Trip	Resident Pier Fishing	Non-Resident Pier Fishing	Resident Gillnet	Totals
1993	41,655	958	69	1,758	1,177		438	46,055
1994	44,473	6,754	3,261	10,885	1,032		392	66,797
1995	47,197	5,985	4,257	11,284	973		385	70,081
1996	44,218	6,188	4,208	11,229	975		615	67,433
1997	42,793	8,022	4,413	11,983	788		664	68,663
1998	43,047	7,453	4,607	12,606	871		708	69,292
1999	40,843	8,161	5,088	13,301	839		665	68,897
2000	43,476	9,253	5,361	16,126	946		669	75,831
2001	45,129	8,890	5,486	17,522	856		621	78,504
2002	45,980	8,957	6,010	18,380	810		634	80,771
2003	45,054	10,008	6,353	19,819	710		595	82,539
2004	48,954	10,269	7,131	22,133	1,259		630	90,376
2005	43,924	5,638	6,117	14,092	666		556	70,993
2006	49,439	6,894	7,502	15,522	500		557	80,414
2007	54,241	8,658	8,367	20,389	524		513	92,692
2008	41,737	17,754	6,490	21,117	102		1,055	88,255
2009	49,061	23,266	7,069	20,478	416		883	101,173
2010	43,752	9,462	6,709	11,624	1,867	670	793	74,877
2011	54,553	20,327	7,983	23,315	3,510	3,958	740	114,386

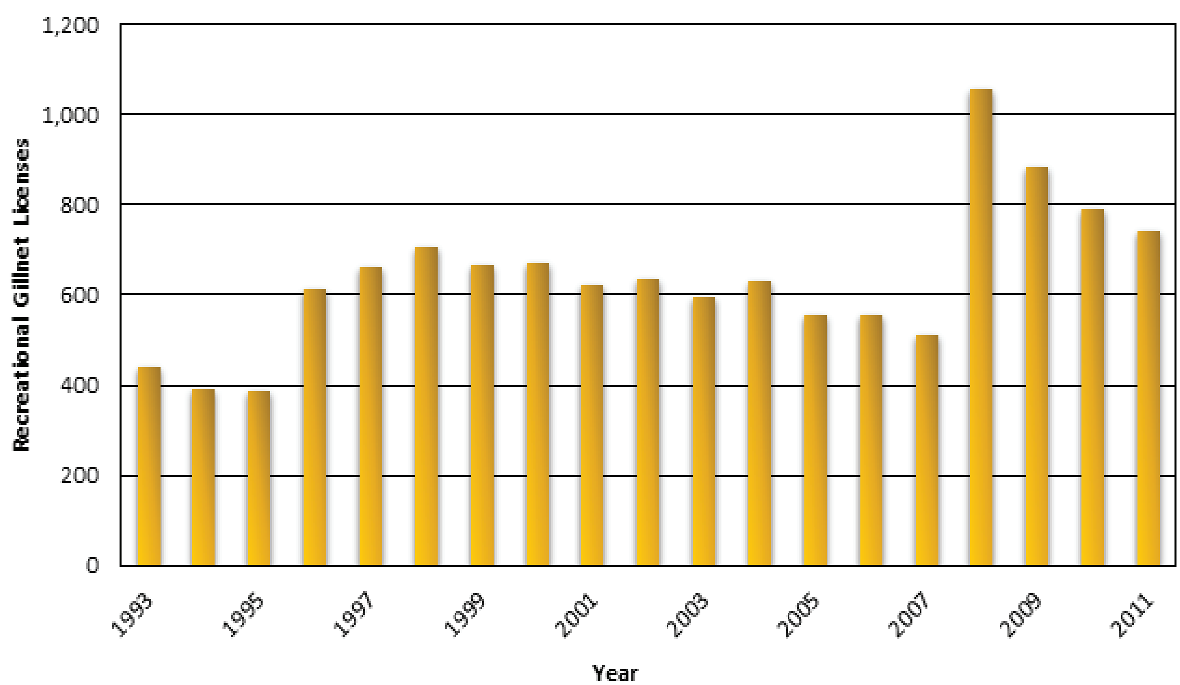


Figure 6.21 Alabama resident recreational gillnet license sales by fiscal year (Oct–Sep) (ADCNR/MRD unpublished data).

Resident recreational saltwater license sales have been stable over the past 20 years (Table 6.17). Non-resident license sales have increased over the same time period. Sales of non-resident licenses is heavily dependent of weather conditions during the summer season. Additionally, non-resident trip licenses (not included) contribute a significant number of sales, but may not have a significant effect on flounder harvest. Notable declines were due to post Hurricane Ivan and Hurricane Katrina (2005), an active hurricane season in 2008 (Gustav and Ike) and most recently due to the DWH Disaster (2010).

Jubilees are events which take place primarily in the northeast quadrant of Mobile Bay. During a jubilee, low dissolved oxygen waters (below 2 Mg/L) are driven shoreward by a westerly wind (seiche) on an incoming tide. This in turn drives benthic animals to the surface or shallower waters (<2 m) where oxygen levels are more favorable. Due to a lack of oxygen, fish, crabs, and shrimp are lethargic and are easily captured by dip nets, gigs, and hand. These events are closely monitored by individuals living in proximity to the water's edge and harvest is coordinated when conditions are favorable. Resource managers are sometimes notified following an occurrence, but photographs clearly indicate upward of a thousand flounder may be taken during a single jubilee event.

Mississippi

The southern flounder has historically been a very popular fish species in Mississippi. From May through November, the shallow waters of the mainland beach and barrier islands are illuminated by the lights of gig fishermen. Flounder are also targeted by hook and line fishermen from boats, piers/jetties, and wade fishing using natural and artificial bait. Recreational licenses in Mississippi have generated

Table 6.18 Mississippi recreational saltwater fishing participation from 1990-2011 (NOAA personal communication).

Year	Resident	Non-Resident	Total
1990	103,169	107,862	211,031
1991	144,047	93,472	237,519
1992	193,235	70,910	264,145
1993	199,651	50,958	250,609
1994	179,860	59,958	239,818
1995	202,491	84,662	287,153
1996	156,200	84,093	240,292
1997	138,071	91,075	229,146
1998	106,904	67,619	174,523
1999	101,748	74,891	176,639
2000	190,411	57,323	247,733
2001	245,087	81,909	326,996
2002	226,680	48,943	275,623
2003	212,668	48,328	260,996
2004	216,971	45,529	262,500
2005	136,824	38,901	175,725
2006	166,799	26,532	193,331
2007	229,063	54,559	283,622
2008	145,754	48,056	193,810
2009	161,544	50,328	211,872
2010	166,102	50,221	216,323
2011	208,362	59,694	268,056

approximately $7M in sales since 2000, with resident license sales averaging 62,000/year and non-resident license sales at slightly more than 5,000/year. Beginning in 2010, Mississippi began selling a one-time license for residents age 65 and older. This was done to exempt all anglers in the state from federal saltwater licensing requirements.

Fishermen fishing north of Highway 90 and south of Interstate 10 have the option of using either a saltwater fishing license or a freshwater fishing license and as such, are not counted strictly as Mississippi saltwater anglers. This affects the ratio of saltwater/freshwater anglers in the state and the distribution of various funds used to enhance sportfishing. On July 1, 1993, the Mississippi Legislature established a recreational saltwater fishing license which at the time only applied to hook and line fishermen and by omission exempted gig fishermen from any recreational licensing requirements. However, in the 2000 legislative session, state statute was amended so that any method of recreational take of a finfish species requires a valid recreational saltwater fishing license and became effective on July 1, 2000. Recreational saltwater license sales generally increased from 1994 through 2005 with the highest year being the 2000/2001 season (Table 6.18 and Figure 6.22). Following hurricane Katrina, license sales were down during the 2006 season, but have again increased with a small drop in the 2009/2010 season. In 2002, Mississippi established an ordinance setting the recreational bag limit for southern flounder at 15 per person with a minimum size of 12 inches TL. All of Mississippi limits are for bag and not possession.

Flounder landings have averaged approximately 154,000 lbs/year or 5.3% by weight of the total recreational harvest in Mississippi over the last 30 years (Table 6.15 and Figure 6.23). Since 2000, flounder have accounted for an average of 4.9% of the total recreational harvest in Mississippi (Table 6.19). Southern flounder have been the only species of flounder harvested by recreational fishermen encountered by creel surveyors through the MFRSS/MRIP program, however, the possibility exists for Gulf flounder being landed but not seen. The MDMR conducted a point access creel survey from 1987-1997 and found that flounder accounted for approximately 12.5% of the total recreational harvest by boat fishermen in Mississippi. The mean weight/length ranged from a low of 0.40 kg/330 mm in 1989 to a high of 0.58 kg/360 mm in 1993. (MDMR unpublished data).

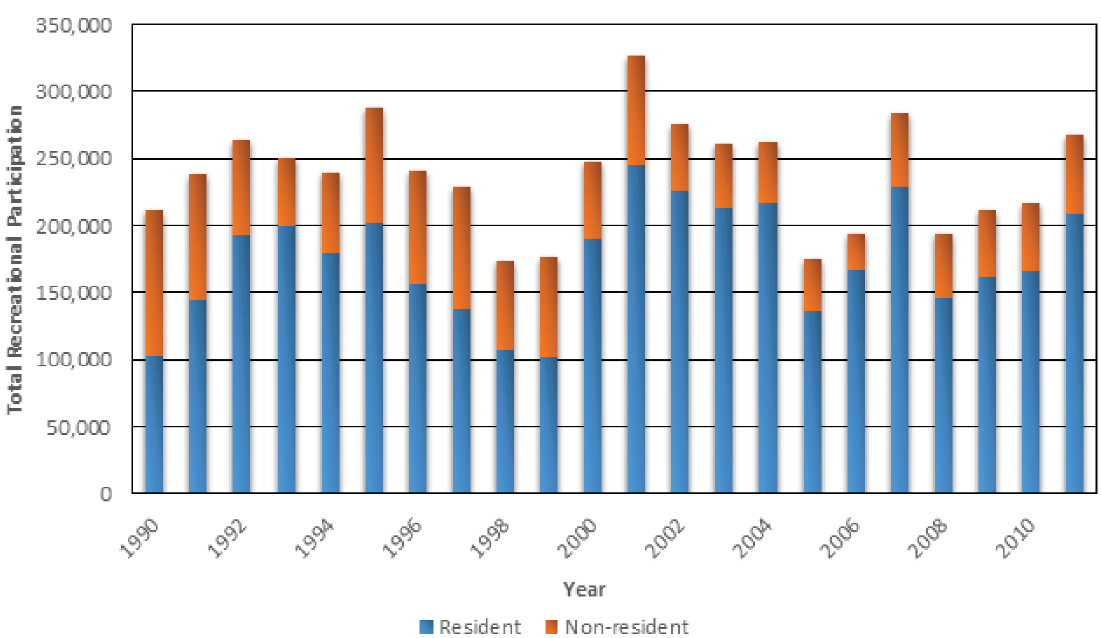


Figure 6.22 Mississippi resident and non-resident recreational saltwater fishing participants from 1990-2011 (NOAA personal communication).

Table 6.19 Contribution of southern flounder as a percentage of all recreational finfish landings (X1,000 lbs) in Mississippi from 1981-2011 (NOAA personal communication).

Year	Southern Flounder	All Other Species	Percent of Total
1981	201.7	40,860.3	4.94%
1982	28.0	46,610.8	0.60%
1983	68.6	39,860.5	1.72%
1984	7.4	18,699.8	0.39%
1985	14.3	23,454.2	0.61%
1986	163.5	27,273.7	6.00%
1987	121.6	23,959.8	5.08%
1988	78.0	34,066.4	2.29%
1989	124.9	25,988.7	4.81%
1990	218.7	21,520.8	10.16%
1991	171.9	30,285.2	5.68%
1992	173.4	33,677.1	5.15%
1993	102.2	21,024.9	4.86%
1994	140.9	25,716.5	5.48%
1995	241.6	34,073.1	7.09%
1996	307.6	37,457.4	8.21%
1997	193.4	45,341.9	4.27%
1998	193.2	26,249.3	7.36%
1999	158.0	30,289.2	5.22%
2000	127.7	28,134.5	4.54%
2001	326.7	36,170.3	9.03%
2002	167.2	31,587.6	5.29%
2003	146.5	28,551.5	5.13%
2004	112.9	26,882.9	4.20%
2005	93.5	15,245.3	6.14%
2006	57.2	19,339.4	2.96%
2007	151.6	18,538.5	8.18%
2008	150.6	20,211.9	7.45%
2009	263.2	35,674.4	7.38%
2010	243.5	26,645.5	9.14%
2011	243.0	49,967.8	4.86%

Louisiana

Recreationally landed southern flounder in Louisiana are primarily caught with hook and line and gigs. Gigs are used mainly at night while fishermen wade through shallow water using high-powered lights to identify flounder lying on the bottom. Recreational catches of southern flounder in Louisiana generally occur along beaches and barrier islands, in inshore lakes and bays, and even in some freshwater areas. A 1993 survey of anglers indicated that southern flounder ranked third in angler preference in Louisiana when caught, following spotted seatrout and red drum, however less than 1% of anglers actually indicated targeting southern flounder (Kelso et al. 1994). Adkins et al. (1990) reported that Louisiana anglers kept flounder 85% of the time when they were caught by recreational anglers. Recreational flounder landings in Louisiana are summarized in Tables 6.14 and 6.15, and Figure 6.24.

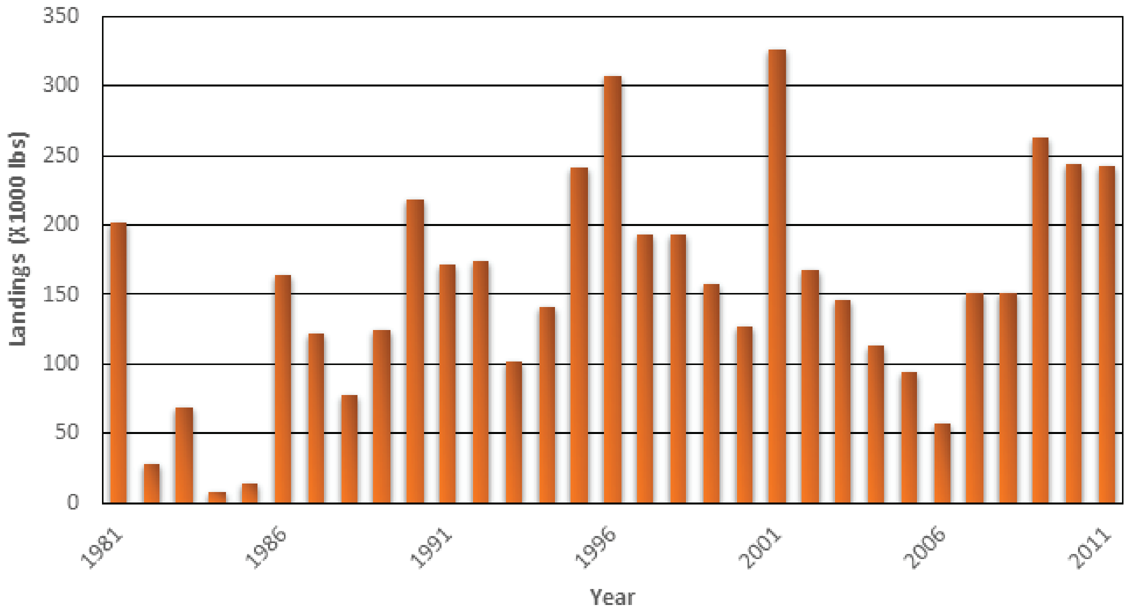


Figure 6.23 Mississippi recreational landings of southern flounder from 1981-2011 for all modes (NOAA personal communication).

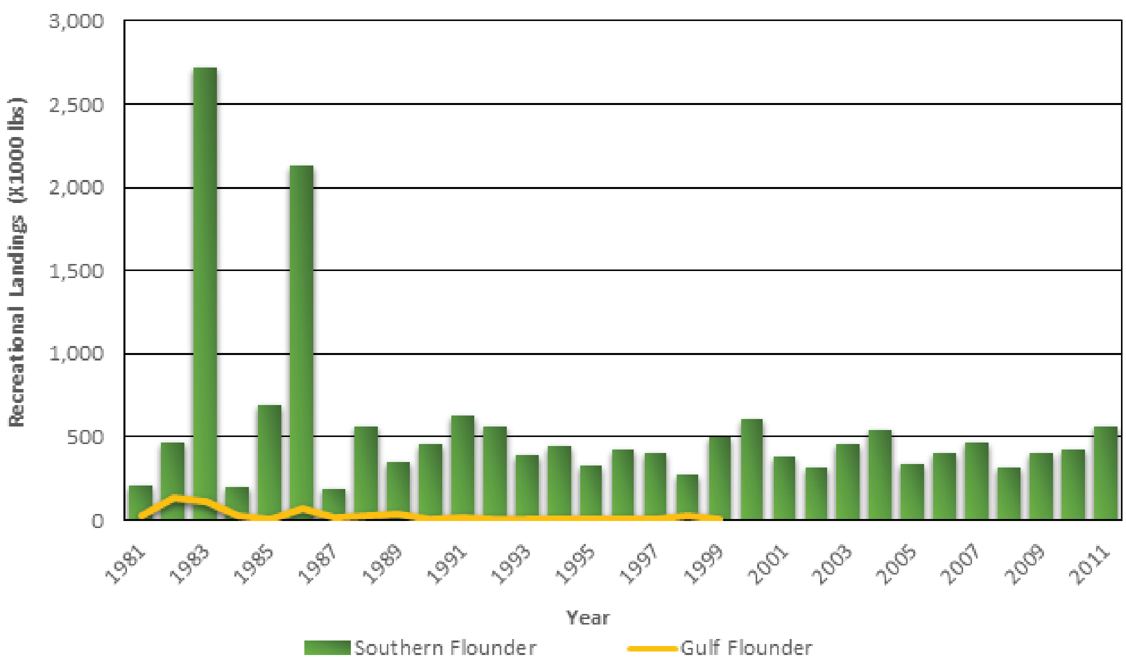


Figure 6.24 Louisiana recreational Gulf and southern flounder landings from 1981-2011 (NOAA personal communication). Note: there is likely a reporting error by anglers during dockside intercepts in 1983 and 1986 elevating the landings artificially (Blanchet personal communication).

A 1984 Louisiana creel survey reported that southern flounder were not targeted as were spotted seatrout, red drum, croakers, mackerels (Scombridae), and snappers (Lutjanidae). Less than 1% of anglers interviewed expressed a preference for southern flounder as a targeted species. Although not specifically targeted, a 1993 survey indicated that they ranked third in angler preference when caught, following spotted seatrout and red drum which ranked first and second, respectively (Kelso et al. 1994).

Duffy (1977) suggested that the peak flounder run may begin in June and last for four months with the best fishing in July, August, and September. In Louisiana, peak catches occurred during September, October, and November with an average recorded size of 345 mm (Adkins et al. 1990). According to MRFSS/MRIP creel data, in 2011, recreationally harvested southern flounder in Louisiana averaged 358 mm (NOAA personal communication). In Louisiana, the majority of southern flounder were harvested from marsh and lake/bay areas: average sizes taken in those areas were 340 mm and 363 mm, respectively, with little variation in size on a monthly basis (Adkins et al. 1990). However, during October and November, flounder ranging in size from 406-457 mm are commonly taken from the spillways leading west from Southwest Pass and South Pass of the Mississippi River, and specimens exceeding 500 mm are caught routinely (Cooper personal communication).

Recreational saltwater angling in Louisiana has generally increased over the 13 license year periods from 1999/2000 through 2011/2012 as reflected in the numbers of resident and non-resident saltwater licenses sold during those years (Table 6.20).

Table 6.20 Resident and non-resident recreational saltwater angler licenses issued 1984-2011 in Louisiana (LDWF unpublished data) (--- indicates no residency designation for issuance).

Year	Resident	Non-Resident	Total
1984	---	---	102,125
1985	---	---	168,149
1986	---	---	198,852
1987	---	---	195,099
1988	---	---	204,686
1989	---	---	208,292
1990	---	---	206,088
1991	---	---	230,043
1992	---	---	246,694
1993	---	---	267,323
1994	---	---	282,490
1995	---	---	299,867
1996	---	---	274,728
1997	270,940	7,428	278,368
1998	284,152	9,649	293,801
1999	323,139	57,971	381,110
2000	306,354	58,896	365,250
2001	303,364	76,638	380,002
2002	301,006	83,728	384,734
2003	311,199	88,183	399,382
2004	319,921	91,047	410,968
2005	294,182	63,190	357,372
2006	321,641	83,036	404,677
2007	344,138	97,808	441,946
2008	350,709	90,603	441,312
2009	368,456	108,142	476,598
2010	352,389	86,425	438,814
2011	385,153	122,019	507,172

Table 6.21 Total number of recreational fishing licenses and stamps sold in Texas from 1978 to 2011 (Green and Campbell 2010 for 1978 through 2007 and TPWD unpublished data for 2008 through 2011). Recreational licenses included fresh and saltwater fishing privileges. Fiscal year is from September 1 to August 31. NA indicates license was not available.

Fiscal Year[1]	Resident Combo Hunt/Fish	Resident Fishing	Non-resident Fishing	Fishing License Total	Stamp Alone	Stamp Combined with License	Stamp Total	Estimated number of Saltwater Anglers[2]
1978	447,740	919,362	72,918	1,440,020	NA	NA	NA	816,728
1979	523,830	1,106,799	84,522	1,715,151	NA	NA	NA	972,772
1980	572,149	1,096,087	77,232	1,745,468	NA	NA	NA	989,967
1981	609,118	1,107,736	81,102	1,797,956	NA	NA	NA	1,019,736
1982	673,212	1,146,935	105,960	1,926,107	NA	NA	NA	1,092,419
1983	724,990	1,168,583	104,483	1,998,056	NA	NA	NA	1,133,226
1984	690,937	1,037,590	87,248	1,815,775	NA	NA	NA	1,029,843
1985	694,409	1,047,731	86,612	1,828,752	NA	NA	NA	1,037,203
1986	663,660	1,107,569	86,836	1,858,065	390,545	NA	390,545	1,053,828
1987	661,386	1,075,984	91,754	1,829,124	542,606	NA	542,606	1,037,414
1988	681,870	1,113,329	95,819	1,891,018	562,622	NA	562,622	1,072,518
1989	671,371	1,064,703	105,755	1,841,829	600,959	NA	600,959	1,044,619
1990	669,645	1,104,746	113,813	1,888,204	580,388	NA	580,388	1,070,922
1991	657,859	1,126,556	119,920	1,904,335	560,802	NA	560,802	1,080,071
1992	529,346	1,097,389	118,166	1,744,901	561,801	NA	561,801	989,645
1993	529,761	1,123,264	122,876	1,775,901	585,545	NA	585,545	1,007,227
1994	512,441	1,171,029	130,987	1,814,457	599,896	NA	599,896	1,029,095
1995	514,875	1,113,613	105,956	1,734,444	624,218	NA	624,218	983,715
1996	502,918	1,070,994	105,315	1,679,227	648,208	NA	648,208	952,397
1997	485,692	1,022,347	105,122	1,613,161	498,757	160,287	659,044	914,927
1998	506,139	1,029,305	103,883	1,639,327	490,874	215,360	706,234	929,768
1999	516,465	1,053,859	107,882	1,678,206	498,787	256,196	754,983	951,818
2000	523,269	1,036,435	103,818	1,663,522	510,958	284,791	795,749	943,490
2001	577,587	1,013,726	96,108	1,687,421	465,781	348,856	814,637	957,045
2002	588,566	985,824	92,877	1,667,267	459,365	379,454	838,819	945,614
2003	594,504	972,055	92,155	1,658,714	452,515	395,151	847,666	940,763
2004	581,966	965,549	81,305	1,628,820	458,393	401,085	859,478	923,808
2005	563,083	958,784	89,366	1,611,233	26,883	888,124	915,007	913,834
2006	586,136	901,460	92,129	1,579,725	20,630	947,366	967,996	895,963
2007	598,774	921,553	96,909	1,617,236	17,337	988,359	1,005,696	917,238
2008	623,884	1,029,579	114,619	1,768,082	18,540	1,200,383	1,218,923	1,002,793
2009	628,919	1,028,581	117,297	1,774,797	17,654	1,207,770	1,225,424	1,006,601
2010	629,839	991,231	110,218	1,731,288	13,450	1,238,386	1,251,836	981,925
2011	639,182	1,043,418	115,619	1,798,219	15,126	1,330,979	1,346,105	1,019,885

[1] Fiscal year 1978 = September 1, 1977 through August 31, 1978.

[2] Estimated number of saltwater anglers = fishing license total / 0.67 x 0.38; where 0.67 adjusts for anglers that fish without a license and 0.38 adjusts for anglers that fish in saltwater; based on Green et al. (1982).

Texas

The number of recreational fishing licenses sold in Texas is shown in Table 6.21. The estimated number of saltwater anglers ranged from 816,728 in 1978 to a high of 1,133,226 in 1983 (Figure 6.25). The estimated numbers of saltwater anglers exceeded 900,000 for all other years except for 1978 and 2006. In Texas, overall sport boat fishing pressure (man-hours) has increased and finfish landings (number of fish) have decreased from 1976 to 2011 (Tables 6.22). Fluctuations in the landings can be attributed to environmental (freeze events, recruitment) and anthropogenic (i.e. TPWD regulation changes, catch and release) events (Tables 6.14 and 6.15). In response to concerns over both overfishing and low recruitment of flounder, more restrictive limits have recently been placed on Texas recreational and commercial fisheries.

Recreational regulations concerning flounder have changed five times in Texas history (Green and Campbell 2010). In 1955, a minimum length of 12 inches for flounder was instituted in Cameron, Kenedy, and Willacy counties located on the southern coast of Texas. It was later repealed in 1984. In 1988, a statewide minimum length of 12 inches with a daily bag and possession limits of 20 and 40 flounder, respectively, was instituted (included all species, their hybrids and subspecies). In 1996, the minimum length was raised to 14 inches and the daily bag and possession limits were lowered to 10 and 20 flounder. In 2006, the possession limit was decreased to 10 flounder per person per day. In 2009, the daily bag and possession limits were further decreased to five flounder per person per day. Also, during the month of November, flounder can only be taken with hook and line, and a daily bag and possession limit of two flounder applies.

Southern flounder is the most common species of flounder landed in Texas. They are caught by anglers primarily in bays and nearshore passes. Some are caught offshore but are generally reported around times of spawning migrations in the fall. During the period of 1991-2012, the percentage of private and party-boat anglers that specifically targeted flounder (*Paralichthys* sp.) ranged from 1.1 to 6.1% and 0 to 1.1%, respectively (Green and Campbell 2010, TPWD unpublished data). Southern flounder are not the

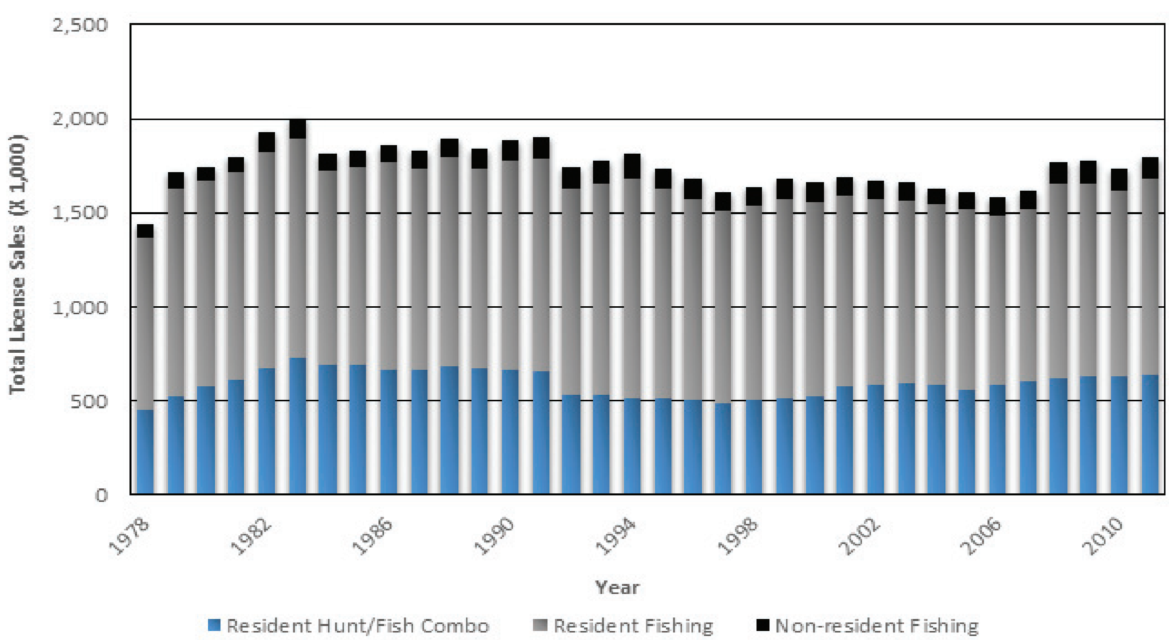


Figure 6.25 Texas recreational fishing licenses sold from 1978-2011 (TPWD unpublished data). Texas 'fishing' license includes both fresh and saltwater.

Table 6.22 Sport boat fishing pressure and finfish landings (numbers of fish) in Texas marine waters from May 1976 to May 2011. Sport boats = private boats and party boats combined. Texas marine waters = bays/passes (1976-1977 through 2010-2011), Texas Territorial Sea (1983-1984 through 2010-2011), and U.S. Exclusive Economic Zone (1983-1984 through 2010-2011) (Green and Campbell 2010 (1976-1977 through 2007-2008) and TPWD unpublished data (2008-2009 through 2010-2011).

