Management Profile for Gulf of Mexico Cobia

Gulf States Marine Fisheries Commission

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Management Profile for Gulf of Mexico Cobia

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Finally, TTF members would like to express their appreciation to Ms. Debora K. McIntyre (Commission) for her support and editorial reviews of the draft profile and Ms. Lucia Hourihan for her extensive final review of the completed document.

Preface

The Gulf States Marine Fisheries Commission (Commission) 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 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. 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 Commission is empowered to recommend to the governor and legislature of the respective states action 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 Commission.

One of the most important functions of the Commission 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 Commission also plays a key role in the implementation of the Interjurisdictional Fisheries (IJF) Act. Paramount to this role are the Commission's activities to develop and maintain regional profiles and plans for important Gulf species.

The *Management Profile for Gulf of Mexico Cobia* 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 Commission made all necessary arrangements for task force workshops. Under contract with the National Marine Fisheries Service (NMFS), the Commission 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 are fish that are brought back to the dock in a form that can be identified by trained interviewers and Type-B1 catch are fish that are used for bait, released dead, or filleted – i.e., they are killed, but identification is by individual anglers. Type-B2 catch are fish that are released alive – again, identifications are by individual anglers and are 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**
C	**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
ECONOMIC CHARACTERISTICS OF THE COMMERCIAL AND RECREATIONAL FISHERIES

List of Tables

List of Figures

Chapter 1
SUMMARY

Cobia (*Rachycentron canadum*) is the only species within the family Rachycentridae and are found throughout most of the tropical and subtropical regions of the world's oceans. Cobia supports both commercial and recreational fisheries but in the U.S., recreational landings substantially exceed commercial landings. This species is managed as a federal fishery in the Gulf of Mexico by the Gulf of Mexico and South Atlantic Fishery Management Councils in the Coastal Migratory Pelagic (CMP) Fishery Management Plan. The Atlantic Cobia stock migrates along the East U.S. as far north as New York down to about the Georgia-Florida line. The Gulf migratory group consists of fish that migrate from East Florida into the Gulf of Mexico. This Management Profile focuses on Cobia belonging to the Gulf migratory group, or the Gulf stock (SEDAR28 2013).

Cobia are a fast-growing, moderately-lived fish, capable of reaching over 6-8 kg and about 53-60 cm fork length (FL) during the first year of life. Although little is known about the specific areas that adult Cobia spawn, eggs are commonly found in offshore waters from May through September and recent work has found eggs inshore in South Carolina (Lefebvre and Denson 2012). Larvae occur in both estuarine and pelagic waters of the Gulf of Mexico and South Atlantic, primarily from May through September and juveniles are routinely collected inshore inhabiting coastal areas such as beaches, river mouths, barrier islands, and high salinity bays and inlets. The transition from juvenile to adult varies but most males begin to mature around 600-650 mm FL, or between 1 and 2 years of age while females mature later, around 800-840 mm FL, or age 2-3.

Adult and sub adult Cobia may occur alone or in small groups and are often found in association with larger fish, such as rays, sharks, and whales. They have also been found shadowing sea turtles. Cobia are also known to be attracted to buoys, floating debris, pilings, shipwrecks, and artificial structures including petroleum platforms and fish attracting devices (FADs) making them highly susceptible to anglers who target them by sighting. In the Gulf of Mexico, Cobia migrate from the southern reaches of the Florida Keys to the northcentral Gulf in the spring. They return to warmer waters during the fall as temperatures decrease. It is generally assumed that the migration is partly related to the spawning season which runs from spring through the summer in the Gulf.

The commercial fishery supported by Cobia in the Gulf of Mexico is minor, averaging just over 160,000 lbs annually which accounts for about 80% of the total U.S. landings. Both coasts of Florida make up the majority of the U.S. landings as hook-and-line fishermen target the fish as they make their spring migrations and from the overwintering Gulf stock in the Florida Keys. The recreational fishery is much more significant with between 500,000 and 1.0M lbs of Cobia landed recreationally from the Gulf annually. Again, Florida accounts for about 75% of the total U.S. recreational catch. In recent years, anglers have reported fewer catches of Cobia along the Florida Panhandle during the spring migration causing many to speculate if the population has been impacted negatively or if changes in climate and generally increasing water temperatures have caused the fish to change their migration patterns.

World-wide, Cobia is quickly becoming a very popular aquaculture species thanks in part to its rapid growth. Most of the production of cultured Cobia originates in China, Taiwan, and Vietnam and has exploded since the early 2000s to be a highly successful species. Aquaculture in the Americas has progressed much slower with most of the production coming from Panama. In the U.S. there has been a lot of interest in growing Cobia as an aquaculture product but the hurdles to pen-culture have yet to be overcome. While Cobia can be raised in tanks and ponds, the level of production has not yet exceeded the costs of production. Open ocean systems may not be economically feasible and only plausible for large commercial operations since they require significant maintenance and support costs managing cages further from land-based operations.

Chapter 2
INTRODUCTION

Cobia (*Rachycentron canadum*) are managed as a federal species in the Gulf of Mexico under the Gulf of Mexico and South Atlantic Fishery Management Councils in the Coastal Migratory Pelagic (CMP) Fishery Management Plan, implemented in 1982, which includes King Mackerel, Spanish Mackerel, as well as Cobia. Likewise, the Atlantic States Marine Fisheries Commission (ASMFC) and SAFMC share management for Cobia along the Atlantic and are currently developing an FMP similar to the federal CMP. The current stock boundary separating the Atlantic and Gulf Cobia stocks was set between the jurisdictions of the GMFMC and SAFMC which was essentially the Florida Keys. Upon completion of a new stock assessment in 2013 (SEDAR28 2013), the stock boundary was redefined as breaking at the Georgia/Florida line which placed all of Florida into the Gulf migratory group and management was split between the Gulf and South Atlantic Council's in CMP Amendment 20B (GMFMC/SAFMC 2014).

At the March 2017 Annual Spring Meeting of the Gulf States Marine Fisheries Commission, the State-Federal Fisheries Management Committee directed staff to begin development of a Management Profile for Gulf of Mexico Cobia ahead of the anticipated stock assessment which was scheduled to begin in 2019. The initiation of this Management Profile was timely as it coincided with the benchmark assessment in progress for SEDAR 58 – Atlantic Cobia. A number of the Technical Task Force (TTF) members were already participating in the various workshops for the SEDAR and included the Species ID Workshop which was held in April 2018 in Charleston, South Carolina in an effort to reevaluate the available data and information to support the current stock boundary. The result of that effort, focusing on primarily Atlantic data, was unable to find enough evidence to warrant changing the current boundary at the Georgia/Florida line but supports a transition zone from Brevard County, Florida to Glynn/Camden County, Georgia (SEDAR 2018). The data and analyses pulled for that workshop and the submitted reports are included in this Management Profile along with additional Gulf of Mexico data that was a lower priority for the Atlantic. This Management Profile, therefore, includes all Cobia data and information from the Gulf of Mexico and East Florida as part of a single Gulf stock.

The Cobia TTF was established in the fall of 2017 and included representation from each of the state marine resource agencies and others as needed. The introductory meeting of the Cobia TTF took place in New Orleans as Hurricane Harvey was moving through the northern Gulf on a course to Texas. The meeting was cut short due to weather concerns but the group volunteered for writing assignments and the draft was begun. Over the following months, the TTF met in Dauphin Island, Alabama in March and in Cedar Key, Florida in June and completed the draft in less than a year. The Management Profile was introduced to the Commission's Technical Coordinating Committee (TCC) in October 2018 in anticipation of their review of the draft beginning in November. The document was approved by the TCC in March 2019.

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.

After passage of the IFA, the Commission initiated the development of a planning and approval process for the management profiles and plans. Since the Gulf Commission has no regulatory authority, all authority resides with the state agencies. Three options exist for profiles or plans within the Commission's IJF Program depending on the needs identified by the state management agencies:

(1) Biological Profile
A Biological Profile contains the elements related to the species itself (biology and habitat) and a brief overview of the fisheries that exist in each state (landings, effort, economics, and a description of participation). This option is provided when biological or fisheries data is limited or unavailable to provide any type of evaluation of the fishery or population. Research and data needs will be highlighted and presented for state agency consideration.

(2) Management Profile
A Management Profile contains the same elements as the Biological Profile plus the addition of any state information related to the stock status but not a regional stock assessment. The Management Profile will identify research and data needs as well as management considerations which are optional for the states should a need arise to change existing management scenarios or to conduct a stock assessment for the resource in the future.

(3) Fishery Management Plan
A Fishery Management Plan is the final option should a state or particular sector within the fishing community request a formal stock assessment be facilitated by the Commission. This may be useful only to the states who do not already have their own state-derived management plans or stock assessments and need a traditional FMP for certification or other purposes. Along with a regional assessment will be recommendations on management goals and objectives as well as a suite of potential biological reference points for management which are available to the state as options. The Commission's Fishery Management Plans continue to have no authority over the states in how they manage their fisheries and participation in development does not obligate any agency to implement the goals, objectives, or reference points for management.

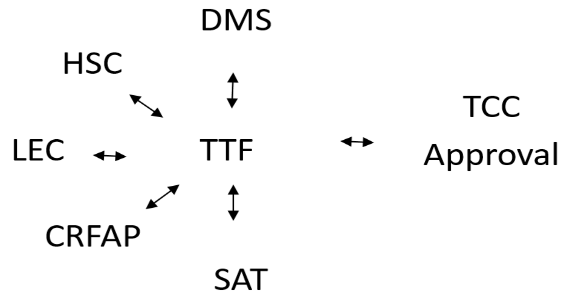
Regardless of which document type, once the profile or plan has received final approval from either the TCC or the Commissioners, the document will be published electronically and made available on the Commission webpage.

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 Commission'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/profile and receives input in the form of data and other information from the DMS and the SAT.

Once the TTF completes a profile or plan, it enters the Commission's review process and, at any point, may be returned to the TTF for modification or further revision. In the case of a management plan, the document will be released for a voluntary public review and comment. After public review, the document and all comments are considered by the Commission who may accept the existing draft, accept the draft with modification, or reject the draft and return it to the TCC or the TTF for further revision. Once approved by the Commission, the plan is submitted to the Gulf states for consideration as potential measures for research or management in their respective states.

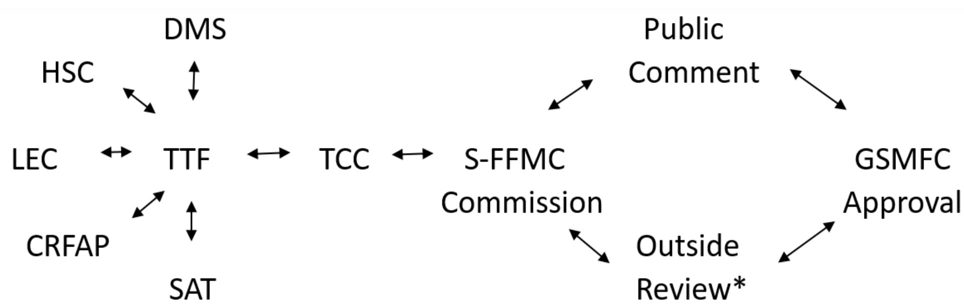
The profile/plan process has evolved to its current form as outlined below:

Biological Profile and Management Profile Review



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

Fishery Management Plan Review



DMS = Data Management Subcommittee
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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

Management Profile Objectives

The objectives of the *Management Profile for Gulf of Mexico Cobia* are:

1. To summarize, reference, and discuss relevant scientific information and studies regarding the management of Cobia in order to provide an understanding of past, present, and future efforts.

2. To describe the biological, social, and economic aspects of the Gulf of Mexico Cobia fisheries.

3. To review state and federal management authorities and their jurisdictions, laws, regulations, and policies affecting Cobia.

4. To ascertain optimum benefits of the Cobia fisheries of the U.S. Gulf of Mexico to the region while perpetuating these benefits for future generations.

5. To identify gaps in the knowledge regarding the species or the fisheries and suggest to the states research needs or improvements in fishery-dependent and fishery-independent data collection to enhance management strategies for Cobia in the future.

Chapter 3
DESCRIPTION OF STOCK(S) COMPRISING THE MANAGEMENT UNIT

Introduction

Cobia (*Rachycentron canadum*) is a migratory pelagic fish found throughout most of the tropical and subtropical regions of the world's oceans. It supports both commercial and recreational fisheries throughout much of its geographical range; however, in the United States, recreational landings substantially exceed commercial landings (Shaffer and Nakamura 1989). Many uncertainties regarding Cobia reproduction, seasonal movements, migratory patterns, and stock boundaries still exist. This profile will primarily focus on Cobia belonging to the Gulf of Mexico management unit, which includes Cobia in the Gulf of Mexico and the southern Atlantic Ocean up to the Georgia-Florida state line.

Geographic Distribution

Cobia occur nearly worldwide in tropical, subtropical, and warm temperate waters (Shaffer and Nakamura 1989, Froese and Pauly 2017; Figure 3.1). In the western Atlantic Ocean, they are commonly found off Massachusetts southward to Argentina, including the Gulf of Mexico, Caribbean Sea, and around Bermuda (Markle et al. 1980, Shaffer and Nakamura 1989). Landings have also been reported along the eastern coast of North America as far north as the Scotian Shelf in Canada (Markle et al. 1980). In the eastern Atlantic, Cobia are found from Morocco to the southernmost tip of South Africa (Smith 1965, Monod 1973). Their range does not extend into the Mediterranean Sea; however, there have been reports of "strays" that have been found in the Red Sea and throughout the Suez Canal (Golani and Ben-Tuvia 1986).

Cobia are also found within the Indian Ocean (Hatchell 1954, Bianchi 1985) and most of the western Pacific. In the western Pacific, they are common in catches from Japan to Australia and throughout the East Indies (Jordan and Seale 1906, La Monte 1952, Ueno 1965, Fourmanoir 1957, Lindberg and Krasyukova 1971, Grant 1972, Relyea 1981). There have been no Cobia documented within the eastern Pacific (Shaffer and Nakamura 1989).

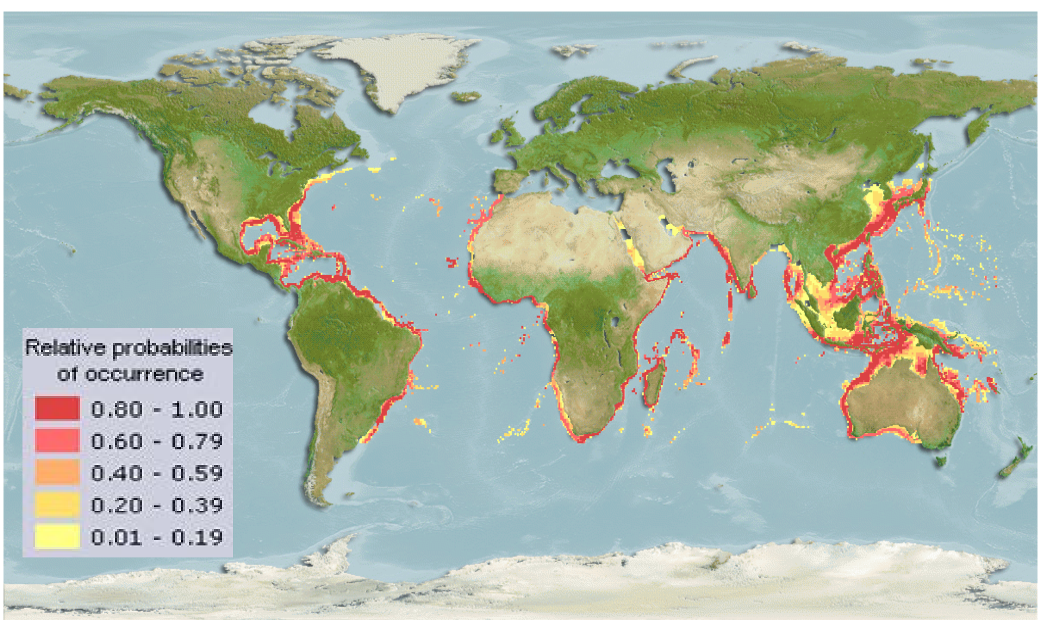

Figure 3.1 Predicted worldwide coastal distribution of Cobia (*Rachycentron canadum*) based on summarized landings data on FishBase (Aquamaps 2017).

Previous tagging studies (Briggs 1958, Richards 1977, Franks et al. 1991) suggested that there were at least two migratory stocks within the Atlantic and Gulf of Mexico. There is an Atlantic migratory stock that consists of the Cobia population that moves as far north as New York down to about the Georgia-Florida line, and a second stock that migrates along East Florida and into the Gulf of Mexico. Such research further identified that within the Gulf of Mexico and South Atlantic, Cobia migrate in an alternating north/south migratory pattern in the spring and fall (Briggs 1958, Dawson 1971, Richards 1977, Franks et al. 1991).

Given the oceanography of the Atlantic and recent acoustic tagging research, it is possible that the South Atlantic Cobia access warmer waters in the winter by moving east towards the Gulf Stream rather than south (Perkinson et al. 2018b). Such tagging efforts in combination with genetic research of this stock have also shown that the previously identified Georgia-Florida boundary line may be more complex than previously thought (Perkinson et al. 2018b). This theory suggests that there is much need for additional acoustic array receivers especially within the northeastern region of Florida north of Brevard County, to truly understand the Gulf of Mexico Cobia stock. Such data is critical to the management of this recreationally and commercially important species.

Biological Description

Rachycentron canadum is the only species within the family Rachycentridae. They are characterized by their elongated, fusiform body shape; dorsally flattened, long and wide head; small eyes; and distinct black lateral bands as juveniles (Shaffer and Nakamura 1989). Their bodies tend to be dark brown on top, with paler brown sides. Often with age, the lateral bands become less prominent and the ventral side becomes drastically lighter.

Cobia are described as a fast-growing, moderately-lived fish, capable of reaching over 6-8 kg and about 53-60 cm fork length (FL) during the first year of life (Franks et al. 1999, Su et al. 1999, Oesterling 2001, Chou et al. 2001). Cobia are known to reach lengths greater than 2 m standard length (SL), weigh over 68 kg (Shaffer and Nakamura 1989) and can live up to 15 years. The largest Cobia caught, based on current recreational records for the Gulf of Mexico and South Atlantic, was approximately 68 kg (149 lbs; Table 3.1); however, since 2000, the average weight of Cobia, derived from the recreational landings, has been around 10 kg or 23 lbs (NOAA unpublished data). Sexual maturity occurs within approximately two years for males and three years for females (Franks et al. 1999, Oesterling 2001, Chou et al. 2001).

In addition to being observed and collected in offshore waters, adult Cobia are also commonly found nearshore around sea buoys and other floating shelter, and along the Florida Panhandle around public fishing piers (Franks personal communication, VanderKooy personal communication). Details on commercial and recreational fishing can be found in Chapter 6.