Survey Year[1]	Fishing Pressure (man-hours X 1,000)	Finfish Landings (X 1,000)
1976-1977	3,415.7	3,698.9
1977-1978	4,486.0	3,504.0
1978-1979	4,383.2	3,009.9
1979-1980	4,146.8	2,701.8
1980-1981	5,245.0	3,933.5
1981-1982	4,550.5	2,504.8
1982-1983	4,580.4	2,645.7
1983-1984	4,485.3	2,816.1
1984-1985	4,165.7	1,490.0
1985-1986	5,044.0	2,448.2
1986-1987	4,955.0	1,998.9
1987-1988	6,201.8	2,522.0
1988-1989	5,417.8	1,994.8
1989-1990	4,725.6	1,463.3
1990-1991	4,721.5	1,324.9
1991-1992	5,130.6	1,826.7
1992-1993	5,895.9	2,348.6
1993-1994	6,073.8	2,154.4
1994-1995	6,785.6	2,433.4
1995-1996	6,258.6	2,101.8
1996-1997	6,362.4	2,519.2
1997-1998	6,338.7	2,294.0
1998-1999	6,856.5	2,474.0
1999-2000	8,088.2	2,674.1
2000-2001	6,905.7	2,446.0
2001-2002	6,682.4	2,052.8
2002-2003	6,569.4	2,061.8
2003-2004	6,559.6	1,999.1
2004-2005	6,374.6	1,984.1
2005-2006	6,543.1	1,982.9
2006-2007	6,164.1	1,888.4
2007-2008	6,333.3	1,838.7
2008-2009	5,799.1	1,776.0
2009-2010	5,747.3	1,700.3
2010-2011	6,106.7	2,093.5

[1] Survey year = May 15 of one year to May 14 of next year.

Table 6.23 Sport boat flounder landings (number of fish X 1,000) in Texas marine waters from May 1976 to May 2011. Sport boats = private boats and party boats combined. Texas marine waters = bays/passes (1976-1977 through 2010-2011), Texas Territorial Sea (1983-1984 through 2010-2011), and U.S. Exclusive Economic Zone (1983-1984 through 2010-2011) (Green and Campbell 2010 (1976-1977 through 2007-2008) and TPWD unpublished data (2008-2009 through 2010-2011).

Year	Southern Flounder	Gulf Flounder	Ocellated Flounder	Unidentified Flounder	Total Flounder
1976-1977	85.0				85.0
1977-1978	102.2				102.2
1978-1979	105.8				105.8
1979-1980	500.7				500.7
1980-1981	180.2				180.2
1981-1982	145.4				145.4
1982-1983	180.9				180.9
1983-1984	133.8	7.7	0.06		141.6
1984-1985	131.5	1.6	0.05		135.0
1985-1986	157.9	2.3			165.8
1986-1987	127.8	6.8	0.20		134.0
1987-1988	200.4	13.4			211.0
1988-1989	138.1	6.9			147.1
1989-1990	102.7	3.9			108.4
1990-1991	125.4	2.9			134.1
1991-1992	168.7	9.7	0.22		175.6
1992-1993	164.5	9.6			173.9
1993-1994	152.7	3.0	0.06		161.7
1994-1995	134.0	5.2	0.05		146.3
1995-1996	132.3	4.1		0.11	140.6
1996-1997	115.1	4.3	0.05		125.5
1997-1998	95.3	3.9			103.2
1998-1999	136.7	1.8	0.07		144.0
1999-2000	144.8	4.0	0.06		154.3
2000-2001	118.8	1.4		0.06	128.4
2001-2002	98.7	1.5		0.06	104.0
2002-2003	94.6	1.2			102.2
2003-2004	119.8	0.7			124.6
2004-2005	95.6	0.3			103.2
2005-2006	63.4	0.3			71.2
2006-2007	55.8	0.2			63.0
2007-2008	46.2	0.2	0.04		51.1
2008-2009	65.8	0.3		0.03	70.6
2009-2010	41.0	0.2			47.1
2010-2011	45.4	0.5	0.04		53.3

[1] Survey year = May 15 of one year to May 14 of next year.

most sought recreational species in Texas. Ditton and Hunt (1996) reported southern flounder as the third species of choice, following spotted seatrout and red drum, among Texas saltwater anglers.

Since 1976, the majority of southern flounder landings were reported from bays and passes by private-boat fishing with some landed from Gulf areas (Texas Territorial Sea and EEZ). The number of fish landed ranged from 41,000 (2009-10) to 500,700 (1979) (Table 6.23). Landings have fluctuated around 100,000-200,000 fish since 1979 but have been substantially lower in the last six years. Since 2005, less than 66,000 southern flounder have been landed per year in Texas. Other species of flounder reported in the landings include Gulf and ocellated flounder. The Gulf flounder is the second most landed species of flounder on the Texas Coast with landings ranging from 200-13,400 individual fish (Table 6.23).

Gigging for southern flounder occurs on the Texas Coast with the majority harvested from a boat. During a special night flounder gig study from July 15 to December 15, 1991 (TPWD unpublished data), recreational giggers were interviewed at boat ramps and selected wade/bank areas. Of the 176 interviews conducted, 162 were recreational fishermen (82 at boat ramps and 80 at wade/banks). Interviewees (N=162) reported that 55.4% gig from a boat, 38.6% wade, and 6% do both. The number of gigging trips per year for those who gig by boat ranged from one to 100, while anglers who gig while wading reported taking one to 75 trips. Only 12.2% and 17.3% of the boat and wading giggers, respectively, fished one trip per year. Approximately 75% of the wade and boat giggers went on 15 and 24 gig trips per year, respectively. The amount of expenditures reported by these anglers per trip ranged from \$0-\$2,000; with 50% spending around \$15-\$20 per trip.

In 2007, another nighttime flounder gigging study was conducted to estimate gigging effort on the Texas coast (TPWD unpublished data). Data collection was conducted by direct intercept at ramps and river/channel bank locations which were followed up with roving counts of empty boat trailers (boat ramps), pre-trip interviews, and lanterns at wade bank access sites on weekdays and weekends to expand the intercept estimates. It was determined that gigging effort is higher from Matagorda Bay to Corpus Christi Bay with more pressure on weekend days. In the pre-trip interviews, recreational gigging activity was higher than commercial gigging activity.

Bycatch

Bycatch in a fishery can be classified into two different types: 1) incidental catch and 2) discarded catch. Incidental catch refers to retained or marketable catch of non-targeted species. Discarded catch is the portion of the catch returned to the sea because of regulatory, economic, or personal considerations. When possible, these terms will be used in this section; otherwise, the overall catch of non-targeted species will be described as bycatch.

Commercial

A substantial number of flounder occur as bycatch in the Gulf of Mexico's commercial shrimp industry. Classified as 'incidental catch', flounder bycatch represents a substantial proportion of commercial landings and provides an economic supplement for trawlers. In an eight-month study during 1978, Matlock (1982) estimated 9,741,000 southern flounder (3-15 inches TL) and 195,700 Gulf flounder (4-12 inches TL) were caught by commercial shrimp trawlers in Texas. The number of southern flounder caught, consisting mostly of juveniles, was estimated to be 13 times higher than the directed fishery (commercial and recreational). Eight other species of flatfish were caught during the sample period: bay whiff, hogchoker (*Trinectes maculatus*), ocellated flounder, blackcheek tonguefish (*Symphurus plagiusa*), lined sole (*Achirus lineatus*), spiny flounder (*Engyophrys senta*), fringed flounder, and shoal flounder.

Fuls et al. (2002) conducted a study to characterize discarded catch (returned to the water and not retained) in commercial shrimp trawls in Texas bays during the spring and fall commercial bay-shrimp seasons from 1993-1995. This study found that southern flounder was the most abundant recreational species caught during the study period, though the catch per unit effort (CPUE) was less than 0.2% of the total discarded catch. The CPUE was highest in Sabine Lake and lowest in Corpus Christi Bay. Except for Sabine Lake, the CPUE was consistently greater in spring than fall. The mean length of southern flounder caught was between 6 and 11 inches TL.

Since 1998, bycatch reduction devices (BRD) have been required in all shrimp trawls fishing in the Exclusive Economic Zone (EEZ) of the Gulf of Mexico and in the state waters of Florida and Texas; however, they are not required in Alabama, Mississippi, or Louisiana state waters. BRDs have shown to be effective in reducing bycatch (Branstetter 1997). Since flounder is a component of bycatch caught in shrimp trawls, flounder will inherently benefit from the use of BRDs, as mortality is reduced. Also, Texas has introduced a buyback program for licenses in the shrimp industry which is estimated to have decreased the overall bycatch in the bays by at least 80% (Riechers 2008). In turn, this bycatch reduction benefits flounder populations.

Passive fishing gears, including nets and crab pots, also have an impact on bycatch of flounder. Evidence exists of flounder caught by ghost fishing in lost or abandoned blue crab traps (GSMFC 2003). Each of the five Gulf states has implemented a derelict blue crab trap removal program using volunteers and state biologists to assist in the cleanups. Between 2002 and 2011, 75,628 derelict blue crab traps were removed from the Gulf of Mexico (GSMFC unpublished data), but estimates suggest that approximately 250,000 derelict traps are added each year (Guillory et al. 2001).

In 2011, NOAA released the first U.S. National Bycatch Report (Karp et al. 2011), a comprehensive document that details discarded catch (bycatch was defined as such within the paper) estimates for fisheries and species. The report constitutes a comprehensive baseline for evaluating improvements and informing strategic investments in the estimation and reduction of discarded catch. The report uses data from 2005 for most species (Brooke 2011). The average annual discarded catch of southern flounder in the Gulf of Mexico shrimp trawl fishery was reported to be ~1.3M lbs (Karp et al. 2011). The next update is expected in 2013 which will include data through 2010 (Brooke 2011).

Recreational

Bycatch within the recreational catch includes any non-targeted species that is harvested or returned to the water. The magnitude and composition of the discarded catch is influenced by local size and bag limits, anglers' species preference, and time of year. Information on the numbers of fish caught and released is one of the elements required to evaluate the mortality of released fish and thus aid in the evaluation of harvest limiting regulations.

The MRFSS/MRIP data from 2000 through 2011 was queried to obtain an overview of bycatch for Florida (west coast), Alabama, Mississippi, and Louisiana when fishermen were targeting Gulf flounder, southern flounder, left-eye flounder genus, or left-eye flounder family (NOAA personal communication). Texas does not take part in the MRFSS/MRIP Program. Each state's top species harvested incidentally while fishermen were targeting flounder and the top species discarded or unavailable for inspection by the interviewer during these targeted trips are discussed below. The percent of flounder that make up the incidental catch and discarded/unavailable catch is also included.

Florida (West Coast)

When fishermen targeted flounder recreationally in Florida between the years 2000 and 2011 the top five species that were harvested incidentally were spotted seatrout, red drum, Spanish mackerel (*Scomberomorus maculatus*), black seabass (*Centropristis striata*), and bluefish (*Pomatomus saltatrix*). During these targeted trips, Gulf and southern flounder were harvested as well representing 38% and

11% of the harvested species, respectively. The top five species that were discarded, or harvested but unavailable for inspection by the MRFSS/MRIP interviewer, while on directed flounder trips were spotted seatrout, red drum, lizardfish genus (*Synodus* spp.), ladyfish (*Elops saurus*), and pinfish (*Lagodon rhomboides*). Of the discarded/unavailable catch during trips targeting flounder, left-eye flounder family, left-eye flounder genus, and Gulf flounder made up 13%, 3%, and 2%, respectively, of discarded or unavailable species (NOAA personal communication).

Alabama

The top five species harvested incidentally by fishermen targeting flounder recreationally in Alabama between 2000 and 2011 were spotted seatrout, sand seatrout, red drum, southern kingfish (*Menticirrhus americanus*), and Atlantic croaker (*Micropogonias undulatus).* During these targeted trips, Gulf and southern flounder represented 3% and 52% of the harvested species, respectively. The top five species that were discarded or harvested but unavailable for inspection by the MRFSS/MRIP interviewer while targeting flounder were Atlantic croaker, sand seatrout, pinfish, hardhead catfish (*Ariopsis felis*), and spotted seatrout. Of the discarded/unavailable catch, left-eye flounder genus, Gulf flounder, and southern flounder made up 4%, 1%, and 7% respectively of the discarded species (NOAA personal communication).

Mississippi

When fishermen targeted flounder recreationally in Mississippi between the years 2000 and 2011, six species were harvested incidentally; sand seatrout, spotted seatrout, Atlantic croaker, red drum, southern kingfish, and black drum (*Pogonias cromis*). During these targeted trips, southern flounder equaled 39% of the harvested species. The top five species that were discarded or harvested but unavailable for inspection by the MRFSS/MRIP interviewer while targeting flounder were Atlantic croaker, spotted seatrout, sand seatrout, hardhead catfish, and red drum. Southern flounder were only 29% of the total discarded/unavailable catch during targeted fishing trips (NOAA personal communication).

Louisiana

The top five species harvested incidentally by fishermen targeting flounder recreationally in Louisiana between the years 2000 and 2011 were red drum, spotted seatrout, sand seatrout, black drum, and freshwater drum (*Aplodinotus grunniens*). During these targeted trips, southern flounder represented 51% of the harvested species. The top five species discarded or harvested but unavailable for inspection by the MRFSS/MRIP interviewer were red drum, Atlantic croaker, spotted seatrout, hardhead catfish, and black drum. Of the discarded/unavailable catch, southern flounder made up 14% of the species discarded (NOAA personal communication).

Texas

From 1984-1986, Saul (1992) estimated that 1.85 fish were caught and released for every fish retained in Texas. Campbell and Choucair (1995) estimated discarded catches of more than 3M fish during a period where 1,800,200 fish were retained (i.e., for every fish kept, 2.25 to 2.49 fish were released). In the bays and passes, flounders (all flounder) were the tenth highest non-retained species preceded by spotted seatrout, hardhead catfish, red drum, Atlantic croaker, silver perch (*Bairdiella chrysoura*), black drum, sand seatrout, ladyfish, and sheepshead (*Archosargus probatocephalus*). Spotted seatrout made up about 36% of total discarded catch, whereas flounders (southern and Gulf flounders grouped) comprised only 1%. In the Gulf, flounders constituted less than 1% of discarded catches (Campbell and Choucair 1995). During this study, flounders occurred in 6% and less than 1% of the bays and passes and the Gulf interviews, respectively.

TPWD data was queried to obtain a list of species that were incidentally caught and retained in 2011 during recreational fishing trips that had been targeting flounder in Texas. Atlantic croaker, black drum, gray snapper (*Lutjanus griseus*), ocellated flounder, pigfish (*Orthopristis chrysoptera*), red drum, sand seatrout, sheepshead, southern kingfish, Spanish mackerel, and spotted seatrout were caught during these trips. Sand seatrout, spotted seatrout, and red drum were the most frequently retained species (Fisher personal communication).

Mariculture

Various researchers studied southern flounder under laboratory conditions that have implications for management. Lasswell et al. (1978) successfully induced spawning of southern flounder by utilizing carp pituitary hormone. Arnold et al. (1977) regulated photoperiod and temperature to simulate seasonal variations which induced adult southern flounder to spawn (Table 3.16). Deubler (1960) experimented with the effects of salinity on growth of postlarval southern flounder. Since southern flounder adapt physiologically to salinity both seasonally and with age, rapid growth in an aquaculture operation could be expected if the proper salinity regimes were adjusted to meet optimum requirements (Stickney and White 1974a).

In laboratory studies, Lasswell et al. (1977) noted low fecundity and a low percentage of fertilization and hatching success and did not recommend this species for mass culture. However, Arnold et al. (1977) proved southern flounder could be successfully raised and maintained to fingerling size under laboratory conditions. Henderson (1972) considered southern flounder a hardy species for freshwater stockings and introduced fingerlings into freshwater reservoirs. Recaptured fish exhibited growth equal to or exceeding that recorded in coastal waters.

White and Stickney (1973) indicated the presence of a hierarchical structure in flatfish populations in early life. Larvae and early juveniles became dominant and may be out competing smaller fish for a sufficient amount of food even at low stocking densities. They suggested food (and its presentation) and disease control as the two areas of major concern to all larval fish development. Decay of food remnants could promote bacterial and ammonia accumulation; being sight feeders, flounder must be trained to accept nonliving food. Feeding of live brine shrimp (*Artemia salina*) to postlarvae and larvae could alleviate some of these problems. In preliminary aquaculture studies, Stickney and White (1974b) described the presence of the viral disease 'lymphocystis'. Although not often fatal, the presence of whitish nodules on fins and body could reduce marketability. This problem was seemingly solved by use of secondary tank filters and soft ultraviolet light sterilization. Another condition common to fish reared in fiberglass tanks lacking a natural substrate was ambicoloration. This condition could also affect marketability.

TPWD has begun an extensive culture program to enhance southern flounder stocks of the Texas Coast. Nims (2012) pointed out the recreational and commercial importance of flounder in Texas waters. Currently, flounder production and research are conducted at Sea Center Texas, Marine Development Center and Perry R. Bass hatchery facilities. Expansion of production capabilities is underway along with the development of a genetic map and markers. Also, researchers are conducting studies of salinity and cold tolerances on pre and post-metamorphic larval flounder. Since 2009, TPWD hatcheries have stocked 178,000 southern flounder on the Texas Coast.

Chapter 7

Description of Processing, Marketing, and Economic Characteristics of the Fishery

This section will discuss some of the underlying economic characteristics of the commercial and recreational flounder (Gulf and southern) fisheries in the Gulf of Mexico region during the 1970-2011 period. Initially, trends in the overall commercial ex-vessel value will be discussed. Although this report attempts to address Gulf and southern flounder in aggregate, the NMFS reported landings are for 'flatfish,' which includes all species of flounder (Table 6.1). Louisiana provides landing data for 'southern' flounder during 2002-2011, while Texas also provides very limited speciation during the same period. Commercial ex-vessel value represents the total amount paid by the first handler to the harvester during the initial offloading of the fish. The price applicable during this transaction is referred to at the ex-vessel price, making reference to the price per pound received by the vessel operator for whole fish. Markups that might occur in subsequent market levels are not included. Annual and monthly nominal (not adjusted for inflationary changes) ex-vessel values will be discussed for each state and the Gulf in general. Annual and monthly nominal ex-vessel prices will be discussed for the region, by state where appropriate, and by gear type. Information on ex-vessel prices and ex-vessel value provides basic insight into the economic importance and performance of the commercial flounder harvest sector.

The sources and uses of flounder by finfish wholesale distributors and processors in the Gulf states will also be discussed. This information provides insight into the importance of the Gulf of Mexico stocks to flounder purveyors in the region, as compared to flounder obtained from other domestic sources and foreign suppliers. This information also provides a more complete assessment of the sources and dispensation of flounder with the Gulf region markets. Unfortunately, the volume and value of flounder sold by the wholesale market sector, as well as the price margins from the ex-vessel to wholesale market levels, are not readily available. Limited information on consumption of flounder will be discussed to provide some insight into the importance of flounder to retail consumers in the region.

The economic importance of flounder as a recreationally-targeted species will also be addressed. Unfortunately, there are few studies that furnish information that provides a direct measure of the value recreational anglers place on flounder in the Gulf. These studies provide for only a partial assessment of the economic importance of this species to recreational fishing activities in the Gulf. Measurements of trip expenditures are discussed and provide insight into the economic value that recreational anglers place on flounder in the Gulf.

Finally, the replacement costs associated with flounder are discussed. These estimates utilize both recreational and commercial values and provide fishery managers and law enforcement agencies with the economic values associated in replacing fish potentially lost through natural phenomena, man-induced habitat destruction, pollution events, and regulatory violations.

Commercial Sector

The following section will focus on reported estimates for ex-vessel value. References to landings volume are also made but not specifically reported in accompanying tables. The reader should refer to Table 6.1 for reported landings volumes.

Table 7.1 Annual nominal flounder ex-vessel value (X $1,000) for the Gulf states, 1970-2011 (TPWD, LDWF, and FWC unpublished data, NOAA personal communication).

Year	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Gulf-Wide
1970	68	135	20	85	65	373
1971	77	155	23	77	76	408
1972	81	188	21	89	120	500
1973	79	136	17	56	105	393
1974	66	180	16	65	149	476
1975	69	174	23	62	176	504
1976	80	196	19	96	180	571
1977	110	163	23	102	171	561
1978	145	210	28	123	173	679
1979	201	272	19	86	190	768
1980	189	226	15	85	154	669
1981	182	307	12	88	138	727
1982	250	303	22	104	521	1,200
1983	221	248	22	162	446	1,099
1984	163	173	22	219	351	928
1985	140	209	41	336	445	1,171
1986	198	237	15	576	540	1,566
1987	190	227	43	738	539	1,733
1988	199	138	29	469	338	1,173
1989	175	176	73	490	201	1,115
1990	195	187	64	490	188	1,124
1991	325	225	82	706	366	1,704
1992	236	175	42	940	396	1,789
1993	271	209	54	1,219	367	2,120
1994	243	228	56	1,278	385	2,190
1995	223	287	78	757	518	1,863
1996	147	253	62	70	447	979
1997	234	253	54	124	342	1,007
1998	178	254	94	163	423	1,112
1999	213	264	164	161	603	1,405
2000	190	285	184	223	322	1,204
2001	255	238	131	92	250	966
2002	230	291	63	80	371	1,035
2003	254	210	49	68	332	913
2004	216	230	32	80	325	883
2005	227	247	20	30	243	767
2006	184	223	36	112	164	719
2007	172	261	58	110	62	663
2008	205	214	40	111	144	714
2009	273	197	58	198	90	816
2010	241	97	64	140	59	601
2011	280	221	118	248	205	1,072

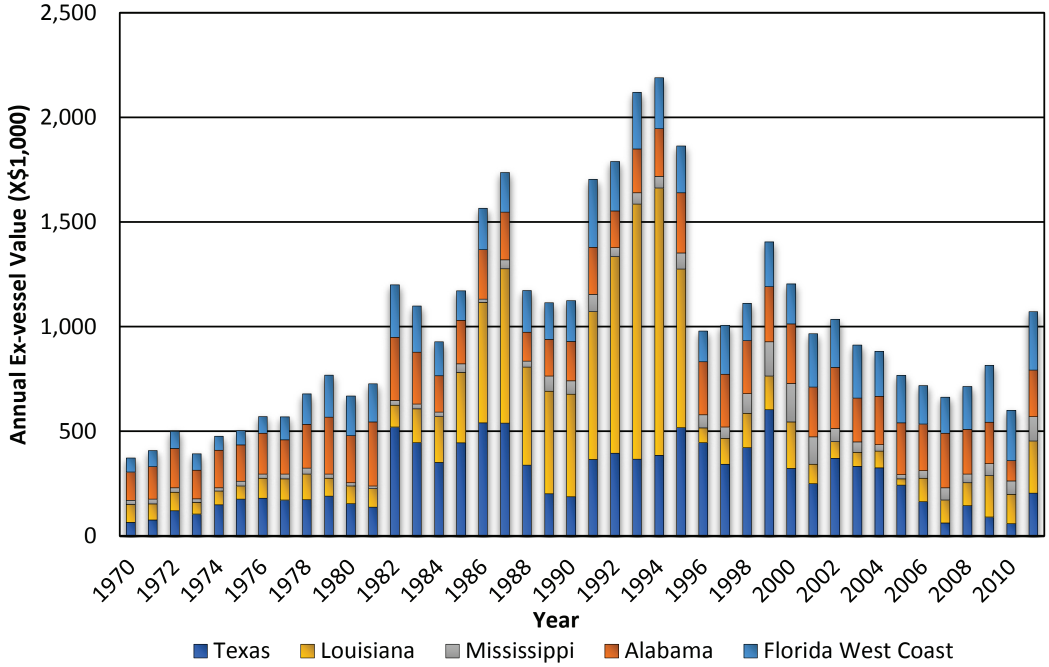


Figure 7.1 Gulf cumulative nominal ex-vessel values ($) of flounder landings by state from 1970-2011 (NOAA personal communication).

Annual Commercial Ex-vessel Value

Gulf-wide Ex-vessel Value

The ex-vessel value for flounder in the Gulf exhibited a somewhat steady upward trend from 1970-1982 (Table 7.1). Nominal ex-vessel value increased from $373,000 in 1970 to $1.2M in 1982. During this same period, landings followed a declining trend (Table 6.1). From 1983-1997, ex-vessel value became somewhat erratic, and value declined to less than $1.0M in 1984. In 1987, value increased to $1.7M. In 1989, value declined to $1.1M, increased to $2.0M in 1993, and decreased again to $979,000 in 1997. Landings followed a similar pattern of peaks and troughs in volumes during this same period (Figure 7.1). Ex-vessel value was $1.1M in 1998, increased briefly, then established an erratic, declining trend until 2011, when ex-vessel value was again reported to be approximately $1.1M. From 1970-1983, average annual ex-vessel value was $638,000. From 1984-1997, average annual ex-vessel value more than doubled to $1.5M. Average ex-vessel value during the 1998 to 2011 period then declined to $919,000.

Ex-vessel Value by State

The annual ex-vessel value for flounder in Florida exhibited an increasing trend from 1970-1982 (Table 7.1 and Figure 7.2a). Nominal ex-vessel value for flounder increased from $68,000 in 1970 to $250,000 in 1982. Ex-vessel value then decreased to $140,000 in 1985 and increased to an all-time high of $325,000 in 1991. Ex-vessel value then decreased steadily to $147,000 in 1996, becoming relatively stable through 2011. Annual ex-vessel value maintained an average annual value of $230,000 during the 1997 to 2011 period.

Ex-vessel value for flounder in Alabama has been relatively stable during the entire 1970-2011 period. Ex-vessel value, however, followed an increasing trend during the 1970 to 1983 period, increasing from $135,000 in 1970 to about $300,000 in 1981 and 1982 (Table 7.1 and Figure 7.2b). From 1983-1997, ex-vessel value of flounder in Alabama remained fairly steady with an average annual value of $215,000. Flounder ex-vessel value also remained relatively steady from 1997-2011, with an average annual value

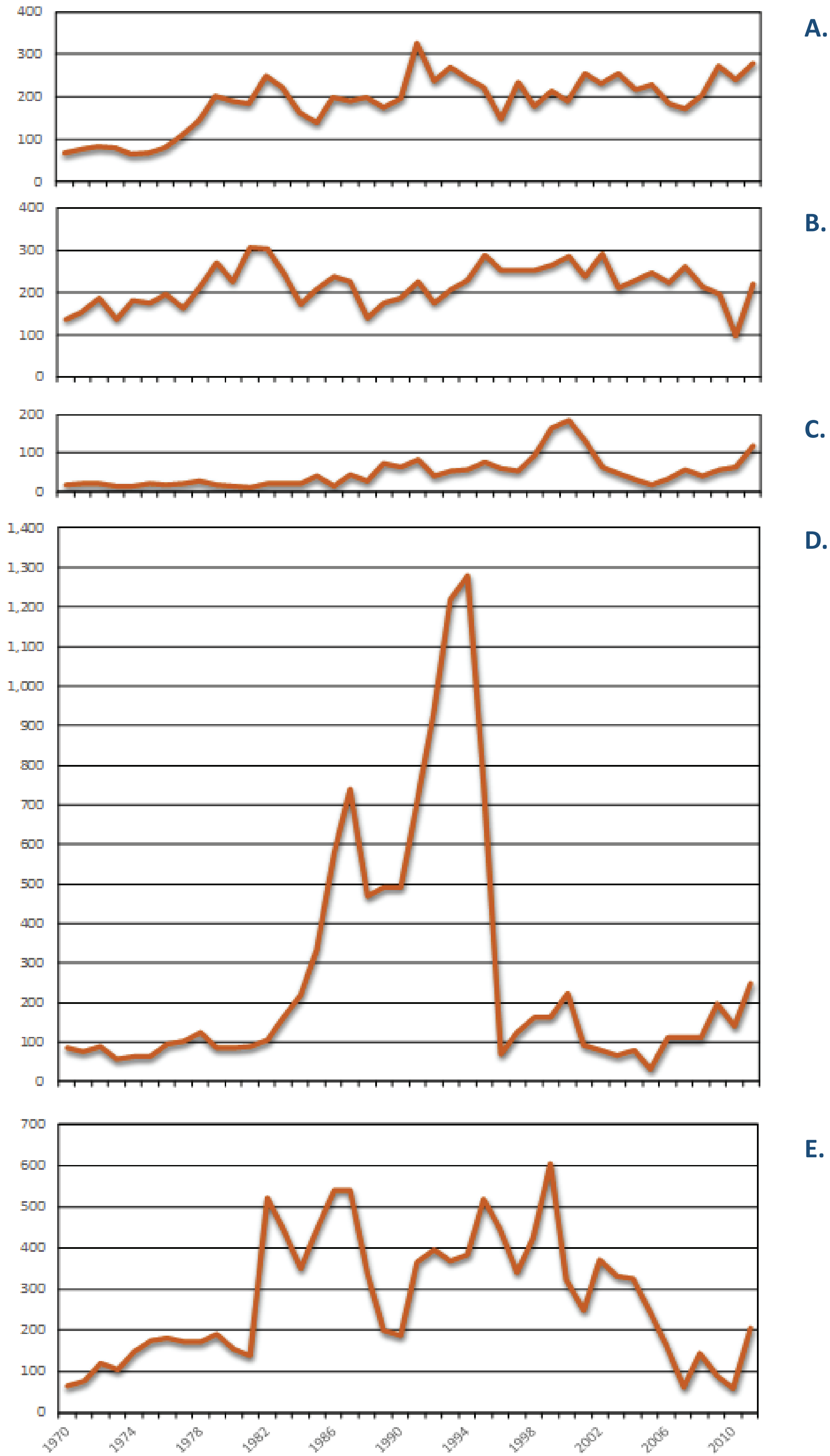


Figure 7.2 Annual nominal ex-vessel values ($) from 1970-2011 for A.) Florida West Coast, B.) Alabama, C.) Mississippi, D.) Louisiana, and E.) Texas (NOAA personal communication).

of $230,000 during this period. The only 'outlier' year would be 2010, which exhibited a relatively lower annual ex-vessel value of $97,000.

Annual ex-vessel values for flounder are the least in Mississippi when compared to the other states in the Gulf region. Annual ex-vessel values averaged $19,000 during the 1970-1983 period (Table 7.1 and Figure 7.3c). Average annual ex-vessel value increased to $51,000 during the 1984-1997 period, with ex-vessel value exhibiting an erratic increase from $22,000 in 1984 to relatively 'high' years during 1989 ($73,000), 1991 ($82,000), and 1995 ($78,000). Ex-vessel value then increased dramatically during 1999 ($164,000), with the 1999-2001 period having an average annual ex-vessel value of $160,000. However, ex-vessel value then declined sharply to $63,000 in 2002 and exhibited an average annual value of $47,000 during the 2002-2010 period. Ex-vessel value increased to $118,000 in 2011.

Annual ex-vessel value of flounder in Louisiana averaged $92,000 from 1970-1983 (Table 7.1 and Figure 7.4d). Ex-vessel value was somewhat erratic during this period, with a low of $56,000 in 1973, to a high of $162,000 in 1983. During the 1984-1994 period, ex-vessel value increased dramatically, being driven by increased landings volumes and strong ex-vessel prices. Ex-vessel value increased from $219,000 in 1984 to about $1.3M in 1994. Ex-vessel value then began a dramatic decrease in 1995 ($757,000), with value decreasing to $70,000 in 1996, just two years after setting an all-time high in 1994. Ex-vessel value continued to remain relatively low during the 1998-2011 period, with average annual ex-vessel value during this time period of $130,000, compared to an average of $601,000 during the 1984-1997 period.