Table 3.1 Current Cobia state recreational saltwater records for the Gulf of Mexico and the current IGFA World Record (IGFA 2018).

City, State	Year	Record Holder	Weight
Destin, Florida	1997	Peter McCollester	130 lb. 1 oz.
Orange Beach, Alabama	1995	Benjamin E. Fairey	117 lb. 7 oz.
Chandeleur Island, Mississippi	1996	Randy McDaniel	106 lb. 13oz.
Grand Isle, Louisiana	1965	Garnett “Lucky” Caudell	149 lb. 13 oz.
unknown city, Texas	1998	Michael Albanese	108 lb. 7 oz.
IGFA World Record Shark Bay, W.A., Australia	1985	Peter Goulding	135 lb. 9 oz.

Classification

The following classification is a complete outline of the species according to FishBase (Froese and Pauly 2017)

Kingdom Animalia
- Subkingdom Bilateria
  - Infrakingdom Deuterostomia
    - Phylum Chordata
      - Subphylum Vertebrata
        - Infraphylum Gnathostomata
          - Superclass Osteichthyes
            - Class Actinopterygii
              - Subclass Neopterygii
                - Infraclass Teleostei
                  - Superorder Acanthopterygii
                    - Order Perciformes
                      - Suborder Percoidei
                        - Family Rachycentridae
                          - Genus *Rachycentron* (Kaup 1826)
                            - Species *Rachycentron canadum* (Jordan 1905)

The valid scientific name for Cobia is *Rachycentron canadum* (Linnaeus 1766). It was assigned this name from Greek "rachis" meaning vertebral column and Greek "kentron" meaning sharp point, referring to their 7-9 sharp, retractable, dorsal spines. The following synonymy for Cobia is provided by FishBase (Froese and Pauly 2017):

Gasterosteus canadus Linnaeus 1766
Scomber niger Bloch 1793
Centronotus gardenii Lacépéde 1802
Centronotus spinosus Mitchill 1815
Rachycentron typus Kaup 1826
Elacate atlantica Cuvier and Valenciennes 1831
Elacate bivittata Cuvier and Valenciennes 1831
Elacate malabarica Cuvier and Valenciennes 1831
Elacate motta Cuvier and Valenciennes 1831
Elacate pondiceriana Cuvier and Valenciennes 1831
Meladerma nigerrima Swainson 1839
Naucrates niger Swaision 1839
Elacate canada DeKay 1842
Elacate falcipinnis Gosse 1851
Elacate nigra Gűnther 1860
Rachycentron canadus Jordan and Evermann 1896
Rachycentron pondicerrianum Jordan 1905
Rachycentron canadum Jordan 1905

All have been accepted as synonyms of *Rachycentron canadum*.

Many common names exist for *R. canadum,* however, the accepted common name in the United States is Cobia (Robins et al. 1980). Other common and market names in the United States include: Ling, Sergeant fish, Bonito, Coalfish (Goode 1884), Cabio, Crabeater (La Monte 1952), Lemonfish (Manooch 1984), Black Bonito (Hildebrand and Schroeder 1928), Lingcod, Black Salmon (Moe 1970), Cubby-yew, Flathead (Burgess 1983). Elsewhere, Cobia are commonly referred to as Bonito Negro (Argentina), Black Kingfish (Australia and India), Bijupirá (Brazil), Bacalao (South America and Central America), Medregal (Cuba), Cabilo (Guyanas), Sugi (Japan), Sao Ambina (Madagascar), Poisson-sergent (Madagascar), Sanghra (Pakistan), Sanglor (Pakistan), Sikin (Persian Gulf), Warangall (Senegal and Gambia), and Runner (South Africa and Tanzania).

Morphology

All life stages of Cobia have been defined throughout most of their geographical range; however, the most extensive morphological descriptions come from animals collected in the western Atlantic, Gulf of Mexico, and from hatchery-reared Cobia in several parts of Asia. Early life stages have been described based on wild collections in addition to laboratory and aquaculture samples (Richards 1967, Hassler and Rainville 1975, Ditty and Shaw 1992, Brown-Peterson et al. 2001). At each life stage, Cobia can be easily identified by their unique characteristics and rapid growth rate.

Eggs

Richard (1967) describes that unfertilized eggs go through three stages: immature, maturing, and mature before they can be released by the female and undergo fertilization. Immature eggs are typically clear, nucleated cells that are about 0.10 - 0.30 mm in diameter. As the egg matures, it grows to approximately 0.36-0.66 mm in diameter, contains a developing oil globule, and has more of a clouded appearance. Mature eggs, the final stage prior to fertilization, double in size measuring about 1.09-1.31 mm in diameter (average 1.2 mm). They have a clear or transparent appearance and contain a single, large oil globule that ranges from 0.29-0.44 mm in diameter (average 0.37 mm). These mature, unfertilized eggs are only slightly smaller than fertilized eggs.

Fertilized Cobia eggs are commonly found in offshore waters from May through September, although Lefebvre and Denson (2012) collected eggs from South Carolina's Port Royal Sound and Saint Helena Sound in April-June. Cobia eggs can be easily identified by their distinctively large, yellow oil globule and embryo that are both mottled with melanin pigment (Hassler and Rainville 1975). Fertilized eggs range from 1.16 to 1.42 mm in diameter (average 1.27 mm), and the single oil globule can measure anywhere from 0.34 to 0.45 mm in diameter depending on the location where they are found (Joseph et al. 1964, Richards 1967, Ditty and Shaw 1992). Cobia eggs have a narrow perivitelline space and the embryo is heavily pigmented with an exception to the caudal peduncle (Figure 3.2; Ditty and Shaw 1992, Kilduff et al. 2002, Lefebvre 2009).

Embryonic Cobia grow fast and hatch within 24-36 hrs in water temperatures of 25-29°C (Ryder 1887, Ditty and Shaw 1992, Brown-Peterson et al. 2001). Ryder (1887) reported that "within 8 hours of fertilization, the entire vitellus was included and covered by the blastoderm's epibolic growth" from wild caught eggs hatched in the lab (Figure 3.3). Within the mid-Atlantic, however, water temperatures are typically cooler than that of the South Atlantic and Gulf of Mexico, with an average of approximately 20°C during the summer months compared to the 25-29°C seen southward. At these cooler water temperatures, eggs have been found to have a slightly delayed hatching, often within about 56 hrs (Pauly and Pullin 1988).

Larvae

Cobia larvae occur in both estuarine and pelagic waters of the Gulf of Mexico and South Atlantic primarily from May through September (Ditty and Shaw 1992, Lefebvre 2009). Through wild-caught collections, Hassler and Rainville (1975) determined that Cobia hatch at approximately 2.5 mm and reported Cobia larvae have a large, well-defined yolk sac that contains a single oil globule, no functional mouth, and only a slight green tint to their developing eye. Larvae also have a single developing fin that extends posteriorly from the head on the dorsal, and from the yolk sac, ventrally, where it joins around the caudal region of the body (Figure 3.4B and C).

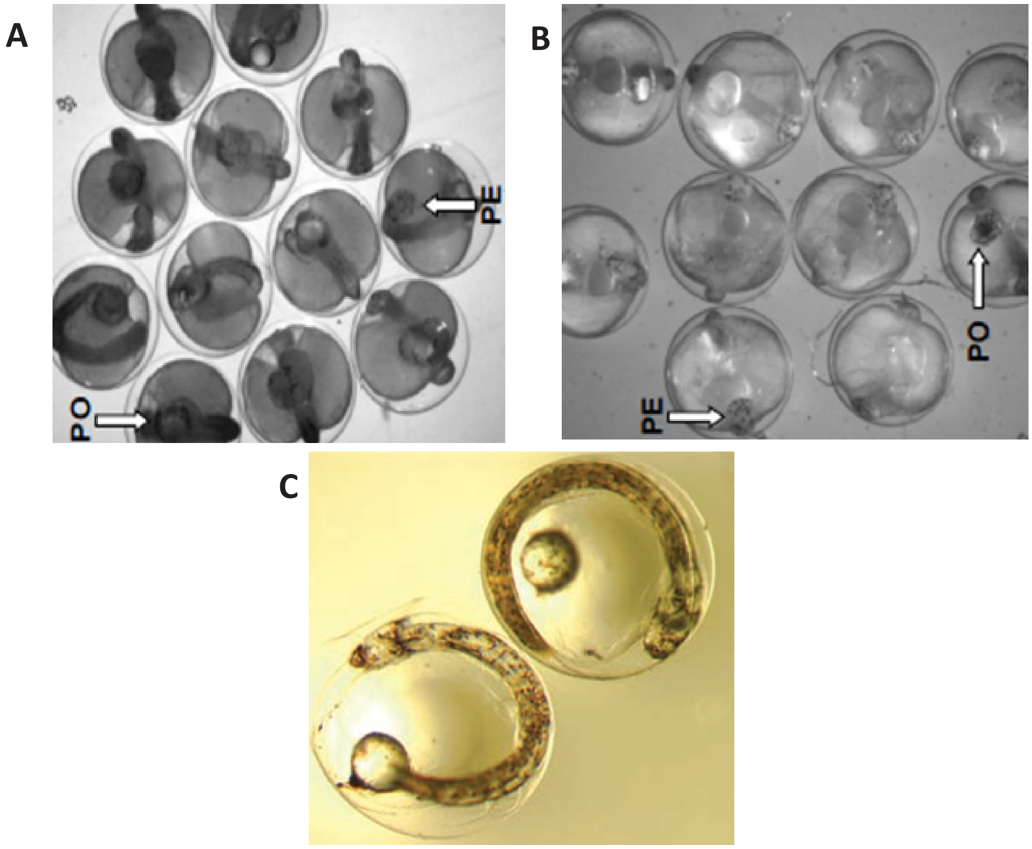

Figure 3.2 A) 21.5-hour old Cobia eggs reared in the hatchery at 25°C. PO= pigment oil droplet; PE= pigmented embryo. B) Eggs identified as Cobia from a plankton collection in Port Royal Sound, South Carolina. Surface water temperature was 25.1°C. (Lefebvre 2009). C) Reared Cobia eggs approximately 36 hours old with a mean diameter of 1.42 mm (Kilduff et al. 2002)

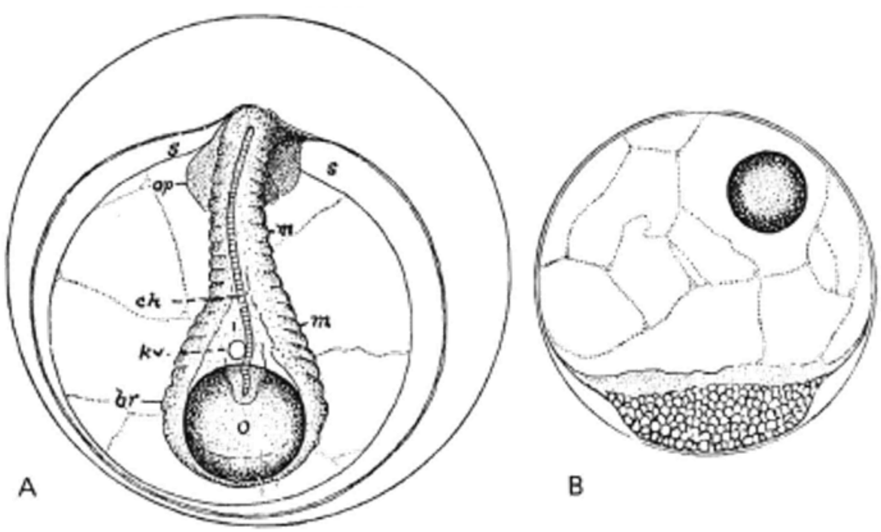

Figure 3.3 Development of Cobia eggs: A) Developing egg of *Rachycentron canadum*, showing the spacious cleavage cavity (s) Kupffer's vesicle (kv), the chorda (ch), segments (m) of the embryo, the limbs (br) of the concrescing blastophore, the oil globule (o), and the optic vesicle (op): B) an earlier phase of the developing egg (Plate 3 *from* Ryder 1887).

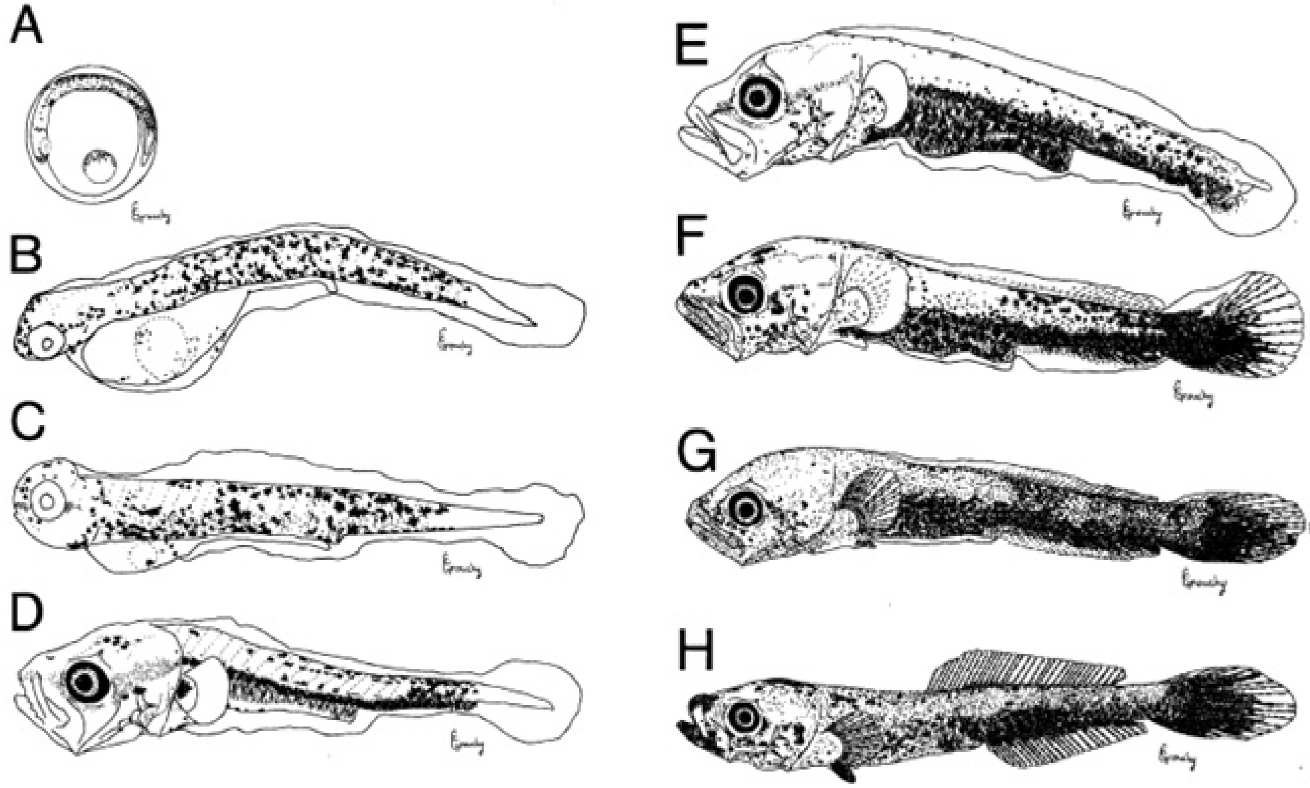

Figure 3.4 Egg and larval development of Cobia (*Rachycentron canadum*). A) Late-stage egg, diameter 1.24 mm. B-C) yolk sac larvae 2.6 and 3.0 mm. D-H) larvae 4.5 mm, 6.8 mm, 10.0 mm SL, 14.1 mm SL, and 18.9 mm SL (Figure 2 *from* Ditty and Shaw 1992).

After about five days (Figure 3.4D), the larvae measure 4-5 mm SL in length, and the eyes are a pigmented dark brown color. By this time, the yolk sac is entirely absorbed and the larvae have developed a functional mouth. Their single fin continues to undergo further development and the pectoral fins are present, allowing limited swimming (Hassler and Rainville 1975, Ditty and Shaw 1992). Cobia larvae at this point also have a faint yellow streak that extends along the entire body (Hassler and Rainville 1975). By the tenth day post-hatch, the larvae are 5-10 mm SL and have a completely developed eye, mouth, and head (Figure 3.4E). Musculature is apparent and fin ray development begins to appear, permitting prolonged, active swimming (Hassler and Rainville 1975, Ditty and Shaw 1992).

Late larval stages begin after about 30 days post-hatch (Figure 3.4F and G) when the larvae start to take on the appearance of an adult Cobia. The late larval stage, 10-15 mm SL, has two color bands extending laterally from behind the head to the posterior end of the body. The upper yellow band and the lower black band meet along the lateral line. Distinct dorsal, anal, caudal, and pelvic fins and fin rays start to take shape, and dorsal spines begin development (Hassler and Rainville 1975, Ditty and Shaw 1992).

By 59 days post-hatch (Figure 3.4H), the larvae measure 15-20 mm SL. The overall appearance resembles a 30-day old Cobia larva; however, the banding is much more defined and appears as if the fish is black with dorsolateral and ventrolateral yellowish-white bands. Fins are distinctly defined with a full complement of rays and are black with yellow tips. Ditty and Shaw (1992) outlines a detailed description of Cobia larval stages (2.6-25.0 mm) and fin development (9-25 mm) from specimens collected in the Gulf of Mexico (Table 3.2 and Figure 3.4).

Juveniles

Unlike larvae and eggs, previous studies have shown that juveniles typically are found inshore inhabiting coastal areas such as beaches, river mouths, barrier islands, and high salinity bays and inlets (Swingle 1971, McClane 1974, Hoese and Moore 1977, Benson 1982). The highest densities of juvenile Cobia are observed July through September, with a few studies reporting high densities of juveniles as early as May (Joseph et al. 1964, Dawson 1971, McClane 1974). Cobia transition into their juvenile stage at about 20 mm SL, marked by a full complement of rays in each fin (Ditty and Shaw 1992). Hassler and

Table 3.2 Morphometrics of larval Cobia (*Rachycentron canadum*) from the Gulf of Mexico, expressed as % standard length (SL) (Ditty and Shaw 1992).

SL (mm)	Preanal length	Head length	Snout length	Orbit diameter	Upper jaw length	Body depth cleithrum	Predorsal length	Prepelvic length	Peduncle length
2.6	61.5	--	--	--	--	--	--	--	--
3.2	62.5	--	--	--	--	--	--	--	--
4.0-4.9	64.4-65.0	27.8-31.2	6.7-7.5	10.0-11.2	10.0-13.8	18.9-21.2	--	--	--
5.0-5.9	68.0-68.6	31.4-34	7.6-10	11.0-12.7	13.6	20.3-20.6	--	33.9	--
6.0-6.9	63.2-67.2	27.9-31.7	7.3-8.3	8.8-10.8	10.3-12.7	19.8-23.3	--	30.9	--
7.0-7.9	64.1-65.3	26.9-29.5	7.0-8.7	9.0-10	10.9-13.3	17.9-20.0	52.6	30.8-33.3	12.0-12.8
9.8	64.3	30.6	8.7	9.2	12.8	21.4	51.0	33.7	12.8
10.0-10.9	57.1-64.1	27.5-29.5	7.0-8.1	9.0-10.0	11.5-13.3	19.0-20.0	50.0-56.3	30.0-36.9	12.1-13.3
11.0-11.9	57.3-60.9	27.7-29.9	6.7-7.8	8.4-8.7	11.3-12	18.3-19.2	49.6-52.2	31.1-34.2	11.5-12.6
12.0-12.9	63.2-63.7	28.2-28.8	7.2-8.0	8.8-8.9	11.2-11.3	16.1-18.4	49.2-50.4	32.0-32.2	12.5-12.8
14.0-14.9	56.6-58.7	26.2-27.3	6.9-7.0	8.0-8.3	11.0-11.2	17.2-17.5	49.0-50.3	29.4-30.3	11.0-11.2
16.0-16.9	58.4-59.9	26.5-26.9	7.2-7.8	7.8-8.4	10.2-10.5	15.0-16.8	48.2-49.4	28.9-30.1	12.0-13.6
19.5	57.4	27.2	7.7	7.7	10.2	15.4	46.2	29.7	12.8
21.0	57.1	24.8	6.7	7.1	9.5	14.3	47.6	27.1	12.8
25.0	56.0	24.0	6.0	7.2	8.8	14.9	46.8	26.8	12.0

Rainville (1975) concluded that this transition is completed after about 59 days. This timing is consistent with transition phases observed in hatcheries (FAO 2007)

A large amount of research has focused on detailed descriptions and body morphometrics of juvenile Cobia (Table 3.3; Richards 2005). Wang and Kernehan (1979) described that juvenile Cobia greater than 50 mm SL greatly resembled an adult, aside from the difference in caudal fin shape. They characterized juvenile as: "Head, long and depressed; lower jaw projecting out farther than the upper jaw; all fin rays and spines developed (dorsal fin with 8- 9 spines, 30 rays; anal fin with 1 spine, 23 rays); dorsal, pectoral, and anal fins elongate; dark horizontal band extending from tip of snout to base of caudal fin; dorsum, ventrum, and fins darkly pigmented" (Figure 3.5; Wang and Kernehan 1979). Joseph et al. (1964) described juvenile Cobia measuring 100-120 mm SL collected from the York River, Virginia, and noted that the greatest difference between juveniles and adults was their color pattern. According to the authors, "They displayed a prominent black longitudinal band, extending the full length of the body, bordered above and below by white stripes. The paired fins were black, except for an inconspicuous margin on the pectorals. Dorsal and anal fins were marked with white margins on the anterior portions. The caudal fin was broadly rounded, with white margins on the dorsal and ventral edges" (Figure 3.6; Joseph et al. 1964). Hildebrand and Schroeder (1928) indicated that juveniles had a more elongated body, less depressed head, and a truncated caudal fin rather than forked.

Juvenile Cobia differ from adults greatly by having a prominent black longitudinal band extending the full length of the body with white bands above and below; the upper white band also extends the length

Table 3.3 Juvenile Cobia (*Rachycentron canadum*) meristics (*from* Richards 2005).

Structure	Count
Number of Vertebrae	
Precaudal	11
Caudal	14
Total	25
Number of Fin Spines and Rays	
First Dorsal	VII-VIII, 1
Second Dorsal	29-32 (26-34)
Anal	I-II, 23-26 (22-28)
Pectoral	20-21
Pelvic	I, 5
Caudal	44-47
Gill Rakers on First Arch	
Upper	7-9
Lower	7-9
Branchiostegal Rays	
Total	7

of the body passing just above the eye (Joseph et al. 1964, Hardy 1978; Figure 3.7). As Cobia continue to grow, these bands gradually fade to varying degrees (Anderson personal observation). The distinct pattern on juvenile Cobia is very similar to that of the Sharksucker (*Echeneis naucrates*) causing some confusion among fishermen.

Adults

Research has shown that the transition of Cobia from juvenile to adult can vary; however, most males begin maturation by 600-650 mm FL, or between one and two years of age (Thompson et al. 1991, Lotz et al. 1996, Smith 1995). Females on the other hand begin to mature slightly later in life, around 800-840 mm FL, or age 2-3 (Thompson et al. 1991, Lotz et al. 1996, Brown-Peterson et al. 2001). There are no reports of immature Cobia age-4 or greater, which suggests all Cobia are mature by this age (Lotz et al. 1996, SEDAR28

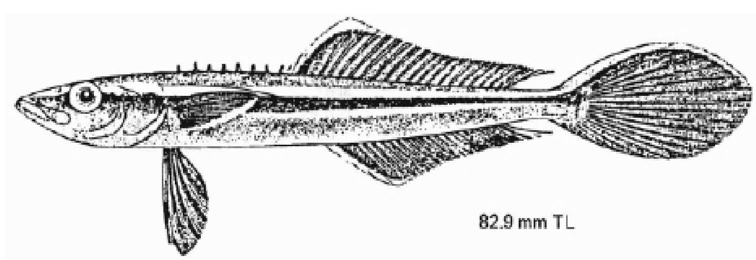

Figure 3.5 Composite drawing of juvenile Cobia (Figure 75 *from* Wang and Kernehan 1979)

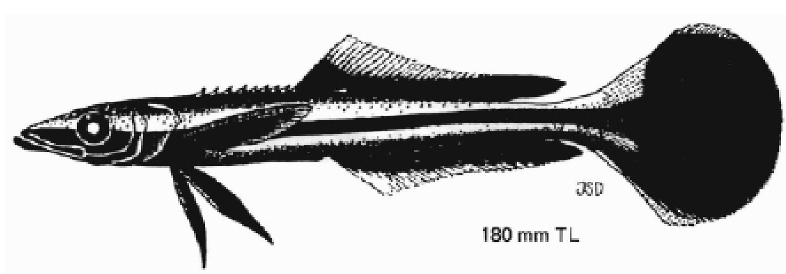

Figure 3.6 Composite drawing of juvenile Cobia (Figure 3 *from* Joseph et al. 1964)

Figure 3.7 Four-month-old Cobia spawned in June, 2001 and raised at the Waddell Mariculture Center in Bluffton, SC. (*from* Hammond 2001).

2013). Robins and Ray (1986) describe adult *Rachycentron canadum* as "almost entirely dark brown, with a dark strip at mid-side that sometimes persists as a blacker area. All fins blackish. Underparts somewhat paler; belly whitish. Caudal fin forked. Lower jaw protrudes; head flattened above. Spinous dorsal fin, usually with 8 separate spines. Soft dorsal fin long-based, with one spine and about 30 rays. Anal fin long-based, with one spine and 23-25 rays" (Figure 3.8). Adult Cobia have also been described as having close resemblance to a small shark or dogfish as well as an appearance that shows great similarity to that of a remora (Coriolano and Coelho 2012).

General Behavior

Cobia may occur alone or in small groups often associated with larger fish, such as rays and sharks, whales, and also sea turtles. Fishermen often exploit this connection by following these larger species in search of Cobia trailing them. These associations are assumed to be either for increased availability of food (Takamatsu 1967, Smith and Merriner 1982, Shaffer and Nakamura 1989) or a generalized sheltering behavior (Carr 1987, Shaffer and Nakamura 1989). Cobia are also known to be attracted to buoys, floating debris, pilings, shipwrecks, and artificial structures (Baughman 1941, Shaffer and Nakamura 1989) including petroleum platforms and fish attracting devices (FADs; see Chapter 4) (Franks 2000). When fishermen target these areas or structures, several Cobia may be caught at one time as the fish become excited after one is hooked-up (Anderson personal communication). Franks reported the abundance of pelagic fish like the Cobia at platforms and FADs is directly correlated to prey availability as bait fish are attracted to these structures. FADs have created a variety of fishery issues globally, among which are inadequate management of FAD fisheries, exploitation of overfished species, and potential effects on fish migrations. This applies to Cobia and other important species as they can be easily targeted by fishermen. Although the use of FADs in most U.S. marine waters is illegal, wrongdoers have become skilled at placing the devices (particularly small FADs in coastal waters) at depths and areas where only they can find them. Another unique behavior Cobia display is their ability to lie on the bottom which has been observed in tanks and by divers in the wild (Franks personal communication). Cobia may rest on the bottom for several hours and only move their heads slightly every few minutes to pass oxygen over their gills (Figure 3.9). More recent studies show Cobia associate with some large reef fish including Atlantic Goliath Grouper, *Epinephelus itajara*, where Sharksuckers commonly aggregate (Félix and Hackradt 2008).

Anomalies and Abnormalities

Physical anomalies and abnormalities have been documented in fish for hundreds of years (Hickey 1972). Genetic, epigenetic, and environmental factors play a role in causing these deformities (Dahlberg

Figure 3.8 Cobia with a conventional dart tag (photo courtesy of Franks).

1970). The effects of these abnormalities can range widely based on severity. They have been shown to decrease swimming ability and balance, making it more difficult for the fish to escape predation, find food, defend territory, or compete for a mate (Hickey 1972).

One such abnormality Cobia are susceptible to is mandibular macrognathia, also referred to as pugheadedness, an abnormality in which the upper jaw is shortened relative to the lower jaw, leading to an inability to completely close the mouth (Shariff et al. 1986, McLean et al. 2008). The first documentation of pugheadedness of a Cobia in the wild was described by Franks (1995; Figure 3.10). This particular fish was relatively unaffected by its deformity, as its length and weight were commensurate with individuals of the same age class. It also had a full stomach and ovaries of a normal stage for its collection date. The pugheaded Cobia was not examined further to determine the skeletal structures that contributed to the deformity. The severity of the deformity determines how much of an effect it has on the fish (Hickey 1972). Severely deformed fish may be at a competitive disadvantage in feeding ability, but moderately deformed individuals could compete well enough to grow and reproduce at rates similar to unaffected fish (Franks 1995, Maclean et al. 2008). Studies on other species (Shariff et al. 1986, Schmitt and Orth 2015)

Figure 3.9 Cobia resting on bottom off Key Largo (*courtesy* Horizon Divers).

Figure 3.10 Pugheaded Cobia with severely deformed or possibly absent premaxilla, maxilla, and anterior cranium (*from* Franks 1995).

have shown decreased growth rates and relative weights for pugheaded individuals. The exact cause for pugheadedness is currently unknown, though Schmitt and Orth (2015) identified genetic anomalies, heavy metal exposure, and hypoxia as possible causes, with hypoxia and anoxia during development as a leading candidate. The northern Gulf of Mexico has one of the world's largest hypoxic zones (Rabalais et al. 2002) as well as areas of elevated heavy metal contamination (Hanson and Evans 1991). Salze et al. (2008) initially postulated a nutritional deficiency as a cause for the deformity, but after noting pugheaded cultured Cobia larvae four days post- hatch (before the first exogenous feeding takes place), they identified genetic factors to be a likely leading cause.

Spinal deformities have also been observed in Cobia. In 2004, Franks (personal communication) was provided an image of a Cobia with a shortened vertebral column caught by an angler in Florida waters (Figure 3.11A). Lakshmanan et al. (2014) described an individual captured off India with an axial spinal deformation, an abnormal ventral curvature (Figure 3.11B). Both of these wild specimens had grown to adult size. Zhou et al. (2012) described spinal deformations in cultured Cobia reared on a diet lacking vitamin C. Much like pugheadedness, the effects of spinal deformities vary with the severity of the deformity. Fish with severe spinal kyphosis, scoliosis, or lordosis have reduced swimming ability and agility, leading to reduced feeding ability and therefore reduced average weight (Branson and Turnbull 2008). In addition to vitamin C deficiency, exposure to antibiotics, excess leucine, and pollutants have shown to be associated with spinal deformities in fish (Ashely 2006). Cultured Cobia raised in water below

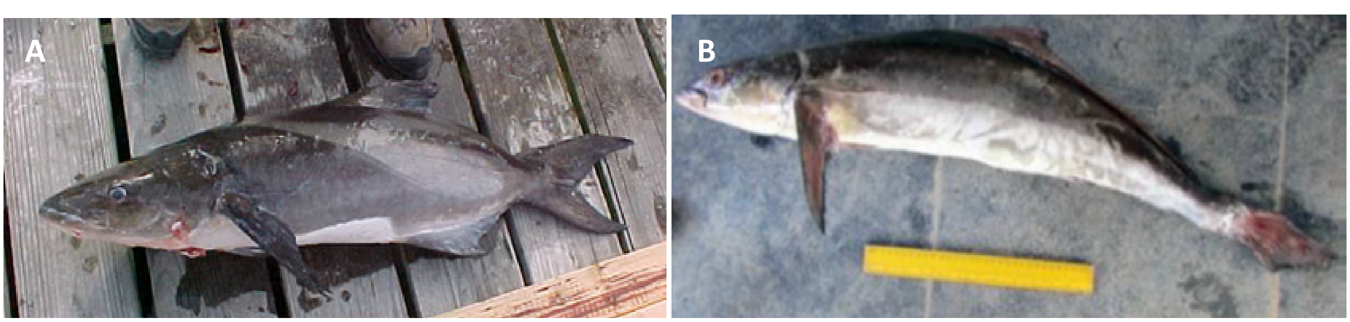

Figure 3.11 Cobia displaying spinal deformities A) Cobia with a shortened spine observed from Florida waters (photo courtesy of Franks). B) Cobia with an axial spinal deformity (a ventral to dorsal bend) from India (*from* Lakshmanan et al. 2014).

Figure 3.12. A normal (left) vs. a diseased (right) Cobia heart. Note the adhesions covering the diseased heart as well as the widespread fusing of the epicardium and the pericardium (*from* Howse et al. 1975).

18°C showed increased rates of spinal deformations, possibly due to lower feeding rates below 18°C leading to nutritional deficiencies (McLean et al. 2008).

Numerous wild Cobia have been observed to have heart deformities. Howse et al. (1975) described a number of Cobia in which a fusing of the epicardium and the pericardium was observed, as well as thick collagenous adhesions covering the surface of the heart (Figure 3.12). The exact cause of these pericardial adhesions in fish is unknown, but bacterial infection is suspected. Incardona et al. (2014) also observed severe cardiac defects in large Gulf predatory pelagic fish larvae exposed to oil from the Deepwater Horizon disaster in 2010, leading to both acute and delayed mortality.

Cobia can also be affected by abnormal pigmentation. Franks (personal communication) observed a Cobia caught by an angler in Florida waters with an anomalous pigmentation pattern similar to individuals with piebald traits found in other species (Figure 3.13). The Cobia's typical coloration pattern is counter shaded to provide a measure of camouflage in the pelagic environment (Cott 1940). This particular individual's pigmentation pattern did not alter this camouflage scheme, and its large size indicates it survived for several years without predation. Lechner and Ladich (2011) showed that fish do not suffer from the hearing damage that many animals do when affected by pigmentation abnormalities. They speculate that this is due to the lack of melanin present in the inner ear of fish.

Figure 3.13 Cobia with a piebald pigmentation pattern captured in Florida waters (courtesy of Franks).

Color patterns other than the typically olive green to brown have been seen in Cobia. In early 2018, French angler Anthony Guenec potentially set the new men's 20 lbs tippet class flyfishing world record for Cobia with a massive 92 lbs 9 oz fish caught off the Bijagos Islands in Guinea Bissau. The Cobia had a very yellow coloration (Figure 3.14A). Tom Herrington of Ocean Springs, Mississippi, captured a blue Cobia on a fishing trip in 1977 off Destin, Florida (Figure 3.14B).

The background rate of abnormalities and anomalies in wild Cobia is unknown, but the recent increase in aquaculture of Cobia has increased their study and documentation (McLean et al. 2008). However, the larger amount observed from fish aquaculture may be skewed by having a large population not subject to natural selection pressures (Branson and Turnbull 2008). This results in fish that may not have survived in the wild being kept alive until adulthood.

Physiologic Requirements

Temperature

Water temperatures greatly influence the life of Cobia. Cobia migrate to cooler waters during the spring and back to warmer waters during the fall. Some Cobia actually overwinter in deeper waters of the northern Gulf instead of making the seasonal migration south (Franks personal observation). They

A

B

Figure 3.14 Different pigmentations patterns observed in wild Cobia. A) 'Yellow' Cobia (photo by IGFA) B) 'Blue' Cobia (center; photo courtesy of Herrington).

have been collected from waters of 16.8-32.0°C (Shaffer and Nakamura 1989). Water temperatures above 37°C are considered lethal to juvenile Cobia (Hassler and Rainville 1975, Shaffer and Nakamura 1989). Cobia begin showing up in Chesapeake Bay when water temperatures reach 19°C (Richards 1967, Shaffer and Nakamura 1989). Atwood et al. (2004) found that juveniles reared in aquaculture systems require water temperatures above 12.9°C and that 100% mortality occurred when temperatures reached 10.4°C. Another study on juveniles focused on behavioral responses to low temperature exposure and determined median temperature for loss of equilibrium was at 12.1°C and the median lethal temperature was 9.7°C (McDonald and Bumguardner 2010). Yu and Ueng (2007) found that juvenile Cobia grew fastest during the summer when water temperatures were above 28°C and slowest during the winter when water temperatures were 15.0-16.5°C.

Salinity

Cobia can be found in open water, inlets, and bays and mouths of tidal creeks (Merriman 1939, Bohlke and Chaplin 1968, Hardy 1978), and can tolerate fairly hypersaline conditions (Shaffer and Nakamura 1989). They have been taken from waters with salinities ranging from 22.5-44.5 ppt, but they may be able to acclimate to lower salinities (Shaffer and Nakamura 1989). Most of the research on the effects of salinity on Cobia involved juveniles reared in aquaculture systems. Denson et al. (2003) found that juveniles reared in salinities of 30 ppt had the most impressive growth when compared to juveniles reared in 5 and 15 ppt. In contrast, Resley et al. (2006) found that juveniles had similar growth rates in the same three salinity regimes. Both studies reported higher mortality among juveniles reared in 5 ppt salinity. Plasma osmolality, the measure of dissolved ions in body fluids, decreased significantly with decreasing salinity according to a study by Burkey et al. (2007) in which 73% mortality occurred among juvenile Cobia exposed to 1 ppt salinity for 24 hours. Surprisingly, zero mortality occurred at 2 ppt for the same period of time, indicating a threshold. Chen et al. (2009) determined the optimal salinity for maximum growth among juvenile Cobia to be between 28.5-29.9 ppt and then decreased when reaching 35 ppt. Salinity tolerance of larvae appears to be age-dependent as mortality among three days post-hatched fish was highest when subjected to abrupt salinity changes and gradually decreased as days post-hatched increased (Faulk and Holt 2006).