Annual ex-vessel value of flounder in Texas averaged $190,000 from 1970-1983 (Table 7.1 and Figure 7.2e). During this period, ex-vessel value varied from a low of $65,000 in 1970 to a high of $521,000 during 1982. The prohibition of red drum and spotted seatrout commercial sales in 1981 resulted in redirected effort in 1982 toward flounder by the commercial sector. However, commercial landings of flounder declined following implementation of the Texas net ban in 1988. During 1984-1987, ex-vessel value increased to approximately $540,000, then declined to $188,000 in 1990. Ex-vessel value then increased steadily, with an all-time high of $603,000 reached in 1999. Ex-vessel value averaged $387,000 during the period from 1984-1997. Ex-vessel value then fell from $423,000 in 1998 to $59,000 in 2010, increasing to $205,000 in 2011. The average ex-vessel value during the 1998-2011 period was $257,000.

Table 7.2 Average flounder monthly nominal ex-vessel value (X $1,000) for the Gulf states from 2007-2011 (NOAA personal communication). Note: The average monthly value for January in Louisiana does not contain data for January 2007.

Month	Florida West Coast	Alabama	Mississippi	Louisiana	Texas
January	3.8	3.3	0.4	0.7*	0.7
February	3.4	1.9	0.8	1.5	1.2
March	10.9	7.9	2.2	0.4	3.5
April	24.4	13.4	5.9	0.7	5.8
May	40.2	13.9	8.2	1.1	10.0
June	31.6	19.2	11.9	2.4	12.0
July	19.3	24.7	11.0	1.4	10.0
August	21.2	27.1	10.1	2.7	16.9
September	21.4	30.8	4.5	3.3	12.8
October	23.7	23.1	6.1	45.4	19.0
November	23.3	28.1	5.0	90.7	6.7
December	10.9	5.0	0.7	11.0	13.5

Monthly Commercial Ex-vessel Value

Average monthly ex-vessel values, by state, are examined from 2007-2011 (Table 7.2). The five-year average ex-vessel value was estimated for each month by state. Nominal values are estimated. Average monthly ex-vessel values for the Gulf states followed similar patterns. Monthly reported ex-vessel values typically peak in the fall months, and the lowest values occurred during late winter or early spring months. Ex-vessel values generally exhibit an upward trend beginning early in the year until a peak is reached in late summer or the fall. An exception to this specific pattern was for the Florida Gulf Coast which exhibited a peak in average monthly ex-vessel values during May but also had an increase in ex-vessel value during the fall months. In addition, average monthly ex-vessel values for Mississippi exhibited a peak in the summer months, but then declined to the lowest levels during the winter, which was similar to all other states.

Annual Ex-vessel Prices for Flounder

Gulf-wide Ex-vessel Prices

From 1970 to 1988, nominal annual ex-vessel prices ($/lb) for flounder increased steadily from $0.19 in 1970 to $1.04, respectively (Table 7.3). Gulf-wide ex-vessel prices continued to exhibit an upward trend through 2010, with only relatively minor price decreases being exhibited during a few years (i.e., 1989, 2000, 2004, and 2006). Gulf-wide ex-vessel prices first exceeded $2.00 in 2005 ($2.06), with an all-time high of $2.26 in 2010. Ex-vessel prices declined to $2.12 (a 6% decrease) in 2011. However, over the majority of the 1970-2011 period, Gulf-wide ex-vessel prices for flounder exhibited a steady increase, with only minor decreases being reported.

Ex-vessel Prices by State

Although variability in ex-vessel prices is likely found on a regional or offloading site basis, existing data do not allow disaggregation beyond the state level. In general, nominal ex-vessel prices for flounder exhibited increasing trends from 1970-2011 for the Gulf states (Table 7.3). Prices for flounder landed in Texas typically exceeded those for all other states, except Florida, for a few select years. Texas prices typically exceeded Florida prices during the 2001-2011 period, when the highest prices for all states were reported. Prior to 1990, ex-vessel flounder prices for each state increased at a relatively stable pace. However, beginning in 1990, ex-vessel prices became more variable on an annual basis. Ex-vessel flounder prices for most Gulf states began increasing dramatically in 1993, reaching all-time highs during the 2007-2010 period. Ex-vessel prices for all Gulf states exhibited a slight decline during 2011.

7.1.4 Monthly Ex-vessel Prices for Flounder

Average monthly ex-vessel prices for flounder were estimated from the period 2007-2011 for each state (Table 7.4). In general, flounder prices were the lowest during the winter months. The trend associated with higher prices was less obvious across states. For example, Florida and Louisiana had higher prices during the summer and early fall, whereas prices for Texas and Alabama peaked in the spring and summer. Prices were generally higher for Texas and Florida, with lowest prices being reported for Louisiana.

Ex-vessel Prices by Type of Harvest Gear

Factors such as seasonal shifts in landings and demand, supply of closely substitutable species, and region of harvest may affect the per pound ex-vessel price for flounder in general or on a species-specific basis. In addition, the harvest gear used may have some influence on the ex-vessel price received. For example, a gear which allows the individual harvested fish to be handled more gently (less damage through crushing, tearing, etc.) and provide a quicker access to the market may result in a perceived, or actual, higher quality product. If buyers recognize these quality attributes and a market for these attributes exists, then a higher per unit price may result.

Table 7.3. Nominal annual ex-vessel prices ($/lb whole weight) for flounder in the Gulf states, 1970-2011 (NOAA personal communication).

Year	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Gulf
1970	0.23	0.17	0.13	0.18	0.22	0.19
1971	0.26	0.16	0.14	0.17	0.24	0.19
1972	0.27	0.16	0.14	0.18	0.26	0.19
1973	0.30	0.19	0.18	0.20	0.31	0.23
1974	0.29	0.20	0.16	0.21	0.29	0.23
1975	0.32	0.21	0.22	0.26	0.36	0.27
1976	0.34	0.24	0.23	0.29	0.41	0.30
1977	0.41	0.27	0.32	0.77	0.55	0.41
1978	0.49	0.33	0.35	0.40	0.73	0.44
1979	0.50	0.41	0.35	0.44	0.82	0.49
1980	0.53	0.45	0.36	0.53	0.79	0.53
1981	0.58	0.52	0.41	0.64	1.06	0.61
1982	0.63	0.48	0.43	0.52	0.97	0.66
1983	0.69	0.49	0.44	0.59	0.94	0.67
1984	0.72	0.56	0.50	0.62	0.92	0.71
1985	0.76	0.55	0.47	0.63	1.00	0.72
1986	1.14	0.61	0.54	0.70	0.96	0.79
1987	1.06	0.79	0.75	0.78	0.98	0.86
1988	1.30	0.90	0.85	0.92	1.23	1.04
1989	1.02	0.93	0.94	1.00	1.21	1.02
1990	1.01	1.12	1.03	1.07	1.25	1.09
1991	1.38	0.98	0.96	1.02	1.16	1.09
1992	1.28	1.03	1.02	1.20	1.27	1.20
1993	1.57	1.19	1.20	1.36	1.52	1.38
1994	1.60	1.15	1.37	1.31	1.66	1.37
1995	1.64	1.38	1.37	1.42	1.73	1.51
1996	1.75	1.70	1.68	1.13	1.84	1.70
1997	1.86	1.72	1.42	1.31	1.83	1.70
1998	1.87	1.72	1.74	1.16	1.94	1.70
1999	1.88	1.70	1.76	1.14	2.10	1.78
2000	2.09	1.79	1.67	1.26	2.02	1.73
2001	2.02	1.74	1.56	1.02	2.06	1.73
2002	2.05	1.65	1.37	0.98	2.14	1.76
2003	2.12	1.78	1.58	1.06	2.13	1.87
2004	2.00	1.67	1.78	1.08	2.15	1.81
2005	2.18	1.90	2.00	1.36	2.27	2.06
2006	2.33	1.89	2.25	1.33	2.42	1.97
2007	2.46	1.96	2.42	1.39	2.55	2.01
2008	2.70	1.96	2.35	1.44	2.48	2.12
2009	2.73	2.03	2.32	1.51	2.84	2.12
2010	2.71	2.02	2.29	1.73	2.93	2.26
2011	2.48	1.99	2.15	1.64	2.75	2.12

Table 7.4 Nominal average monthly ex-vessel prices ($/lb whole weight) for flounder in the Gulf states, 2007-2011 (NOAA personal communication).

Month	Florida West Coast	Alabama	Mississippi	Louisiana	Texas
January	1.82	1.69	2.04	0.88	2.81
February	2.33	2.02	2.30	1.10	2.65
March	2.66	2.06	2.37	1.13	3.06
April	2.68	2.10	2.34	1.35	2.78
May	2.68	2.02	2.28	1.37	2.84
June	2.68	2.05	2.33	1.56	2.79
July	2.74	2.08	2.31	1.40	2.90
August	2.81	1.96	2.24	1.39	2.80
September	2.78	2.08	2.31	1.60	2.71
October	2.56	1.99	2.17	1.68	2.65
November	2.44	1.95	2.05	1.56	2.15
December	2.19	1.60	2.36	1.31	2.43

Nominal ex-vessel prices ($/lb) were computed for landings of flounder by major gear type during the 2002-2011 period (Table 7.5). These prices represent ex-vessel prices for flounder across all Gulf states, except where noted. The prices were computed by dividing total nominal ex-vessel value for each gear type by the respective landings for each gear type. The gear types selected for comparison included those that accounted for the majority of landings reported within the Gulf region, even if some gears were only used in certain state(s). The gear types selected included gigs/spears, hook/line, trawls (otter, etc.), skimmer/butterfly nets, gill nets, traps, and cast nets. The reported landings for these select gear types (3.4M lbs) represented approximately 82% of the total landings of flounder reported for all gear types (4.1M lbs) in the Gulf of Mexico region during the 2002-2011 period.

The highest ex-vessel prices are associated with flounder landed with spears, followed by cast nets, hook/line, and gill nets. The relatively lower prices are associated with traps, skimmer/butterfly nets, and trawls. The lowest ex-vessel prices are associated with flounder caught by trawls.

Table 7.5 Nominal ex-vessel flounder prices ($/lb) by gear type for the Gulf of Mexico from 2002-2011 (FWC and TPWD unpublished data, NOAA personal communication).

Year	Gigs / Spears	Hook / Line	Trawls (combined)	Skimmer / Butterfly Nets	Gill Nets (MS, AL)	Traps (FLW, LA)	Cast Nets
2002	2.10	1.76	0.77	1.02	1.71	1.40	1.87
2003	2.24	1.81	0.97	1.26	1.87	1.23	1.84
2004	2.13	1.86	0.93	1.17	1.72	1.77	2.05
2005	2.18	1.91	1.16	1.01	1.98	1.43	1.81
2006	2.35	2.03	1.12	1.34	1.82	1.48	2.02
2007	2.51	2.21	1.27	1.41	2.02	1.40	2.42
2008	2.60	2.36	1.47	1.44	2.05	1.66	2.48
2009	2.76	2.24	1.45	1.50	2.10	1.62	2.46
2010	2.67	2.32	1.45	1.81	2.02	1.91	2.50
2011	2.55	2.03	1.40	1.66	2.05	1.59	2.21
Average	2.41	2.05	1.20	1.36	1.93	1.55	2.17

Processing and Marketing

Market Channels

Few studies have been conducted to describe the processing and marketing of flounder in the Gulf of Mexico. In particular, no studies have attempted to describe the marketing channels associated with flounder in the region. Degner et al. (1989) examined the marketing channels for mullet in Florida. However, the variety of products derived from mullet (i.e., fillets, smoked, roe, split carcasses for bait, and gizzards) provided for a more complex market channel system than would be anticipated for flounder.

To better understand the market system for flounder in the Gulf of Mexico region, a brief market survey was originally designed and conducted by the GSMFC in 1996 (GSMFC unpublished data). This survey solicited information on sources of flounder supply, product forms, and disposition of flounder products in and out of the Gulf states. The relative importance of various product forms demanded by wholesalers, retailers, restaurants, and retail consumers was also solicited. This survey was repeated, with minor changes to the survey instrument, in 2013, thereby soliciting information for the 2012 calendar year. Information of this nature will allow a better understanding of the economic values associated with the flounder resource as the various products derived from it move from vessel to final consumer. The original survey instrument was mailed to seafood wholesale distributors. The 2013 survey was conducted by NMFS port agents and various state fisheries management staff via face-to-face interviews of fish house operators. Of the total number of survey interviews conducted, 15 were with Florida firms, 15 with Alabama firms, five with Mississippi firms, and no interviews were completed with Texas and Louisiana firms. A total of 35 responses were obtained. A copy of the most recent survey instrument is located in Chapter 11. The findings of the 2013 survey are discussed below.

Respondents were asked about the source of their supply during 2012. Approximately 57% of the flounder purchased by wholesalers in the Gulf was obtained directly from local harvesters, while 2% was obtained from out-of-state harvesters. Another 26% was obtained from other in-state wholesalers, while 15% was obtained from out-of-state wholesalers (Table 7.6). Of the total amount of flounder handled by the respondents, about 3% was obtained from foreign imports (GSMFC unpublished data).

Respondents were then asked to describe the product forms into which the initial supplies were converted. Overall, of the total amount of flounder obtained from harvesters and other wholesalers, respondents indicated that most were left as fresh, round/whole form (69%) for final sale, while 28% was processed into fillets and 3% into ‘Other’ product forms for final sale. Approximately 78% of the total sales were as fresh product, while the remaining 22% was sold as frozen product.

Respondents were asked to describe how their sales were distributed across buyers and what product forms were demanded by these buyers (Table 7.7).

Wholesale Buyers - Sales to wholesale buyers accounted for 23% of flounder sales, with 8% and 15% of those sales going to in-state and out-of-state wholesale buyers, respectively. The majority (91%) of flounder product sold to wholesaler distributors/processors remained in round/whole form, while

Table 7.6 Sources of flounder supply for wholesalers in the Gulf states in 1996 (GSMFC unpublished data).

Supply Source	In-State (% of Total)	Out-of-State (% of Total)
Fishermen	57%	2%
Other Wholesalers	26%	15%
Other Domestic Sources	0%	0%

Table 7.7 Sales (percentage) by sector and product forms for flounder wholesalers in the Gulf states (GSMFC unpublished data). Percentages given by respondents (see survey instrument in Section 13.2) are summed and divided by the total number of responses, including zero (0) responses. Missing values are excluded. Percentages are computed only for those market channels utilized by respondents.

Market Sector	Destination Percent			Product Form Sold[1]				
	In-State	Out-of-State	Total	Whole	Fillets	Other	Fresh	Frozen
Wholesalers	8%	15%	23%	91%	9%	0%	90%	10%
Retailers	17%	2%	19%	47%	51%	2%	80%	20%
Restaurants	10%	2%	12%	42%	49%	9%	54%	46%
Retail Consumers	46%	-	46%	58%	42%	0%	67%	33%
Total (*average %*)	81%	19%	100%	*(59%)*	*(38%)*	*(3%)*	*(73%)*	*(27%)*

[1] These values represent indices of importance relative to each product form for the respective market sector.

9% of sales to wholesalers was sold as fillets. Of the total amount sold to wholesalers, 90% was fresh, with the remaining 10% sold frozen.

Retail Buyers - Sales to retail buyers accounted for 19% of flounder sales, with 17% and 2% being sold to in-state and out-of-state retail buyers, respectively. Of the flounder product sold to retail buyers, 47% was sold as whole product, while 51% of sales to retail buyers was sold as fillets. An additional 2% was sold as some 'Other' form of product. Of the total amount sold to retail buyers, 80% was fresh, with the remaining 20% sold frozen.

Restaurants - Sales to restaurants accounted for 12% of flounder sales, with 10% and 2% being sold to in-state and out-of-state restaurant buyers, respectively. Of the flounder product sold to restaurants, 42% was sold as whole product, while 49% of sales to restaurants was sold as fillets. An additional 9% was sold as some 'Other' form of product. Of the total amount sold to restaurants, 54% was fresh, with the remaining 46% sold frozen.

Retail Consumers - Sales to retail consumer buyers accounted for 46% of flounder sales. The majority (58%) of flounder product sold to retail consumers remained in round/whole form, while 42% of sales to retail consumers was sold as fillets. Of the total amount sold to retail consumers, 67% was fresh, with the remaining 33% sold frozen.

Across all buyer types – A total of 81% of flounder sales by respondents was made to in-state buyers, while the remaining 19% was made to out-of-state buyers. In addition, an average of 59%, 38%, and 3% of sales were in whole, fillet, and other product forms, respectively. Also, 73% of sales were as a fresh product, while 27% was sold frozen.

Whole product represented the most important product form for wholesale buyers. However, fillets and whole form were of almost equal importance for sales to all other types of buyers. In addition, all types of buyers apparently preferred fresh product, although frozen product was more important to restaurant and retail consumer buyers. Finally, in-state sales were the most important component of the regional market while an additional 20% of total flounder sales went to out-of-state buyers.

Processed Product

Flounder landed in the Gulf of Mexico is sold in a variety of products forms, including whole and processed product. A number of processing facilities are located within the Gulf region, but due to

Table 7.8 Volume and value of processed (all product forms) flounder in the Gulf region, 1990-2012 (NOAA personal communication).

Year	Volume (processed weight, 1,000 lbs)	Value ($ 1000)
1990	898	2,019
1991	989	2,225
1992	360	873
1993	524	1,250
1994	456	1,080
1995	549	1,559
1996	449	1,073
1997	505	1,303
1998	701	1,760
1999	587	1,357
2000	973	2,898
2001	573	1,308
2002	571	1,284
2003	460	1,027
2004	456	1,026
2005	704	2,392
2006	111	449
2007*	157	427
2008	203	560
2009	182	431
2010	214	509
2011	277	738
2012	417	1,230

* The data for 2007 contained a record that contained values for pounds and value that were an order of magnitude greater than any other reported values. Thus, these 'outlier' values were well outside two standard deviations for both pounds and values.

confidentiality reasons, the volume and value of processed flounder cannot be provided on a state basis. However, the aggregate volume and value is provided on an annual basis for the 1990-2012 period (Table 7.8).

Aggregate, annual volumes and values for processed flounder product, as reported by the NMFS-certified processors, exhibited an erratic, decreasing trend during the 1990-2012 period. Volume and value were at a peak during 1991 (989,000 lbs and $2.23M, respectively). Volume and value declined dramatically during 1992, but then increased in 1993 and remained somewhat stable during the 1993-1999 period, with an average annual reported processed volume and value during this period of 539,000 lbs and $1.34M. However, annual volume and value peaked again in 2000, then declined through 2004, with another peak occurring in 2005. Both annual volume and value declined dramatically in 2006, remaining at considerably lower levels through 2012. The average annual processed volume and value during the 2000-2005 period was 623,000 lbs and $1.66M, respectively. These average annual amounts fell to 223,000 lbs and $621,000, respectively, during the 2006-2012 period.

Table 7.9 Processed flounder by product form (1990–2012) as reported in the Gulf Region (NOAA personal communication).

Product Form	Volume	Value
Breaded and Stuffed	19%	21%
Dressed	57%	47%
Fillet	11%	15%
Stuffed	14%	18%
Whole	<1%	<1%

Flounder is processed into a number of product forms, such as 'Breaded and Stuffed', 'Dressed', 'Stuffed', 'Whole' and 'Fillets'. Due to confidentiality issues, the volume and value reported by product form cannot be provided by year or by state. However, a discussion of the relative importance of these product forms across the overall time period in which the data are reported by NMFS is possible. For example, 'dressed' products dominated the reported volume and values throughout the majority of the 1990-2012 time period, though 'Breaded and Stuffed' products represented the majority of the volume and value during the very early (1990 and 1991) and most recent (2011 and 2012) reporting years. During the entire 23-year time period from 1990-2012, the average annual percent of total processed volume and processed value associated with each product form is provided in Table 7.9.

Consumption Estimates

Few studies exist that indicate the importance of flounder to consumers. Published per capita seafood consumption estimates do not identify species-specific, fresh, finfish products and are not provided on a regional basis (USDOC 1997). A study by Degner et al. (1994) estimated weekly and annual per capita consumption (edible meat weight) by Florida residents for 34 saltwater and freshwater finfish species and 11 shellfish species. In addition, per capita consumption estimates for a number of processed products were also derived. Among all finfish species likely consumed in fresh or frozen form, the per capita consumption estimate for flounder was exceeded only by grouper. The study found that resident, adult Floridians consume approximately 2.4 lbs of flounder each year. This represented about 10% of all finfish consumed, including canned and further processed products. Degner, et al (1994) did not provide consumption estimates for flounder that were disaggregated into species of flounder or source (i.e., domestic and imported). However, of the total amount of flounder consumed, approximately 12% was obtained via recreational fishing. A study of seafood consumption in Louisiana found that 8.7% of that state's residents prefer to eat 'flounder' (Research Strategies, Inc. 1996). USDA via the Continuing Survey of Food Intake by Individuals (CSFII) found that the U.S. population, on average, consumed 0.58g of 'flounder' per person, per day, uncooked equivalent (USEPA 2002).

Table 7.10. Mean trip expenditures ($) for angling trips during 2011 on which flounder was targeted (MRFSS/MRIP and TPWD unpublished data).

State in which Trip Occurred	Private Boat Mode	Shore Mode
Florida West Coast	$12	NA
Alabama	$58	$22
Mississippi	$26	$20
Louisiana	$44	$47
Texas	$162	$133
Gulf of Mexico Region	$61	$42

Recreational Sector

Saltwater recreational fishing represents an important industry to the Gulf states. The economic importance of recreational fishing arises from the benefits that individuals accrue from consumptive and non-consumptive uses of the resources as well as the economic activities set in motion by the supportive industries dependent upon recreational fishing expenditures. Saltwater recreational fishing for all species results in angler expenditures alone of $2.21B in Florida (both coasts), $124.0M in Alabama, $155.0M in Mississippi, $205.0M in Louisiana, and $888.0M Texas (Maharaj and Carpenter 1997). Unfortunately, expenditures specifically associated with effort targeting flounder have not been regularly estimated. An exception is a survey conducted by the TPWD (unpublished data) of the nighttime flounder gig fishery in Texas. This study indicates that approximately 90% of the fishery participants, whether fishing from boats or wading, spent less than $100/trip. Similar studies for flounder fishing in other areas of the Gulf, as well as for other modes of fishing, do not exist. No studies have attempted to estimate the economic importance of activities associated with recreational fishing for flounder in the Gulf. Therefore, the relative importance of flounder as a recreationally-targeted species must be inferred from the degree in which recreational anglers specifically target flounder at the local or state level as discussed in Chapter 6. These studies provide some insight into the popularity and preference associated with this important Gulf of Mexico finfish resource. However, the true economic values associated with flounder, such as recreational anglers' willingness to pay for access to the resource and the economic impact to local economies resulting from resident and non-resident recreational angler expenditures, is currently unknown.

Table 7.11 Civil restitution values ($/fish) for individual flounder by size (TPWD 2013).

Size (inches)	Texas	Size (inches)	Texas
1	$0.11	24	64.70
2	0.11	25	72.88
3	0.23	26	81.75
4	0.36	27	91.35
5	0.80	28	101.70
6	1.64	29	112.83
7	2.38	30	124.78
8	3.02	31	137.58
9	4.24	32	161.26
10	5.67	33	165.85
11	7.35	34	181.38
12	9.31	35	197.89
13	11.56	36	215.42
14	14.15	37	233.98
15	17.10	38	253.61
16	20.44	39	274.36
17	24.19	40	296.24
18	28.40	41	319.30
19	33.08	42	343.56
20	38.26	43	369.06
21	43.99	44	395.83
22	50.28	45	423.91
23	57.18		

The MRFSS/MRIP program has attempted to measure expenditures associated with recreational angling trips when flounder was the targeted species (Table 7.10). Expenditures were highest for Texas, with mean expenditures for private boat trips and shore trips where flounder was targeted of $162 and $133, respectively. In contrast, expenditures for private boat and shore trips where flounder was targeted in Mississippi were $26 and $22, respectively. The average private boat and shore-based expenditures in the Gulf region on trips where flounder was targeted were $61 and $42, respectively.

Civil Restitution Values and Replacement Costs

Some states have assigned monetary values wherein they assess damage for the loss of finfish resulting from negligence or illegal activities. These values are determined in a variety of ways for both recreationally and commercially important species. Cost of replacement may be assessed based on the costs associated with hatchery production, willingness to pay by users and non-users, or travel cost expenditures by recreational users. The individual states may utilize additional methods for estimating the value associated with an individual fish for the purpose of damage assessment, such as utilizing existing market prices for commercially important species and estimated hourly valuation of fishing for recreationally-important species (LDWF 1989, TPWD 2013). The American Fisheries Society (Southwick and Loftus 2003) has estimated replacement values for certain species (primarily freshwater) and provides the methods for determining these values. State civil restitution values may be linked directly with these published estimates and methods.

Restitution values vary considerably by state. Values for flounder in Texas are a function of size (Table 7.11). For example, values for flounder in Texas range from $0.11, $14.15, to $124.78 for one-inch, 14-inch, and 30-inch fish, respectively (TPWD 2013). In Florida and Louisiana, a fixed per each restitution value ($16.80 and $16.08, respectively) is assessed for all sizes of southern flounder (FDEP 1995, LAC 2011). These values provide at least some means for assessing the damage to stocks of flounder. Mississippi has utilized the Louisiana values for previous fish kill valuations. Alabama has not applied restitution for flounder to date.

Chapter 8

Social and Cultural Framework of Domestic Fishermen and Their Communities

There is virtually no information available to describe the socio-cultural characteristics of the flounder fishery participants in the Gulf of Mexico. Further, socio-cultural values are qualitative in nature making it difficult to measure social valuation of marine resources and fishing activities. In the first version of the management plan for Gulf and southern flounder (VanderKooy 2000), there was very little direct data on flounder fishermen and anglers. Due to the nature of the fishery being primarily 'incidental catch', proxies from other fisheries were applied. Today, the availability of socio-cultural data has not improved, as demographic information has not been recently updated for the other commercial and recreational fisheries. Thus, this chapter will describe what is known regarding the user groups that catch flounder, by sector (commercial and recreational) and by gear type (trawls, nets, gigs/spears, and hook-and-line).

Fishermen generally use the generic terms 'flatfish' or 'flounder' (or, regionally, 'flattie'), and do not distinguish flounder to the species level (Gulf or southern) for identification. Although fishermen with knowledge of the species-habitat relationship would be more likely to identify flounder by species (Gulf and southern), using the generic term flatfish or flounder remains the most salient common name for both of these species. There does not appear to be a cultural preference for one species over the other; rather, fishermen encounter flounder opportunistically according to the predominant substrate in the region. Thus, regional landings represent the available species, rather than fishermen having a species preference. In addition, there is no economic benefit to species identification in the seafood dealer/processor level; all flounder fetch the same price per pound regardless of species further reinforcing use of the generic terminology. Finally, in regions where there is not overlap of the two dominant species, there is even less need to identify the fish and only the generic term would be used. Therefore, we will provide regional specific information when available but the characterization of the flounder fishery participants will discuss flounder generically, ignoring the different species.

Introduction

Flounder are some of the most recognizable fish, even among fishing novices (Boster and Johnson 1989), and very popular to eat. While other non-targeted fish may be discarded when caught, a flounder will almost always be retained. Yet despite its popularity, flounder tend to be landed incidentally or as part of a multi-species fishing activity, creating an overlap among the fisheries and user groups. Commercially, flounder can be the primary target species or incidentally caught while fishing for another species (e.g. shrimp). This makes it difficult to define and discuss the characteristics of commercial flounder fishermen, and to identify their reliance on flounder to generate income. Although there are avid recreational flounder anglers, and an increase in the small directed fishery of gigging or spearing flounder, flounder remains best described as a popular, opportunistic fishery.

Targeted versus Incidental Catch/Bycatch

Targeted (or directed), and 'bycatch' are concepts related to identifying waste or unintended catches in fishing activities and are widely used by fishery managers and environmental non-government organizations (NGOs). Unfortunately, bycatch is often used to differentiate between the desired and undesired catch. We define these terms in Chapter 6 for our purposes and split 'bycatch' into two additional categories, incidental and discarded catch. 'Incidental catch' refers to retained or marketable catch of non-targeted species. 'Discarded catch' is the portion of the catch returned to the sea because of regulatory, economic, quality, or personal considerations. In other words, most commercial and recreational fishermen do not consider desirable species to be bycatch unlike certain other species, particularly the hardhead catfish (*Ariopsis felis*), which are considered a nuisance by most saltwater anglers and more accurately designated as 'bycatch'. From the fishery manager perspective, these terms are primarily used to categorize the species landed on fishing trips. From a sociologist's perspective, these terms may be useful to evaluate sociocultural importance.

There is an inherent conflict in describing a highly prized fish like flounder as 'bycatch' yet a large part of the total commercial and recreational harvest is retained despite not being targeted. Although flounder is considered a desirable catch, flounder is not often the primary target species of recreational fishing trips; red drum and spotted sea trout tend to dominate lists of favorite target species. Nevertheless, flounder is usually a welcome addition to a fisherman's creel basket during inshore recreational fishing trips. Likewise, flounder are frequently retained by commercial fishermen actively pursuing other species like shrimp or other finfish and kept as incidental catch. The amount of non-target species has been severely restricted in recent years over concerns related to the mortality of discards but flounder, unless undersized, are rarely discarded and do provide some supplemental income to the commercial fishermen's take. Table 8.1 outlines the allowable targeted and incidental catches by commercial fishermen in each of the Gulf states.

Without available socio-cultural data, including descriptions of participants in the flounder fishery and socio-demographics, landings data are commonly used to examine fishing behavior and effort; management measures are restrictions to effort. A causal relationship is not implied and may not exist between implementation of an effort restriction and subsequent years' landings. Effort is influenced by many factors and a decline in landings does not imply overfishing. Numerous other factors affect landings including preference and abundance of other species (effort shifts); fuel prices and other economic considerations; season closures; regulatory changes; and environmental events or weather conditions.

Table 8.1 Current size and bag limits for flounder in the Gulf of Mexico.