Reproduction

Cobia are gonochoristic, and no external sexual dimorphism has been reported for the species (Shaffer and Nakamura 1989). Most studies that investigated reproduction in Cobia from the U.S. Gulf of Mexico and South Atlantic reported a higher percentage of females than males in their samples. The most comprehensive studies of reproduction biology of Cobia caught from coastal waters of the southern U.S. are 1) Brown-Peterson et al. (2001) who described gonadal development, batch and total fecundity, and spawning frequency, and 2) Brown-Peterson et al. (2002) who described male gonad (testicular) development and reproductive classes. Franks and Brown-Peterson (2002) provided a review of Cobia reproduction research conducted in the Gulf of Mexico and South Atlantic to that time. More recently, Lefebvre and Denson (2012) reported onshore spawning of Cobia in coastal South Carolina. All Cobia examined in the above studies were caught in the recreational fishery.

Prior to the above studies, assessments of Cobia reproduction from the northcentral Gulf of Mexico recreational fishery were conducted by Thompson et al. (1992), Biesiot et al. (1994), Lotz et al. (1996) and Burns et al. (1998). Burns et al. (1998) also reported on gonadal development of Cobia from the southeast Atlantic. Other prior studies conducted in the U.S. South Atlantic were Richards (1967) and Smith (1995) who reported on gonadal maturity and spawning seasonality. Shaffer and Nakamura (1989) published a synopsis of known literature on Cobia reproduction which included indirect evidence of seasonal and spatial aspects of Cobia spawning in the Gulf of Mexico based on collections of larvae and small juveniles off Texas (Finucane et al. 1979 and Baughman 1950, respectively) and small juveniles from the northcentral Gulf of Mexico (Dawson 1971).

Size and Age at Maturity

Historically, few small and immature Cobia of either sex have been examined from U.S. waters due to minimum size restrictions on Cobia. However, Shaffer and Nakamura (1989) reported that Cobia grow rapidly and become sexually mature at a relatively early age. All Cobia age-3+ are considered mature (SEDAR 2013).

Van der Velde et al. (2010) reported 50% sexual maturity for Cobia from Australia as 784 mm FL, with the smallest sexually mature female from Australia 671 mm FL. The smallest reproductively active female from the U.S. Gulf of Mexico was 700 mm FL (Brown-Peterson et al. 2001), similar to results from Australia. Females collected from the lower Chesapeake Bay and mid-Atlantic waters reached earliest maturity in their third year, at 696 mm FL and 3.27 kg (Richards 1967). Lotz et al. (1991) observed no immature female Cobia age-4 or older in the northern Gulf of Mexico. Smith (1995) found that 'most' females caught off the southeastern U.S. were mature by 800 mm FL, which is less than the minimum size in the commercial and recreational fisheries (838 mm FL). Accurate estimation of size at sexual maturity in U.S. waters will require capturing females <750 mm FL.

The smallest mature male specimen among those collected by Richards (1967) from the lower Chesapeake Bay and mid-Atlantic waters was 518 mm FL and 1.14 kg (and at age-2). In the Gulf of Mexico, male Cobia typically become sexually mature between one to two years of age, although some may reach sexual maturity before age-1 (Thompson et al. 1992, Lotz et al. 1996). Thompson et al. (1992) reported the smallest male Cobia collected in his samples was 528 mm FL but did not provide the size of the smallest male at maturity, only to comment that "most males appear ripe (loose sperm in the gonads) at age two." Lotz et al. (1996) examined 135 male Cobia and reported the smallest male exhibiting evidence of spermatogenesis was 640 mm FL (estimated age-1), but remarked that the actual onset of spermatogenesis may occur when males are smaller than 640 mm FL because no smaller males were examined histologically in their study.

Brown-Peterson et al. (2001) indicated that both sexes of Cobia achieved physiological maturity at a smaller size than that reported for functional maturity of Cobia by Lotz et al. (1996). The apparent variation in size at sexual maturity could be partially explained by regional differences, considering that most small female Cobia in the Brown-Peterson et al. (2001) study were captured in the eastern Gulf of Mexico, whereas Lotz et al. (1996) and Thompson et al. (1991) sampled Cobia from the northcentral Gulf of Mexico. In general, Cobia in the Gulf of Mexico grow faster than those off the U.S. Atlantic Coast, and females grow faster and attain larger sizes than males in both regions (Franks and Brown-Peterson 2002). The oldest observed Cobia in the U.S. Atlantic was 16 years (female) (ODU unpublished data) and 11 years (female) in the Gulf of Mexico (Franks et al. 1999).

Spawning Season

The spawning season for Cobia in the U.S. Gulf of Mexico and South Atlantic has been described using various methodologies, including gonadal histology, larval collections, and the gonadosomatic index (GSI) (see above referenced studies). There are no known published studies of the reproductive biology of Cobia from the Florida Keys or Mexican Gulf of Mexico. Overall, Cobia have an extended spawning season during spring and summer months throughout their range, and individual females likely release multiple batches of eggs during this time.

Brown-Peterson et al. (2001) defined the Cobia spawning season using GSI values (see detail below) and histological assessments of specimens examined between December 1995 and November 1997 from the recreational fishery from the southeastern Atlantic Ocean (Morehead City, North Carolina, to Cape Canaveral, Florida), eastern Gulf of Mexico (Ft. Myers to Crystal River, Florida), northcentral Gulf of Mexico (Destin, Florida, to Chandeleur Islands, Louisiana), and western Gulf of Mexico (Port Aransas, Texas). Their research showed that, overall, Cobia undergo a protracted spawning season between April and September, with slight variances within that time frame among the different regions sampled.

Thompson et al. (1992) and Lotz et al. (1996) reported similar findings of Cobia spawning between April and September in the northcentral Gulf of Mexico based on specimens caught between Louisiana and northwest Florida in the recreational fishery. Biesiot et al. (1994) described the biochemical changes in developing ovaries of Cobia from the northern Gulf of Mexico and reported that spawning occurred during spring and summer.

The spawning season off Virginia may be shorter than in more southern locations. Joseph et al. (1964) reported that Cobia spawn off Virginia in July, while Richards (1967) indicated that Cobia spawn from late June through mid-August off Virginia, and that females likely spawn multiple times during this period. In their historic synopsis of Cobia biological data, Shaffer and Nakamura (1989) commented that “the presence of gravid females and appearance of Cobia eggs in plankton collections indicated that spawning occurs between mid-June and mid-August on the Atlantic coast.” Spawning may occur earlier in North Carolina waters; Hassler and Rainville (1975) collected nearly 2,000 Cobia eggs from May 23 to the end of their sampling period on June 28 in Gulf Stream waters 25-50 km from the coast. Off South Carolina, spawning has been recorded as early as mid-May, extending to the end of August in offshore waters, approximately 80 km from the coast (Hammond personal communication). Actively spawning female Cobia were found in inshore estuaries in South Carolina in May and June (Lefebvre and Denson 2012).

The spawning season occurs concurrently with the annual seasonal migration of Cobia from southern Gulf of Mexico waters into coastal regions of the northern Gulf of Mexico, typically followed by spring through summer residency there (Biesiot et al. 1994, Franks et al. 1999, Brown-Peterson et al. 2001). The spring migration is coincident with rising water temperature, and it is hypothesized that the migration is associated with reproduction (Biesiot et al. 1994, Lotz et al. 1996, Brown-Peterson et al. 2001) and access to feeding grounds (Meyer and Franks 1996). Cobia are known to form small groups (‘pods’ in angler jargon) during their eastern Gulf of Mexico spring migration; however, it is uncertain if such aggregating behavior observed in this region is directly related to spawning activity. Richards (1967) commented that Cobia may form spawning aggregations in the Chesapeake Bay region. He reported a disproportionate sex ratio (74:26, male:female) in specimens from the eastern and western shore areas of the Chesapeake Bay during warmer months and commented on a possible relationship between the ratio and spawning. Along the South Atlantic, seasonal aggregations of Cobia within the Port Royal Sound and St. Helena Sound estuaries in South Carolina were confirmed to be associated with reproduction based on documentation of the presence of eggs, newly hatched larvae, and reproductively active females (Lefebvre and Denson 2012).

Gonadal Development

Gonadosomatic Index (GSI)

The GSI is the proportion of gonad weight to fish weight and indicates gonadal recrudescence and spawning. GSI is calculated as: GSI = [GW/(TW-GW) × 100], where GW = gonad weight and TW = total fish weight. Brown-Peterson et al. (2001) reported GSI values for male and female Cobia collected from southern U.S. waters (Figure 3.1) showed a similar trend, with female GSI values typically elevated from spring through summer (April through August) and near resting levels by September. Peak female GSI values were seen in May and June in all regions, but tended to be slightly higher in the southeastern Atlantic Ocean (Brown-Peterson et al. 2001). Mean GSI values for males reached similar mean maxima in both the northern Gulf of Mexico and southeastern Atlantic regions, but were somewhat lower in the eastern Gulf of Mexico (Figure 3.15; Brown-Peterson et al. 2001). Previous studies from the northern Gulf of Mexico reported peak spawning for both sexes off Louisiana occurred May through July, with maximum GSI values in May (Lotz et al. 1996) and June (Thompson et al. 1992).

Along the southeastern Atlantic, Joseph et al. (1964) reported that peak Cobia spawning off Virginia occurred in July, while Brown-Peterson et al. (2001) reported that GSI values for females increased sharply from April to May between North Carolina and Florida. Peak mean GSI was in May for fish caught off South Carolina and June for fish caught off North Carolina, with spawning in these two areas of the South Atlantic closely related to water temperatures reaching 20-25°C (SEDAR 2013).

Gonadal Histology

Histological examination of gonadal material provides a more accurate description of spawning seasonality than GSI values (West 1990, Brown-Peterson et al. 2011). While histological terminology varies widely among studies, the current standardized terminology for describing reproductive development in fish as presented in Brown-Peterson et al. (2011) will be used here.

Males

Brown-Peterson et al. (2001) reported that some male Cobia in their samples (n= 147, 365-1,270 mm FL) from all areas sampled in the Gulf of Mexico and U.S. southeast Atlantic were spawning capable during all months. Spermatogenic activity varied over the reproductive season, but males captured during February–May exhibited active spermatogenesis throughout the testes. No spermatogenesis occurred

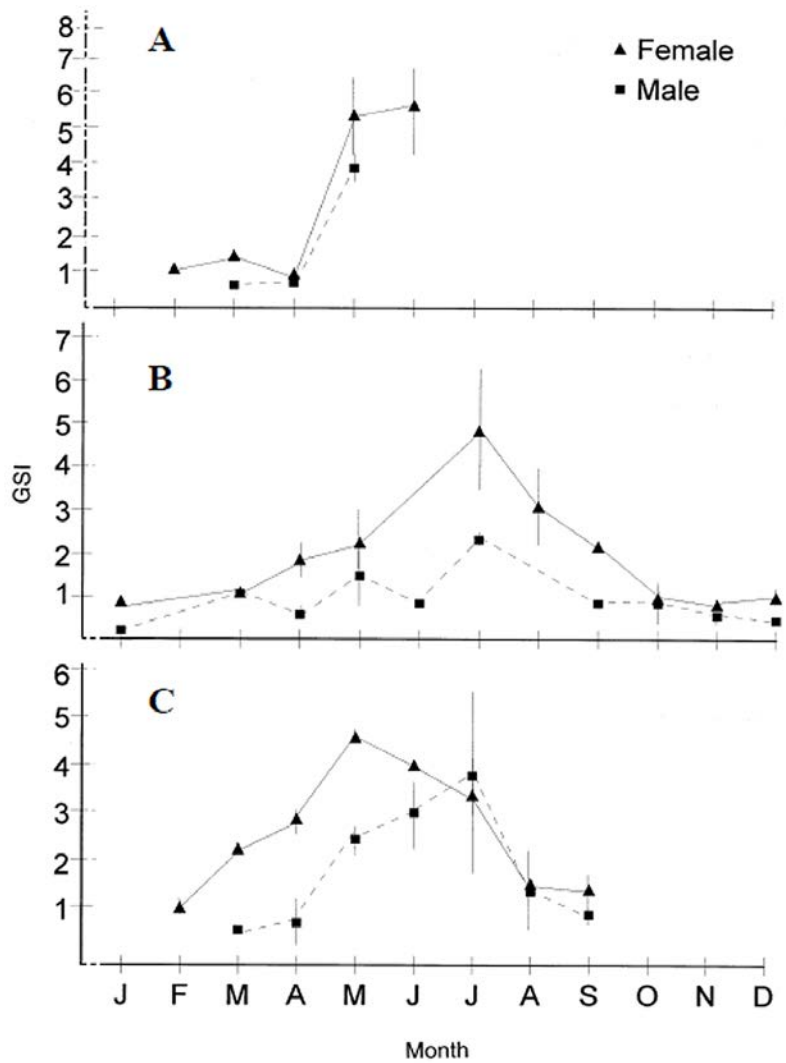

Figure 3.15 Mean (±SE) GSI values for male and female Cobia collected in 1996 - 1997 from southeastern U.S. waters; A) Southeastern Atlantic. B) Eastern Gulf of Mexico. C) North-central Gulf of Mexico (*from* Brown-Peterson et al. 2001).

during August and September, but the testes contained spermatozoa. Males from the eastern Gulf of Mexico had spermatozoa in the testes during October through December, although greater than 50% of the males from that region had testis classified as regressing in November and December.

In a more in-depth study of male Cobia, Brown-Peterson et al. (2002) reported the testes of male Cobia from the Gulf of Mexico and southeast U.S. Atlantic contained sperm year-round but stated that the presence or absence of sperm in Cobia is not an accurate indicator of reproductive condition. Active spermatogenesis was found from February-August, while spermatogonial proliferation was observed during non-spawning months. Using reproductive phases defined by changes in the testicular germinal epithelium (GE) and stages of germ cells present to describe testicular development and spermatogenesis provides a more accurate description of male reproduction than obtained by previous traditional methodologies (Brown-Peterson et al. 2002). Males in the early, mid, and late GE sub-phases of the spawning capable phase are all undergoing active spermatogenesis and have spermatozoa in the lumens of the lobules and the sperm ducts, while males in the regressing phase still have spermatozoa in the lumens of the lobules but have reduced or no active spermatogenesis (Figure 3.16).

Females

Thompson et al. (1992) reported that, although their histological assessments revealed no hydrated oocytes or postovulatory follicles (POF), peak spawning of Cobia caught off Louisiana occurred May through July as evidenced by the presence of late stage vitellogenic oocytes. In their study, atresia (i.e., breakdown of ovarian follicles) was observed July–August, and ovaries examined during early spring, fall and winter were comprised of primary oocytes, i.e. in the regenerating phase. Lotz et al. (1996) histologically examined ovaries from 508 females (580-1,530 mm FL) caught from the northern Gulf of Mexico and reported that fish larger than 834 mm FL had vitellogenic oocytes as early as March and April. Based on oocyte size-frequency distributions and ovarian histology, Lotz et al. (1996) characterized stages of Cobia ovarian development as undeveloped, early developing, mid-developing, and late developing. They reported 'ripe' fish (i.e., spawning capable; Figure 3.17) from May-September, with atresia in some ovaries from July through mid-October, and no vitellogenic oocytes beyond late October.

Biesiot et al. (1994) and Lotz et al. (1996) reported that some female Cobia from the northern Gulf of Mexico appeared to remain in spawning condition through September, i.e., until the end of the spawning

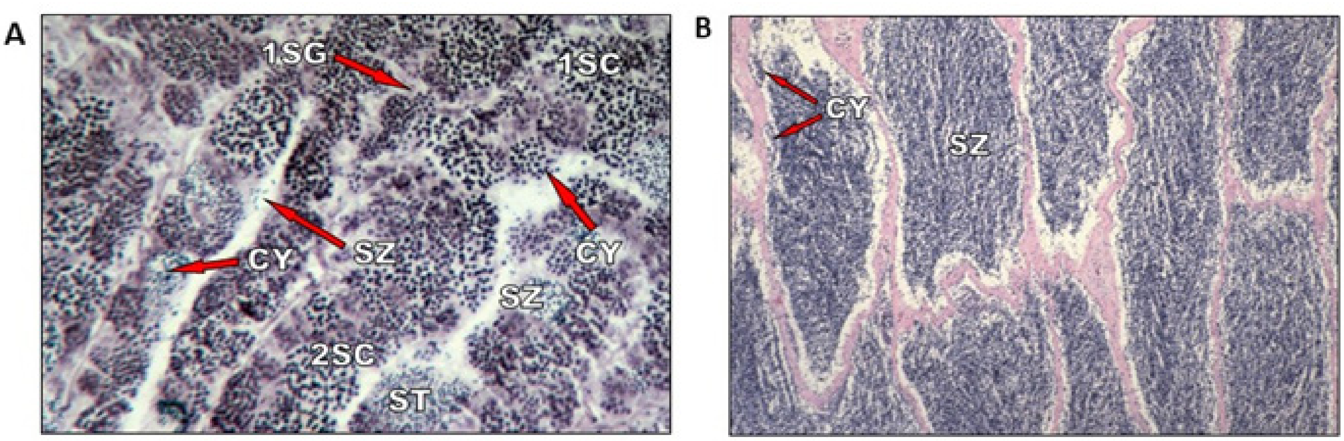

Figure 3.16 Cobia testicular histology with spermatogenic stages. A) Early GE sub-phase of spawning capable, with some spermatozoa in lumen of lobule and active spermatogenesis. B) Regressing phase, with lobules filled with spermatozoa and minimal spermatogenesis in spermatocysts. 1SG-primary spermatogonia; 1SC-primary spermatocytes; 2SC-secondary spermatocytes; CY-spermatocysts; ST-spermatid; SZ-spermatozoa (*from* Brown-Peterson et al. 2002, with terminology modified to follow Brown-Peterson et al. 2011).

season, but also found that a high percentage of females from the northern Gulf of Mexico were 'spent and regressed' by July, similar to reports from Louisiana (Thompson et al. 1992).

Histological assessment of ovaries from Cobia collected from coastal waters of the southern U.S. (n=383, 355-1,385 mm FL) revealed phases of ovarian development that included early developing through regenerating (Brown-Peterson et al. 2001; Figure 3.18A). They found Cobia in the actively spawning sub-phase undergoing oocyte maturation (OM; Figure 3.18B) and POF in ovaries from all study regions during April–September and reported the timing of the protracted spawning season for Cobia, overall, was consistent throughout the Gulf of Mexico.

Figure 3.17 Well-developed Cobia ovaries in the spawning capable phase (photo courtesy Franks)

Even though Cobia are capable of a protracted spawning season, a portion of the females in northern Gulf of Mexico samples appeared to spawn during April–June only and perhaps were incapable of spawning during the entire extent of the spawning period (Brown-Peterson et al. 2001). The regressing and regenerating females in July and August had a broad length distribution (850-1,280 mm FL), which suggested that multiple size (age) classes have an abbreviated reproductive season (Brown-Peterson et al. 2001). Furthermore, some smaller, younger females may delay ovarian maturation and spawn between July and September, a theory that would account for the small percentage of females in the early developing and developing phases in May and June (Brown-Peterson et al. 2001).