State	Species	Commercial		Recreational	
		Min Length (Inches)	Bag/Possession	Min Length (Inches)	Bag/Possession
Florida	Flounder Gulf Southern Summer Fringed	12 TL	Incidental bycatch - 50lb/ day	12 TL	10/10
Alabama	Flounder	12 TL		12 TL	10/10
Mississippi	Flounder	12 TL	QUOTA	12 TL	15/15
Louisiana	Flounder	NONE	10/licensed commercial fishermen/day (Does not apply to shrimp boats – incidental percentages apply)	NONE	10/10
Texas	Flounder (All Species)	14	30/person with commercial finfish license 5/licensed shrimp boat captain November pole and line only and limit 2	14	5/person/day (Jan-Oct, Dec) 2/person/day pole & line only (Nov)

Commercial Harvesters

Prior to the implementation of several regulations directed at the commercial sector (Table 8.2), the commercial flounder fishery was predominantly an incidental catch fishery; most commercial flounder was retained from commercial nets and trawls while engaging in other fisheries. These regulations did not address flounder specifically; rather, the use of entanglement nets was restricted or prohibited in several states, and bycatch devices [turtle excluder devices (TEDs) and bycatch reduction devices (BRDs)] were required in commercial trawls. Being an incidentally landed species from these gear types, flounder landings were affected indirectly (Figure 8.1). Since the implementation of regulations in the 1990s, landings of flounder from nets and trawls have decreased substantially in Florida and Mississippi, which collect gear type data for commercial landings. Landings by gear type before and after these regulations are not available for Louisiana and Texas, although it is likely that these regulations affected commercial flounder landings similarly in these states. Recent data from the states recording flounder landings by gig/spear (Florida, Alabama, and Mississippi) have shown an increase in the proportion of flounder landed by this gear type. Other gear types, including hook and line, represent small proportions of landings (Tables 6.4, 6.6, 6.8, and 6.10).

Compared to shrimp and other finfish (snappers and groupers), flounder landings from commercial trawls are relatively minor by weight and value, making it difficult to identify any commercial reliance on the flounder (Figure 8.1). For example, in 2009, 29% of Gulf-wide commercial flounder were landed in the two coastal counties of Alabama (Mobile and Baldwin). As a proportion of commercial trawl landings for all species in those counties alone, flounder only represented 0.34% of the total landings by weight and 0.52% by value while shrimp landings represented 76.9% by weight and 84.3% by value of the total

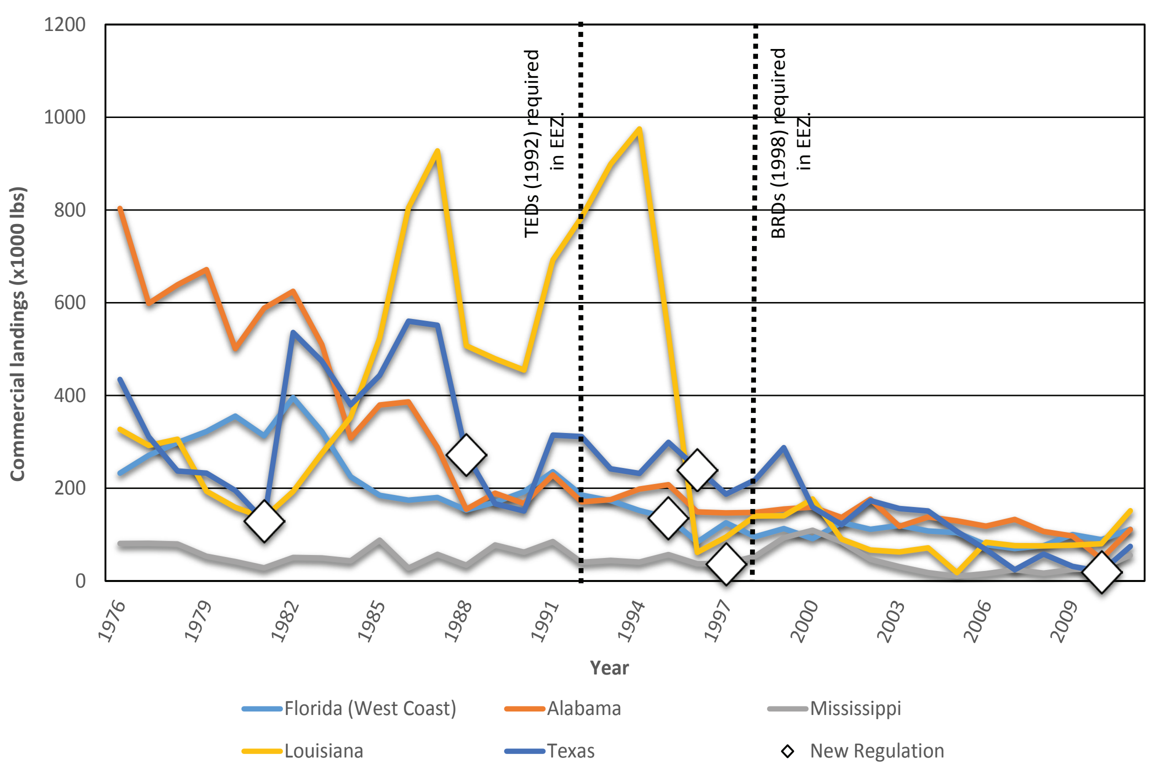


Figure 8.1 Commercial flounder landings by state from 1976-2011 (all gear types combined) and timeline of regulations implementation, by state (NOAA personal communication). A description of the corresponding regulation is provided in Table 8.2.

Table 8.2 Brief history of regulations affecting commercial harvest including prohibitions on nets and requirements for turtle excluder devices (TEDs) and bycatch reduction devices (BRDs).

Year	Regulatory Actions				
	Florida	Alabama	Mississippi	Louisiana	Texas
1981					Ban on commercial sale of red drum and spotted sea trout
1988		Ban nets on south shore of Bon Secour Bay			Net ban and 12" min size on flounder
1992	Federal: TEDs required in all trawls in the EEZ. Mississippi requires TEDs in state waters.				
1995	July 1: prohibited use of commercial entanglement (gill and trammel) nets within 3 miles			Ban on entangling (gill and trammel) nets (had most comm flounder landings from '85 til then, in Gulf)	Limited entry for shrimpers
1996					Minimum size increased to 14", and a 60 fish bag limit, 2 bag possession.
1997			Gill/trammel nets must be constructed of degradable material	Incidental bycatch of flounder on commercial vessels not to exceed 100 lbs per trip.	
1998	Federal: BRDs required in all trawls in the EEZ (state waters excluded).				
2002					Implementation of shrimp effort reduction and vessel buy back program.
2010					30 fish bag limit, 2 bag possession.

landings. This illustrates the difficulty in drawing conclusions about commercial fishermen's engagement and reliance on flounder fishing, given its relatively small position within all Gulf finfish fisheries.

Following the adoption of prohibitions on certain types of nets, implemented in most Gulf states, the proportion of flounder landings from net and trawl gears decreased dramatically. Aggregated commercial net and trawl gears, in 1991, represented 60.3% of all the flounder landings in Florida and 94% of Mississippi's commercial flounder landings. In 1996, the shrimp and groundfish trawl fisheries contributed an estimated 19.9% of total landings in Florida, Alabama, and Mississippi while the remnant gill and trammel net fisheries landed an estimated 40.1% of the flounder. In the same year, another 35.5% was taken by gig, hook and line, and spear fishers (NOAA personal communication). By comparison, in 2011, aggregated landings from nets and trawls represented 2.6% of Florida's landings and 0.3% of Mississippi's commercial flounder landings. In contrast with other Gulf states, Alabama has not prohibited or severely restricted the use of gill and trammel nets, and commercial harvesters continue selling incidentally caught flounder. This is reflected in the commercial flounder landings from nets and trawls, which have remained more stable over time; 95% of 1991 landings and 83.1% of 2011 landings were landed from nets and trawls, with annual average landings fluctuating around these values (Table 8.3). However, a buyback program has reduced the number of permits for these gear types.

Landings by gear type are not available for Louisiana prior to 2000 thus it is not possible to quantify changes in net and trawl landings of flounder before and after Louisiana's 1995 ban on entangling nets (gill and trammel). Nevertheless, it is recognized that the entangling net bans resulted in a sharp decrease in commercial flounder landings (Figure 8.1). Also, in 1997, Louisiana implemented regulations restricting the amount of bycatch a shrimp vessel may retain, to not more than 50% of the total weight of shrimp aboard and incidental bycatch of flounder may not exceed 100 lbs per trip. Today, the LDWF still does not collect landings data for gigs/spears, so it cannot be determined if commercial flounder landed by gig/spear is increasing in Louisiana.

In Texas, prior to 2007, the TPWD did not record commercial landings by gear type, preventing a comparable examination of changes in gear type used to land flounder over time, such as shifts in effort away from shrimping due to increasing regulatory pressure. Since 2007, Texas does categorize their flounder landings into three gear types using trip tickets; trawl, hook and line, trotline, and gig. Nevertheless, commercial landings overall have declined sharply since the state's 1988 net ban. In 2002, Texas implemented commercial limited entry and buy-back program of shrimp vessels which reduced flounder bycatch by at least 40% (Riechers 2008).

Social Change and Commercial Fishery Demographics

While it is possible to identify communities with high proportions of Gulf-wide landings and values, it is more difficult to characterize the fleet and its labor force, particularly regarding demographics and places of residence for captains and crews. There is little to no information on captains and crews, including their demographic makeup. Furthermore, commercial fishermen may switch between fisheries and gear types as part of their livelihood strategies; they may intensify or diversify their fishing strategies (McCay 1978). It has been shown in most of the Gulf fisheries that commercial harvesters will hold multiple licenses and endorsements and at any time of year will switch fisheries as prices and availability change (Perry and VanderKooy 2014). As limited effort programs are implemented by federal and state fisheries, retaining and renewing multiple endorsements allow commercial fishermen to adapt to resource availability, seasonal regulatory changes, and shifts in the economic value of the resource in the market. In addition, many fishermen engage in non-fishing wage labor to supplement their incomes part-time or seasonally. For example, many oil and gas workers in Louisiana also work in commercial fishing, moving back and forth between the two livelihoods as the economy changes (Horst and Holloway 2002).

Adaptive in the short-term, effort shifting may contribute to new problems requiring additional management. For example, after Texas banned the commercial sale of red drum and spotted seatrout

Table 8.3 Comparison of commercial flounder landings by gear type (NOAA personal communication).

Year	Florida		Alabama		Mississippi	
	Net/Trawl	Gig/Spear	Net/Trawl	Gig/Spear	Net/Trawl	Gig/Spear
1991	60.3%	15.2%	95.0%	5.0%	94%	4.80%
1997	15.1%	55.1%	80.0%	20.0%	54.90%	32.20%
2009	4.0%	72.4%	91.0%	7.1%	6.20%	50.00%
2011	2.6%	81.3%	83.1%	13.7%	0.30%	86.30%

in 1981, commercial flounder landings increased (Johns 1990). As fishermen were no longer authorized to harvest the newly declared sport fish species, some had adapted by shifting effort toward other species, including flounder. A few years later in 1988, Texas implemented a ban on the use of nets, which corresponded with the sharp decline in commercial flounder landings.

Most commercial flounder is landed using trawls, nets, and gig/spears. The net and trawl regulations of the 1990s contributed significantly to the decline in commercial flounder landings; although, in relation to the broader impacts on the fleets from the regulations, any impacts were proportionately minimal (Gallaway personal communication). Alongside decreased landings from trawls and nets, the proportion of landings coming from gig/spears has increased in states that monitor landings by this gear type (Florida, Alabama, and Mississippi). In recent years, there has been a steady increase in flounder landings by gig/spear in Mississippi (Table 6.8), while landings in Alabama and Florida fluctuate widely. It is unknown if some commercial fishermen have shifted effort from other fisheries, if there are new entrants to the commercial flounder fishery, or if increases in flounder landed by gig/spear reflect opportunistic conditions.

Trawl Harvesters

As noted above, socio-demographic profiles do not exist in the Gulf region for those participating in the flounder fishery; however, considering the importance of flounder in the other directed fisheries, some assumptions can be made using published information in other fisheries such as the commercial shrimp fishery and other net fisheries.

There is very little current demographic information for captains and crews in the Gulf shrimp fishery but some attempts have been made to quantify the proportion of participants of participants, such as Asian American, by ascribing 'Asian' identity based on the surname of the individual. These techniques have been shown to be successful in some cases, especially in tightly knit or racially segregated communities but are mostly limited to ethnically-based surnames; the technique has not worked well for all groups (i.e. African Americans) (Coldman et al. 1988, Fiscella and Fremont 2006). This methodology was utilized in an effort to identify the ethnicity of federally permitted shrimp vessel owners by NOAA Fisheries. However, since the entry of a large number of Southeast Asian immigrants in the 1970s, techniques like this may become less successful, and less useful, due to following generations becoming much more culturally integrated into American society and marrying across ethnic/racial groups. Nonetheless, the results of the NOAA surname study indicated that approximately one-third of the boats holding federal shrimp permits were owned and operated by fishermen of Southeast Asian descent (Crabtree 2007).

The results of NOAA's effort (Crabtree 2007) reflect the change and importance that Southeast Asian immigrants have had on the Gulf shrimp industry. Durrenberger (1994) pointed out that within a ten year period (1975-1985), the Vietnamese who arrived in Mississippi as refugees had become strong, effective participants in the shrimp fishing fleet. At this time, roughly 50% of the shrimpers and boats operating in Mississippi waters were of Southeast Asian origin. The original flounder FMP (VanderKooy 2000) provides a good overview of the issues that arose during that period as the recent immigrants merged with the traditional Gulf fishermen from all fisheries. Since that time, those types of conflicts have subsided (Gallaway personal communication) and while the current social structure of the fishery, including inter-ethnic group interaction, has not been investigated, it is not likely that ethnic identity continues to play the same role in the social structure of the community as it once did.

After several decades of involvement in the shrimp fishery and broader acculturation in American society, how the descendants of these immigrant families self-identify and the importance they place on their heritage is unknown. Ascribing identity does not improve on understanding the role ethnicity may play in the structure of social relationships underlying the fishery. Rather, research is needed on the social organization of shrimpers including intra or inter-ethnic group interactions. An ascribed identity cannot be assumed to match an individual's self-identity, nor can the importance of the self-identity be assumed in shaping that person's position or practice in the fishery.

Other Net Harvesters

The amount of commercial flounder landings coming from nets decreased significantly since implementation of the regulations in the 1990s largely displaced several types of nets (e.g., gill and trammel). In 1986, entanglement nets Gulf-wide contributed 345,843 lbs of flounder which was 17.5% of the total landings (NOAA personal communication). In 1997, Alabama and Mississippi were the only two states reporting entanglement net landings at 92,205 lbs, or 26.7% of the estimated total flounder landings although Louisiana did have landings but did not report by gear type (NOAA personal communication). Restrictions on material requirements of nets in Mississippi and Alabama further reduced their contribution to the Gulf flounder landings and, since 2001, there have been no reported flounder landings in Louisiana from entanglement nets (Table 6.10). A minor entanglement net fishery still exists in Alabama, but a buyback program implemented in 2008-2009 reduced the number of gill net licenses by about 25% to a total of 84 licenses in 2011 (Table 6.7).

Although the use of entangling nets has been greatly reduced in the Gulf, the gear still contributes a substantial amount of the commercial flounder landings, regionally (e.g., 74.8% of Alabama's landings in 2011). Dating back to the 1980s and 1990s, Alabama contributed a large portion of the mullet landings for the 'roe' fishery, which catered to supplying the high demand for mullet roe by the Japanese market overseas (Leard et al. 1995). However, with the decline in the demand for mullet roe and the restrictions regionally on entanglement nets, the mullet fishery is virtually non-existent and there is no socio-cultural data available on those who continue to purchase gill net licenses anywhere in the northern Gulf. VanderKooy (2000) provides a historical overview of the published information that was available prior to the sweeping gear restrictions that occurred throughout the 1990s, but there is nothing more recent which could provide insight into those who still participate and land flounder.

Gig Harvesters

In recent years, flounder harvested by gig represents an increasing share of commercial landings. Gigged flounder brings a better price than flounder landed incidentally from a trawl. Flounder is also relatively easy and accessible to gig, often found in shallow waters, physically accessible to waders from shore. There is minimal investment to begin fishing, beyond rigging a pole, a bucket, and a headlamp. The increase in demand for fresh, local caught seafood corresponds with an increase in consumer awareness and interest in wild, locally caught seafood. Despite providing a high quality, high demand product, gig harvesters are unable to significantly contribute to the total landings for flounder, primarily due to the method of fishing.

Gig fishing relies on direct sight, with the fisherman literally walking or floating over shallow water at night with a light. The fisherman must identify the partially buried, well camouflaged flounder lying still on the bottom and stab it with single or multi-point spear, the gig. Prevailing conditions (water clarity, bottom type, wave action) limit the 'good nights' in which gig fishermen can be successful, further restricting the amount of fish any single commercial gig fisherman can contribute to total landings. Commercial gig fishermen can have very low investments in their flounder gear which may be as simple as a basic gig and lamp, to very high investments involving elaborate shallow water skiffs with generators, overhead lighting, and platforms with railing from which to search the water bottom.

Although gig harvesting exists in each of the Gulf states, only Mississippi and Louisiana require a specific gear license to commercially harvest flounder; Mississippi's license is a combined gig/hook-and-line. Therefore, the ability to identify individuals who actually participate in the gig fishery Gulf-wide is not possible and as a result, no socio-cultural data on active participants are available at this time.

Hook-and-Line Harvesters

Most of the socio-cultural studies related to hook-and-line fishing that exists are based on the recreational sector. Little or no information exists on the makeup of the commercial harvesters in the Gulf, even though the contribution from commercial hook-and-line fishermen has increased in recent years. For example, Texas commercial finfish harvesters contribute even greater numbers of flounder since the designation of red drum and spotted seatrout as 'sport fish' in 1981 which eliminated them from the commercial market, and the 1988 net ban (Figure 6.13). Displaced from those fisheries, many commercial harvesters switched to other species and other harvesting techniques including commercial hook-and-line.

Dealers and Processors

Dealers and processors handling flounder in the Gulf are multi-species operations. Historically, these businesses are owned by white, middle-class males between the ages of 25-55 years old (Leard et al. 1993, VanderKooy 2000). Work in Texas by Osburn et al. (1990) indicated that individuals of Vietnamese, Cambodian, and Laotian decent comprised less than 9% of all licensed seafood dealers in 1985 and were concentrated adjacent to the Galveston Bay system. Although recent work was conducted looking at the economic aspects of the Gulf's dealers and processors (Miller et al. 2014a, 2014b), there is no data available on the social or cultural aspects of the industry.

Recreational Anglers

Among recreational fishermen, flounder often fall behind red drum and spotted seatrout as the reported preferred target species, but it is still regarded as an important fishery for both commercial and recreational fishermen (Adkins et al. 1998). Flounder are also included on many fishing tournaments, but garners fewer points compared to other species. Some anglers value them highly, though, and for them, it is the primary target species. Anglers vary in terms of their fishing knowledge and experience, and in their fishing behavior and their preferred target species. In addition to residents of coastal communities involved in the support industries of recreational fisheries, the recreational community consists of numerous participation roles (e.g., anglers, fishing guides and crew) and social organizations, such as clubs, tournaments, the recreational sector includes anglers, their representatives, fishing guides, fishing club members, and tournament participants, and various fishing practices that are used by different groups of anglers.

Studies describing recreational anglers specifically targeting flounder do not exist. Several studies have described flounder as a common non-target, yet highly-desired species for anglers (Deegan 1990, Ditton et al. 1990, Donaldson et al. 1991, Kelso et al. 1991). The reports that exist have been conducted at the state level, and the information gathered for each study differs by state making comparison difficult. Furthermore, these reports address recreational fishing generally; flounder make up a relatively small proportion of recreational landings of all finfish. Thus, generalizations about recreational fishermen cannot be assumed to apply to those engaged in the flounder fishery. Nevertheless, to evaluate the recreational harvest of flounder, anglers are most often categorized and discussed geographically by state, mode, and gear type.

Unlike commercial harvesters who usually live and work in coastal communities, most marine anglers live in urban or metropolitan statistical areas adjacent to the coast (USFWS 1996, Ditton and Hunt 1996). Recreational anglers travel to coastal communities to use the fishing-related infrastructures. These include facilities and services provided by state fisheries management agencies such as piers, launch ramps, and access areas, and those provided by the private sector: guides, boat rentals, marinas, private launch facilities, retail stores, restaurants, hotels, motels, campgrounds, and the rest of the tourism support system. Many of the people involved in the aforementioned businesses and facilities are connected in important social relationships, working together in local areas to promote their fishing destination as

Table 8.4 Participation rates for ethnicity, gender and age cohorts by state in the Southeast Region [a] (Table 3-1 *from* Milon 2001).

State	Alabama (%)	Florida (%)	Georgia (%)	Louisiana (%)	Mississippi (%)	North Carolina (%)	South Carolina (%)
White-Male							
16-25	9.01	8.86	9.23	9.73	9.34	7.44	7.45
26-45	26.47	29.3	28.44	34.01	29.98	24.97	26.52
46-64	20.89	19.86	16.2	17.04	18.3	20.23	18.2
65+	6.58	9.09	5.65	4.65	5.9	6.04	6.67
Total	62.95	67.11	59.52	65.43	63.52	58.68	58.84
White-Female							
16-25	2.86	2.74	2.82	2.97	3.32	2.55	2.69
26-45	10.59	11.83	12.62	12.14	12.04	11.75	11.7
46-64	7.44	7.54	7.16	6.38	7.62	7.73	6.59
65+	2.72	2.01	3.01	1.05	1.47	2.77	1.73
Total	23.61	24.12	25.61	22.54	24.45	24.8	22.71
Non-White Male							
16-25	2.15	1.15	0.94	1.55	1.6	1.55	2.6
26-45	4.15	2.95	4.71	4.4	4.42	5.64	5.89
46-64	1.43	1.7	3.01	3.04	1.97	3.09	3.81
65+	0.57	0.64	1.88	0.74	0.37	1.19	0.87
Total	8.3	6.44	10.54	9.73	8.36	11.47	13.17
Non-White Female							
16-25	0.29	0.26	0.56	0.74	0.25	0.72	0.52
26-45	2.72	1	1.51	0.74	1.23	2.19	2.08
46-64	1.57	0.8	1.32	0.62	1.6	1.58	1.73
65+	0.57	0.26	0.94	0.19	0.61	0.57	0.95
Total	5.15	2.32	4.33	2.29	3.69	5.06	5.28

[a] Percentages may not sum to 100% due to rounding.

more desirable than other communities in the region. Thus, people are directly involved through these networks and relationships, in shaping the identity of the community.

Regional Demographics and Recreational Angler Preferences

Little recent information is available about the socio-demographics of recreational anglers but historical descriptions can be found in Deegan (1990), USFWS (1996), Ditton and Hunt (1996), LDWF (1997), and Milon (2001). Milon (2001) utilized the existing Marine Recreational Fisheries Statistics Survey (MRFSS) to examine demographic data of recreational anglers (Table 8.4). The 'add-on' questions in the telephone portion of the survey from 1997-1998 indicated that the majority of saltwater anglers in the Southeast Region (excluding Texas which doesn't participate in the MRFSS or its newer version, the Marine Recreational Information Program (MRIP) program) examined were middleclass (<$60,000 annual income), Caucasian males between the age of 26-55 (47%). About 90% of all anglers surveyed were Caucasian, 7.5% were African American, and only a few participants (4.5%) identified themselves as Hispanic. Additionally, about 73% of all the respondents were male. During the same time period (1998), Floyd et al. (2006) conducted a phone survey of 3,000 Texas anglers in an effort to generate a profile of residents that participate in outdoor recreation in Texas and for fishing in general (not just saltwater).

The study essentially found that those most likely to participate in fishing as a recreational activity were Caucasian males with higher incomes, of middle-age or younger.

Florida

The USFWS (2014b) examined U.S. Census Bureau data to generate estimates of participation in hunting and fishing for each state. The Florida survey indicated that in 2011, 1.39M residents made 25.4M saltwater fishing trips in their state. Of those who responded, 12% of the resident anglers indicated targeting flounder (flatfish). In addition, similar proportions of the respondents (7-31%) also including the other species categories offered (striped bass, bluefish, red drum, seatrout, mackerel, Mahi Mahi, and tuna). Finally, 37.5% of the responding anglers included the 'Anything' category (USFWS 2014b). The wide range of species targeted may suggest that Florida anglers have more opportunity to fish a wider number of species groups and those responding to the Census Bureau survey do not necessarily target any one particular species consistently. Interestingly, nearly 50% of the responding anglers indicated 'Another type of saltwater fish' on the survey (snapper and grouper were not offered as options). Of those who did report fishing in the state, the majority were between the ages of 35 and 55 although each age bracket 25-65+ was well represented ranging from 13-23%. Anglers responding were male (76%) and non-Hispanic (94%) who earned between $50-100K annually (modal value). Racially, the majority of respondents identified themselves as 'White' (83%) and the remainder indicated 'African American' (14%) (USFWS 2014b).

A summary of the almost 900,000 Florida residents who purchased a saltwater fishing license in 2013 provides basic demographics of gender, ethnicity, and age (FWC unpublished data). In Florida, not separating for Atlantic of Gulf Coast, the majority of anglers required to purchase a license are male (75%) and are dominated by those identifying themselves as 'White' (86%). An additional 10% identify as 'Hispanic' and 2% as 'Black'. The remaining 2% include 'Asian', 'Native American', and 'Other'. Among the 'White' and 'Asian' ethnic groups, females made up a little more than 25% of the anglers in those groups. 'Black' females only comprised about 13% of the 'Black' anglers and 'Hispanic' females made up about 16% of the 'Hispanic' anglers (FWC unpublished data).

Florida residents holding saltwater licenses ranged in age from 1 to over 100 years old, because the number of 'lifetime' licenses is included with annual license data (FWC unpublished data). The majority of 'White' anglers (47.6%) were in the 40-59 age bracket. However, among 'Hispanic' anglers, the majority (65.7%) were slightly younger, between 25-49 years of age. A similar pattern was observed in 'Black' anglers with 51.3% in a broader age category of 30-59 years of age. It should be noted that the state of Florida exempts children under the age of 16 and resident seniors 65 and older from being required to purchase a fishing license and are not included in the data above unless they have been issued a 'lifetime' license (FWC unpublished data).

Alabama

Milon (2001) summarized saltwater anglers in Alabama using the MRFSS socio-economic add-on questions mentioned above. As with the other states included in the Southeast Region, Milon reported the majority of recreational anglers in Alabama were Caucasian males between the ages of 26-64 (47%). Almost 19% of the anglers were Caucasian women between the ages of 26-64 as well. In Alabama, a recreational fishing license is required for all permitted recreational gear types; to gig or spear flounder, no additional license is required. Thus, data are not available to identify the proportion of anglers using any gear type other than hook-and-line gear to harvest finfish. Since 1997/1998, no other socio-demographic work has been conducted to describe Alabama anglers.

The USFWS (2014a) examined U.S. Census Bureau data to generate estimates of participation in hunting and fishing for each state. The census data indicated that in 2011, 69,000 residents made 1.4M saltwater fishing trips in Alabama marine waters. When asked about type of fish they targeted, 100% of resident respondents indicated 'all types of fish' while an additional 54% also included 'another type of saltwater fish'. Interestingly, red snapper (*Lutjanus campechanus*) was not included in the list of species provided as options; flounder (flatfish) was not indicated by any respondents or may have been too low a number to be included (USFWS 2014a).

Mississippi

Deegan (1990) reported that in Mississippi the typical saltwater recreational angler was a 49 year-old male earning approximately $40K per year who had been fishing recreationally for nearly 30 years. Education level and ethnic background of respondents was not addressed in this survey. In the same survey, flounder ranked third among recreational anglers in Mississippi for species of preference behind spotted seatrout and red drum (Deegan 1990). The survey found that the average fisherman mostly fishes inshore areas, where these three species are found.

In the MRFSS add-on for 1997/1998, Milon (2001) reported that recreational anglers in Mississippi tended to be younger than in other states in the Southeast Region with the majority of respondents indicating they were 26-45 years of age. Again, Caucasian males and females dominated those surveyed at 63% and 24%, respectively. There were more non-Caucasian males reporting in Mississippi (8.36%) than in Florida (6.44%) but the difference was negligible between Mississippi and Alabama (8.3%). There have been no further efforts to characterize the ethnic or racial makeup of recreational anglers in the state. Prior to 2000, gig fishermen were exempted from the requirement to possess a general saltwater fishing license to harvest finfish including flounder, but after 2000 any recreational take required a general saltwater license. Because there is no 'gig' endorsement in Mississippi, it is not possible to differentiate recreational landings by gear/spear and from general hook-and-line.

The USFWS (2013a) examined U.S. Census Bureau data to generate estimates of participation in hunting and fishing for each state. The 2011 census data indicated over 116,000 individuals made 2.2M saltwater fishing trips in Mississippi marine waters in 2011. While all Mississippi respondents indicated they fished for 'all types of fish', 56% also included red drum in their fishing preference (USFWS 2013a). All of the respondents were between 25 and 64 years of age with the majority in the 45-64 year old range (56%). Unlike the other Gulf states, the gender of respondents was split 56% and 44% between males and females, respectively. Of those who responded, 100% were non-Hispanic and 65% identified themselves as 'White' while 35% indicated they were 'African American'. The majority of anglers (52%) reported their annual income as <$20-$39K with 37% in the modal value of $20-29K; the remainder could be combined in a $50-$149K group which included 29% of the anglers (USFWS 2013a).

Louisiana

The LDWF (1997) provided limited socio-economic information on recreational anglers in general using several different surveys conducted by Kelso et al. (1991, 1992, and 1994), the USFWS fishing expenditure survey (1993), and data available from the MRFSS from 1981-1996 (NOAA personal communication). Flounder was reported as the primary target species by only 1.2% of Louisiana anglers. In other surveys, flounder comes in third for preferred species among anglers (Adkins et al. 1998). Approximately 68% of the saltwater anglers surveyed reported targeting spotted seatrout and red drum in 1992-1996 (LDWF 1997). Anglers harvest flounder mainly by hook-and-line, and gig (Reagan and Wingo 1985). The LDWF report (1997) summarized that, of those residents who applied for recreational saltwater fishing licenses in Louisiana, 34% were between 35-44 years of age and an additional 27% were between 25-34 years of age. On average, Louisiana recreational anglers earn $40-$45K per year. However, none of the sources characterized the ethnicity of anglers (LDWF 1997).