An extended spawning season from May-August was reported for Cobia from the U.S. Atlantic Coast (Richards 1967, Shaffer and Nakamura 1989). Smith (1995) and Richards (1967) commented that, based on direct observation of gonadal tissue, Cobia spawned in Chesapeake Bay and adjacent mid-Atlantic waters from late June through mid-August, although gonadal tissues from those fish were not examined histologically. Histological analysis of ovaries from Cobia caught from South Carolina inshore waters (Port Royal Sound and St. Helena Sound) confirmed the presence of actively spawning females with GSI values higher than values for females caught offshore (Lefebvre and Denson 2012).

Based on histological assessments, Lotz et al. (1996) and Brown-Peterson et al. (2001) found similar developmental stages of oocytes in tissues removed from the anterior, middle, and posterior region of either ovary from a large sample of Cobia, demonstrating ovarian homogeneity regardless of where ovarian tissues were obtained. Additionally, Cobia have asynchronous oocyte development (Figure 3.18B), suggesting that they are batch spawners during their extended spawning season.

Batch Fecundity

Female Cobia in the Gulf of Mexico and U.S. South Atlantic exhibit continuous, asynchronous oocyte

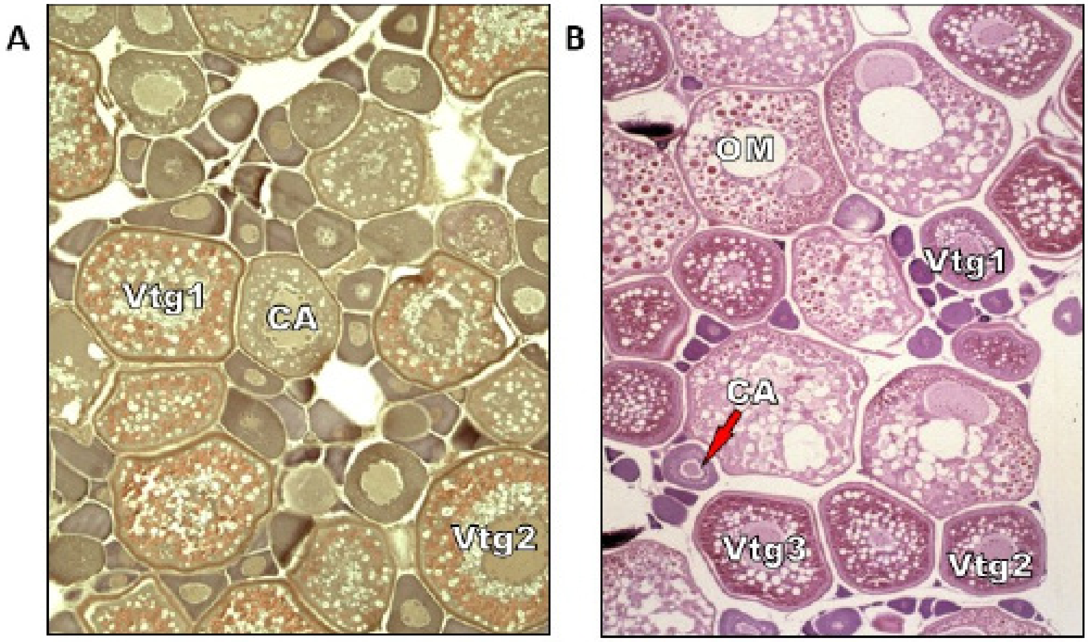

Figure 3.18 Cobia ovarian histology with oocyte stages. A) Developing phase. B) Actively spawning sub-phase of spawning capable phase. CA-cortical alveolar; OM-oocyte maturation; Vtg1-primary vitellogenic; Vtg2-secondary vitellogenic; Vtg3-tertiary vitellogenic. (photos courtesy Brown-Peterson).

maturation throughout their spawning season and are capable of releasing multiple batches of eggs (i.e., serial spawners) throughout their prolonged spawning period (Smith 1995, Lotz et al. 1996, Brown-Peterson et al. 2001). In ovaries of Cobia from the northcentral Gulf of Mexico, Lotz et al. (1996) found oocyte size-frequency distributions to be multi-modal and estimated batch fecundity on the basis of the proportion of oocytes which were represented by the most advanced ('mature') oocytes, i.e., the largest mode of oocytes. Their estimated batch fecundity ranged from 2.6×10^6 to 1.9×10^8 (mean 4.8×10^7; S.E. 9.8×10^6) eggs, with larger females with larger ovaries producing larger batches of eggs. Lotz et al. (1996) were unable to estimate the exact number of spawns and spawning frequency because of the lack of recently hydrated oocytes.

The most complete fecundity assessment for Cobia from southeastern U.S. coastal waters (Brown-Peterson et al. 2001) calculated batch fecundity using three different methods to enumerate oocytes: 1) oocytes >700 µm that were fixed in Gilson's fixative, 2) oocytes >700 µm that were fixed in 10% neutral buffered formalin (NBF), and 3) oocytes undergoing oocyte maturation (OM) via histological examination. The use of oocytes undergoing OM in their study was essential since hydrated oocytes were not encountered in any females examined. Due to low sample sizes, Brown-Peterson et al. (2001) combined their data for the southeastern U.S., the eastern Gulf of Mexico, and the northcentral Gulf of Mexico to calculate batch fecundity. They found no significant difference in oocyte counts among the three methods and reported that mean batch fecundity ranged from 377,000 ±64,500 to 1,980,500 ±1,598,500 eggs. Batch fecundity calculated with the NBF method showed a positive relationship with fork length ($P = 0.021$, $r^2 = 0.132$) and ovary-free body weight (OFBW; $P=0.016$, $r^2 = 0.143$). Relative batch fecundity was not significantly different among months during the spawning season and averaged 53.1 ±9.4 eggs/g OFBW for the NBF method and 29.1 ±4.8 eggs/g OFBW for the OM method.

Total Fecundity

Richards (1967) reported fecundity for six Cobia from Chesapeake Bay ranged from 1.9M to 5.4M eggs. However, due to no size or age-based estimates for the number of spawns per year and uncertainties in how many times Cobia spawn each year, annual egg production or fecundity cannot be reliably estimated (Brown-Peterson et al. 2001). However, Brown-Peterson et al. (2001) estimated potential total annual fecundity of a 20 kg Cobia from the southeastern Atlantic or northcentral Gulf of Mexico to be 20,952,000–38,232,000 eggs between April and September. In contrast, a female the same size from the western Gulf of Mexico would spawn 8,730,000–21,240,000 eggs during the same period (Brown-Peterson et al. 2001).

Spawning Frequency

Using histological assessments, Brown-Peterson et al. (2001) were the first to describe spawning frequency in Cobia by using ovaries in the spawning capable phase that contained either POF or OM. They estimated that Cobia from the southeastern Gulf of Mexico, U.S. South Atlantic, and northcentral Gulf of Mexico waters spawned once every 4-6 days, whereas Cobia from the western Gulf of Mexico were estimated to spawn once every 9-12 days. However, samples from the western Gulf of Mexico were taken in the latter part of the spawning season which might have affected their frequency estimates. Some Cobia in the southeastern Atlantic may only spawn over a 30-45 day period rather than undergo a protracted, multi-month spawning period (Brown-Peterson et al. 2001). It remains unclear if some individuals spawn throughout the entire spawning season or only over a short period of time during the spawning season.

Courtship and Spawning Behavior

As with most fish species, Cobia courtship and spawning behavior in the wild are essentially unknown. Observations of what was believed to be spawning by Cobia were reported by James M. Barkuloo (U.S. Fish Wildlife Service, Panama City, FL) on 23 March 1988 as follows. On August 8 and August 10, 1974, while on an oil drilling ship in the Gulf of Mexico about 30 miles southwest of Panama City, Florida, Barkaloo saw as many as nine Cobia, ranging from 30 to 50 pounds each, near the surface and separated into groups of two or more. The fish released “bubble-like” substances (eggs?) and “white clouds” of material (sperm?) while undergoing changes in body color from uniform brown to a light horizontal-striped pattern on their lateral surfaces (Shaffer and Nakamura 1989). Ditty and Shaw (1992) estimated the depth of the water at this location to be between 82-165 m deep. Observations of Cobia in culture systems have provided no definitive confirmation of spawning behavior.

Spawning Location and Time of Spawning

Spawning location of Cobia in the Gulf of Mexico has yet to be determined although there are several studies which collected eggs and/or larvae suggesting a relative proximity of spawning to shore. Eggs have been collected from inside lower Chesapeake Bay (Joseph et al. 1964), inlets in North Carolina estuaries (Hettler and Settle personal communication *in* Ditty and Shaw 1992), in coastal waters 20-49 m deep, and both near the edge of the Florida Current and in the Gulf Stream (Hassler and Rainville 1975, Eldridge et al. 1977). Off North Carolina, Cobia eggs are usually collected on flood tides but few larvae are found in tidal inlets (Hettler and Settle personal communication *in* Ditty and Shaw 1992). They have also been collected in samples taken from offshore waters (Shaffer and Nakamura 1989). In contrast, Lefebvre and Denson (2012) documented Cobia spawning inshore along East South Carolina based on the presence of actively spawning females, significantly higher GSI values, and the collection of eggs inside both Port Royal and Saint Helena Sounds, leading to questions regarding the significance of inshore waters as spawning and Cobia nursery habitat.

Larval Transport

Most Cobia larvae in the Gulf of Mexico have been collected from offshore waters (Shaffer and Nakamura 1989), although Ditty and Shaw (1992) reported Cobia larvae co-occurred in both estuarine and shelf waters, primarily during May-September. Early larvae (~6.8 mm) are also collected at stations within the 65-134 m isobaths range off Texas during September suggesting that some spawning likely occurs on the shelf 50-90 km from the coast (Finucane et al. 1979). Ditty and Shaw (1992) reported that seven Cobia larvae (all >9.5 mm) were identified from beyond the 180 m depth contour and all were collected off the Mississippi River Delta. Baughman (1950) observed that young juvenile Cobia were common off Texas in May, June, and July. Dawson (1971) suggested that spawning occurs primarily offshore. Collections of small juvenile Cobia (<30 mm SL) by Joseph and Yerger (1956) and Boschung (1957) in the northern Gulf of Mexico primarily occurred between late May and mid-July with the smallest specimens (16-19 mm SL) occurring offshore and larger specimens (45-140 mm SL) occurring nearshore/inshore. Dawson (1971) also reported nekton samples from June 1967 contained Cobia 16-27 mm. Early juveniles move inshore and inhabit coastal areas near beaches, river mouths, barrier islands, lower reaches of bays and inlets, or bays of relatively high salinities (Benson 1982, Hoese and Moore 1977, McClane 1974, Swingle 1971, Shaffer and Nakamura 1989).

Ditty and Shaw (1992) believed that Cobia spawn in the Gulf of Mexico during the day since all Cobia embryos they examined in ichthyoplankton samples from the region were at similar stages of development (i.e., late stage after Ahlstrom and Moser 1980) when collected during midmorning. One exception was a collection of late-stage eggs taken near midnight. Daytime spawning by Cobia might have been witnessed to occur about 48 km southwest of Panama City, Florida (Barkaloo personal observation *reported in* Shaffer and Nakamura 1989). Cobia appear to spawn in South Carolina's Port Royal Sound and Saint Helena Sound in the afternoon and early evening based on ages of field-collected eggs, histological analysis, and the presence of females with hydrated oocytes (Lefebvre and Denson 2012). There is no mechanism identified at this time for movement of Cobia eggs and larvae beyond possibly passive transport on prevailing currents (Franks personal communication).

Genetics

Hrincevich (1993) and Beisiot et al. (1993) examined mtDNA from 90 Cobia collected from the Gulf and Virginia to determine if separate stocks existed between the two regions. Although their results distinguished 86 haplotypes, they were unable to find evidence disputing a single spawning stock suggesting that Cobia in U.S. waters are a single management stock. Garber et al. (2002) sampled Cobia from Mississippi waters and developed species specific primers based on mtDNA control regions for Cobia in the northern Gulf to be used in assessing population structures.

Most of the interest in Cobia today is primarily driven by the desire to generate markers to determine wild fish from potential hatchery/cultured Cobia. This is especially useful considering the explosion of culturing of Cobia in other parts of the world and the potential for aquaculture in the United States. One of the most extensive studies was Pruett et al. (2005) who sequenced 20 microsatellites from 24 wild caught fish in the northcentral Gulf of Mexico. The authors intended to utilize this genomic DNA library in future work exploring population genetics and trait inheritance for aquaculture.

Gold et al. (2013) compared tissue samples from Cobia in the U.S. (Gulf and Atlantic) to fish from Taiwan to explore the possibility of using fish from other regions in aquaculture as broodstock. While the fish from Southeast Asia were markedly different from U.S. fish, they found Cobia from Louisiana, Mississippi, and Virginia were homogeneous based on microsatellite genotypes and mtDNA haplotypes. They do caution moving fish between regions in the U.S. as well for broodstock as not all microsatellites are selectively neutral and could be less beneficial in a different environment or under some regional conditions. The results of Gold et al. (2013) was likewise based on a relatively small number of samples from the four locations sampled with Louisiana's contribution being the smallest (14 fish).

McDowell et al. (2018) sampled fin clips from 427 Cobia collected from Virginia to Louisiana with the majority (310) originating from Virginia and North Carolina waters. Using DNA microsatellites from the total collection and mtDNA sequences from 161 individual Cobia, they confirmed the presence of genetically distinct populations of Cobia in the Gulf of Mexico to East Florida and along the mid-Atlantic from North Carolina to Virginia.

Darden et al. (2018) examined archived Cobia samples from the South Carolina DNR Genetic Tissue Collection for regions of the Atlantic and Gulf of Mexico. Regional samples were censored to only include the reproductive season of April-June. Gulf of Mexico fish were represented by samples from Florida, Mississippi, and Texas. Atlantic Coast samples included Virginia, North and South Carolina, and Georgia. Population genetic structure was examined using standard genetic analyses. Their focus was on the Atlantic migratory group but genetic similarities were found between the samples from South Carolina northward and Florida to the Gulf in the current transition zone which is from Cape Canaveral, Florida to Savannah, Georgia. For management purposes, this zone (which includes all of South Florida to the Keys) is known as the Florida East Coast Zone. This zone from the Georgia/Florida line south is technically an overlap area between the South Atlantic and the Gulf of Mexico Fisheries Management Councils. Management of this zone is described is greater detail in Chapter 5. The results from Darden et al. (2018) support the current stock boundary based on the limited reproductive exchange between the Gulf and the Atlantic around the Georgia/Florida border.

Age and Growth

This section provides recent information available on age and growth of Cobia and the current techniques used for ageing are described in VanderKooy (2009). Richards (1967) described the age and growth of Cobia using scales and mean size at age was back calculated from those annuli. Recent studies have compared other structures for determining the age of Cobia. Comparisons of spines and sectioned otoliths have determined that the sagittal otoliths are a more accurate structure (Burns and Neidig 1992, Hendon et al. 2004). Hendon et al (2004) also compared reads of whole otoliths with spines. Erosion of spine cores led to underestimates of age and vague bands in whole otoliths led to discrepancies in band counts compared to sectioned otoliths.

Recent studies have used sectioned otoliths for age and growth determination (Thompson et al. 1992, Smith 1995, Burns et al. 1998, Franks et al. 1999) (Table 3.4). Marginal Increment Analysis (MIA) has shown that a single band is formed annually each spring to summer (Thompson et al. 1992, Smith 1995, Burns et al. 1998, Franks et al. 1999). However, Franks et al. (1999) theorized that annulus deposition may be more related to migration for Cobia stocks in the northern Gulf of Mexico. Cobia from the Gulf of Mexico grow faster than their Atlantic counterparts, achieving similar overall lengths in fewer years (Table 3.5). Females are known to grow faster and larger than the males in both the Gulf and the Atlantic (Shaffer and Nakamura 1989, Smith 1995, Franks et al. 1999, Franks and Brown-Peterson 2002; Table 3.6).

Cobia are considered a fast-growing fish (Franks and Brown-Peterson, 2002), particularly for the first three years (ages 0-3) (Smith 1995, Franks et al. 1999) (Table 3.5). Larval Cobia begin with a truncated tail at 12-24 mm SL, which transforms into a rounded or paddle-like tail from 27-180 mm SL (Hardy 1978). Afterwards the tail takes on the adult characteristics of the forked tail (Hardy 1978).

Growth experiments by Denson et al. (2003) reported that growth and salinity have a direct relationship. Cobia cultured in 5 ppt had decreased length and weight, and increased infection rates compared to Cobia in 30 ppt. Benetti et al. (2010) demonstrated that Cobia could be raised in cage culture in the open ocean and inferred stocking densities were attributable to the differences in growth between two sites with similar water quality conditions. Cobia were raised from 200 mm TL and grown to 400 mm TL at Puerto Rico and Bahama sites. No differences in sex ratios were described between the two sites. In general, the weight to length relationship does not differ between the sexes (Table 3.7). Table 3.8 provides conversions for measurements of Cobia by fork length (FL) and total length (TL).

Life Span

Cobia in the Gulf of Mexico are recorded as females reaching age-11 (Franks and Brown-Peterson 2002) and males to age-10 (Thompson et al. 1992). In contrast Cobia from the Atlantic Ocean are recorded

Table 3.4 Von Bertalanffy growth parameters reported in various studies using scales, otoliths, or other techniques and by region.

Location	Sex	Technique	L_{inf}	K	t_0	Reference
W LA	M	Sectioned Otolith	1,132	0.49	0.49	Thompson et al. 1992
	F	Sectioned Otolith	1,294	0.56	-0.11	
NC	M	Sectioned Otolith	1,050	0.37	-1.08	Smith 1995
	F	Sectioned Otolith	1,350	0.24	-1.53	
N GOM	Combined	mark recapture	1,172	0.57	N/A	Dippold et al. 2017
N GOM	M	Sectioned Otolith	1,171	0.43	-1.15	Franks et al. 1999
	F	Sectioned Otolith	1,555	0.27	-1.25	
Chesapeake	M	Scales	1,210	0.28	0.6	Richards 1977
	F	back-calculated	1,640	0.23	0.08	
Atlantic	M		1,138	0.31	-0.98	SEDAR 2018
	F		1,410	0.25	-0.79	
GOM	M		1,178	0.43	-0.54	
	F		1,408	0.36	-0.55	

as living longer, but growing slower. Females in the Atlantic reach age-13 and the males reached age-14 (Franks and Brown-Peterson 2002). Maximum age observed for Cobia in the Gulf of Mexico is 11 (Franks et al. 1999) while the maximum observed age of Cobia in the Atlantic is 16 (Brenkert et al. 2015). The above ages are observed maximum ages and no author has stated what the theoretical maximum age of Cobia may be in each region or for either sex.