Milon (2001) utilized the social and economic add-on questions to the 1997/1998 MRFSS phone interviews and determined that approximately 89% of the recreational saltwater anglers in Louisiana were Caucasian, of which 65% were males. In addition, like the other survey data by LDWF (1997), the majority of anglers (76%) were between the ages of 26-64; this included all gender and ethnic groups (Table 8.4).

The USFWS (2013b) examined U.S. Census Bureau data to generate estimates of participation in hunting and fishing for each state. In Louisiana, the census data indicated over 196,000 individuals made saltwater fishing trips in 2011, and of those, the majority (63% and 44%) indicated fishing for red drum and seatrout. While flounder was a category option, it was either not selected or too few indicated they targeted flounder (flatfish) to report. The demographic data included in the report (USFWS 2013b) does not separate saltwater from freshwater anglers but in general, among those participating in 'fishing' in Louisiana (21,000 surveyed), 31% were 65 years or older and over 50% were over the age of 45. Almost 70%were male and nearly all respondents reported they were non-Hispanic (99%); 72% identified themselves as 'White'. A number of respondents declined to indicate their economic status but of those reporting, 34% had household incomes of $50-$150K per year. The only other reporting group was 8% in the $20-30K category (USFWS 2013b).

Texas

Flounder is one of the top three fish species targeted by anglers in Texas. A survey conducted in 2012 of the Texas saltwater fishing community showed that 15% of saltwater anglers identified flounder as their first preference of fish to catch, up from approximately 10% in previous surveys (Kyle et al. 2014). The average age of saltwater anglers was 43, with 73% of saltwater anglers between the ages of 30-59. Just over 12% of saltwater anglers were female. The median gross household income category was $80-$99K, with 44% of respondents indicating incomes over $100K annually. Half of all saltwater anglers reside in the Houston area, followed by Corpus Christi (9%), San Antonio (8%), and Austin (6%), the majority of whom (93%) were 'White". Just over 12% were of Spanish/Hispanic origin. Based on a 1994 recreational survey of Texas anglers, 69.6% fish with hook-and-line while 11.4% use gigs for flounder; an additional 18% use both gears (TPWD unpublished data). Kyle et al. (2014) showed that just over half (57%) of all saltwater anglers fished for flounder during the 12 months preceding the 2012 survey. Of those anglers, 98% used rod-and-reel, and 28% used a gig.

Kyle et al. (2014) was able to identify specific demographics for those anglers who reported harvesting flounder using gigs. Of the 225 who indicated fishing for flounder in the last year, a total of 63 (28%) also fished with gigs or used them exclusively for flounder. Those Texas anglers were predominantly male (91%) and were almost 40 years of age. Approximately 15% indicated they were Hispanic and 91% identified themselves as 'White' and 4.1% as 'Black'.

The USFWS (2014c) examined U.S. Census Bureau data to generate estimates of participation in hunting and fishing for each state. The census data indicated that 685,000 resident anglers made 4.8M saltwater fishing trips in Texas in 2011. When asked about targeted species, the majority of anglers reported three species; red drum (73.3%), seatrout (42%), and flounder (flatfish – 28%). The majority of Texas anglers were male (76%) and non-Hispanic (83%). The percent of Hispanic respondents was higher in Texas than in all the other Gulf states combined at 17%. In addition, 75% of the respondents identified themselves as 'White' with other groups, including African Americans, either not being reported or in too low of numbers to report (USFWS 2014c). About 56% of the respondents were between the ages of 35 and 64 years of age but all ages were represented in the survey from 18-74 years of age. About 10% reported incomes of <$20K annually and the remaining respondents ranged from $50-$150K+ per year.

Jubilee (Opportunistic Recreational Harvest)

'Jubilee' is the local name for a phenomenon in which a hypoxic condition develops in shallow waters, driving large quantities of demersal species such as flounder, crabs, shrimp, and rays shoreward in an attempt to escape oxygen-depleted waters. Usually occurring at night or in the pre-dawn hours, the abundant quantities of desirable, edible species are easy to catch, due to their oxygen-deprived, dazed

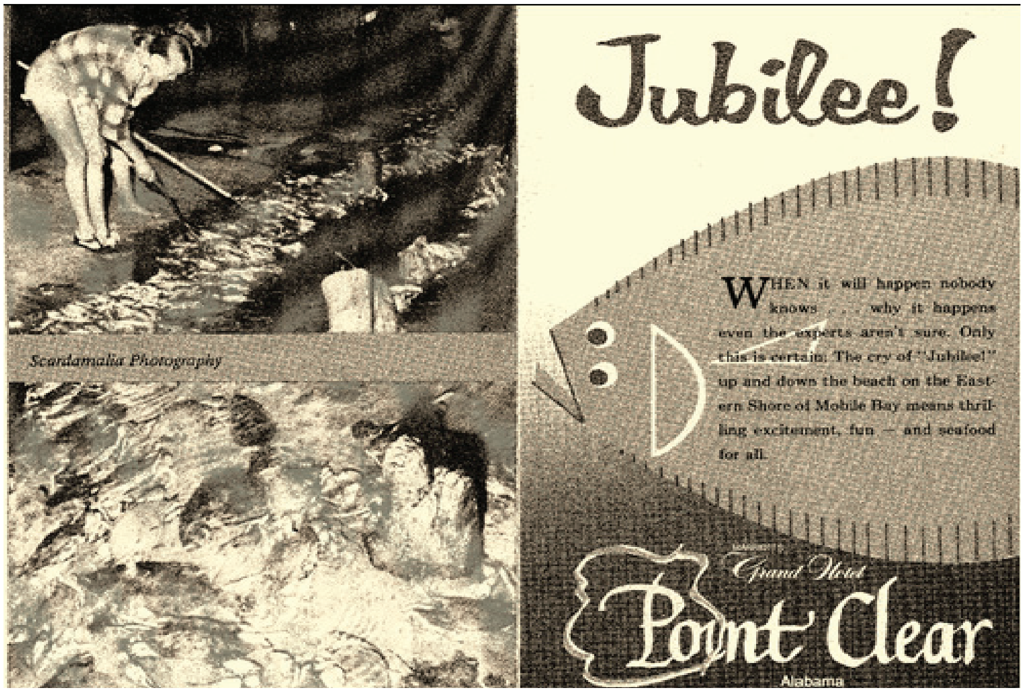


Figure 8.2 Pamphlet advertising the jubilee phenomenon in Point Clear, Alabama.

state, and presence in easily accessible, shallow water. Flounder were observed to "slither up the banks" in an attempt to escape the lack of oxygen (Loesch 1960). When a jubilee event occurs, local residents seize the opportunity to quickly scoop up what they can. The case of a hypoxic event that leads to a jubilee event represents a somewhat negative event for flounder and other affected marine life, but provides a positive social experience for many people who might not often engage in fishing otherwise.

While the jubilee along the shores of Mobile Bay, Alabama, is the most well-known regionally (and Alabama claims the term and event as their own - Figure 8.2), hypoxic conditions and subsequent jubilee can occur in any shallow estuary when conditions are right. Although jubilee events in Mobile Bay occurred prior to the arrival of Europeans, the oldest recorded jubilee event in the Mobile Bay area dates from the 1860s (May 1973). News of a jubilee event spreads quickly through the informal social networks of local residents. People take the time to call their friends, family, and neighbors, to inform them of the jubilee and share in the opportunity to harvest flounder and other available, edible species.

Stressors Affecting Fishery Participants

Environmental and anthropogenic processes and events have contributed to acute or chronic stress on both commercial and recreational participants in the flounder fishery. Acute events, (e.g., hurricanes, oil spills, and algal blooms), as well as long-term stress (e.g., coastal gentrification, and environmental change) affect fishermen's livelihoods and ability to participate in fishing activities in both the short and long-term.

Factors that may affect flounder fishing include increasing regulations aimed at controlling effort. The impacts of a series of regulations aimed at nets and trawls during the 1990s on the flounder fishery were discussed earlier. Long-term effects of these regulations include increased vulnerability of fishing communities and negative impacts on the well-being of commercial fishing families; in Florida, the net ban affected the coping abilities of families and increased stress levels for men and women who experienced and manifested the stress in different ways (Smith et al. 2003). For Florida fishermen, "the net ban was, in some ways, the culmination of a progressively more restrictive series of regulations" (Smith et al. 2003). Families had already been engaged in a process of adopting coping strategies in response to increasing regulations, which speaks to the resilience of these families.

Additionally, as a result of multiple environmental and anthropogenic disasters, fishermen in a 2013 socioeconomic survey of the crab fishery showed more concern over the potential for short- and long-term environmental impacts associated with various forms of pollution in estuarine and marine waters (Perry and VanderKooy 2014). The uncertainty associated with the aftermath of these events and the continued release of information on potential consequences heightened fears over coastal water quality following these events. Finally, local, state, and federal educational and outreach activities and non-profit environmental programs continue to increase awareness of habitat loss issues and the importance of habitat to fisheries production which is a high-profile issue common to all stakeholders (commercial fishermen, recreational anglers, conservation groups, and coastal residents in general).

Hurricanes and Tropical Activity

The frequent occurrence of tropical systems in the Atlantic or Gulf basins cause all coastal residents to evaluate their safety and the status of their homes, property, and businesses. For both commercial and recreational fishermen, the uncertainty of future potential damage can lead to chronic stress and the actual development of storm systems may result in acute stress. The concern for potential damage depends on the proximity to the coast and the reliance on waterfront infrastructure (harbors, fuel docks, processors, etc.).

In 2005, Hurricanes Cindy, Katrina, Wilma, Rita, Dennis and Tropical Storm Arlene all made landfall in the Gulf of Mexico totaling over $100B in economic damages (NSB 2007). The states of Louisiana, Mississippi, and Alabama sustained the most significant economic losses in that year, with Louisiana accounting for approximately 60% of those losses to the fishing industry, including damages to dealers and processors, as well as commercial and recreational fishing vessels (Caffey et al. 2007). Because of its proximity, Louisiana has borne the brunt of these impacts, which having occurred in a region where commercial seafood industry has been under economic decline for some time and is thus more vulnerable to disruption, was then struck by these storms (Caffey et al. 2007).

The 2005 storms resulted in the closure of many fishing businesses, however it is important to note that these businesses were already experiencing economic stress and vulnerability due to other factors in the fishery. The fishery failure following these storms (Caffey et al. 2007) provides an example of a *convergent catastrophe* (Oliver-Smith and Hoffman 1999). A convergent catastrophe refers to a situation where the social environment is experiencing broad, long-term stress leading to increased vulnerability. Without the long-term stress, in this case economic stress such as from increasing regulatory pressure and economic strain from cheap shrimp imports, the shrimping communities may have been more resilient and able to reconstitute their livelihoods. However, intense, episodic events such as the 2005 hurricanes, converging upon a stressed, vulnerable community, made recovery less likely and far more difficult.

In addition to the loss of infrastructure, vessels, and gear, Louisiana processors lost between 35% and 40% of their laborers and Alabama processors also faced labor shortages because they were forced to compete for labor with the higher paying construction industry (IAI 2007). Since 2005, flood and wind insurance costs have soared along with coastal property rates across the U.S. In 2012, Congress passed the Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12) which has contributed to great uncertainty as to how much these insurance costs will eventually rise. As a result, some people are leaving the coastal areas because they are no longer able to afford the flood insurance on their personal dwellings and are unable to secure or retain home loans without insurance. This is dramatically impacting the ability of these businesses to find laborers willing to work for low-pay in often arduous conditions (VanderKooy and Smith 2014) and will likely reduce the number of commercial fishermen who can ‘afford’ to self-insure their property and vessels.

Oil Spills and Pollution

The Gulf of Mexico is rich in petroleum with oil and natural gas reserves locked in the limestone and sandstone deep beneath the seafloor. As a result, the Gulf is an important region for the production, shipping, and refining of petroleum with approximately 4,000 production platforms occurring in state and federal waters from Texas to Alabama (≈1,500 natural gas and ≈2,500 oil) (Boland 2013). The Gulf contains 43M acres under lease for oil and gas production and since 1982, has produced 9.6 trillion barrels of oil and 109 trillion ft^3 of natural gas. Natural oil seeps contribute the highest single source amount of oil to the marine environment, accounting for an estimated 47% of the annual load to the world's oceans (NRC 2003). Remote sensing surveys indicate that there are about 350 seeps in the Gulf and that visible oil slicks in the northern Gulf contribute approximately 73,000 metric tons per year (Kvenvolden and Cooper 2003).

Additional petroleum and petroleum byproducts are released into the Gulf through spills which originate from both oil and gas exploration/production and vessel operation. When 'oil' is spilled in an aquatic system, the lighter components enter the air while the heavier ones either become floating balls of tar or sink to the bottom where they can damage benthic organisms. Some compounds can last many years in the sediments. The type of damage incurred by the fisheries, therefore, depends not only on the quantity of petroleum spilled, but also on the type of product spilled and the time it takes to respond to the spill. The long-term effects on the environment and marine organisms have yet to be determined.

In Louisiana, many oil and gas workers also work in commercial fishing, moving back and forth between the two livelihoods as the economy changes (Horst and Holloway 2002). The close relationship

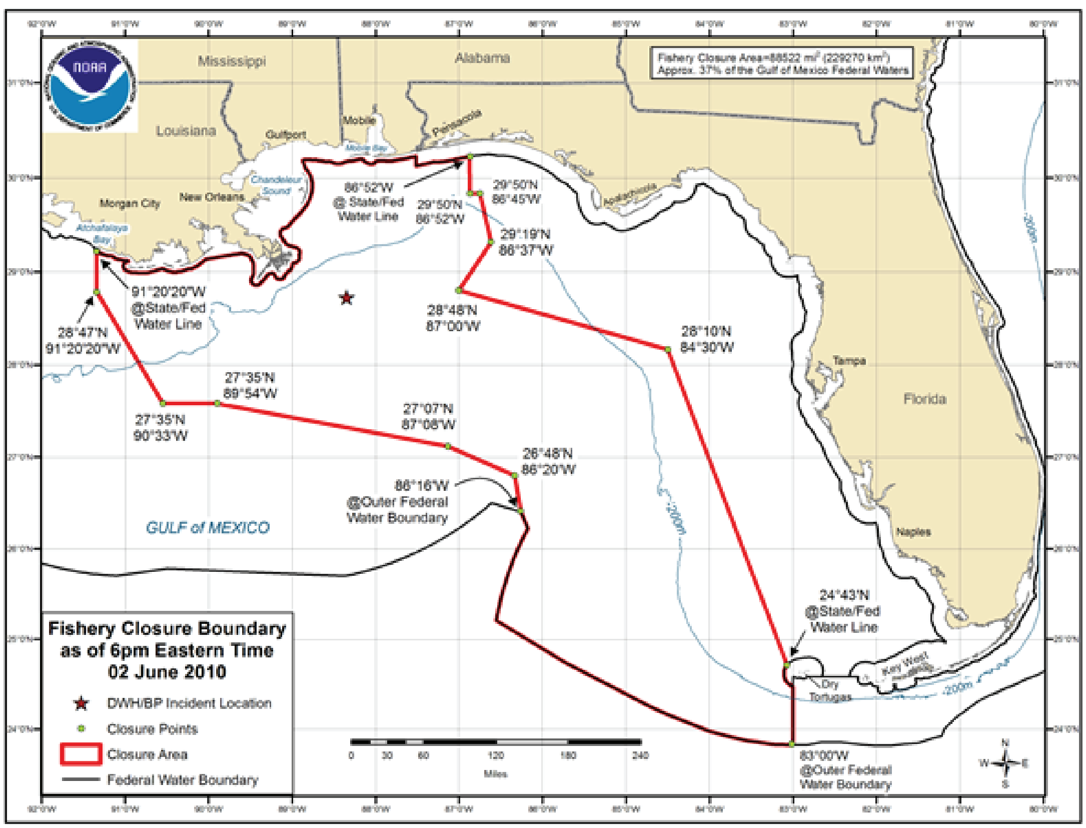


Figure 8.3 Map of the Gulf of Mexico showing the site of the BP Deepwater Horizon Oil Spill and fishery closure boundary on 13 July 2010 (Source: SERO).

of employment in both industries contributes to social vulnerability and exemplifies the dependent relationship where an episode in the oil industry can affect the fishing and tourist industries Gulf-wide.

In the aftermath of the Deepwater Horizon (DWH) disaster in April 2010, the closure of almost 90,000 square miles of the Gulf of Mexico caused significant stress to all residents of the Gulf coastal areas as a large area of fishing grounds were closed. The DWH disaster affected at least one-third of the Gulf area from western Louisiana east to the Florida panhandle and south to the Campeche Bank in Mexico (Figure 8.3) and released an estimated 4.9M barrels of oil into the Gulf. Even in 2014, there are still areas in the nearshore Louisiana marshes that are closed to fishing due to oiling from the BP disaster (LDWF personal communication).

During the spill and its immediate aftermath, socio-cultural impacts were manifested by lost fishing opportunities resulting from extensive fishery closures, impacts to tourism as tourists canceled trips to the Gulf Coast and the American public lost confidence in the safety of Gulf seafood. In response to the general public mistrust as to the safety of consuming Gulf seafood, a substantial amount of funding was made available after the spill to promote Gulf seafood products and to encourage tourists back to the Gulf Coast (Hode personal communication). For example, from April to June 2010, BP spent three times what it spent during the same time period in 2009 on advertising, or approximately $5M per week, and also gave $89.5M toward promoting tourism in the Gulf region (DuBois 2010).

Great concerns remain regarding the long-term effects of petroleum and dispersants on the Gulf of Mexico and its marine life. The potential for impacts to recruitment success, adult mortality, susceptibility to disease, and other life history parameters in all the Gulf fisheries are a constant concern to the recreational and commercial fishing communities as well as environmentalists and residents in general.

Gentrification

Gentrification refers to the process of change in land use where residents of lower socio-economic means are pushed out of their established communities as property values and taxes rise. This process of geo-social change has become common along coastal areas of the U.S. and around the world. Land use changes in coastal areas typically include loss of docks and fish houses, thereby reducing the capacity of smaller-scale commercial fishing operations (Blount 2006). As described above, the damage resulting from the 2005 hurricanes occurred within a social environment already under stress and vulnerable to such acute events. Thus, hurricanes may accelerate the process of coastal gentrification as fishing infrastructure is altered, devalued, or in some cases, destroyed.

The customary social space of commercial fishing activities (e.g., docks, processing facilities) are defined as 'working waterfronts' (VanderKooy 2012). Working waterfronts tend to be displaced with development that is often stated as the 'highest and best' use of waterfront property, but often is not associated with water-dependent occupations. For example, commercial docks and processing facilities compete with condominiums, recreational fishing facilities, and casinos for desirable coastal space. However, with the continued removal of these types of businesses over time the local economy becomes less diverse and more reliant on the service sector and tourism. As home values increase, people of lower socio-economic means find it difficult to live within these communities and consequently spend more time and expense commuting to work if jobs continue to be available. Newer residents often have no association with the water-dependent employment and may see that type of work and its associated gear as unappealing to the aesthetics of the community. They often do not see the linkage between those occupations and the aesthetics of the community that produced the initial appeal for many migrants (GMFMC 2009). The rapid disappearance of these types of waterfronts has important implications for the disruption of various types of fishing-related businesses and employment and has generated programs to protect and preserve this infrastructure such as the Stan Mayfield Working Waterfronts

Florida Forever Program. The Mayfield Program, which was established in 2008, is a component of the *Florida Communities Trust* as a local land acquisition project to acquire lands for community use and support of Florida's seafood harvesting and aquaculture industries by providing funds to develop areas of water access to fishermen such as boat parking and gear storage, processing facilities, and water access through launches and ramps (FDEP personal communication).

Looking at demographic trends within counties and communities can provide some indication as to whether these types of coastal change may be occurring. Factors affecting the loss of working waterfronts in fishing communities include coastal development, rising property taxes, decreasing access to waterfront due to increasing privatization of public resources, rising cost of dockage and fuel, lack of maintenance of waterways and ocean passages, competition with imported fish, and other less tangible (often political) factors (SAFMC 2007). Yagley et al. (2005) identify three factors as drivers of gentrification: 1) urban sprawl, 2) people attracted to natural amenities, and 3) in-migration of retirees. Colburn and Jepson (2012) evaluated gentrification based on these three integral components (urban sprawl; natural amenities; and retiree migration), along with indices for fishing reliance and fishing engagement. This research provides the foundation for sustained data collection which would enable fishery managers to include consideration of land use change as a potential social effect of a proposed fishery regulation.

While less of an issue for recreational anglers, the decline of 'working waterfronts' has signaled a cultural shift away from long established fishing lifestyles to tourism and other uses. This directly impacts many of the commercial fisheries that harvest flounder in the Gulf. In fact, many of the recreational anglers benefit with increased property values since they can afford to remain in the coastal community and do not rely on fishing for their livelihood but rather, for recreation. This is especially true for places like Monroe County which has very limited land area and has seen a steady rise in land values. Recent research on the Florida Keys' communities (Shivlani 2009) has described the problem of increasing land values and disappearance of working waterfronts, especially for communities like Key West.

Operational Costs

Increasing fuel costs have always been a concern for commercial fishermen. Since about 2002, the cost of No. 2 diesel fuel has risen by approximately 300% (USEIA 2013). Most commercial fishing boats (shrimp trawlers, charter boats, and high-end sportfishing boats) benefit by using less-expensive, off-road diesel fuel, versus DOT approved highway diesel fuel which does not have roadway taxes associated with its use. Increasing fuel costs in the U.S. are primarily related to additional refining that is now required under more stringent EPA regulations to reduce sulfur emissions in both diesel and regular gasoline.

Smaller vessel operators and recreational anglers have also seen substantial increases in the cost of fuel. The average price per gallon for regular, unleaded fuel, which most of the outboard motors today operate on, was about $1.50 in 1998 when the previous survey was completed and around $3.50/gallon in 2012 (adjusted for inflation to 2012 dollars). This represents over a 200% increase over 15 years (USEIA 2013).

A preliminary examination of recreational fishing effort from 2000-2008 (Miller et al. unpublished data) indicated that for each 1% increase in fuel price, angler trips into federal waters decreased by -0.66% suggesting a shift to nearshore species groups rather than the reef fish complex (snapper-grouper). While intuitive, this type of macroeconomic approach to fuel price and effort had not been attempted. Miller, the GSMFC staff economist, pointed out that data from these types of exercises can be used to evaluate expected fishing patterns as the U.S. economy rises and falls in the future. The study also examined the effect of GDP, state unemployment rates, and seasonal weather conditions on the frequency of angler trips (Miller personal communication). Additional variables could be examined in the future, such as boat sales as predictors of shifts in fishing patterns.

Basic Understanding and Information Needs

A prioritization of resources is needed for the collection of socio-cultural data to improve fisheries management (NRC 2006). Collecting social and cultural information about fishery participants is time-consuming, requiring fieldwork in fishing communities in addition to substantial data processing and analysis. To understand the potential socio-cultural impacts of fisheries management and related regulations, more information is needed on the demographics, social relationships; fishing practices, behavior, and preferences; and indicators of well-being for the multiple participation roles within commercial and recreational communities. Participation roles include employees at commercial dealers and processors, captains and crew of charter and commercial vessels, for-hire passengers, and owners and passengers on private recreational vessels. Also, understanding the socio-cultural ties that bridge and connect these participation roles, such as between commercial and recreational user groups, would improve understanding of potential regulatory impacts.

Supplemental to this baseline information of addressing potential impacts, it is important to understand social change as a result of fishery management following substantial regulatory change, over time. For example, the social structure underlying user groups may change over time. Thirty-five years after the immigration of Southeast Asian refugees into the Gulf of Mexico commercial fishing industry, little is known about current social interactions among the descendants of these refugees and the broader commercial industry, or the continuation of 'familial ties' to and participation in the industry of subsequent generations.

Through licensing records, most Gulf states are able to identify recreational fishing guides who operate in their state waters. However, very little is known regarding the community structure of these individuals or the customers they cater to. State lists of guides need to be maintained on a regular basis so they can be queried as to their interests in particular decisions. Other elements of the private sector support-structure are more general in their support of coastal tourism and are more difficult to monitor on a regular basis. It is also extremely difficult to identify and isolate the impacts from a fishing regulation implemented for a particular species from the broader context of commercial or recreational fisheries as a whole. This is especially true for flounder, given its relatively small proportion of all finfish landings. Nevertheless, fisheries managers should understand that these support businesses have a legitimate stake in resource management decision making, since their livelihoods are likely to be impacted by any new rules which are implemented. Research including support businesses could assist fisheries managers' understanding of the complex web of effects from regulatory change.

The limited extent of angler surveys currently available which specifically focus on flounder anglers provide little insight into this recreational fishery. There is an important social and cultural framework for understanding the flounder fishery and the diversity of anglers and experiences found therein, but current studies focus only on documenting the extent of flounder anglers and their activity as well as their catch and effort. Elements of the social and cultural framework need to be viewed as high priority items for data collection and subsequent management efforts as a means of understanding and dealing with the diversity found in flounder angling and the relationship of flounder fishing with other species.

Chapter 9

Research Needs and Management Considerations

This fishery includes several species in the United States Gulf of Mexico. All paralichthyid flounders which are caught in the Gulf of Mexico are generally referred to as flounder or flatfish. Two species, southern flounder (*Paralichthys lethostigma*) and Gulf flounder (*P. albigutta*), make up the majority of landings in the fishery. Several other flounder species are occasionally included in the Gulf landings: ocellated flounder (*Ancylopsetta quadrocellata*), Mexican flounder (*Cyclopsetta chittendeni*), spotfin flounder (*C. fimbriata*), shoal flounder (*Syacium gunteri*), and broad flounder (*P. squamilentus*). Additional flounder which are impacted as incidentals in the shrimp industry bycatch include juveniles of the above-mentioned species as well as four members of the genus *Etropus* and two additional members of the genus *Syacium*.

The management unit consists of many species included in the general category of flounder or flatfish. These species include the entire population of Gulf and southern flounder as well as other species belonging to the family Paralichthyidae in the United States Gulf of Mexico.

Goals and Objectives for the Fishery

In summary of the following considerations, the overall goal is to provide management personnel with a set of easily understandable strategies to evaluate the actions, encourage compatibility and standardization among resource agencies, facilitate enforcement's role, and reduce management conflicts. Gulf and southern flounder management personnel should continue to collaborate among all stakeholder agencies and entities that directly or indirectly affect flounder resources in the estuarine and marine environment. Given the prior considerations and recommendations, management goals for future evaluation are:

- Maintain flounder populations at levels that sustain their function in the ecosystem, to the extent practicable, and maintain economically viable fisheries, with continued support for important social and cultural aspects of associated fishing communities.
- Improve the states' role in monitoring the resource through improved data collection methods, reporting, and knowledge of flounders' function in the ecosystem.
- Develop methods to identify environmental factors that affect flounder stocks, and more fully integrate those factors into stock assessments.

Data Gaps and Considerations for Management

The following is a discussion of relevant issues related to the effective management of Gulf and southern flounder through the setting of goals and objectives. The process begins with consideration of items that have a direct bearing on flounder in the Gulf of Mexico. Items considered were compiled from discussions and data gaps identified when exploring the possibility of conducting a Gulf-wide benchmark assessment. Proposed actions are then recommended to resolve those deficiencies and establishment of goals and objectives would be the final step. Goals are the end product to which objectives are directed, objectives are the measurable action(s) to which effort/resources are directed. The final goals and objectives developed in this document do not obligate any of the agencies to implement the recommendations.

Status of the Stock(s)

The development of a complete Gulf-wide stock assessment for flounder was not possible due to a lack of speciated and cohesive flounder data for the Gulf of Mexico. Therefore, we will provide a superficial approach with the Texas stock assessment representing southern flounder in the western Gulf (TPWD 2013), the Louisiana stock assessment representing southern flounder in the north-central Gulf

(LDWF 2010), and the Florida stock assessment representing Gulf flounder in the eastern Gulf (Chagaris et al. 2012).

The most common conservation target for fisheries is the spawning potential ratio (SPR) of 30%, or $SPR_{30\%}$. The measure of SPR is the average fecundity of a recruit over its lifetime when the stock is fished, divided by the average fecundity of a recruit over its lifetime when the stock is unfished. The SPR is based on the principle that certain levels of fish need to survive in order to spawn and replenish the stock at a sustainable level. Targets of $SPR_{30\%}$ have been adopted by many of the Gulf states for their various inshore fisheries.

Although limited, the available information for southern flounder in the Gulf does not cause immediate concern. Texas' assessment of southern flounder (TPWD 2014) indicates a transitional SPR above the target of 30%. Results from Louisiana's assessment (LDWF 2010) indicates that although the disappearance rate for southern flounder is high (1.1-1.3 per year based on catch rates from 1994-1996), recent regulations (Chapter 5) should allow them to achieve $SPR_{30\%}$. The limited LDWF data suggests that without large increases in effort, southern flounder stocks should be able to be maintained at current levels in the western and central Gulf. The Florida assessment (Chagaris et al. 2012) indicates the Gulf flounder on the Florida West Coast were overfished and overfishing was occurring prior to the Net Limitation Amendment and new recreational and commercial management measures, but has not been overfished and overfishing has not been occurring in recent years (TPWD 2014).

Western Gulf

The TPWD's most recent assessment (TPWD 2014) for southern flounder indicates that the combined commercial and recreational landings of southern flounder in Texas waters initially decreased after new regulations were implemented in late 2009. The decline was due to a 50% reduction in daily bag limits (five fish for recreational take and 30 fish for commercial take) from the previous regulations implemented in 2006. However, combined landings increased from a record low of 88,992 lbs in 2010 to 250,137 lbs in 2012, which is 12% above average for the previous ten years and the highest value since 2005. Commercial landings contributed 24% of the harvest in 2012 (59,524 lbs) while the majority of landings were attributed to recreational fishermen (76% or 190,613 lbs).

Fishery-independent catch rates of southern flounder caught on spring gill nets increased from a record low of 0.012/hour in 2007 to 0.050/hour in 2012, the highest catch rate since 1991. Fall gill nets increased from a record low of 0.029/hour in 2007 to 0.090/hour in 2011, the highest catch rate since 1990, and only slightly decreased to 0.067 in 2012.

Results of the latest Virtual Population Analysis (VPA) show that the catch weighed fishing mortality for female flounder, ages two and older, decreased from 1.267 in 2005 to a record low of 0.216 in 2010 and remained low in 2012 with 0.326. The natural mortality used in the VPA model was 0.6 indicating that before the new set of regulations, fishing mortality was considerably higher than natural mortality while, after the last round of regulations were implemented, fishing pressure decreased and fishing mortality is now well below natural mortality.

The SPR in the western Gulf stock (Texas) responded favorably to the new set of regulations implemented by the TPWD in 2009. The estimated SPR values increased to 51% in 2010 and remain high at 46% in 2012. Desirable SPR values are above 30%; however, the accepted threshold is 20% for the population to remain in equilibrium; a SPR below 20% will most likely result in a decrease in population.

North-Central Gulf

The LDWF (2010), the source of the North-Central Gulf southern flounder assessment, reported that the 2008 combined commercial and recreational harvest of 478,817 lbs was about 10% below the average annual harvest between 1997 and 2007, inclusive. Regulations implemented between 1995 and 1997 caused significant reductions in commercial landings from prior levels, and the effects of Hurricanes Katrina and Rita in 2005 had effects for both recreational and commercial harvest in that year (Chapter 6). Some effects may have been seen in the 2008 harvest from Hurricanes Gustav and Ike. The 2008 commercial harvest was only 25% of the 20-year mean, while recreational harvest was about 90% of the mean.

The conservation standard for southern flounder in Louisiana is 30% SPR. The results of yield per recruit analysis based on the VPA estimates of *F* (fishing mortality rate) at age indicate that if the natural mortality rate (*M*) equals 0.5 (the value that provides the lowest allowable harvest within the conservation standard), the fishery in the years assessed (2002 - 2008) was operating between $F_{0.1}$ and F_{MAX}, with yields of 98-100% of maximum and SPR at 21-25%. An *M* of 0.8 (the highest value within the range examined) would produce a yield per recruit (YPR) of 73-86% of maximum with SPR at 39-47%.

Southern flounder enter the fishery at age-0 and are fully recruited by age-2 (LDWF 2010). It takes several years of consistent regulations and harvest conditions before VPA analyses accurately measure the impact of regulations, since the methods rely on the relative harvest of the age-classes measured. In the case of southern flounder it would take at least three years of consistent regulations and harvest conditions assuming selectivities of age-2 and older is 100% available for harvest.

As a result of the availability of several years of commercial trip ticket data, and recreational fishery statistics data, the department was able to begin a program to representatively sample fishery dependent otoliths in 2002 (LDWF 2010). The program uses trip ticket data and recreational survey data to weight sampling sites so that otolith collections reflect harvest from the fisheries for the species of interest. It is expected that this method of otolith sampling by the LDWF will improve stock assessments by providing more accurate annual catch-at-age data.

Eastern Gulf

According to the FWC (2012) assessment, nearly all flounders landed in Florida are one of three species in the genus Paralichthys: Gulf flounder, *P. albigutta*; southern flounder, *P. lethostigma*; or summer flounder, *P. dentatus*. Gulf flounder are the only species to range along the entire Florida Coast and are the most commonly caught flounder on the Florida West Coast. Southern flounder are generally only found north of the Loxahatchee River on the Florida East Coast and north of the Caloosahatchee River on the Florida West Coast. Only Gulf flounder are summarized below since they were the only species included from the Florida West Coast in the assessment.

A catch-based *MSY* analysis estimated *MSY* of Gulf flounder to be 434,000 lbs. Based on this estimate, landings exceeded *MSY* during the 1980s and early 1990s but have remained at or below the lower limit of *MSY* in the most recent five years. A non-equilibrium surplus production model (ASPIC) of Gulf flounder was also run on the west coast which indicated that prior to 1995, the stock was overfished and overfishing was occurring. After 1995, fishing mortality fell below F_{MSY} and biomass increased above B_{MSY} suggesting that the stock was not overfished and overfishing was not occurring in recent years. The examination of the catch and effort data, catch rates, and fisheries independent indices may suggest the Net Limitation Amendment and introduction of minimum size limits may have had a positive effect on flounder stock sizes. The models used support this conclusion. Both the ASPIC and catch-based *MSY* analyses indicated that overfishing was likely occurring during the period leading up to those regulations and that fishing mortality has decreased and stock sizes increased during the period after their implementation.

The simple modeling approaches applied here are informative but have serious limitations and should be viewed with caution. Because life history information and age composition data were not available, the models were primarily based on catch and effort statistics. If the flounder stocks were only lightly fished, then the time series of catch does not contain sufficient information about productivity and the catch-based *MSY* method is not appropriate. Also, the catch-based *MSY* model is sensitive to the prior ranges of the rate of population increase and carrying capacity. The model fits to data in the ASPIC analysis was generally poor due to negative correlations between some indices.

Considerations

- Not every state has adequate fishery-independent data to conduct a stock assessment and the three noted above represent the 'best available science' to evaluate the status of flounder populations throughout the Gulf of Mexico region.
- There are a number of models available to fisheries managers which allow for data poor species to be assessed. However, in areas of species overlap, there needs to be a separation in the data to account for diverse life histories and differences in mortality from a variety of fisheries (i.e., trawl, hook-and-line, gig/spear).

Fishery-Dependent and Fishery-Independent Monitoring

Management recommendations should be made based upon the best biological, social, and economic data available for a particular species and fishery. In the case of flounders in the Gulf of Mexico, a multi-species fishery recorded as a single unit, a Gulf-wide assessment of flounder could not be completed because many of the traditional stock assessment parameters are either unavailable or unreliable. Fitzhugh et al. (1999) identified the major deficiencies in the Gulf and southern flounder data which have hindered the completion of a Gulf-wide stock assessment for both species due to inadequate or biased data both in the original flounder FMP (GSMFC 2000) and this revision. The lack of data on age-and-growth, species, sex and size composition, and CPUE by species have prevented the estimation of population size, mortality rates, empirical and back-calculated growth curves, and population age structure. Without this information, especially age-and-growth, landing trends are the only indicator available on the health of the stocks. The growth data which are available in the Gulf are also subject to additional ageing problems such as sexual dimorphism and high variability even within year classes (Fitzhugh et al. 1999). Because of these data gaps, management agencies should consider expanding the amount and types of data collected during their collection of the fishery dependent and independent data to fill these gaps. Until a regional stock assessment is completed using appropriate data, the following management considerations may help to facilitate expanded and improved data collection programs for flounder.

Considerations

- Recreational anglers and commercial dealers typically lump most species of flounder into a general flounder category. Requirements for reporting flounder landings do not demand speciation and are inconsistent between state and federal agencies.
- Age, sex, discard survival, and gear type information, in addition to speciation, from the fishery-dependent surveys are not collected.
- Flounders account for a large quantity of bycatch in the Gulf of Mexico and are a result of gear efficiency in the shrimp and groundfish fishing industries. Because of the Gulf states' current size and bag limits for flounder, the discarding of legal size flounder has likely increased within the commercial trawl industry. Seasonality, trawl duration, salt box usage, effectiveness of bycatch reduction devices, culling techniques, and volume of catch all likely affect the survival of discarded flounder from trawl fisheries.
- The increased concentration of flounder as they migrate through passes and aggregate for spawning increases their vulnerability to commercial and recreational gears. The potential for a marked impact by both commercial fishermen and recreational anglers on spawning stocks is due to the high number of fish moving through restricted passes in the late fall and winter.

Assessing Domestic Market Channels and Tracking Imports and Exports

Few studies have been conducted to describe the processing and marketing of flounder in the Gulf of Mexico. In particular, no studies have attempted to describe the marketing channels associated with flounder in the region. Although the market channel analysis conducted for the original flounder FMP (GSMFC 2000) indicated that the most important source of flounder is from domestic producers, it was estimated that less than 2% of the total supply is obtained from foreign sources. However, it is unknown how much of the domestic supply obtained from other wholesalers may have been originally obtained from foreign sources or from states outside the Gulf. The flounder which originates outside the Gulf may or may not be Gulf or southern flounder and these unidentified flounder may serve as close substitutes in the marketplace.

Considerations

- To better understand the structure, conduct and performance of the regional and national markets for flounder originating from the Gulf of Mexico, concepts such as product traceability and fishery sustainability should be addressed.
- Traceability programs describe the chain of custody through the market, moving from harvester to consumer.
- Sustainability programs help ensure product enters into the market in a manner that provides for long term resource and community viability.
- Both of these concepts can have a significant impact of Gulf-region seafood markets. Thus, efforts to understand how imposing traceability and sustainability programs upon Gulf of Mexico flounder production and distribution will allow fishery managers, harvesters and dealers to meet the needs of growing markets within the region and nation.

Habitat Monitoring and Preservation

Flounder spend most of their lives in nearshore or estuarine areas and are indirectly affected by numerous human activities. Several management options exist in relation to the protection and monitoring of critical flounder habitats. The identification of critical habitat which supports the fishery is now recognized as key in continuing to effectively manage flounder in the Gulf of Mexico. Problems arise when those critical and necessary habitats are impacted whether by natural or man-made causes.

Considerations

- The quality and quantity of nearshore habitat are of major importance in maintaining fishery stocks. Naturally occurring physical and biological processes affect the quality of coastal wetland habitats, including, erosion, relative sea level rise, plankton blooms, disease, storm events, and freshwater inflows.
- Human impact and anthropogenic impact on the environment has and continues to occur. Some of the activities impacting the environment include; habitat alteration, dredge and fill, thermal discharge, industrial and agricultural run-off, wetland impoundment and water management, freshwater diversion, point and nonpoint source pollution, relative sea level rise, urban development, and the introductions of non-native flora and fauna.

Maintaining healthy ecosystems is crucial to maintaining healthy fisheries including the flounder fishery.

Regional Research Priorities and Data Requirements

Research and data needs of the flounder fishery encompass a wide range of biological, social, economic, and environmental studies. Additional research and data collection programs are needed, and Table 9.1 is a partial list of some of the more important needs.

Table 9.1 Prioritized list of data needs identified during the development of the management profile.

Research Need Category	Recommendation	Priority
Biological	Improve speciation of flounder by fishery-dependent samplers.	High
Biological	Collect additional age frequency data to better understand the age structure of both Gulf and southern flounder.	High
Biological	Improve estimates of natural mortality and predation especially on early life stages.	Med/High
Resource Management	Evaluate existing management programs to determine their effectiveness in meeting management goals and objectives.	Med/High
Biological	Quantify the impacts of habitat change including the effects of varying salinities (freshwater inflow and seasonality), marsh degradation, loss of seagrass beds, etc. on all flounder life history stages.	Med/High
Biological	Track flounder spawning migration patterns, timing, and return to estuaries by both sexes.	Med/High
Biological	Continue and expand mark/recapture studies where appropriate.	Med/High
Environmental	Determine optimum physiologic/environmental requirements for both Gulf and southern flounder especially on early life stages.	Med/High
Biological	Determine if mortality estimates are different between males and females.	Med/High
Biological	Investigate ecosystem dynamics and their relation to Gulf and southern flounder stocks.	Med/High
Biological	Continue and expand genetic studies on variability of both species across the Gulf and relate the results of those studies to the effectiveness of management actions.	Med/High
Biological	Investigate potential effect of changing water temps on sex ratios of southern flounder (juveniles) in the wild.	Med/High
Economic and Social	Qualitative and quantitative information is needed regarding the composition, motivating factors, satisfaction, and desires of various user groups.	Med
Economic and Social	Quantitative data are needed on the values of the commercial and recreational fisheries.	Med
Biological	Determine population effects from stocked flounder.	Med
Industrial/Technological	Identify existing processing and marketing activities for flounder and evaluate alternative methods.	Med
Biological	Increase intercept studies to determine the nature and size of catches as well as effort on a state or areal basis.	Low

Chapter 10

References

ADCNR/MRD (Alabama Department of Conservation and Natural Resources, Marine Resources Division). Unpublished data. Gulf Shores, Alabama.

Adkins, G. Personal communication. Louisiana Department of Wildlife and Fisheries, Bourg, Louisiana.

Adkins, G., J. Tarver, P. Bowman, and B. Savoie. 1979. A study of commercial finfish in coastal Louisiana. Louisiana Department of Wildlife and Fisheries Technical Bulletin Number 29. Baton Rouge, Louisiana. 87p.

Adkins, G., S. Hein, P. Meier, and B. McManus. 1998. A biological and fisheries profile for southern flounder, *Paralichthys lethostigma*, in Louisiana. Louisiana Department of Wildlife and Fisheries Fishery Management Plan Series Number 6, Part 1. 60p.

Adkins, G., V. Guillory, and M. Bourgeois. 1990. A creel survey of Louisiana recreational saltwater anglers. Louisiana Department of Wildlife and Fisheries, Technical Bulletin Number 41:1-58.

Adriance, J. Personal Communication. Louisiana Department of Wildlife and Fisheries, New Orleans, Louisiana.

Ahlstrom, E.H., K. Amaoka, D.S. Hensley, H.G. Moser, and B.Y. Sumida. 1984. Plueronectiformes: development. Pages 640-670 *In*: Moser, H.G. (ed). Ontogeny and Sytematics of Fishes. American Society of Ichthyology and Herpetology Special Publication Number 1.

Allen, R.L., and D.M. Baltz. 1997. Distribution and microhabitat use by flatfishes in a Louisiana estuary. Environmental Biology of Fishes 50:85-103.

Anderson, J.D., and W.J. Karel. 2012. Population genetics of southern flounder with implications for management. North American Journal of Fishery Management. 32:656-662.

Anderson, J.D., W.J. Karel, and A.C.S. Mione. 2012. Population structure and evolutionary history of southern flounder *Paralichthys lethostigma* in the Gulf of Mexico and western Atlantic Ocean. Transactions of the American Fisheries Society 141:46-55.

Arnold, C.R., W.H. Bailey, T.D. Williams, A. Johnson, and J.L. Lasswell. 1977. Laboratory spawning and larval rearing of red drum and southern flounder. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 31:437-440.

Arnold, E.L., Jr., R.S. Wheeler, and K.N. Baxter. 1960. Observations on fishes and other biota of east lagoon, Galveston Island. U.S. Fish and Wildlife Service Special Scientific Report 344. 30p.

Balon, E.K. 1975. Terminology of intervals in fish development. Journal of the Fishery Research Board of Canada 32:1663-1670.

Baltz, D.M. 1990. Autecology. Pages 585-607 *In*: Schreck, C.B., and P.B. Moyle (eds). Methods for fish biology. American Fisheries Society, Bethesda, Maryland.

Barbieri, L., and J. Landsberg. 2006. Effects of the 2005 red tide event on recreational fisheries in Southwest Florida. SEDAR12-RD12 FL FWCC/FWRI.

Barrett, B. 1970. Water measurements of coastal Louisiana. Louisiana Wild Life and Fisheries Commission, Report 2-22-R/88-309.174p.

Barrett, B.B., J.L. Merrel, T.P. Morrison, M.C. Gillespie, E.J. Ralph, and J.F. Burdon. 1978. A study of Louisiana's major estuaries and adjacent offshore waters. Louisiana Department of Wildlife and Fisheries Technical Bulletin Number 27.

Bass, G., and V. Guillory. 1979. Community structure and abundance of fishes inhabiting oceanic oyster reefs and spoil islands in the northeastern Gulf of Mexico. Northeast Gulf Science 3(2):116-121.

Becker, C.P., and R.M. Overstreet. 1979. Haematozoa of marine fishes from the northern Gulf of Mexico. Journal of Fish Disease 2:469-479.

Bell, G.W., and D.B. Eggleston. 2005. Species-specific avoidance responses by blue crabs and fish to chronic and episodic hypoxia. Marine Biology 146(4):761-770.

Benson, N.G. 1982. Life history requirements of selected finfish and shellfish in Mississippi Sound and adjacent areas. United States Fish and Wildlife Service FWS/OBS-81/51. United States Army Corp of Engineers, Slidell, Louisiana. 97p.

Berlinsky, D.L., W. King V, T.I.J. Smith, R.D. Hamilton, J. Holloway, and C.V. Sullivan. 1996. Induced ovulation of southern flounder *Paralichthys lethostigma* using gonadotropin releasing hormone analogue implants. Journal of the World Aquaculture Society 27(2):143-152.

Blanchet, H. 2010. Assessment of Southern Flounder in Louisiana Waters 2010 Report.

Blandon, I. R., R. Ward, T. L. King, W. J. Karel, and J. P. Monaghan. 2001. Preliminary genetic population structure of southern flounder, *Paralichthys lethostigma*, along the Atlantic Coast and Gulf of Mexico. Fishery Bulletin 99:671-678.

Blaylock, R.B., and R.M. Overstreet. 1999. *Margolisianum bulbosum* n.g. and n.sp. (Nematoda:Philometridae) from the southern flounder, *Paralichthys lethostigma* (Pisces:Bothidae), in Mississippi Sound. Journal of Parasitology 85(2):306-312.

Blount, B.G. 2006. Factors affecting participation in marine fisheries: case studies in Georgia and North Carolina. Project Final Report, MARFIN, National Marine Fisheries Service, Southeast Region.

Böhlke, J.E., and C.C.G. Chaplin. 1993. Fishes of the Bahamas and adjacent tropical waters. Second Edition. University of Texas Press, Austin, Texas. 771p.

Boland, G. 2013. Oil and Gas Exploration. NOAA Office of Ocean Exploration and Research and Minerals Management Service. NOAA Ocean Explorer website. http://oceanexplorer.noaa.gov/explorations/06mexico/background/oil/oil.html

Borror, D.J. 1960. Dictionary of word roots and combining forms. Mayfield Publishing, Mountain View, California. 134p.

Bourgeois, M. Personal Communication. Louisiana Department of Wildlife and Fisheries. Baton Rouge, Louisiana.

Boster, J.S., and J.C. Johnson. 1989. Form or function: A comparison of expert and novice judgments of similarity among fish. American Anthropologist 91(4):866-889.

Bradshaw, C. Personal Communication. Florida Fish and Wildlife, Fish and Wildlife Research Institute, 100 8th Avenue Southeast, St. Petersburg, Florida.

Branstetter, S. 1997. Bycatch and its Reduction in the Gulf of Mexico and South Atlantic Shrimp Fisheries. Gulf and South Atlantic Fisheries Development Foundation, Inc., Tampa, Florida. 27p.

Breuer, J.P. 1962. An ecological survey of the lower Laguna Madre of Texas, 1953-1959. Publication of the Institute of Marine Science, University of Texas 8:153-183.

Brooke, S. 2011. The First U.S. National Bycatch Report. PowerPoint update to the NOAA Fisheries Service Council Coordination Committee, Charleston, South Carolina. 32 slides.

Burdon, J.F. 1978. Systematic account, section IV. Pages 115-131 *In:* A study of Louisiana's Major Estuaries and Adjacent Offshore Waters. Louisiana Department of Wildlife and Fisheries Technical Bulletin Number 27.

Burke, J.S. 1995. Role of feeding and prey distribution of summer and southern flounder in selection of estuarine nursery habits. Journal of Fish Biology 47:355-366.

Burke, J.S., J.M. Miller, and D.E. Hoss. 1991. Immigration and settlement pattern of *Paralichthys dentatus* and *P. lethostigma* in an estuarine nursery ground, North Carolina, USA. The Netherlands Journal of Sea Research 27:393-405.

Burrage, D. 1997. Inshore TED evaluation and technology transfer. Final Report MARFIN Cooperative Agreement Number NA57FF0282. National Marine Fisheries Service Southeast Regional Office, St. Petersburg, Florida. 41p.

Caffey, R.H., R.F. Kazmierczak, H. Diop, and W.R. Keithly, Jr. 2007. Economic Damages to Infrastructure Incurred by Louisiana Fishing Industries Due to Hurricanes Katrina and Rita in 2005. Report to the U.S. Department of Commerce, NOAA.

Campbell, R.P., and P.C. Choucair. 1995. Characterization of finfish bycatch of private-boat recreational anglers in Texas marine waters. The Saltonstall-Kennedy Grant Program. Texas Parks and Wildlife Department, Coastal Fisheries Division, Austin, Texas. Final Report. 24p.

Carr, W., and C.A. Adams. 1973. The Food habitats of juvenile marine fishes occupying seagrass beds in the estuarine zone near Crystal River, Florida. Transactions of the American Fisheries Society 102:511-540.

Chagaris, D., B. Mahmoudi, M.D. Murphy, and C. Guenther. 2012. Status of flounder fishery resources in Florida. Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute In-House Report. 74p.

Christmas, J.Y. 1973. Cooperative Gulf of Mexico estuarine inventory and study, Mississippi. Gulf Coast Research Laboratory, Ocean Springs, Mississippi. 512p.

Christmas, J.Y., and R.S. Waller. 1973. Estuarine vertebrates, Mississippi. Pages 320-434 *In:* Christmas, J.Y. (ed) Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Gulf Coast Research Laboratory, Ocean Springs, Mississippi.

Colburn, L.L., and M. Jepson. 2012. Social Indicators of Gentrification Pressure in Fishing Communities: A Context for Social Impact Assessment. Coastal Management 40:289-300.

Coldman, A.J., T. Braun, and R.P. Gallagher. 1988. The classification of ethnic status using name Information. Journal of Epidemiology and Community Health 42:390-395.

Colura, R.L. Personal communication. Texas Parks and Wildlife Department. Coastal Fisheries Division, Perry R. Bass Marine Fisheries Research Station, Station HC02, Box 385, Palacios, Texas.

Comp, G.S. 1985. A survey of the distribution and migration of the fishes in Tampa Bay. Pages 393-425 *In*: Treat et al. (eds) Proceedings of the Tampa Bay Area Scientific Information Symposium. Bellwether Press.

Conner, J.C., and F.M. Truesdale. 1972. Ecological implications of a freshwater impoundment in a low salinity marsh. Pages 259-276 *In*: Chabreck, R.H. (ed) Proceedings of the Coastal Marsh and Estuary Management Symposium. Louisiana State University, Baton Rouge, Louisiana.

Cooper, P., Jr. Personal Communication. Outdoor Writer, P.O. Box 172, Buras, Louisiana.

Crabtree, R.L. 2007. Regional administrator's report to the Gulf of Mexico Fishery Management Council. F/SER24:SB. St. Petersburg, Florida: National Marine Fisheries Service.

Crandall, K.A., O.R.P. Bininda-Emonds, G.M. Mace, and R.K. Wayne. 2000. Considering evolutionary processes in conservation biology. Trends in Ecology and Evolution 15:290-295.

Dahlberg, M.D. 1972. An ecological study of Georgia coastal fishes. Fishery Bulletin 70:323-353.

Daniels, H. 2000. Species profile: southern flounder. Texas A&M University, College Station, Texas, USA: Southern Regional Aquaculture Center Publication. 726: 1-4.

Daniels, H.V., D.L. Berlinsky, R.G. Hodson, and C.V. Sullivan. 1996. Effects of stocking density, salinity, and light intensity on growth and survival of southern flounder *Paralichthys lethostigma* larvae. Journal of World Aquaculture Society 27 (2):153-159.

Daniels, H., and R. Borski. 1998. Effects of low salinity on growth and survival of southern flounder (Paralichthys lethostigma) larvae and juveniles. Nutrition and technical development of aquaculture. Pages 187-192 *In*: Howell et al. (eds.), Nutrition and Technical Development of Aquaculture. New Hampshire University, Durham. Sea Grant Program.

Darnell, R.M. 1958. Food habits of fishes and larger invertebrates of Lake Pontchartrain, Louisiana, an estuarine community. Publication of the Institute of Marine Science, University of Texas 5:353-416.

Darnell, R.M. 1985. Distribution of fishes and penaeid shrimp of commercial and recreational importance on the continental shelf off Mississippi and Alabama. Pages 1-61 *In:* B.A. Vittor and Associates, Inc. Tuscaloosa Trend Regional Data Search and Synthesis Study, Appendix B, Volume IIB Supplemental Reports. Minerals Management Service, Metaire, Louisiana.

Darnell, R.M., and J.A. Kleypas. 1987. Eastern Gulf shelf bio-atlas: a study of the distribution of demersal fishes and penaeid shrimp of soft bottoms of the continental shelf from the Mississippi River Delta to the Florida Keys. OCS Study MMS86-0041. New Orleans, Louisiana. 548p.

Dawson, C.E. 1962. Notes on anomalous American Heterostomata with descriptions of five new records. Copeia 1962(1):138-146.

Dawson, C.E. 1967. Three new records of partial albinism in American Hetersomata. Transactions of the American Fisheries Society 96(4):400-404.

Dawson, C.E. 1968. Contributions to the biology of Mexican flounder, *Cyclopsetta chittendeni* in the northern Gulf of Mexico. Transactions of the American Fisheries Society 97(4):504-507.

Dawson, C.E. 1969. Three unusual cases of abnormal coloration in northern Gulf of Mexico flatfishes. Transactions of the American Fisheries Society 98:106-108.

Deardorff, T.L., and R.M. Overstreet. 1981. Larval Hysterothylacium (=Thynnascaris) (Nematoda:Anisakidae) from fishes and invertebrates in the Gulf of Mexico. Proceedings of the Helminthological Society of Washington 48(2):113-126.

Degner, R.L., C.M. Adams, and S.D. Moss. 1989. An analysis of potential regulatory changes on the economic structure of the eastern Gulf of Mexico finfish industry centered in Florida. Industry Report 89-2, Florida Agricultural Market Research Center, Food and Resource Economics Department, University of Florida, Gainesville, Florida. 197p.

Degner, R.L., C.M. Adams, S.D. Moss, and S.K. Mack. 1994. Per capita fish and shellfish consumption in Florida. Industry Report 94-2. Florida Agricultural Market Research Center, Food and Resource Economics Department, University of Florida, Gainesville, Florida. 409p.

DeGroot, S.J. 1971. On the interrelationships between morphology of the alimentary tract, food and feeding behavior of flatfishes (Pisces:Pleuronectiformes). The Netherlands Journal of Sea Research 5(2):121-196.

DeKay, J.E. 1842. Zoology of New-York, or the New-York fauna; comprising detailed descriptions of all the animals hitherto observed within the state of New-York, with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. Part IV. Fishes. W. & A. White & J. Visscher, Albany. 415p.

Delamater, E.D., and W.R. Courtenay, Jr. 1974. Studies on scale structure of flatfishes. I. The genus Trinectes, with notes on related forms. Proceedings of the 27th Annual Conference of the Southeastern Association of Game and Fish Commissioners. Pages 591-608.

Del Toro-Silva, F.M., J.M. Miller, J.C. Taylor, and T.A. Ellis. 2008. Influence of oxygen and temperature on growth and metabolic performance of *Paralichthys lethostigma* (Pleuronectiformes: Paralichthyidae). Journal of Experimental Marine Biology and Ecology 358(2):113-123.

Deubler, E.E., Jr. 1958. A comparative study of the postlarvae of three flounders (*Paralichthys*) in North Carolina, Copeia 1958(2):112-116.

Deubler, E.E., Jr. 1960. Salinity as a factor in the control of growth and survival of postlarvae of the southern flounder, *Paralichthys lethostigma*. Bulletin of Marine Science of the Gulf and Caribbean 10:338-345.

Deubler, E.E., Jr., and G.S. Posner. 1963. Response of postlarval flounder, *Paralichthys lethostigma*, to water of low oxygen concentrations. Copeia 1963:312-317.

Deubler, E.E., Jr., and J.C. White, Jr. 1962. Influence of salinity on growth of postlarvae of summer flounder, *Paralichthys dentatus*. Copeia 1962(2):468-469

Deubler, E.E., Jr., and W.E. Fahy. 1958. A reversed ambicolorate summer flounder, *Paralichthys dentatus*. Copeia 1958(1):55.

DeVeen, J.F. 1969. Abnormal pigmentation as a possible tool in the study of the populations of the plaice (*Pleuronectes platessa* L.). Journal du Conseil 32(3):344-383.

Ditton, R.B., and K.M. Hunt. 1996. Demographics, participation, attitudes, management preferences, and trip expenditures of Texas anglers. Technical Document #HD-605. Department of Fisheries and Wildlife Sciences, Texas A&M University, College Station, Texas. 58p.

Ditton, R.B., K.M. Hunt, S. Choi, M.F. Osborn, R. Riechers, and G.C. Matlock. 1990. Trends in demographics, participation, attitudes, expenditures, and management preferences of Texas saltwater anglers, 1986-1988. Human Dimensions of Fisheries Research Laboratory Report #HD-602. Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas. 67p.

Donaldson, D.M., M.O. Osborn, K. Faulkner, R.B. Ditton, and G.C. Matlock. 1991. Demographics, participation, attitudes, expenditures, and management preferences of Texas non-resident anglers, 1987. Texas Parks and Wildlife Department Management Data Series Number 81. Austin, Texas. 64p.

DuBois, S. 2010. Update: BP's advertising budget during the spill neared $100 million. CNN Money On-line. http://money.cnn.com/2010/09/01/news/

Duffy, M. 1977. Flounders on the tidal flats. Louisiana Conservationist 29:4-7.

Dugas, R.J. 1975. Variation in day-night trawl catches in Vermilion Bay, Louisiana. Louisiana Wildlife and Fisheries Commission Technical Bulletin Number 14. 13p.

Dunham, F. 1972. A study of commercially important estuarine-dependent industrial fishes. Louisiana Wildlife and Fisheries Commission, Technical Bulletin Number 4. 63 pp.

Durrenberger, E.P. 1994. Shrimpers, processors, and common property in Mississippi. Human Organization 53:74-82.

Eby, L.A., and L.B. Crowder. 2002. Hypoxia-based habitat compression in the Neuse River Estuary: context-dependent shifts in behavioral avoidance thresholds. Canadian Journal of Fisheries and Aquatic Sciences 59:952-965.

Enge, K.M., and R. Mulholland. 1985. Habitat suitability index models: southern and gulf flounders. United States Fish and Wildlife Service Biological Report 82(10.92). 25p.

Epperly, S.P. 1984. Fishes of the Pamlico-Albermarle Peninsula, North Carolina, area utilization and potential impacts. North Carolina Department of Natural Resources and Community Development. Special Scientific Report Number 42. 129p.

Etzold, D.J., and J.Y. Christmas. 1979. A Mississippi marine finfish management plan. Mississippi-Alabama Sea Grant Consortium MASGP-78-046. 36p.

FDEP (Florida Department of Environmental Protection). 1995. Florida Administrative Code Chapter 62-11. Tallahassee, Florida.

FDEP (Florida Department of Environmental Protection). Personal Communication. FEDP, Office of Operations, Land and Recreation Grants Programs, Tallahassee, Florida

Felley, J.D. 1989. Nekton assemblages of the Calcasieu estuary. Contributions in Marine Science 31:95-117.

Fiscella, K., and A.M. Fremont. 2006. Use of Geocoding and Surname Analysis to Estimate Race and Ethnicity. Health Services Research 41(4):1482-1500.