Migration

Information is limited and the true cause of movements of this species is still being discovered. Smith and Merriner (1982) observed juvenile Cobia positioning themselves over the backs of Cownose Rays in Chesapeake Bay. Anecdotal reports and photographs confirm that Cobia often associate with structure or other marine life. Cobia have been observed in association with sharks, rays, sea turtles, Whale Sharks, and Manatees, swimming with them along their routes to opportunistically feed. Large migrations may be a result of Cobia's hitchhiker behavior, response to environmental conditions, spawning or following food sources. Richards (1977) noted from tag returns that Cobia in the Chesapeake exhibited repetitive summer habitation and that a subpopulation may exist. Efforts to better understand migration have been addressed by genetic analysis, comparison of life history information, conventional, acoustic and satellite tagging (Perkinson et al. 2018b), while gaps in the data have led to additional questions of along shore migrations as well as inshore-offshore migrations. Klibansky (2018) compiled the presence/absence of Cobia from 15 different fishery-independent and fishery-dependent scientific surveys (see Figure 3.19) that demonstrate Cobia as a coastal pelagic that is prevalent on the continental shelf of the Gulf of Mexico

Table 3.5 Mean fork length (mm) at age of Cobia reported in various studies and by region.

Region	Sex	Mean Fork Length (mm) at Age												Technique	Ref
		0	1	2	3	4	5	6	7	8	9	10	11		
SW FL	M		558	715	854	947	1,028	1,058						Sectioned otoliths, back calculated	Burns and Neidig 1992
	F		891	916	934	992	1,065								
NE GOM	M	380	656	919	984	1,020	1,065	1,156	1,100	1,025				Sectioned otoliths, length at age	Burns et al 1998
	F	487	883	981	1,075	1,166	1,221	1,313							
NE GOM	M	439	705	885	971	1,034	1,070	1,140	1,198		1,250			Sectioned otoliths, length at age	Franks et al. 1999
	F	409	720	956	1,056	1,140	1,248	1,346	1,385	1,553	1,507	1,813	1,568		
Chesapeake	M		351	587	732	836	920	973	993	1,025	1,080	1,166		Scales back-calculated	Richards 1967
	F		361	605	813	940	1,052	1,120	1,184	1,237	1,278				

and the western U.S. Atlantic Ocean. Some Cobia were also collected off the shelf and the low occurrence offshore may be a function of survey efforts off the shelf.

Based on the most recent genetics work, sampling along the Gulf and the Atlantic indicates that two stocks occur in U.S. waters (McDowell et al. 2018, Darden et al. 2018). While life history information is not definitive, data show distinction among all stocks that may show differences due to environmental conditions, habitat, or prey availability. Maximum age, and size-at-age were found to be different among the stocks (Gulf vs Atlantic), but not significantly different. Cobia taken along East Florida were smaller at age than their Gulf of Mexico complements within the Gulf of Mexico stock. This information may imply that migrations or mixing within the Gulf of Mexico stock around the tip of Florida is limited.

Table 3.6 Cobia length and weight data by sex from various studies in the Gulf and Atlantic regions

Region	Sex	N	Length Range (mm FL)	Weight Range (kg)	Reference
Virginia	M	155	1,194	19	Richards 1967
	F	98	1,377	34	
NC	M	174	390 - 1,360	0.5 - 32.0	Smith 1995
	F	182	440 - 1,420	0.7 - 32.2	
NE GOM	M	275	345 - 1,450	0.3 - 29.0	Franks et al. 1999
	F	730	335 - 1,651	0.3 - 62.2	
W LA	M	464	528 - 1,432	1.5 - 30.8	Thompson et al. 1992
	F	218	358 - 1,445	1.0- 45.6	
FL GOM	M	19	209 - 469		Burns and Neidig 1992
	F	19	295 - 476		
GOM & ATL	C	165	400 - 1330	0.6 - 28.5*	Pulver and Whatley 2016

*Derived from W-L equation

Table 3.7 Weight to length conversions for Cobia from various studies.

Equation	Reference
logW = 3.4logFL-13.0 (kg, cm)	Smith 1995
log10W=-9.2445+3.4287(logFL) (kg, mm)	Franks et al. 1999
W = exp(-20.1)L^3.26 (kg, mm)	Pulver and Whatley 2016

Conventional, acoustic and satellite tagging results below demonstrate that low levels of migration and mixing between the Gulf migratory group and Atlantic migratory group are occurring. However, Cobia are being recaptured in relative proximity to their tagging location. Given that the species is a coastal pelagic, the surprising results indicate some level of residency for Cobia.

Conventional Tagging

The use of dart tags in Cobia began in the mid-1980s and since the first releases by NOAA in 1986, over 25,000 Cobia have been tagged by eight different institutions from Virginia to Mississippi (Perkinson et al. 2018a; Table 3.9). Most of these programs have been angler-based using volunteers from the public

Table 3.8 Total length ~ Fork length conversion equations for Cobia.

Reference	Equations	R^2
Thompson et al. 1992	TL (cm) = 1.13(FL)+0.57	0.98
	FL (cm) = 0.87(TL)+0.94	0.98
Dippold et al. 2017	FL (mm) =0.91(TL)+0.23	0.98
Smith 1995	TL (cm) = 1.1 FL-1.1	0.99
	TL (cm) = 1.1 FL-0.7	0.99
	TL (cm) = 1.1 FL-0.9	0.99

to capture, tag, and record data on these fish (Burns and Neidig 1992, Hendon and Franks 2010, Wiggers 2010, Perkinson and Denson 2012, Lefebvre and Denson 2012). The general public is encouraged to return tags when encountered through a reward program. Perkinson et al. (2018a) evaluated and summarized the migratory trends of Cobia in the Atlantic and Gulf of Mexico as part of the Species ID Workshop, held for SEDAR 58 Atlantic Cobia Benchmark Assessment (SEDAR 2018). The majority of information in the following section is summarized from that effort.

Many of the tagged Cobia are recaptured quickly and near the original release site. Therefore, Perkinson et al. (2018a) censored the available data to only include fish at liberty for more than 30 days. In addition, only returns with reported tag/recapture locations were included, resulting in a total of 1,745 recaptures of 2,124 total. Overall, the mean days at large from all programs ranged from 362 to 766 days (Table 3.10).

Atlantic Tagging

The majority of fish tagged in Virginia were also recaptured (83.5%) in the same region, 12% from upper North Carolina, and 2.3% in central Florida. Less than 1% (N=3) moved to the Gulf of Mexico. However these fish were recaptured along the northcentral Gulf indicating significant movement within the Gulf of Mexico. The overwhelming majority of Cobia tagged in North Carolina (85.7%) were recaptured in the

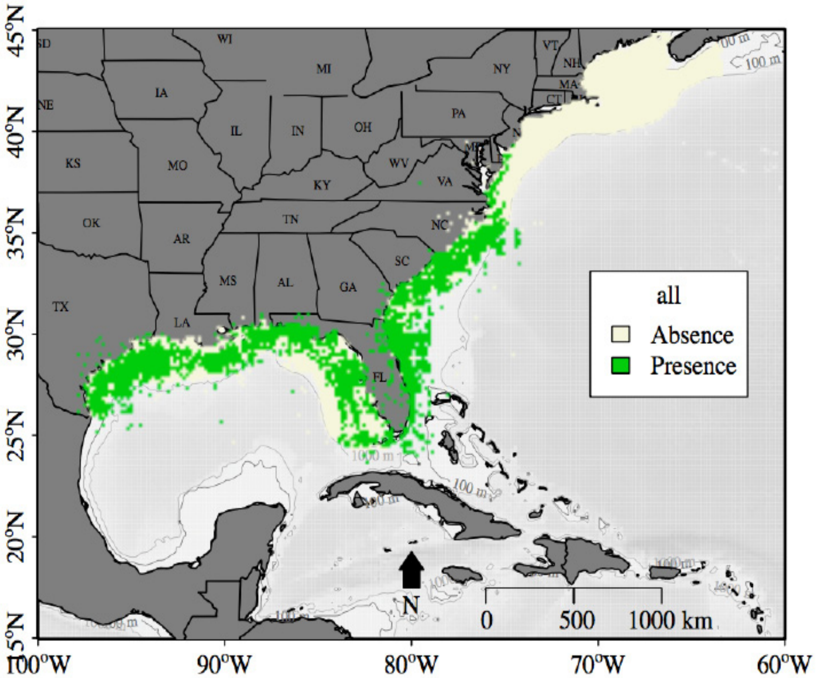

Figure 3.19 Presence/absence of Cobia from scientific data sources (*from* Klibansky 2018).

southern portions of Virginia. One North Carolina fish did show up north of Virginia and one in South Carolina, but none were recaptured further south along the Atlantic or in the Gulf of Mexico (Perkinson et al. 2018a).

South Carolina recaptured 87.5% of their tags in their state waters and 10.2% were recaptured off East Florida. One fish from South Carolina migrated around the Florida Peninsula and was recaptured just south of St. Petersburg, Florida in the Gulf of Mexico. A total of 92% of all Cobia recaptured off South Carolina occurred in Port Royal Sound.

Table 3.9 Total number of Cobia tagged, recaptures, and recapture percentage of the included data sources from the Gulf of Mexico and Western Central Atlantic (Table 3 *modified from* Perkinson et al. 2018a).

Data Source	Total Tagged	Total Recaptured	Recapture %	Years Covered
Virginia Institute of Marine Sciences	3,899	433	11.1	1995-2017
North Carolina Depart of Marine Fisheries	73	5	6.8	2017
South Carolina Department of Natural Resources	1,170	214	18.3	1990-2014
Hilton Head Reef Foundation	95	14	14.7	2007-2012
NOAA Southeast Fisheries Science Center	1,557	159	10.2	1986-2014
Mote Marine Lab	920	100	10.9	1991-2001
Gray Fishtag Research	24	2	8.3	2015-2017
Gulf Coast Research Lab	18,129	1,197	6.6	1988-2017
TOTAL	25,867	2,124	8.2	1986-2017

Florida East Coast Zone Tagging

Two Cobia tagged off Georgia remained at large for four and seven years, respectively, before recapture. These fish represent all returns from the 24 Cobia tagged in Georgia and were both recaptured off North Carolina. Cobia tagged around Cape Canaveral in central Florida (Brevard County) dispersed widely with a total of 90 recaptures from New Jersey to Texas. The largest percentage of Brevard tagged Cobia were recaptured in the same areas they were tagged (36.7%). Twenty-two percent of the Cobia tagged in Brevard migrated into the Gulf of Mexico, with most occurring along the Florida Panhandle (Perkinson et al. 2018a).

Gulf of Mexico Tagging

Cobia tagged south of Brevard and north of the Florida Keys (Biscayne Bay), moved throughout the Gulf of Mexico region. A total of seven tagged fish have been recaptured, three in the same area between Brevard and the Keys, two from the Keys, one off Fort Meyers, Florida (just north of the zone still considered the Keys), and one was recaptured off the Mississippi Coast.

Of the 181 fish tagged in the Florida Keys, the majority (57.5%) were recaptured in the Keys, although how long the fish were at-large is not clear. Sixty seven of the Cobia (37%) moved to the northwest into the Gulf of Mexico proper and most were recaptured before they left Florida waters. One fish was recaptured at the Louisiana/Texas line. Eight of the Cobia tagged in the Keys moved to the northeast and were recaptured just north of the Keys and two at Canaveral in Brevard County (Figure 3.20).

Because the SEDAR 58 Stock ID Workshop was primarily focused on the Atlantic Cobia stock, Perkinson et al. (2018a) did not provide much detail on the tagging efforts in the Gulf of Mexico. They did note that Cobia tagged in the Gulf of Mexico by GCRL's Sport Fish Tag and Release Program (Hendon and Franks 2010) had the largest number of recaptures at 970 included in their analysis after censoring for days-at-liberty and reliable location data. Most of the recaptures came from the Gulf of Mexico (84.6%), although a number of Cobia were recaptured in the Keys (9.3%) and along the East Florida, south of Brevard County (3%). Cobia tagged in the Gulf were recaptured off all five Gulf states and one tag was recovered as far south and west as Vera Cruz, Mexico (Dippold et al. 2017).

Dippold et al. (2017) summarized the entire GCRL Cobia tagging project from its inception in 1988 through 2014. Over the 27 years of data included in the analysis, 17,875 Cobia were tagged with the majority (57%) occurring between 1990 and 1998. The Gulf of Mexico and South Atlantic were divided into seven geographic zones from the Texas/Mexico border to the North Carolina/Virginia border (Figure 3.21). A total of 1,137 Cobia were recaptured, with the greatest number recaptured between 1990 and 1998, the same period with the highest initial tagging. The northcentral Gulf zone consisted of the entire coasts of Alabama and Mississippi, and eastern Louisiana to the mouth of the Mississippi River. Of all

Table 3.10 Days at large for Cobia by original tagging location (Table 4 *from* Perkinson et al. 2018a).

Tag Zone	Mean Days at Large
Virginia	539±25
North Carolina	766±190
South Carolina	496±33
Brevard	400±38
South of Brevard	430±86
Keys	362±22
Gulf of Mexico	449±13
Total	464±10

the recaptures reported to the program, the most were from the northcentral zone and the fewest recaptures were from Texas. However, only 6.6% of all the tags released through the 27-year program were reported, meaning that fish either died naturally and the tags were lost, or the fish were harvested and not reported. Franks (personal communication) believes that the latter may be the situation in the western Gulf for Cobia that migrate south into Mexico. The single tag return from Vera Cruz provides support for this possibility.

All Cobia tagged in Texas were recaptured in the western Gulf in Texas and Louisiana although the number was relatively low (n = 5). A number of the fish tagged in Louisiana (west of the mouth of the Mississippi River) were recaptured in the same region - 41 of the 61 returns (Table 3.11). However, similar to the northcentral Gulf, a few fish moved throughout the Gulf of Mexico from Texas to Brevard County

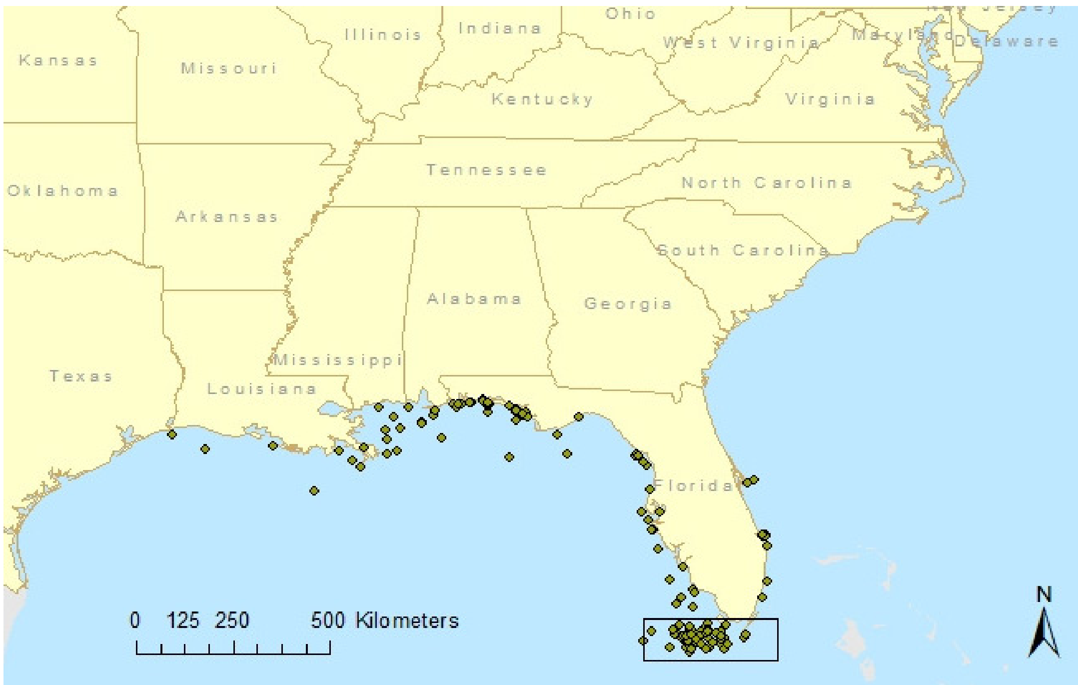

Figure 3.20 Recapture locations (green diamonds) of Cobia tagged in the Florida Keys. Box indicates the general tagging area (Figure 12 *from* Perkinson et al. 2018a).

and to East Florida and three fish traveled past the Georgia/Florida line into the Atlantic migratory group's range. In contrast, 15 Cobia tagged along the Atlantic, north of the Florida Keys, did enter the Gulf of Mexico and were recaptured along the entire coast as far as Louisiana but never as far west as Texas (Table 3.11).

A previously unknown Cobia tagging effort was conducted in Texas by Steve Qualia who used a network of recreational anglers to conventionally tag just over 2,500 fish since 1985. While most of Qualia's data is no longer available, and therefore not included in Perkinson et al. (2018a), he did report that three Cobia released along the Texas Coast were recaptured in Mexico: two in Vera Cruz and one in Tampico (Qualia unpublished data).

A network analysis conducted by Perkinson et al. (2018a) shows connectivity for the Gulf of Mexico and the Florida Keys, the Gulf of Mexico to Brevard County, Brevard County to the Florida Keys, and separate connectivity between Virginia and North Carolina (Figure 3.22). Recapture data suggest that a majority of the populations remain resident for an unspecified period of time. The Florida Keys may serve as a

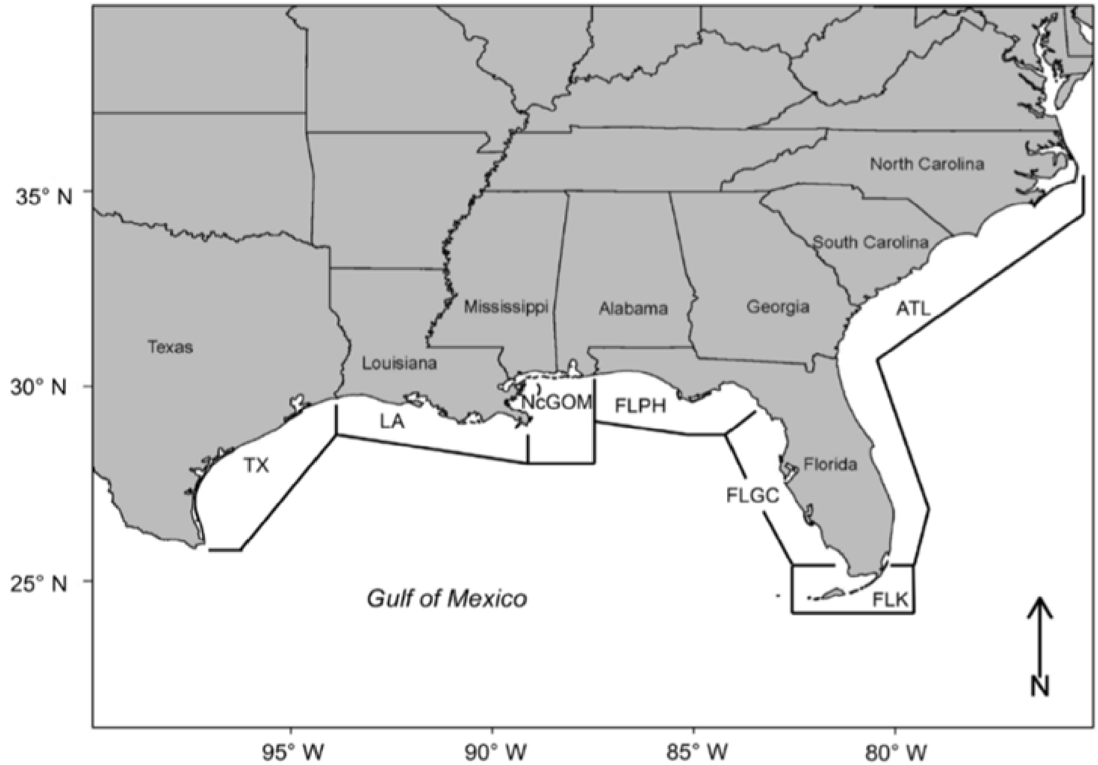

Figure 3.21 Map of the 7 geographic zones used to determine large-scale and seasonal movements of Cobia (*Rachycentron canadum*) tagged and recaptured in the Gulf of Mexico and South Atlantic Ocean during 1988–2014. The 7 zones are Texas (TX), Louisiana (LA), northcentral Gulf of Mexico (NcGOM), Florida panhandle (FLPH), Florida Gulf Coast (FLGC), Florida Keys (FLK), and the South Atlantic Ocean (ATL) (*Figure 1 from* Dippold et al. 2017).

wintering ground for the Gulf of Mexico and the mixing of Gulf and Atlantic migratory groups may occur in South to Central Florida as movements are from Central to South Florida and Gulf to South Florida. The connectivity analysis looks for natural breaks in the data and by excluding outliers in movement (retaining the top 89%), one can visualize the core behaviors seen in the tagging data. Perkinson et al. (2018a) note that "these data represent a very small percentage of recaptures and are not representative of the two populations. Overall, the data indicates a mixing zone of the Atlantic and the Gulf of Mexico populations that occurs somewhere from Cape Canaveral through Georgia."

Perkinson et al. (2018a) further conclude that, based on the apparent lack of recaptures of Cobia tagged in the Florida Keys anywhere north of Cape Canaveral, fish overwintering in the Keys are likely not Atlantic migratory group fish as was previously hypothesized (Figure 3.22). However, it should be noted that conventional tagging does not provide information on where the fish went prior to recapture, and considering Cobia's high return rate to the same areas in which they were tagged, the data from the Keys needs further analysis. Perkinson et al. (2018a) indicate that indeed, some portion of the population in the Florida Keys may in fact be residents year-round. Acoustic tags would provide better information on mixing given an adequate receiver coverage and tagging effort throughout Cobia's range.

Acoustic Tagging

Perkinson et al. (2018b) tagged 143 Cobia from 2014-2017 along the coast from Charleston, South Carolina down to West Palm Beach, Florida. Cobia were detected by acoustic receivers as far north as Chesapeake Bay down to the Florida Keys.

Table 3.11 A matrix of the number and proportion of Cobia (*Rachycentron canadum*) (n=875, time-at-liberty ≥30 days) tagged and recaptured in the Gulf of Mexico and South Atlantic Ocean during 1988–2014 and the recapture percentage among the 7 geographic zones used in this study. The zones are the South Atlantic Ocean (ATL). Florida Gulf Coast (FLGC), Florida Keys (FLK), Florida panhandle (FLPH), Louisiana (LA), northcentral Gulf of Mexico (NcGOM), and Texas (TX) (*Table 4 from* Dippold et al. 2017).

Zone of tagging	Zone of Recapture								Recapture Percentages						
	ATL	FLGC	FLK	FLPH	LA	NcGOM	TX	Total	ATL	FLGC	FLK	FLPH	LA	NcGOM	TX
ATL	***30***	0	5	2	1	2	0	40	***0.75***	0	0.12	0.05	0.02	0.05	0
FLGC	0	***30***	7	6	2	1	0	46	0	***0.65***	0.15	0.13	0.04	0.02	0
FLK	6	9	***63***	18	4	7	1	108	0.06	0.08	***0.58***	0.17	0.04	0.06	0.01
FLPH	30	9	24	***73***	61	63	16	276	0.11	0.03	0.09	***0.26***	0.22	0.23	0.06
LA	3	1	3	5	***41***	3	5	61	0.05	0.02	0.05	0.08	***0.67***	0.05	0.08
NcGOM	15	10	33	55	35	***184***	7	339	0.04	0.03	0.10	0.16	0.10	***0.54***	0.02
TX	0	0	0	0	1	0	***4***	5	0	0	0	0	0.20	0	***0.80***
Total	84	59	135	159	145	260	33	875							

South Carolina Cobia were detected primarily off South Carolina from April through November, with highest detections in May and June. General movements were north and south along South Carolina with peak detections in May and June. Thirteen Cobia tagged nearshore were detected within a South Carolina estuary and four offshore tagged Cobia were found within a South Carolina estuary. No Cobia tagged outside of South Carolina were found in its estuaries, but two Cobia from South Carolina were detected in Chesapeake Bay.

Cobia tagged off Georgia were detected from April through November, with highest detections in June. No fish were detected within 30 km of a receiver. Cobia detections were most frequent at an artificial reef complex 45 km offshore. None of the Cobia were detected in an estuary or making any long migrations.

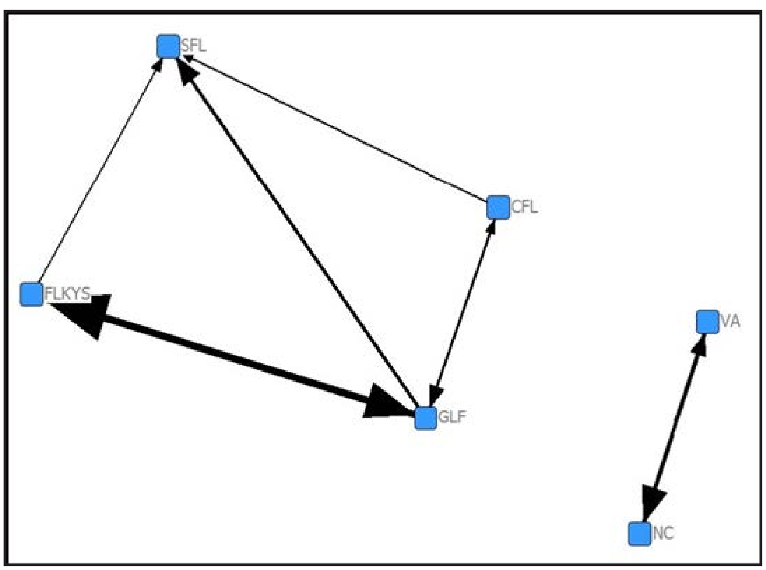

Figure 3.22 Visualization of one mode matrix showing the top 89% of movements between zones (Figure 155 *from* Perkinson et al. 2018a). The thicker lines indicate a greater level of movement and arrows indicate the direction of travel. FLKYS = Florida Keys, GLF = Gulf of Mexico, CFL = Brevard, SFL = South of Brevard, NC = North Carolina, and VA = Virginia.

Central Florida tagged Cobia (Cape Canaveral) were considered 'resident' fish in that they were detected year-round, with highest detections from January and February. Six Cobia were detected as migrating to the Florida Keys in April and May and then returned to Cape Canaveral. One Cobia migrated off of Charleston, South Carolina.

South Florida (Jupiter) Cobia were detected year-round with highest detections from March through May. These Cobia were classified as resident and traveler groups. Of 39 fish tagged, six traveled to different areas. Two Cobia migrated to the Florida Keys (April-May) and then up around Tampa in the Gulf of Mexico. Four fish migrated up to Georgia and South Carolina in October and one of these then was detected near Grand Bahama (Dec-March) before returning to the Cape Canaveral area.

Sea surface temperatures were fairly consistent across the range of areas and movements were generalized as a response to fluctuations in the areas. South Florida and Georgia had the warmest mean temperatures at 27.3 and 27.5°C, respectively. South Carolina sea surface temperatures averaged 26.7°C. Central Florida had the lowest temperatures at 25.2°C due to summer upwellings in August of 2015 and 2016. Additionally, it was noted that detections increased in relation to subsurface structures in proximity to the acoustic receivers.

Satellite Tags

Jensen and Graves (2018) used pop-up satellite archival tags (PSATs) to monitor movements of Cobia off of Virginia. PSATs collect environmental data, depth, and light levels for up to two years. All 36 fish were provided by anglers so they were all over the 33 inches TL minimum size and, once released, were at liberty from 1 to 192 days. Environmental data showed water temperatures occupied by the Cobia ranged from 12.1-29.3°C and most depth readings were less than 50 m, but the max depth recorded was 86.1 m. Twenty-five percent of all depth observations were in the top meter of the water column in August and September, and 40% of depth observations were in the top 3 m of the water column during the warmer months. From October through February, less than 5% of depth observations were in the top 3 m.

Conclusions of the data show that Virginia fish tend to stay in coastal waters during warmer months, but occupy deeper waters off of North and South Carolina in the cooler months. One Cobia did migrate as far south as Daytona, Florida; another moved up Chesapeake Bay into Maryland waters; and one tag popped up off Georgia during movements and the full extent of its movements is unknown.

Parasites and Diseases

Cobia are infected by several kinds of metazoan parasites, including trematodes (flukes), monogeneans (ectoparasitic flatworms), cestodes (tapeworms), nematodes (roundworms), acanthocephalans (spiny-headed worms), and copepods (sea-lice), other crustaceans, and a leech. Most occur in the gastrointestinal tract except monogeneans, copepods, and a few small groups on the gills and skin. Table 3.12 provides an incomplete list of Cobia parasites from wild Cobia except where otherwise noted. Other lists exist but none is entirely accurate (e.g., Shaffer and Nakamura 1989, Williams and Bunkley-Williams 1996, Arthur and Te 2006, McLean et al. 2008). Junior synonyms, mostly names of species transferred by taxonomists from one to another genus to accommodate nomenclatural rules, are not always included, but the names in the Table are accepted according to WoRMS (World Register of Marine Species). However, some species not in Table 3.12 probably exist as cryptic species - species that are morphologically similar but genetically different from a recognized named species. Since the Cobia occurs throughout a wide range, one could expect the same parasite species to have the same cosmopolitan distribution as the fish host. However, individual fish do not necessarily cover the range, and the intermediate hosts of the trematodes, cestodes, nematodes, and acanthocephalans differ throughout the ranges of those parasites and the fish. For example, the blood fluke *Cardallagium anthicum (as Psettarium a.)* (see Yong et al. 2018), from the heart of the Cobia in the Gulf of Mexico, appears similar to a species in Cobia from Vietnam that has several slightly different gene sequences and presumably a different intermediate host (Bullard and Overstreet 2006, Warren et al. 2017). For blood flukes, unlike most flukes, the definitive fish (Cobia) host also serves as the second intermediate host. A good example of biodiversity relative to geographic range are the seven morphologically differentiated species of the trematode genus *Stephanostomum* reported by Bray and Cribb (2003). The nematode accepted as *Iheringascaris inguies* throughout the wide range of documented records will probably be shown to consist of a complex of species having somewhat different genetic sequences once those from disparate regions are analyzed. For example, the listed junior synonyms *I. iheringascaris* from Brazil and *Neogoezia elacateiae* from West Pakistan (Deardorff and Overstreet 1981a) will probably be shown to be acceptable species based on genetic sequences, and other reported parasites from other regions have not been named. The presently unrecognized cryptic species ultimately will be described as a new species, increasing the number and recognized biodiversity of Cobia parasites.

Most species, especially endohelminths, occur in small numbers in a Cobia and do not harm the host. Moreover, some infect the alimentary canal in large numbers and still do not cause harm. For example, the trematode *Stephanostomum pseudoditrematis* is found in high numbers in the intestine (Shaffer and Nakamura 1989), and numbers of up to 3.5 cm long specimens of *Iheringascaris inguies* can reach several hundred to a few thousand adult individuals in the stomach and pyloric ceca of a single Cobia in the northern Gulf of Mexico (Overstreet 1978, Deardorff and Overstreet 1981b) without apparent harm. Moreover, preadults (L4's) of that species can develop in nests of typically non-inflamed, regenerating stomach tissues (Deardorff and Overstreet 1981b). Whereas most blood fluke species occur in the lumen of blood vessels and other structures, low numbers of *Cardallagium anthicum* and *Littorellicola billhawkinsi* thread themselves within the myocardial lacunae of the ventricle and atrium of the hearts of Cobia and Florida Pompano (*Trachinotus carolinus*), respectively, and could directly harm the heart tissues if present in high intensity (Bullard and Overstreet 2006, Bullard 2010, Warren et al. 2011, Overstreet and Hawkins 2017). A study by Menoza-Franco and Vidal-Martínez (2011) from the Yucatan Peninsula found the endoparasitic monogenean *Pseudempleurosoma gibsoni*, originally described from the esophagus of a sciaenid fish in Brazil (Santos et al. 2001), in the pyloric ceca of cultured Cobia in Mexico. Monogeneans, usually external, are often harmful if present in high intensities per infested fish.

Examples of infections by small numbers of a helminth involving tissue invasion seldom severely harm the wild Cobia host, and these include nematodes and acanthocephalans. The ascaridoid nematode *Goezia pelagia* can cause conspicuous lesions in the stomach, but few infected fishes are actually diseased (Deardorff and Overstreet 1980). On the other hand, the stomach wall can be infected with another ascaridoid, *Raphidascaris* sp., which can cause degeneration of the stomach wall, erosion of gastric mucosa and abnormalities in the blood vessels and underlying muscle tissue (Khatoon and Bilqees 1996), and such infections may harm the host. Acanthocephalans such as *Serrasentis sagittifer* can cause intestinal damage in Cobia examined by Blaylock and Whelan (2004), but Overstreet (personal observations) has observed hundreds of infections of this species without apparent harm to the Cobia hosts. The adults is highly host specific to cobia in both the US and northern Australia (Barton et al, 2018) and infects a variety of prey-fish. Cobia infections from the related worm *S. nadakali* can result in hyperplastic, metaplastic, and hypertrophic changes to connective tissue, epithelial and muscle cells of the intestine; attachment of the worm to the intestinal wall can cause destruction of the villi as well as degeneration and necrosis of the mucosal epithelium (George and Nadakal 1981). In aquaculture farms in Rio de Janeiro, Brazil, cobia were fed trash fish, and one individual became infected in the liver serosa with *Hysterothylacium deardorffoverstreetorum* (see Calixto et al. 2017).

Low numbers of some parasitic species also occur externally on most wild Cobia. The barnacle *Conchoderma virgatum* was found on a Cobia from Mississippi waters. Surprisingly, the barnacle was actually attached to the parasitic copepod *Lemaeolophus sultanus*, which was embedded just behind the

Table 3.12 Partial list of parasites of wild Cobia except when indicated as from aquaculture.

Parasite	Geographic Region	Host Site	Reference
Protozoans (from aquaculture)			
Amyloodinium sp.	Australia		Lee et al. 2018
Amyloodinium ocellatum	Brazil, India, Gulf of Thailand	Gills	Moreira et al. 2013, Rameshkumar et al. 2018, Dung et al. 2017
Brooklynella hostilis	Puerto Rico (shipped from Florida?)	Skin and gills	Bunkley-Williams and Williams 2006
Cryptocaryon irritans	Puerto Rico (shipped from Florida?), Gulf of Thailand	Gills	Bunkley-Williams and Williams 2006; Dung et al. 2017
Epistylis sp.	Vietnam		Le and Svennevig 2005, Nhu et al 2011
Ichthyobodo sp.	Puerto Rico (shipped from Florida?)	Skin and gills	Bunkley-Williams and Williams 2006
Pseudorhabdosynochus epinepheli	Vietnam		Le and Svennevig 2005, Nhu et al. 2011
Sphaerospora-like myxosporidean	Penghu Islands, Taiwan	Kidney (renal tubules and tubule epithelium)	Chen et al. 2001, Lopez et al. 2002
Trichodina sp.	Vietnam, Gulf of Thailand		Le and Svennevig 2005, Nhu et al. 2011, Dung et al. 2017
Vorticella sp.	Vietnam		Le and Svennevig 2005, Nhu et al. 2011
Monogeneans			
Benedenia sp. (from aquaculture)	Malaysia	Body	Chu et al. 2013
Dionchus sp.	SW Pacific-Australia, Gulf of Mexico	Gills	Rohde 1978, Bullard et al. 2000
Dionchus rachycentris	Gulf of Mexico-TX, LA, FL	Gills	Koratha 1955, Hargis 1955
	Queensland, Australia	Gills	Young 1970
Neobenedenia girellae (from aquaculture)	Taiwan	Eyes and body surface	Lopez et al. 2002, Ogawa et al. 2006
Neobenedenia melleni (from aquaculture)	Brazil	Body surface	Moreira et al. 2013
Neobenedenia girellae (from aquaculture)	Taiwan, Australia	Eyes and body surface	Lopez et al. 2002, Ogawa et al. 2006, Brazenor et al. 2018
Neobenedenia sp.	Gulf of Thailand		Dung et al. 2017
Pseudempleurosoma gibsoni (from aquaculture)	Yucatan, Mexico	Pyloric ceca	Mendoza-Franco and Vidal-Martínez 2011
Pseudorhabdosynochus epinepheli	Vietnam		Le and Svennevig 2005, Nhu et al. 2011
Pseudorhabdosynochus sp.	Gulf of Thailand		Dung et al. 2017