Fischer, A. 1999. The life history of southern flounder (*Paralichthys lethostigma*) in Louisiana waters. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana. 68p.

Fischer, A.J., and B.A. Thompson. 2004. The age and growth of southern flounder, *Paralichthys lethostigma*, from Louisiana estuarine and offshore waters. Bulletin of Marine Science 75(1): 63-77.

Fisher, M. Personal Communication. Texas Parks and Wildlife Department, Coastal Fisheries Division, 4200 Smith School Road, Austin, Texas.

Fitzhugh, G. Personal Communication. National Marine Fisheries Service, 3500 Delwood Beach Road, Panama City, Florida.

Fitzhugh, G.R. 1993. An individual-based approach to understanding patterns of differential growth and population size structure in juvenile southern flounder (*Paralichthys lethostigma*). Ph.D. Dissertation. North Carolina State University, Raleigh, North Carolina. 200p.

Fitzhugh, G.R., L.B. Crowder, and J.P. Monaghan. 1996. Mechanisms contributing to variable growth in juvenile southern flounder (*Paralichthys lethostigma*). Canadian Journal of Fisheries and Aquatic Sciences 53:1964-1973.

Fitzhugh, G.R., W.L. Trent, W.A. Fable, Jr. 1999. Age-structure, mesh-size selectivity, and comparative life history parameters of southern and gulf flounder (*Paralichthys lethostigma* and *P. albigutta*) in northwest Florida. Contribution Series 99-5. National Marine Fisheries Service, Panama City, Florida. 78p.

Fitzhugh, G.R., W.A.J. Fable, and W.L. Trent. 2008. Life history parameters of gulf flounder (*Paralichthys albigutta*) from northwest Florida. Gulf of Mexico Science 2008(2):100-117.

Floyd, M.F., L. Nicholas, I. Lee, J.H. Lee, and D. Scott. 2006. Social stratification in recreational fishing participation: research and policy implications. Leisure Sciences 28(4):351-368.

Fox, L.S., and C.S. White. 1969. Feeding habits of the southern flounder, *Paralichthys lethostigma*, in Barataria Bay, Louisiana. The Proceedings of the Louisiana Academy of Sciences 32:31-38.

Franks, J.S., J.Y. Christmas, W.L. Siler, R. Combs, R. Waller, and C. Burns. 1972. A study of nektonic and benthic faunas of the shallow Gulf of Mexico off the state of Mississippi as related to some physical, chemical and geological factors. Gulf Research Reports 4:1-148.

Fraser, T.H. 1971. Notes on the biology and systematics of the flatfish genus *Syacium* (Bothidae) in the Straits of Florida. Bulletin of Marine Science 21:491-509.

Frick, M.R. 1988. Age and growth of the southern flounder in the northern Gulf of Mexico. M.S. Thesis. Auburn University, Auburn, Alabama. 38p.

Fuls, B.E., T. Wagner, and L.W. McEachron. 2002. Characterization of commercial shrimp trawl bycatch in Texas during spring and fall commercial bay-shrimp seasons: 1993-1995. Management Data Series Number 180. Texas Parks and Wildlife Department, Coastal Fisheries Division. Austin, Texas.

FWC (Florida Fish and Wildlife Conservation Commission). 2012. Marine Fisheries Information System. Florida Fish and Wildlife Research Institute, St. Petersburg, Florida. Accessed August 8, 2012. http://myfwc.com/research/saltwater/fishstats/commercial-fisheries/landings-in-florida/.

FWC (Florida Fish and Wildlife Conservation Commission). Unpublished data. Florida Fish and Wildlife Conservation Commission, Farris Bryant Building, 620 S. Meridian St, Tallahassee, Florida.

FWC/FWRI (Florida Fish and Wildlife Conservation Commission/Florida Wildlife Research Institute). Unpublished data. Florida Fish and Wildlife Conservation Commission, 100 Eighth Avenue SE, St. Petersburg, Florida.

FWC/FWRI (Florida Fish and Wildlife Conservation Commission/Florida Wildlife Research Institute). 2010. FWC News Releases: Oil forces partial closure in Escambia County, published Sunday, June 13, 2010 and Closed fish-harvesting area in Escambia County reopens, published Saturday, July 31, 2010. http://myfwc.com/news/resources/fact-sheets/oil-spill/.

Gallaway, B. Personal Communication. LGL-Ecological Research Associates, Inc. Bryan, Texas.

Gartner, J.V., Jr. 1986. Observations on anomalous conditions in some flatfishes (Pisces:Pleuronectiformes) with a new record of partial albinism. Environmental Biology of Fishes 17(2):141-152.

Gilbert, C.R. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Florida); southern, gulf, and summer flounders. United States Fish and Wildlife Service Biological Report 82 (11.54). United States Army Corps of Engineers TR EL-82-4. 27p.

Ginsburg, I. 1952. Flounders of the genus *Paralichthys* and related genera in American waters. Fisheries Bulletin 52:265-351.

Glass, L.A. 2003. Distribution, Condition, and Growth of Newly Settled Southern Flounder (*Paralichthys lethostigma*) in the Galveston Bay Estuary, Texas. M.S. Thesis. Texas A&M University.

Glass, L.A., J.R. Rooker, R.T. Kraus, and G.J. Holt. 2008. Distribution, condition, and growth of newly settled southern flounder (*Paralichthys lethostigma*) in the Galveston Bay Estuary, Texas. Journal of Sea Research 59:259-268.

GMFMC (Gulf of Mexico Fishery Management Council). 2009. Amendment 31 to the fishery management plan for the reef fish resources in the Gulf of Mexico. Gulf of Mexico Fishery Management Council. Tampa, Florida.

Goode, G. B., and T. H. Bean. 1879. Catalogue of a collection of fish sent from Pensacola, Florida, and vicinity, by Mr. Silas Stearns, with descriptions of six new species. Proceedings of the U.S. National Museum 2:121-156.

Gray, I.E. 1960. Unusual pigmentation in the flounder *Paralichthys lethostigma*. Copeia 1960(4):346-347.

Green, L.M. 1986. Fish tagging on the Texas coast, 1950-1975. Management Data Series Number 99. Texas Parks and Wildlife Department, Coastal Fisheries Division, Rockport, Texas. 70p.

Green, L.M., and R.P. Campbell. 2010. Trends in finfish landings of sport-boat anglers in Texas marine waters, May 1974-May 2008. TPWD Management Data Series. No. 257. 645p.

Greenwood, P.H., D.L. Rosen, S.H. Weitzman, and G. Myers. 1966. Phyletic studies of teleolstean fishes with a provisional classification of living forms. Bulletin of the American Museum of Natural History 131(4):341-455.

GSMFC (Gulf States Marine Fisheries Commission). Unpublished Data. 1996 market channel survey for spotted seatrout and flounder in the Gulf of Mexico region. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi.

GSMFC (Gulf States Marine Fisheries Commission). 2003. Guidelines for developing derelict trap removal programs in the Gulf of Mexico. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Publication Number 110, 85p.

Gudger, E.W. 1935. Two partially ambicolorate flatfishes (Heterostomata). I. a summer flounder, *Paralichthys dentatus*. II. a rusty dab, *Limanda ferruginea*. American Museum Novitates 1935(768)1-8.

Gudger, E.W., and F.E. Firth. 1936. Three partially ambicolorate four-spotted flounders, *Paralichthys oblongus*, two each with a hooked dorsal fin and a partially rotated eye. American Museum Novitates 1936(885):1-9.

Guillory, V., and G. Hutton. 1990. A survey of the marine recreational fishery of lower Barataria Bay, Louisiana, 1975-1977. Pages 59-73 *In*: Louisiana Department of Wildlife and Fisheries Technical Bulletin Number 41.

Guillory, V., A. McMillen-Jackson, L. Hartman, H. Perry, T. Floyd, T. Wagner, and G. Graham. 2001. Blue Crab Derelict Traps and Trap Removal Programs. Gulf States Marine Fisheries Commission. Ocean Springs, Mississippi. Publication Number 88, 14p.

Gunter, G. 1936. Studies of the destruction of marine fish by shrimp trawlers in Louisiana. Louisiana Conservation Review 5(4):18-24, 45-46.

Gunter, G. 1938. Seasonal variations in abundance of certain estuarine and marine fishes in Louisiana, with particular reference to life histories. Ecological Monographs 8(3):313-346.

Gunter, G. 1945. Studies of marine fishes of Texas. Publication of the Institute of Marine Science, University of Texas 1:1-190.

Gunter, G. 1967. Some relationships of estuaries to the fisheries of the Gulf of Mexico. Pages 621-638 *In*: Lauff, G.H. (ed.), Estuaries. American Association for the Advancement of Science, Publication 83. Washington, D.C.

Gunter, G., and C.H. Lyles. 1979. Localized plankton blooms and jubilees on the Gulf coast. Gulf Research Reports 6(3):297-299.

Gunter, G., and G.E. Hall. 1965. A biological investigation of the Caloosahatchee estuary of Florida. Gulf Research Reports 2(1):1-71.

Gutherz, E.J. 1967. Field guide to the flatfishes of the family Bothidae in the western North Atlantic. United States Department of the Interior, United States Fish and Wildlife Service, Bureau of Commercial Fisheries Circular 263, Washington, D.C. 47p.

Gutherz, E.J. 1970. Characteristics of some larval Bothid flatfish, and development and distribution of larval spotfin flounder, *Cyclopsetta fimbriata* (Bothidae). Fishery Bulletin 68(2):261-283.

Gutherz, E.J., G.M. Russell, A.F. Serra, and B.A. Rohr. 1975. Synopsis of the northern Gulf of Mexico industrial and foodfish industries. Marine Fisheries Review 1:1-11.

Harrington, R.A., G.C. Matlock, and J.E. Weaver. 1979. Standard-total length, total length-whole weight and dressed-whole weight relationships for selected species from Texas bays. Management Data Series Number 26. Texas Parks and Wildlife Department, Coastal Fisheries Branch, Austin, Texas. 6p.

Henderson, G.G., Jr. 1972. Marine introductions. Texas Parks and Wildlife Department, Federal Aid Project Number F-18-R5/Job Number 8. 33p.

Henderson-Arzapalo, A., R.L. Colura, and A.F. Maciorowski. 1988. Temperature and photoperiod induced maturation of southern flounder. Management Data Series Number 154. Texas Parks and Wildlife Department, Coastal Fisheries Branch. 20p.

Herke, W.H. 1971. Use of natural, and semi-impounded, Louisiana tidal marshes as nurseries for fishes and crustaceans. Ph.D. Dissertation. Louisiana State University, Baton Rouge, Louisiana. 264p.

Herke, W.H. 1979. Some effects of semi-impoundment on coastal Louisiana fish and crustacean nursery usage. Pages 325-346 *In*: J.W. Day, D.D. Culley, Jr., R.E. Turner, and A.J. Mumphrey, Jr. (eds). Proceedings of the Third Coastal Marsh and Estuary Management Symposium. Louisiana State University Division of Continuing Education, Baton Rouge, Louisiana.

Hickman, C.P., Jr. 1968. Glomerular filtration and urine flow in the euryhaline southern flounder, *Paralichthys lethostigma*, in seawater. Canadian Journal of Zoology 46:427-437.

Hildebrand, H.H. 1954. A study of the fauna of the brown shrimp (*Penaeus aztecus* Ives) grounds in the western Gulf of Mexico. Publications of the Institute for Marine Science, University of Texas 3:233-366.

Hildebrand, S.F., and L.E. Cable. 1930. Development and life history of fourteen teleostean fishes at Beaufort, North Carolina. Bulletin of the United States Bureau of Fisheries 46:383-488.

Hode, R. Personal Communication. Oil Disaster Response Program. Gulf States Marine Fisheries Commission. Ocean Springs, Mississippi.

Hoese, H.D. 1965. Spawning of marine fishes in the Port Aransas, Texas, area as determined by the distribution of young and larvae. Ph.D. Dissertation. The University of Texas, Austin, Texas. 144p.

Hoese, H.D., and R.H. Moore. 1998. Fishes of the Gulf of Mexico; Texas, Louisiana, and adjacent waters. Second Edition. Texas A & M University Press, College Station, Texas. 422p.

Hoff, F.H., Jr. 1969. Ambicoloration of an adult flounder, *Paralichthys albigutta*. Copeia 1:208-209.

Holling, C.S. 1959. The components of predation as revealed by a study of small-mammal predation of the European pine sawfly. The Canadian Entomologist 91(5):293-320.

Horst, J. 2003. Flounder Facts. Louisiana State University Agricultural Center, Louisiana Sea Grant College Program.

Horst, J., and D. Bankston. 1987. Bottom longline fishing off Louisiana's coast: techniques for profits. Louisiana State University. Sea Grant Publication Number LSU-T-87-001. 37p.

Horst, J., and H. Holloway. 2002. Louisiana License Statistics and Trends, 1987-2000: Commercial Fishing, Recreational Gear, Commercial Wildlife, and Related Industries. Louisiana Sea Grant College Program, Louisiana State University. Baton Rouge, Louisiana. LSU-S-02-001.

Horst, J., and M. Lane. 2006. Angler's guide to fishes of the Gulf of Mexico. Pelican Publishing. 432p.

Hoss, D.E., and D.S. Peters. 1976. Respiratory adaptations: fishes. Pages 335-346 *In*: M. Wiley (ed) Estuarine Processes, Volume I. Academic Press, New York, New York.

IAI (Impact Assessment, Inc.). 2007. Final technical report: preliminary assessment of the impacts of Hurricane Katrina on Gulf of Mexico coastal fishing communities. Submitted to National Marine Fisheries Service Southeast Regional Office Contract # WC133F-06-CN-0003.

IGFA (International Game Fish Association). 2013. World record game fishes B International Game Fish Association Freshwater and Saltwater all-tackle records, Section 4BWorld Records. The International Game Fish Association, Fort Lauderdale, Florida.

Jackson, P.M., and D. Timmer, Jr. 1976. A guide to fishing in Louisiana, the sportsman's paradise. Louisiana Wildlife and Fisheries Commission, Wildlife Education Bulletin Number 107. 37p.

Johns, M.A. 1990. Trends in Texas commercial fishery landings, 1972-1989. Texas Parks and Wildlife Department, Management Data Series Number 37, 136 pp.

Jordan, D.S., and B.W. Evermann. 1898. The fishes of North and middle America: a descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama, Part III. Bulletin of the United States National Museum 47(3):2184-2744.

Jordan, D.S., and C.H. Gilbert. 1879. Notes on the fishes of Beaufort Harbor, North Carolina. Proceedings of the United States National Museum 1:365-388.

Jordan, D.S., and C.H. Gilbert. 1882. Synopsis of the fishes of North America. Bulletin of the United States National Museum Number 16.

Jordan, D.S., and C.H. Gilbert. 1883. Notes on a collection of fishes from Charleston, South Carolina, with descriptions of three new species. Proceedings of the United States National Museum 5:580-620.

Jordan, D.S., and J. Swain. 1885. Notes on fishes collected by David S. Jordan at Cedar Keys, Florida. Proceedings of the United States National Museum 7:230-234.

Jordan, D.S., and S.E. Meek. 1884. List of fishes observed in the Saint John's River at Jacksonville, Florida. Pages 235-237 *In*: Jordan, D.S., and C.H. Gilbert (eds). Proceedings of the United States National Museum 7.

Juneau, C.L. 1975. An inventory and study of the Vermilion Bay-Atchafalaya Bay complex. Louisiana Department of Wildlife and Fisheries, Technical Bulletin Number 13. 153 pp.

Karp, W.A., L.L. Desfosse, and S.G. Brooke (eds). 2011. U.S. National Bycatch Report. United States Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-117E, 508p.

Kelly, J.R., Jr. 1965. A taxonomic survey of the fishes of the Delta National Wildlife Refuge with emphasis upon distribution and abundance. M.S. Thesis, Louisiana State University. 133p.

Kelso, W.E., B.D. Rogers, D.A. Rutherford, and D.R. Rodgers. 1991. Survey of Louisiana sport fishermen - 1990. Louisiana Agricultural Experiment Station Mimeo Report 57.

Kelso, W.E., B.D. Rogers, D.A. Rutherford, and D.R. Rodgers. 1992. Survey of Louisiana sport fishermen - 1991. Louisiana Agricultural Experiment Station Mimeo Report 68.

Kelso, W.E., B.D. Rogers, T.A. Bahel, D.A. Rutherford, and D.R. Rogers. 1994. A 1993 survey of Louisiana saltwater anglers. School of Forestry, Wildlife, and Fisheries, Louisiana State University Agricultural Center, Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana. 93p.

Kemp, R.J. 1949. Report on stomach analysis from June 1, 1949 through August 31, 1949. Annual Report of the Game, Fish and Oyster Commission 1948-1949:101-127.

King, B.D., III. 1971. Study of migratory patterns of fish and shellfish through a natural pass. Texas Parks and Wildlife Department. Technical Series Number 9, Austin, Texas. 54p.

Knapp, E.T. 1950. Menhaden utilization in relation to the conservation of food and game fishes of the Texas Gulf coast. Transactions of the American Fisheries Society 79:137-144.

Kvenvolden, K.A., and C.K. Cooper. 2003. Natural seepage of crude oil into the marine environment. GeoMarine Letters 23:140-146.

Kyle, G.T., M.A. Schuett, K. Lee, J. Yoon, C. Ding, and K. Wallen. 2014. Demographics, attitudes, and management preferences of Texas anglers. College Station, Texas: Texas A&M University.

LAC (Louisiana Administrative Code). Title 76. Part I. Chapter 3. Subchapter D. §315. Fish and Wildlife Values. Updated August 2011.

Laska, A.L. 1973. Fishes of the Chandeleur Islands, Louisiana. Ph.D. Dissertation, Tulane University, New Orleans, Louisiana. 260p.

Lasswell, J.L., G. Garza, and W.H. Bailey. 1977. Status of marine fish introduction into the fresh waters of Texas. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 31:399-403.

Lasswell, J.L., B.W. Lyons, and W.H. Bailey. 1978. Hormone-induced spawning of southern flounder. Progressive Fish-Culturist 40:154.

LDWF (Louisiana Department of Wildlife and Fisheries). Personal Communication. Baton Rouge, Louisiana.

LDWF (Louisiana Department of Wildlife and Fisheries). Unpublished Data. Baton Rouge, Louisiana.

LDWF (Louisiana Department of Wildlife and Fisheries). 1989. Louisiana Administrative Code 76, subchapter C.315. Baton Rouge, Louisiana.

LDWF (Louisiana Department of Wildlife and Fisheries). 1997. 1997 report on the status of spotted seatrout. Louisiana Department of Wildlife and Fisheries, Marine Fisheries Division, Socioeconomic Research and Development Section, and Enforcement Division. Baton Rouge, Louisiana. 30p.

LDWF (Louisiana Department of Wildlife and Fisheries). 2010. Assessment of Southern Flounder in Louisiana Waters 2010 Report. Louisiana Department of Wildlife and Fisheries, Marine Fisheries Division. Baton Rouge, Louisiana. 27p.

Leard, R.L., B. Mahmoudi, H. Blanchet, H. Lazauski, K. Spiller, M. Buchanan, C. Dyer, and W. Keithly. 1995. The striped mullet fishery of the Gulf of Mexico, United States: a regional management plan. Gulf States Marine Fisheries Commission Publication Number 33, Ocean Springs, Mississippi.

Leard, R.L., R. Matheson, K. Meador, W. Keithly, 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. Gulf States Marine Fisheries Commission Publication Number 28, Ocean Springs, Mississippi.

Levine, S.J. 1980. Gut contents of forty-four Lake Pontchartrain, Louisiana, fish species. Report for the United States Corps of Engineers. Pages 899-1029 *In*: J.H. Stone (ed) Environmental Analysis of Lake Ponchartrain, Louisiana, Its Surrounding Wetlands, and Selected Coastal Areas. Louisiana State University, Sea Grant Publication Number LSU-CEC-80-08.

Livingston, R.J. 1976. Diurnal and seasonal fluctuations of organisms in a north Florida estuary. Estuarine 4:373-400.

Loesch, H. 1960. Sporadic mass shoreward migrations of demersal fish and crustaceans in Mobile Bay, Alabama. Ecology 41(2):292-298.

Lowe, M.R., D.R. DeVries, R.A. Wright, S.A. Ludsin, and B.J. Fryer. 2011. Otolith microchemistry reveals substantial use of freshwater by southern flounder in the northern Gulf of Mexico. Estuaries and Coasts 34:630-639.

Luckenbach, J.A., J. Godwin, H.V. Daniels, and R.J. Borski. 2003. Gonadal differentiation and effects of temperature on sex determination in southern flounder (*Paralichthys lethostigma*). Aquaculture 216(1–4):315-327.

Luckenbach, A.J., J. Godwin, H.V. Daniels, J.M. Beasley, C.V. Sullivan, and R.J. Borski. 2004. Induction of diploid gynogenesis in southern flounder (*Paralichthys lethostigma*) with homologous and heterologous sperm. Aquaculture 237(1-4):499-516.

Luquet, C.P., Jr., R.H. Blanchet, D.R. Lavergne, D.W. Beckman, J.W. Wakeman, and D.L. Nieland. 1998. A biological and fisheries profile of black drum (*Pogonias cromis*) in Louisiana. Louisiana Department of Wildlife and Fisheries. Fisheries Management Plan Series Number 2, Part 1. 67p.

Lyczkowski-Shultz, J., D. Ruple, S.L. Richardson, and J.H. Cowan. 1990. Distribution of fish larvae relative to time and tide in a Gulf of Mexico barrier island pass. Bulletin of Marine Science 46:563-577.

Maharaj, V., and J.E. Carpenter. 1997. The 1996 economic impact of sport fishing in the United States. American Sportfishing Association. United States Fish and Wildlife Service Cooperative Grant Agreement Number 14-48-0009-1237. 10p.

Manooch, C.S., III. 1984. Fisherman's guide: fishes of the southeastern United States. North Carolina State Museum of Natural History, Raleigh, North Carolina. 362p.

Martin, F.D., and L. McEachron. 1986. Occurrence of select juvenile fishes during post spawning periods in Texas bay-gulf passes. Texas Parks and Wildlife Department Management Data Series Number 96, Austin, Texas. 23p.

Matlock, G.C. 1982. By-catch of southern flounder and gulf flounder by commercial shrimp trawlers in Texas bays. Texas Parks and Wildlife Department Management Data Series Number 31, Coastal Fisheries Branch. 16p.

Matlock, G.C. 1985. Lengths of 24 saltwater fishes caught in trammel nets in Texas bays. Texas Parks and Wildlife Department. Management Data Series Number 83. 29p.

Matlock, G.C., and M.A. Garcia. 1983. Stomach contents of selected fishes from Texas bays. Contributions in Marine Science 26:95-110.

May, E.B. 1973. Extensive oxygen depletion in Mobile Bay, Alabama. Limnology and Oceanography 18(3):353-366.

McCay, B.J. 1978. Systems ecology, people ecology, and the anthropology of fishing communities. Human Ecology 6(4):397-422.

McEachran, J.D., and J.D. Fechhelm. 2005. Fishes of the Gulf of Mexico, Volume 2. University of Texas Press.

McEachron, L.D., and B.E. Fuls. 1996. Trends in relative abundance and size of selected finfishes and shellfishes along the Texas coast: November 1975-December 1995. Texas Parks and Wildlife Department Management Data Series 124:1-95.

MDMR (Mississippi Department of Marine Resources). Unpublished data. 1141 Bayview, Suite 101, Biloxi, Mississippi, 39530.

Midway, S.R. Personal Communication. USGS PA Cooperative Fish and Wildlife Research Unit. University Park, Pennsylvania.

Midway, S.R., and F.S. Scharf. 2012. Histological analysis reveals larger size at maturity for southern flounder with implications for biological reference points. Marine and Coastal Fisheries 4(1):628-638.

Miles, D.W. 1949. A study of the food habits of the fishes of the Aransas Bay area. Texas Game, Fish and Oyster Commission, Marine Laboratory Annual Report 49:126-169.

Miller, A. Personal Communication. Gulf States Marine Fisheries Commission. Ocean Springs, Mississippi.

Miller, A.L., and J.C. Isaacs. 2011. An Economic Survey of the Gulf of Mexico Inshore Shrimp Fishery: Implementation and Descriptive Results for 2008. Gulf States Marine Fisheries Commission Publication Number 195.

Miller, A., E. Ogunyinka, and J. Isaacs. 2014a. An economic baseline and characterization of U.S Gulf of Mexico dockside seafood dealers. Gulf States Marine Fisheries Commission. Ocean Springs, Mississippi, Publication 226 86p.

Miller, A., J. Isaacs, and L. Bharadwaj. 2014b. An economic baseline and characterization of U.S. Gulf of Mexico seafood processors. Gulf States Marine Fisheries Commission. Ocean Springs, Mississippi. Publication 225. 98p.

Miller, A., S. Aultman, and E. Mykerezi. Unpublished Data. The quantity and distribution of marine recreational fishing effort in the Gulf of Mexico as a function of macroeconomic variables (Preliminary Results). A presentation to the Commercial/Recreational Fisheries Advisory Panel. 60th Annual Meeting of the Gulf States Marine Fisheries Commission. October 12th-16th, 2009. Biloxi, Mississippi

Miller, J.M. 1965. A trawl survey of the shallow gulf fishes near Port Aransas, Texas. Publications of the Institute of Marine Science, University of Texas 10:80-107.

Miller, J.M., J.P. Reed, and L.J. Pietrafesa. 1984. Patterns, mechanisms and approaches to the study of migrations of estuarine-dependent fish larvae and juveniles. Pages 209-225 *In*: McCleave, J.D., G.P. Arnold, J.J. Dodson, and W.H. Neill (eds). Mechanisms of Migrations in Fishes. Plenum Press, New York, New York.

Milon, J. W. 2001. Current and future participation in marine recreational fishing in the southeast U.S. region, NOAA Technical Memorandum NMFS-F/SPO-44. 33p.

Minello, T.J. 1999. Nekton densities in shallow estuarine habitats of Texas and Louisiana and the identification of essential fish habitat. American Fisheries Society Symposium 22:43-75.

Minello, T.J., R.J. Zimmerman, and E.X. Martinez. 1987. Fish predation on juvenile brown shrimp, *Peneaus aztecus* Ives: effects of turbidity and substratum on predation rates. Fishery Bulletin 85(1):59-70.

Minello, T.J., R.J. Zimmerman, and E.X. Martinez. 1989. Mortality of young brown shrimp (*Penaeus aztecus*), in estuarine nurseries. Transactions of the American Fisheries Society 118:693-708.

Moe, M.A., Jr., and G.T. Martin. 1965. Fishes taken on monthly trawl samples offshore of Pinellas County, Florida, with new additions to the fish fauna of the Tampa Bay area. Tulane Studies in Zoology and Botany 12:129-151.

Moffet, A.W. 1975. The hydrography and macro-biota of the Chocolate Bayou estuary, Brazoria County, Texas (1969-1971). Texas Game and Fish Commission Technical Series Number 14, Coastal Fisheries Branch, Austin, Texas. 72p.

Monaghan, J.P., Jr. 1992. Tagging studies of southern flounder (*Paralichthys lethostigma*) and gulf flounder (*Paralichthys albigutta*) in North Carolina. North Carolina Department of Environmental, Health, and Natural Resources, Division of Marine Fisheries Completion Report for Project F-29. 21p.

Montalvo, A.J., C.K. Faulk, and G.J. Holt. 2012. Sex determination in southern flounder, *Paralichthys lethostigma*, from the Texas Gulf Coast. Journal of Experimental Marine Biology and Ecology 432–433(0):186-190.

Moritz, C. 1994. Defining ‘Evolutionarily Significant Units’ for conservation. Trends in Ecology and Evolution 9:373-375.

Murdock, J.F. 1957. Report on the sport and commercial fisheries of the Braden and Manatee rivers. The Marine Laboratory, University of Miami, Miami, Florida. Report Number 57-23. 22p.

Murphy, M.D., R.G. Muller, and B. McLaughlin. 1994. A Stock Assessment of Southern Flounder and Gulf Flounder. Florida Marine Research Institute. In-house report series IHR 1994-003. 80p.

Music, J.L., Jr., and J.M Pafford. 1984. Population dynamics and life history aspects of major marine sportfishes in Georgia’s coastal waters. Georgia Department of Natural Resources, Coastal Research Division. Contribution Service 38. 382p.

Nall, L.E. 1979. Age and growth of the southern flounder, *Paralichthys lethostigma*, in the northern Gulf of Mexico with notes on *Paralichthys albigutta*. M.S. Thesis. Florida State University. 53p.

Nañez-James S.E., G.W. Stunz, and S.A. Holt. 2009. Habitat use patterns of newly settled southern flounder, *Paralichthys lethostigma*, in Aransas-Copano Bay, Texas. Estuaries and Coasts 32:350-359.

Naughton, S.P., and C.H. Saloman. 1978. Fishes of the nearshore zone of St. Andrew Bay, Florida, and adjacent coast. Northeast Gulf Science 2:43-55.

Nelson, J. S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and Scientific Names of Fishes from the United States, Canada, and Mexico, 6th Edition. American Fisheries Society, Bethesda, Maryland.

Nims, M.K. 2012. Low salinity habitat use patterns of southern flounder (*Paralichthys lethostigma*) on the Texas Gulf Coast. Master’s Thesis. University of Texas at Austin, Texas. 358p.

NOAA (National Oceanic and Atmospheric Administration). Personal Communication. NOAA Office of Science and Technology, National Marine Fisheries Service. Annual Commercial and Recreational Landings Data.

Norden, C.R. 1966. The seasonal distribution of fishes in Vermilion Bay, Louisiana. Wisconsin Academy of Sciences and Arts Letters 55:119-137.

Norman, J.R. 1934. A systematic monograph of the flatfishes (Heterosomata), Volume 1. Psettodidae, Bothidae, Leuronectidae. British Museum, London.

NRC (National Research Council). 2006. Review of Recreational Fisheries Survey Methods. National Academy of Sciences. 202p.

NSB (National Science Board). 2007. Hurricane warning: the critical need for a national hurricane research initiative, NSB-06-115, 1-36.

Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co., Philadelphia, Pennsylvania.

Ogren, L.H., and H.A. Brusher. 1977. The distribution and abundance of fishes caught with a trawl in the St. Andrew Bay system, Florida. Northeast Gulf Sciences 1(2):83-105.

Oliver-Smith, A., and S. Hoffman. 1999. The Angry Earth: Disaster in Anthropological Perspective. New York, NY: Routledge.

Olla, B.L., C.E. Samet, and A.L. Studholme. 1972. Activity and feeding behavior of the summer flounder (*Paralichthys dentatus*) under controlled laboratory conditions. Fishery Bulletin 70(4):1127-1136.

Osburn, H.R, D.L. Trimm, G.C. Matlock, and K.Q. Tran. 1990. Characteristics of Indochinese seafood dealers and commercial fishermen in Texas. Texas Parks and Wildlife Department Management Data Series Number 47, Coastal Fisheries Branch, Austin, Texas. 14p.

Overstreet, R.M. 1978. Marine maladies? Worms, germs, and other symboints from the northern Gulf of Mexico. Mississippi-Alabama Sea Grant Consortium MASGP-78-021. 140p.

Overstreet, R.M., and R.H. Edwards. 1976. Mesenchymal tumors of some estuarine fishes in the northern Gulf of Mexico. II. Subcutaneous fibromas in the southern flounder, *Paralichthys lethostigma*, and the sea catfish, *Arius felis*. Bulletin of Marine Science 26(1):41-48.

Overstreet, R.M., and H.D. Howse. 1977. Some parasites and diseases of estuarine fishes in polluted habitats of Mississippi. Annual New York Academy of Sciences 298:427-462.

Overstreet, R.M., and G.W. Meyer. 1981. Hemorrhagic lesions in stomach of rhesus monkey caused by a piscine ascaridoid nematode. Journal of Parasitology 67(2):226-235.

Overstreet, R.M., and R.W. Heard. 1982. Food contents of six commercial fishes from Mississippi Sound. Gulf Research Reports 7(2):137-149.

Palko, B.J. 1984. An evaluation of hard parts for age determination of pompano (*Trachinotus carolinus*), ladyfish (*Elops saurus*), crevalle jack (*Caranx hippos*), gulf flounder (*Paralichthys albigutta*), and southern flounder (*Paralichthys lethostigma*). United States Department of Commerce, National Marine Fisheries Service, Panama City, Florida. 11p.

Pearse, A.S., H.J. Humm, and G.W. Wharton. 1942. Ecology of sand beaches at Beaufort, N.C. Ecological Monographs 12(2):137-190.

Perret, W.S., and C.W. Caillouet, Jr. 1974. Abundance and size of fishes taken by trawling in Vermilion Bay, Louisiana. Bulletin of Marine Science 24:52-74.

Perret, W.S., B.B. Barrett, W.R. Latapie, J.F. Pollard, W.R. Mock, G.B. Adkins, W.J. Gaidry, and C.J. White. 1971. Cooperative Gulf of Mexico estuarine inventory and study, Louisiana. Phase IV, Biology. Louisiana Wildlife and Fisheries Commission. Pages 35-68.

Perry, H.M., and S. VanderKooy (eds). 2014. The Blue Crab Fishery of the Gulf of Mexico, United States: A Regional Management Plan. 2014 Revision. GSMFC Publication No. **243**

Peters, D.S., and M.A. Kjelson. 1975. Consumption and utilization of food by various postlarval and juvenile fishes of North Carolina estuaries. Pages 448-472 *In*: L.E. Cranin (ed). Estuarine Research. Volume 1, Chemistry, Biology, and Estuarine Systems. Academic Press, Inc., New York, New York.

Peters, D.S., and F.A. Cross. 1992. What is coastal fish habitat? Pages 17-22 *In*: R.H. Stroud (ed). Stemming the tide of coastal fish habitat loss. National Coalition for Marine Conservation, Savannah, Georgia.

Pew, P. 1966. Food and game fishes of the Texas coast. Texas Parks and Wildlife Department Bulletin Number 33, Series Number IV. Marine Laboratory, Austin, Texas. 70p.

Phalen, P.S., D.W. Moye, and S.A. Spence. 1989. Comparison of two trawls used for monitoring juvenile fish abundance in North Carolina. North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries. 14p.

Powell, A.B. 1974. Biology of the summer flounder, *Paralichthys dentatus*, in Pamlico Sound and adjacent waters, with comments on *P. lethostigma* and *P. albiguata*. Master's Thesis, University of South Carolina, Chappel Hill. 145p.

Powell, A.B., and F.J. Schwartz. 1972. Anomalies of the genus *Paralichthys* (Pisces, Bothidae), including an unusual double-tailed southern flounder, *Paralichthys lethostigma*. The Journal of the Mitchell Society 88(3):155-161.

Powell, A.B., and F.J. Schwartz. 1977. Distribution of paralichthid flounders (Bothidae:*Paralichthys*) in North Carolina estuaries. Chesapeake Science 18(4):334-339.

Powell, A.B., and F.J. Schwartz. 1979. Food of *Paralichthys dentatus* and *P. lethostigma* (Pisces, Bothidae) in North Carolina estuaries. Estuaries 2(4):276-279.

Powell, A.B., and T. Henley. 1995. Egg and larval development of laboratory-reared gulf flounder, *Paralichthys albigutta*, and southern flounder, *P. lethostigma* (Pisces, Paralichthyidae). Fisheries Bulletin 93(3):504-515.

Prentice, J.A. 1989. Low-temperature tolerance of southern flounder in Texas. Transactions of the American Fisheries Society 118:30-35.

Randall, J.E., and R. Vergara. 1978. Bothidae. *In*: W. Fischer (ed). FAO species identification sheets for fishery purposes. West Central Atlantic (fishing area 31). Volume 1, Food and Agricultural Organization (FAO) of the United Nations.

Reagan, R.E., Jr., and W.M. Wingo, 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico); southern flounder. United States Fish and Wildlife Service. Biological Report 82 (11.4). United States Army Corps of Engineers TR EL-82-4. 9p.

Reid, G.K. 1954. An ecological study of the Gulf of Mexico fishes in the vicinity of Cedar Key, Florida. Bulletin of Marine Science of the Gulf and Caribbean 4(1):1-94.

Reid, G.K., Jr. 1955. A summer study of the biology and ecology of East Bay, Texas. Part II: The Fish Fauna of East Bay, the Gulf Beach, and Summary. Texas Journal of Science 7:430-453.

Reid, G.K., Jr., A. Inglis, and H.D. Hoese. 1956. Summer foods of some fish species in East Bay, Texas. The Southwestern Naturalist (1):100-104.

Research Strategies, Inc. 1996. Unpublished data. Louisiana seafood customer perception research. New Orleans, Louisiana.

Rice, J.A., L.B. Crowder, and K.A. Rose. 1993. Interactions between size-structured predator and prey populations: experimental test and model comparison. Transactions of the American Fisheries Society 122:481-491.

Ricklefs, R.E. 1993. The economy of nature: a textbook in basic ecology, 3rd edition. Freeman, New York City, New York.

Riechers, R. 2008. Regulations Committee Southern Flounder Update. Texas Parks and Wildlife Department Regulation Committee. Houston, Texas <http://www.tpwd.state.tx.us/business/feedback/meetings/2008/0821/transcripts/regulations_committee/index.phtml>

Roberts, K.J., J.W. Horst, J.E. Roussel, and J.A. Shepard. 1991. Defining fisheries: a user's glossary. As amended in: Wallace, R.K., W. Hosking, and S.T. Sxedlmayer. 1994. Fisheries Management for Fishermen: A Manual for Helping Fishermen Understand the Federal Management Process. Auburn University Marine Extension & Research Center Sea Grant Extension.

Robins, C.R., G.G. Ray, J. Douglass, and E. Freund. 1986. A field guide to Atlantic coast fishes of North America. Houghton Mifflin Company, Boston, Massachusetts. 354p.

Rogers, B.D., and W.H. Herke. 1985. Temporal patterns and size characteristics of migrating juvenile fishes and crustaceans in a Louisiana marsh. Louisiana State University Agricultural Experiment Station. Research Report Number 5. 81p.

Rogers, S.G., T.E. Targett, and S.B. Van Sant. 1984. Fish-nursery use in Georgia salt-marsh estuaries: the influence of springtime freshwater conditions. Transactions of the American Fisheries Society 113(5):595-606.

Ross, S.W., and R.K. Carpenter. 1983. Estuarine stock assessment-juvenile finfish stock assessment and nursery area monitoring. Pages 1-30 *In:* A Plan for Management of North Carolina's Estuarine Fishes B Phase I. Semiannual Report for North Carolina's Office of Coastal Zone Management Fisheries Assistance Program, December 1979-September 1980. North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries.

Ross, S.W., and S.P Epperly. 1985. Utilization of shallow estuarine nursery areas by fishes in Pamlico Sound and adjacent tributaries, North Carolina. Pages 207-232 *In:* Yanez-Arancibia, A. (ed). Fish Community Ecology in Estuaries and Coastal Lagoons: Towards an Ecosystem Integration. Mexico: DR (R) UNAM Press.

Ross, S.W., J.H. Hawkins, D.A. DeVries, C.H. Harvell, and R.C. Harriss, Jr. 1982. North Carolina estuarine finfish management program completion report for project 2-372-R. North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Morehead City, North Carolina. 171p.

Rozas, L.P. Personal Communication. NOAA Estuarine Habitats and Coastal Fisheries Center. Lafayette, Louisiana.

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

Rozas, L.P., and T.J. Minello. 1998. Nekton use of salt marsh, seagrass, and non-vegetatded habitats in south Texas (USA) estuary. Bulletin of Marine Science 63: 481-501.

Rozas, L.P., and T.J. Minello. 1999. Effects of structural marsh management on fishery species and other nekton before and during spring drawdown. Wetlands Ecology and Management 7:121-139.

Russell, S.J., J.H. Render, R.M Parker, S. Ellsworth, L.F. Picou, D. Domengeaux, and G.W. Bane. 1986. State/federal cooperative fishery statistics program in Louisiana; quarterly report. Sea Grant Publication Number LSU-CFI-86-27. 26p.

Sabins, D.S. 1973. Diel studies of larval and juvenile fishes of the Caminada Pass area, Louisiana. M.S. Thesis. Louisiana State University, Baton Rouge, Louisiana. 163p.

Sabins, D.S., and F.M. Truesdale. 1975. Diel and seasonal occurrence of immature fishes in a Louisiana tidal pass. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 28:116-171.

Safrit, G.W., and F.J. Schwartz. 1988. Length-weight relationships for gulf flounder, *Paralichthys albigutta*, from North Carolina. Fisheries Bulletin 86(4):832-833.

SAFMC (South Atlantic Fishery Management Council). 2007. Snapper Grouper Amendment 15A. South Atlantic. South Atlantic Fishery Management Council. Charleston, South Carolina.

Sanders, N., Jr., D.M. Donaldson, and P.A. Thompson (eds). 1990. SEAMAP environmental and biological atlas of the Gulf of Mexico, 1987. Gulf States Marine Fisheries Commission Publication Number 22, Ocean Springs, Mississippi.

Saul, G.E. 1992. Recreational fishery bycatch in the Galveston Bay system. The Galveston Bay National Estuary Program. Publication GBNEP-25. Galveston, Texas. 115p.

Sawyer, R.T., A.R. Lawler, and R.M. Overstreet. 1975. Marine leeches of the eastern United States and the Gulf of Mexico with a key to the species. Journal of Natural History 9:633-667.

Shepard, J. 1986. Spawning peak of southern flounder, *Paralichthys lethostigma*, in Louisiana. Louisiana Department of Wildlife and Fisheries. Technical Bulletin Number 40:77-79, Baton Rouge, Louisiana.

Shipp, R.L. 1986. Dr. Bob Shipp's guide to fishes of the Gulf of Mexico. Twentieth Century Printing Company. Mobile, Alabama.

Shivlani, M. 2009. Characterization of stakeholder uses in marine protected areas in support of establishing limits of acceptable change.

Simmons, E.G. 1951. Fish trap investigation, September 1, 1950 to August 31, 1951. Pages 1-27 *In:* Annual Report of the Marine Laboratory. Texas Game and Fish Commission, Rockport, Texas.

Simmons, E.G. 1957. An ecological survey of the Upper Laguna Madre of Texas. Publications of the Institute of Marine Science, University of Texas 4(2):156-200

Simmons, E.G., and H.D. Hoese. 1959. Studies on the hydrography and fish migration of Cedar Bayou, a natural tidal inlet on the central Texas coast. Publications of the Institute of Marine Science 6:56-80.

Sindermann, C. J. 1979. Pollution-associated diseases and abnormalities of fish and shellfish: a review. Fishery Bulletin 76(4):717-749.

Smith, J.W. 1981. A guide to flounder fishing in South Carolina. South Carolina Sea Grant Consortium, Marine Advisory Publication 81-02. 16p.

Smith, S., S. Jacob, C. Adams, G. Israel, G. Evans, J. Gates, and M. Zacks. 2000. The Impacts of the Florida Net Ban on Commercial Fishing Families. Technical Paper 101. Florida Sea Grant College Program.

Smith, W.G. 1973. The distribution of summer flounder, *Paralichthys dentatus*, eggs and larvae on the continental shelf between Cape Cod and Cape Lookout, 1965. Fishery Bulletin 71(2):537-548.

Smith, W.G., J.D. Sibunka, and A. Wells. 1975. Seasonal distributions of larval flatfishes (Pleuronectiformes) on the continental shelf between Cape Cod, Massachusetts, and Cape Lookout, North Carolina, 1965-66. National Oceanic and Atmospheric Administration Technical Report NMFS SSRF-691.

Smith, T.I.J., D.C. McVey, W.E. Jenkins, M.R. Denson, L.D. Heyward, C.V. Sullivan, and D.L. Berlinsky. 1999. Broodstock management and spawning of southern flounder, *Paralichthys lethostigma*. Aquaculture 176(1-2):87-99.

Smith, S., S. Jacob, and M. Jepson. 2003. After the Florida Net Ban: The Impacts on Commercial Fishing Families. Society and Natural Resources 16:39-59.

Sogard, S., D.E. Hoss, and J.J. Govoni. 1987. Density and depth distribution of gulf menhaden, *Brevoortia patronus*, Atlantic croaker, *Micropogonias undulatus*, and spot, *Leiostomus xanthurus* in the northern Gulf of Mexico. Fishery Bulletin 85(3):601-609.

Southwick, R.I., and A.J. Loftus. 2003. Investigation and Monetary Values of Fish and Freshwater Mussel Kills. American Fisheries Society Summary Special Publication 30. CD-Rom

Springer, V.G., and A.J. McErlean. 1962. Seasonality of fishes on a south Florida shore. Bulletin of Marine Science of the Gulf and Caribbean 12(1):39-60.

Springer, V.G., and K.D. Woodburn. 1960. An ecological study of the fishes of the Tampa Bay area. Florida Board of Conservation Marine Laboratory, Professional Paper Series 1:1-104.

Steel, J. (ed.), 1991. Status and Trends Report of the Albemarle-Pamlico Estuarine Study. North Carolina DEHNR and U.S. EPA National Estuarine Program, Raleigh.

Stickney, R.R., and D.B. White. 1974a. Effects of salinity on the growth of *Paralichthys lethostigma* postlarvae reared under aquaculture conditions. October 14-17, 1973. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 27:532-540.

Stickney, R.R., and D.B. White. 1974b. Lymphocystis in tank cultured flounder. Aquaculture 4(3):307-308.

Stokes, G.G. 1973. Life history studies of *Paralichthys lethostigma* and *P. albigutta* in the vicinity of Aransas Pass, Texas. Annual Report. Texas Parks and Wildlife Department, Fisheries Division. 37p.

Stokes, G.G. 1977. Life history studies of southern flounder (*Paralichthys lethostigma*) and gulf flounder (*P. albigutta*) in the Aransas Bay area of Texas. Texas Parks and Wildlife Department Technical Series Number 25. 37p.

Stunz, G.W., T.L. Linton, and R.L. Colura. 1996. Project 14: morphometric and biochemical analysis of the population structure in southern flounder, *Paralichthys lethostigma*, inhabiting the Texas Gulf coast. Federal Aid in Sportfish Restoration Act, Grant Number F-36-R. 23p.

Stunz, G.W., T.L. Linton, and R.L. Colura. 2000. Age and Growth of Southern Flounder in Texas Waters, with Emphasis on Matagorda Bay. Transactions of the American Fisheries Society 129:119-125.

Subrahmanyam, C.B., and C.L. Coultas. 1980. Studies on the animal communities in two north Florida saltmarshes. Part III - Seasonal Fluctuations of Fish and Macroinvertebrates. Bulletin of Marine Science 30:790-818.

Subrahmanyam, C.B., and S.H. Drake. 1975. Studies on the animal communities in two north Florida saltmarshes. Part 1- Fish Communities. Bulletin of Marine Science 25:445-465.

Swingle, H.A. 1971. Biology of Alabama estuarine areas-cooperative Gulf of Mexico estuarine inventory. Alabama Marine Resources Bulletin. Number 5. 123p.

Swingle, W.E. 1976. Analysis of commercial fisheries catch data for Alabama. Alabama Marine Resources Bulletin Number 11:26-50.

Tabb, D.C., and R.B. Manning. 1961. A checklist of the flora and fauna of northern Florida Bay and adjacent brackish waters of the Florida mainland collected during the period July 1957 through September 1960. Bulletin of Marine Science Gulf and Caribbean 11:552-649.

Tagatz, M.E. 1967. Fishes of the St. Johns River, Florida. Quarterly Journal of the Florida Academy of Science 30(1):25-50.

Tagatz, M.E., and G.L. Dudley. 1961. Seasonal occurrence of marine fishes in four shore habitats near Beaufort, North Carolina, 1957-1960. United States Fish and Wildlife Service Special Scientific Report, Fisheries Number 390. 19p.

Takade-Heumacher H., and C. Batsavage. 2009. Stock Status of North Carolina Southern Flounder (*Paralichthys lethostigma*). North Carolina Division of Marine Fisheries. 25p.

Tarver, J.W., and L.B. Savoie. 1976. An inventory and study of the Lake Pontchartrain-Lake Maurepas estuarine complex. Phase II, Biology. Louisiana Wildlife and Fisheries Commission Technical Bulletin 19:7-99.

Taylor, J. C., and J. M. Miller. 2001. Physiological performance of juvenile southern flounder, *Paralichthys lethostigma* (Jordan and Gilbert, 1884), in chronic and episodic hypoxia. Journal of Experimental Marine Biology and Ecology 258(2):195-214.

Taylor, J.C., J.M. Miller, and D. Hilton. 2008. Inferring southern flounder migration from otolith microchemistry. Final Report, North Carolina Sea Grant, Fishery Resource Grant 05-FEG-06. 27p.

Taylor, J.C., J.M. Miller, L.J. Pietrafesa, D.A. Dickey, and S.W. Ross. 2010. Winter winds and river discharge determine juvenile southern flounder (*Paralichthys lethostigma*) recruitment and distribution in North Carolina estuaries. Journal of Sea Research 64(1-2):15-25.

TCEQ (Texas Commission on Environmental Quality). 2006. Preserving and Improving Water Quality- The Programs of the Texas Commission on Environmental Quality for Managing the Quality of Surface Water GI-351.

Thomas, J. Personal Communication. Shrimp Producers Association, 95289 Nassau River Road, Fernandina Beach, Florida.

Topp, R.W., and F.H. Hoff, Jr. 1972. Flatfishes (Pleuronectiformes). Memoirs of the Hourglass Cruises 4(2):135.

TPWD (Texas Parks and Wildlife Department). Unpublished Data. Coastal Fisheries Division, 4200 Smith School Road, Austin, Texas.

TPWD (Texas Parks and Wildlife Department). 1996. Parks and wildlife proclamations, chapters 69.20-69.29. Texas Parks and Wildlife Department, Austin, Texas.

TPWD (Texas Parks and Wildlife Department). 2002. The Texas shrimp fishery: Executive Summary. A report to the Governor and the 77th legislature of Texas. September 2002. TPWD. Austin, Texas. 63p.

TPWD (Texas Parks and Wildlife Department). 2013. Listing of Species Value by Inch Length Species: Southern Flounder (00616) *Paralichthys lethostigma* for Fiscal Year 2013. Texas Administrative Code, Title 31, Part 2, Chapter 69, Subchapter B, Rule §69.25 Aquatic Life--Recovery Value.

Turner, W.R., and G.N. Johnson. 1973. Distribution and relative abundance of fishes in Newport River, North Carolina. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Report SSRF-666. 23p.

USDOC (United States Department of Commerce). 1990-1998 (Various Issues). Current fisheries statistics: fisheries of the United States. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

USEPA (United States Environmental Protection Agency). 2002. Estimated Per Capita Fish Consumption in the United States. EPA-821- C- 02-003. 262p.

USFWS (United States Fish and Wildlife Service). 1996. National survey of fishing, hunting, and wildlife-associated recreation. U.S. Government Printing Office, Washington, D.C. 115p.

USFWS (United States Fish and Wildlife Service). 2013a. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - Mississippi. U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. FHW/11-LA (Revised 2013). 94p.

USFWS (United States Fish and Wildlife Service). 2013b. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - Louisiana. U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. FHW/11-LA (Revised 2013). 94p.

USFWS (United States Fish and Wildlife Service). 2014a. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - Alabama. U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. FHW/11-LA (Revised 2014). 94p.

USFWS (United States Fish and Wildlife Service). 2014b. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - Florida. U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. FHW/11-LA (Revised 2014). 94p.

USFWS (United States Fish and Wildlife Service). 2014c. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - Texas. U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. FHW/11-LA (Revised 2014). 94p.

VanderKooy, S.J. (ed.). 2000. The Flounder Fishery of the Gulf of Mexico, United States: A Regional Management Plan. Gulf States Marine Fisheries Commission. Publication No. 83. Ocean Springs, Mississippi.

VanderKooy, S.J. (ed). 2012. The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan 2012 Revision. Gulf States Marine Fisheries Commission. Publication No. 202. Ocean Springs, Mississippi.

VanderKooy, S.J., and J.W. Smith. 2015. The Menhaden Fishery of the Gulf of Mexico, United States: A Regional Management Plan. 2015 Revision. Gulf States Marine Fisheries Commission. Publication No. 240. Ocean Springs, Mississippi.

Vick, N.G. 1964. The marine ichthyofauna of St. Andrews Bay, Florida, and nearshore habitats of the northeastern Gulf of Mexico. Texas A&M University Project 286-D, Department of Oceanography and Meteorology, Research Foundation, College Station, Texas. 77p.

Voss, F. Personal communication. Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Florida Independent Monitoring Program, 100 Eighth Avenue SE, St. Petersburg, Florida.

Wagner, P.R. 1973. Seasonal biomass, abundance and distribution of estuarine dependent fishes in the Caminada Bay system of Louisiana. Ph.D. Dissertation, Louisiana State University, Baton Rouge, Louisiana. 177p.

Wang, J.C.S., and E.C. Raney. 1971. Distribution and fluctuations in the fish fauna of the Charlotte Harbor estuary, Florida. Charlotte Harbor Estuarine Studies 3, Mote Marine Laboratory, Sarasota, Florida.

Ward, G.H., Jr., N.E. Armstrong, and Matagorda Bay Project Team. 1980. Matagorda Bay, Texas: its hydrography, ecology, and fishery resources. United States Fish and Wildlife Services, Biological Services Program FWS/OBS-81/52. 230p.

Warlen, S.M. 1975. Night stalking flounder in the ocean surf. Marine Fisheries Review 37(9):27-30.

Warlen, S.M., and J.S. Burke. 1990. Immigration of larvae of fall/winter spawning marine fishes into a North Carolina estuary. Estuaries 13(4):453-461.

Watanabe, W.O., P.M. Carroll, and H.V. Daniels. 2001. Sustained, natural spawning of southern flounder *Paralichthys lethostigma* under an extended photothermal regime. Journal of the World Aquaculture Society 32(2):153-166.

Watterson, J.C., and J.L. Alexander. 2004. Southern flounder escapement in North Carolina, July 2001-June 2004. Final Performance Report F-73, Segments 1-3. North Carolina Department of Natural Resources, Division of Marine Fisheries. 41p.

Weinstein, M.P. 1979. Shallow marsh habitats as primary nurseries for fishes and shellfish, Cape Fear River, North Carolina. Fishery Bulletin 77:339-357.

Weinstein, M.P., S.L. Weiss, R.G. Hodson, and L.R. Gerry. 1980. Retention of three taxa of postlarval fishes in an intensively flushed tidal estuary, Cape Fear River, North Carolina. Fishery Bulletin 78(2):419-436.

Weixelman, M., H.R. Maddux, and D.L. Trimm. 1992. Status of southern flounder fishery in Texas. Pages 193-22 *In:* Goodwin, M.H., S.M. Kau, and G.T. Waugh (eds). Proceedings of the Forty-Second Annual Gulf and Caribbean Fisheries Institute. Charleston, South Carolina.

Wenner, C.A., W.A. Roumillat, J.E. Moran, Jr., M.B. Maddox, L.B. Daniel, III, and J.W. Smith. 1990. Investigations on the life history and population dynamics of marine recreational fishes in South Carolina: Part I. Marine Resources Research Institute, South Carolina Wildlife and Marine Resources Department, Charleston, South Carolina. 194p.

Whitaker, R.H., and S.A. Levin. 1975. Introduction. Page 448 *In*: Whitaker, R.H., and S.A. Levin (eds). Niche; theory and application. Benchmark papers in ecology No. 3. Dowden, Hutchinson, and Ross, Stroudsburg, Pennsylvania.

White, D.B., and R.R. Stickney. 1973. A manual of flatfish rearing. Skidaway Institute of Oceanography Technical Report Series Number 73-7, Savannah, Georgia. 36p.

White, J.C., Jr. 1962. A reversed ambicolorate postlarval gulf flounder, *Paralichthys albigutta*. Copeia 1962(4):854.

Wilcox, J.A., P.L. Tracy, and N.H. Marcus. 2006. Improving live feeds: effect of a mixed diet of copepod nauplii (*Acartia tonsa*) and rotifers on the survival and growth of first-feeding larvae of the southern flounder, *Paralichthys lethostigma*. Journal of the World Aquaculture Society 37(1):113-120.

Williams, A.B., and E.E. Deubler. 1968. A ten year study of meroplankton in the North Carolina estuaries: assessment of environmental factors and sampling success among bothid flounders and penaeid shrimps. Chesapeake Science 9:27-41.

Williams, E.H., Jr. 1979. Leeches of some fishes of the Mobile Bay region, Alabama. Northeast Gulf Science 3(1):47-49.

Wolff, M. 1977. Preliminary stock assessment, North Carolina: flounder (*Paralichthys* sp.). North Carolina Department of Natural Resources Project 20294-R. Completion Report. 19p.

Woolcott, W.S., C. Beirne, and W.H. Hall, Jr. 1968. Descriptive and comparative osteology of the young of three species of flounders, genus Paralichthys. Chesapeake Science 9(2):109-120.

Wright, R.A., L.B. Crowder, and T.H. Martin. 1993. The effects of predation on the survival and size-distribution of estuarine fishes: an experimental approach. Environmental Biology of Fishes 36:291-300.

Yagley, J., L. George, C. Moore, and J. Pinder. 2005. They Paved Paradise…Gentrification in Rural Communities. Report Prepared for U.S. Department of Housing and Urban Development (HUD), Washington, DC, Housing Assistance Council.

Appendix 1

Flounder Market Survey

********* PLEASE RESPOND TO THE FOLLOWING QUESTIONS WITH YOUR "BEST GUESS" *ESTIMATES* *********
(The following questions to "flounder" which include both Gulf and southern flounders)

1. FROM WHOM AND WHERE DID YOUR SUPPLY **COME** *FROM?*

A. Of the total volume of whole flounder you handled last year (2012), what percent (*estimate*) were obtained directly from each of the following sources?

1. In-state fishermen ________ %
2. Out-of-State fishermen ________ %
3. In-State Wholesale Distributor/Processor ________ %
4. Out-of-State Wholesale Distributor/Processor ________ %
5. Other In-State Source (please describe____________________) ________ %
6. Other Out-of-State Source (please describe____________________) ________ %

Total → 100 %

B. Of the total volume of flounder you handled last year, what percent (*estimate*) originated from foreign sources (i.e., imported from Mexico, Costa Rica, etc).

________ %

2. DID YOU CUT IT, LEAVE IT WHOLE, FREEZE IT, OR WHAT?

A. Of the total volume of flounder you processed last year, what percent (*estimate*) was processed into the following product forms prior to final sale by your firm?

1. Whole form (gutted, headed, and/or eviscerated) ________ %
2. Fillets ________ %
3. Other (please describe____________________) ________ %

Total → 100 %

B. What percent (*estimate*) of the flounder you handled last year was sold by your firm as fresh or frozen?

1. Fresh ________ %
2. Frozen ________ %

Total → 100 %

3. WHO DID YOU SELL IT TO AND HOW DID THEY WANT IT?

A. Of the total volume of flounder you handled last year, what percent (*estimate*) was sold to each of the following types of buyers?

1. In-state Wholesale Distributor/Processor ________ %
2. Out-of-state Wholesale Distributor/Processor ________ %
3. In-state Retailer (grocery, seafood market, etc) ________ %
4. Out-of-state Retailer ________ %
5. In-state Restaurant ________ %
6. Out-of-state Restaurant ________ %
7. Retail Consumer ________ %

Total → 100 %

B. For each of the following types of buyers to whom you sell flounder, please indicate the percentage (*estimate*) of each product form purchased by each in a typical year. Also, for each type of buyer, show the percentage of fresh versus frozen purchased. Both sets of %'s should total to 100%.

FLOUNDER PRODUCT FORM

Buyers	**Whole**	**Fillets**	**Other**	**Total**	**Fresh**	**Frozen**	**Total**
Example: Restaurants	*(25%)*	*(50%)*	*(0%)*	*100%*	*(75%)*	*(25%)*	*100%*
Wholesale Distributor/Processor	( )	( )	( )		( )	( )	
Retailers	( )	( )	( )		( )	( )	
Restaurants	( )	( )	( )		( )	( )	
Retail Consumers	( )	( )	( )		( )	( )	
Other (please describe____________)	( )	( )	( )		( )	( )	

4. WHERE ARE YOU LOCATED?

In what states do you operate fish houses where flounder are handled? Indicate the number in each of the states listed.

Texas __________
Louisiana __________
Mississippi __________
Alabama __________
Florida (Gulf region) __________

THANK YOU FOR PARTICIPATING!!

About the Artist
Ava Lasseter

A native Floridian, Ava Lasseter is an avid scuba diver and underwater photographer and combines her background in art and passion for spearfishing to paint gyotaku (Japanese fish prints) from her catches of Gulf of Mexico fishes. Each fish is carefully speared, inked, printed, filleted, and eaten by the artist.