Table 3.12 Continued

Parasite	Geographic Region	Host Site	Reference
Digenetic trematodes			
Aponurus carangis	Gulf of Tonkin		Arthur and Te 2006
Bucephalus cf. *"varicus"*	Gulf of Tonkin		Arthur and Te 2006
Cardallagium anthicum (as *Psettarium a.*)	Gulf of Mexico	Endocardium	Bullard and Overstreet 2006
Cardallagiumcf. anthicum (as Psettarium cf. a.)	Nha Trang Bay, Vietnam	Endocardium	Warren et al. 2017
Derogenes varicus	Gulf of Tonkin		Arthur and Te 2006
Dinurus longisinus	Gulf of Mannar	Stomach	Parukhin 1976
Dinurus selari	Gulf of Tonkin	Stomach	Arthur and Te 2006
Ectenurus lepidus (as *E. trachuri*)	Coast of Kuwait, Arabian Gulf	Stomach	Nahhas and Sey 2002
Ectenurus virgulus	Gulf of Mannar	Stomach and intestine	Parukhin 1976
Gonocerca sp. juvenile	Gulf of Mannar	Stomach	Parukhin 1976
Haplosplanchnus caudatus (as *Laruea straightum*)	Arabian Sea-Pakistan, Indian Ocean	Intestine	Jahan 1973
Lecithochirium canadus	Indian Ocean		Bilquees 1972
Lecithochirium microstomum	South China Sea		Shen 1990
Lecithochirium monticelli (as *Sterrhurus m.*)	NW Atlantic-North Carolina		Linton 1905
Lecithocladium jagannathi	Bay of Bengal-India	Stomach	Ahmad 1981
Lepidapedon megalaspi (taxon *inquirendum*)	Gulf of Mannar, Gulf of Tonkin	Intestine	Parukhin 1976, Arthur and Te 2006
Neometanematobothrioides rachycentri	Gulf of Tonkin, South China Sea	In gills and body cavity	Parukhin 1976, Arthur and Te 2006
Phyllodistomum parukhini	South China Sea, Gulf of Tonkin, Red Sea	Urinary bladder?	Parukhin 1976, Arthur and Te 2006
Plerurus digitatus	Indian Ocean-Umhlanga Rocks, Natal	Stomach	Bray 1990
Psettarium anthicum	Gulf of Mexico	Endocardium	Bullard and Overstreet 2006
Psettarium cf. anthicum	Nha Trang Bay, Vietnam	Endocardium	Warren et al. 2017
Psettarium rachycentri	Gulf of Mannar, Indian Ocean	Kidney	Lebedev and Parukhin 1972, Parukhin 1976
Pseudolepidapedon pudens (questionable Identification)	NW Atlantic-North Carolina		Linton 1905, Williams and Bunkley-Williams 1996
Sclerodistomum prevesiculatum	Brazil, W Atlantic	Stomach	Teixeira de Freitas and Kohn 1967
Sclerodistomum rachycentri	Indian Ocean		Parukhin 1978
Siphoderina morosovi	Gulf of Tonkin, South China Sea	Intestine	Parukhin 1976, Arthur and Te 2006
Stephanostomum cloacum	Bay of Bengal -India	Intestine	Hafeezullah 1978

Table 3.12 Continued

Parasite	Geographic Region	Host Site	Reference
Stephanostomum cobia	Heron Is, Australia	Intestine	Bray and Cribb 2003
Stephanostomum dentatum	NW Atlantic-North Carolina		Linton 1905
Stephanostomum imparispine	Gulf of Mexico-FL, W Atlantic (Gulf of Mannar and South Atlantic?)	Rectum	Linton 1905, Sogandares-Bernal and Hutton 1959, Parukhin 1976
S. imparispine (as metacercaria)	Gulf of Tonkin, W Atlantic		Arthur and Te 2006, Williams and Bunkley-Williams 1996
Stephanostomum microsomum	Bay of Bengal-India	Intestine	Madhavi 1976
Stephanostomum pseudoditremat	Bay of Bengal-India	Intestine	Madhavi 1976
Stephanostomum rachycentronis	Hainan Island-South China Sea		Shen 1990
Sterrhurus monticelli	NW Atlantic-North Carolina		Linton 1905
Tormopsolus filiformis	Gulf of Mexico-FL, W Atlantic	Rectum	Sogandares–Bernal and Hutton 1959, Williams and Bunkley-Williams 1996
(as *Tormopsolus rachycentri*)	Gulf of Tonkin, South China Sea	Intestine	Parukhin 1976, Arthur and Te 2006
(as *Tormopsolus spatulum*)	Bay of Bengal-India	Intestine	Madhavi 1976, Hafeezullah 1978
Tubulovesicula angusticauda	Gulf of Mannar-Indian Ocean, Gulf of Tonkin	Stomach	Parukhin 1976, Arthur and Te 2006
Cestodes (metacestode stage)			
Bombycirhynchus sphyraeniaicum	Queensland, Australia		Beveridge and Campbell 1989, Palm 2004
Callitetrarhynchus gracilis	Senegal, Mediterranean Sea	Body cavity	Dollfus 1942, Palm 2004
Nybelinia sp.	NW Atlantic-North Carolina	Stomach wall	Linton 1905, Palm 2004
Rhinebothrium sp.	NW Atlantic-North Carolina	Alimentary canal	Linton 1905
"Rhynchobothrium" sp.	NW Atlantic-North Carolina		Linton 1905
Scolex polymorphus (larval name)	NW Atlantic-North Carolina		Linton 1905
Tentacularia coryphaenae	Gulf of Mexico	Mesentery	Palm and Overstreet 2000
	NW Atlantic-North Carolina	Stomach wall	Linton 1905
Nematodes			
Anisakis sp. (larva)	Gulf of Tonkin		Arthur and Te 2006
Anisakis sp.	Gulf of Thailand		Dung et al. 2017
Anisakis simplex complex (experimental infection)	Taiwan	Stomach lumen, abdominal cavity	Shih et al 2010
"Capillaria sp."	Gulf of Mannar	Intestine	Parukhin 1976
Capillariidae gen. sp. 4	Timor Reef, Australia	Intestine	Moravec and Barton 2018b

Table 3.12 Continued

Parasite	Geographic Region	Host Site	Reference
"Dichelyne (Neocucullanellus) sindensis"	Sindh-Pakistan	Intestine	Akram 1992
Digitiphilometroides marinus (as *Philometroides m.*)	NW Atlantic coast-South Carolina, Australian waters	Body cavity (surface of gonads)	Moravec and de Buron 2009, Moravec and Barton 2018a
Goezia pelagia	Gulf of Mexico	Stomach	Deardorff and Overstreet 1980
Hysterothylacium deardorffoverstreetorum (from aquaculture) (taxon inquiredum)	Brazil	Liver	Calixto et al. 2017
Hysterothylacium cf. megacephalum	South China Sea, Indian Ocean	Intestine	Parukin 1976
Hysterothylacium shyamasundarii	Bay of Bengal		Lakshmi and Rao 1989
Iheringascaris inquies	Australian waters	Stomach	Bruce and Cannon 1989
	Gulf of Mexico	Stomach and pyloric ceca	Overstreet 1978, Deardorff and Overstreet 1980, 1981a
	Gulf of Tonkin, South China Sea		Parukhin 1976, Arthur and Te 2006
	NW Atlantic-MA, NC	Stomach	Linton 1901, 1905
	Arabian Sea-W Pakistan	Stomach, alimentary canal	Khan and Begum 1971, Rasheed 1965
Philometroides marinus	NW Atlantic Coast-South Carolina	Body cavity (surface of gonads)	Moravec and de Buron 2009
Philometrid sp.	Gulf of Mannar	Body cavity	Parukhin 1976
Procamallanus sp.	Gulf of Thailand		Dung et al. 2017
Acanthocephalans			
Leptorhynchoides sp.	Gulf of Thailand		Dung et al. 2017
Serrasentis nadakali	Arabian Sea-India	Intestine and pyloric ceca	George and Nadakal 1981
Serrasentis sagittifer	NW Atlantic-North Carolina E. Atlantic-Senegal	Intestine	Linton 1905, Golvan 1956
	Northern Australian coastal waters	Intestine	Barton et al. 2018, Moravec and Barton 2018a
	Gulf of Tonkin, South China Sea		Arthur and Te 2006
	Arabian Sea-India	Intestine	Soota and Bhattacharya 1981
	Gulf of Mexico	Intestine and pyloric ceca	Overstreet 1978
Annelida			
Leeches			

Table 3.12 Continued

Parasite	Geographic Region	Host Site	Reference
Zeylanicobdella arugamensis (from aquaculture)	Malaysia	Body surface	Chu et al. 2013
Piscicola geometra	Taiwan	Body surface	Rizky et al. 2017
Crustacean			
Barnacle			
Conchoderma virgatum	Gulf of Mexico, W Atlantic		Dawson 1969, Williams and Bunkley-Williams 1996
Branchiurids			
Argulus quadristriatus (from aquaculture)	India	Head and operculum	Subburaj et al. 2018
Copepods			
Caligus lalandei (from aquaculture)	Taiwan		Chang and Wang 2000
Caligus sp. (from aquaculture)	Malaysia		Chu et al. 2013
Caligus epidemicus	Philippines, Taiwan		Ho et al. 2004
Euryphorus nordmannii (as *E. coryphaenae*)	Gulf of Mexico-TX, W Atlantic		Causey 1953
Lernaeenicus longiventris	Gulf of Mexico-TX, W Atlantic	Fin surface	Causey 1953, Williams and Williams-Bunkley 1996, Hogans 2018
Lernaeolophus hemiramphi	Gulf of Mexico-TX, W Atlantic		Causey 1953
Lernaeolophus sultanus	Gulf of Mexico-MS	Body surface	Dawson 1969
Parapetalus occidentalis	NW Atlantic -North Carolina	Inside surface of operculum	Wilson 1908
	Gulf of Mexico	Body surface and gills	Pearse 1952, Causey 1955
	Indian Ocean-India	Gills and inner surface of operculum	Pillai 1962
	SW Pacific-Australia	Gills	Kabata 1967
	Gulf of Thailand		Purivirojkul and Areechon 2008, Dung 2017
(from wild and cultured Cobia)	Taiwan		Ho and Lin 2001
(from aquaculture)	Penghu Islands, Taiwan		Ku and Lu 2009
Parapetalus sp.	Gulf of Thailand		Dung et al. 2017
Tuxophorus caligodes	NW Atlantic-North Carolina	Body surface	Wilson 1908
	Gulf of Mexico-TX, W Atlantic	Body surface	Causey 1953

last dorsal fin ray (Dawson 1971). This infestation, rare in the Gulf of Mexico, also occurred attached to plastic packing bands around sharks (Overstreet 1978).

The likelihood of parasites occurring in large numbers with corresponding harm to the host becomes a real threat when fish are reared in aquaculture pens and cages. Cultivated cobia are more susceptible to parasitic infections than wild cobia. Few internal helminths cause mortalities of cultured cobia. Blood flukes are one case involved with cage and pen culture that is a potential threat (Bullard and Overstreet 2002, Warren et al. 2017). Some external metazoans also pose potential threats. Caligid copepods have a reputation of causing disease, mortality, or reduced growth of cultured fish. In Taiwan, cultured cobia have been reported as susceptible to *Caligus lalandei* by Chang and Wang (2000), to *C. epidemicus* by Ho et al. (2004), and to *Parapetalus occidentalis* by Ho and Lin (2001). The latter infested 33% of the examined wild cobia in the Gulf of Thailand by Purivirojkul and Areechon (2008), but in that population, each infested fish had an average of only one copepod. Records of this copepod from wild cobia in the Gulf of Mexico are referred to in the original literature as the synonym *Parapetalus gunteri* (see Ho and Lin 2001). If in high abundance in aquaculture, the copepods could be considered a serious risk (Ku and Lu, 2009).

Monogeneans include species that cause heavy mortalities of cultured fishes, especially in freshwater systems. The marine species *Neobenedenia girellae*, not specific to cobia, and not considered by Brazenor et al. (2018) as a junior synonym of *N. mellani,* caused corneal opacity and ulceration around the eyes. Also, temperature affected morphological features. No other agent was associated with the lesions in cultured Cobia in Taiwan, and Ogawa et al. (2006) attributed the lesions to the monogenean and consequently the cause of mass mortalities. The agent could have spread from other fishes being cultured and shipped, similar to other related monogeneans. The leech *Piscicola geometra* infests cultured Cobia, especially juveniles, and water extracts of roots of *Scutellaria baicalensis* and leaves of *Morinda citripolia* killed 100 and 80% of the tested leeches, respectively (Rizky et al. 2017).

Bacteria and viruses had a major influence on cultured Cobia. Prior to a later investigation, Lopez et al. (2002) also examined Cobia from cage culture in Taiwan and detected the bacteria *Vibrio alginolyticus, V. vulnificus*, and *V. parahaemolyticus* associated with head lesions on the monogenean-infested fish. In fish without head lesions, they isolated and cultured *Photobacterium damselae piscicida* from the liver and spleen of those fish, which were also infected by a *Sphaerospora*-like myxosporidian. Chen et al. (2001) also attributed 90% mass mortalities within one month in Cobia (45-80 g) exhibiting anemia, ascites, and a discolored and extremely enlarged kidney with cream-colored patches or spherical nodules associated with the myxosporidian. No bacterium or virus was isolated from those fish. Rajan et al. (2001), using biochemical tests, attributed a mortality in the same region to *Vibrio alginolyticus.* Mortalities in Malaysia in 2007 were studied by Chu et al. (2013), and those Cobia had an external leech (*Zeylanicobdella arugamensis*), a monogenean (‘*Benedenia*’ sp.), and caligid copepods but no associated bacterium. They later considered the mass mortalities were probably caused by Viral Nervous Necrosis (VNN). Limited information exists on Cobia viral diseases, but VNN or notavirus has been reported to cause mass mortalities of cultured larval Cobia (McLean et al. 2008). A study by Chi et al. (2003) reported increasing mortalities in cultured Cobia and other species in Taiwan from VNN. Histological investigations on expiring Cobia with VVN in an aquaculture facility in Vietnam revealed an accumulation of vacuoles in the retina and brain (Hitch and Duyen 2008). Actually, betanodavirus has been detected in wild Cobia in India (Jithendran et al. 2017) and in cultured Cobia in Taiwan (Chi et al. 2003). Nodavirus occurred in Cobia in fresh water from Taiwan (Yong et al. 2017) but spread in sea water. Moreover, a special Cobia genotype of lymphocystis has been analyzed (Borrego et al. 2017). One can assume that mass mortalities of cultured Cobia can and will be caused by several different microbial and parasitic agents individually or in conjunction with the mentioned or with other agents.

The bacterial pathogen *Photobacterium damselae piscicida* is known to cause photobacteriosus, which can result in 80 % mortality of cultured Cobia (McLean et al. 2008). Chang et al. 2005 determined that progeny of wild-caught Cobia can be more resistant to this pathogen than offspring of inbred Cobia, implying that using wild-caught Cobia as brood stock would improve growth and disease resistance. Vibriosis can occur in Cobia of all sizes and cause external signs like darkening of the skin, lethargy, swollen abdomen, pale gill color, erosion, hemorrhage in the fins, skin-lesions, and internal damage to the peritoneal cavity, liver, and kidneys (McLean et al. 2008). Vibriosis can account for 45% mortality in cage-stocked juveniles and is caused by several species of *Vibrio,* including *Vibrio alginolyticus*, *V. parahaemolyticus*, *V. vulnificus*, and *V. harveyi* (see McLean et al. 2008). Geng et al. (2011) investigated the effects of different levels of *Bacillus subtilis* and chitosan on the growth performance, immunity, and protection against *Vibrio harveyi* infection in Cobia. Fish fed a diet with a combination of 1.0 g/kg of *B. subtilis* and 6.0 g/kg chitosan was optimal for the growth, innate immunity, and disease resistance.

Vibrios and *Photobacterium* spp. cause mortality in cultured Cobia in India (Sharma et al. 2016, Rasheed et al. 2017, Ramashkumar et al. 2017). The same can be said for *Streptococcus dysgalactias* in cultured Cobia in Taiwan (Nguyen et al. 2017, 2018). Fish shipped from Florida to Trinidad and Tobago had ocular mycobacterial infections (Philips et al. 2017). The gram-negative bacterium *Endozoicomonas elysicola* has also been discovered encysted in Cobia in larviculture in Colombia, causing epitheliocystis and leading to eventual mass mortality (Mendoza et al. 2013). Cases were treated in detail by Blandford et al. (2018).

Several protozoan parasites can also affect cultured Cobia, presumably when the Cobia become stressed. Bunkley-Williams and Williams (2006) reported those 'protozoans' listed in Table 3.12: *Brooklynella hostilis*, which causes slime-blotch disease; *Cryptocaryon irritans*, which causes marine ich; and *Ichthyobodo* sp., which causes marine costia. Those authors discuss the importance of unintentionally introducing such agents into farms. *Amyloodinium ocellatum* also has become a serious problem with cultured Cobia in the western Pacific (Gómez and Gast 2018), Brazil (Moreira et al. 2013, Tavares-Dias and Martins 2017), and Australia (Lee et al. 2018). Overstreet and Hawkins (2017) illustrated and discussed infestations in wild fishes, and Landsberg (1995) provided an interesting hypothesis involving mass mortalities of wild fish. Nowak (2007) provided a thoughtful general article relating protozoan and metazoan parasites in monocultures of fish in marine cage culture. She pointed out that some mariculture conditions are similar to serial passage experiments that allow adaption during experimental evolution of free-living and parasitic pathogens on fish. Photos of a variety of diseases and disorders in India include a few more agents not mentioned elsewhere in this section (Rameshkumar et al. 2017, 2018).

The parasites listed as infecting wild Cobia are not known to infect humans. However, caged-farmed Cobia in Taiwan Strait hosted ascaridoid nematodes with a public health risk (Shih et al. 2010). Consequently, those authors examined local wild fish eaten by the caged Cobia for ascaridoids, and then they experimentally fed wild prey fish with infection to uninfected Cobia and then examined those Cobia for ascaridoids. Based on a PCR-RFLP assay, the recovered larvae demonstrated a recombinant genotype of *Anisakis simplex* sensu stricto and *A. pegreffii.* Both of those ascaridoids are known to infect humans, so the authors developed strategies to ensure safety of the consumers after eating the commercial Cobia product.

Uncommon noninfectious diseases also have been reported from wild Cobia. For example, a mouth deformity commonly known as pugheadedness has been observed in the Gulf of Mexico (Franks 1995). Thick collagenous adhesions connecting the epicardium and pericardium have been noted (Howse et al. 1975). A mixed germ cell-sex cord stromal tumor has been reported (Overstreet and Hawkins 2017). Other conditions such as 'scoliosis' are common (25-30%) in younger fish from cold habitats (Schwarz et al. 2007). Conditions in Cobia from aquaculture also are exhibited more commonly than in wild fish; these include mouth deformities, vertebral abnormalities ('scoliosis'), cataracts, and fin abnormalities, and they could result from nutritional, genetic, and/or environmental features (Salze et al. 2008, McLean et al. 2008). Herpesvirus, associated with papillomas, have been detected in Brazil (de Souza et al. 2017).

Feeding, Prey, and Predators

Cobia are voracious feeders and regularly swallow entire prey, making identification of gut contents easier than for most predatory fish. Cobia mostly feed on benthic or epibenthic organisms, but the occurrence of pelagic prey indicate diversity of foraging behavior (Meyer and Franks 1996). Feeding studies summarized by Shaffer and Nakamura (1989) revealed that Cobia from the Gulf of Mexico have a more diverse diet, especially teleost prey items, when compared to studies conducted from the Atlantic and Indian Oceans (Table 3.13). Nevertheless, they have been called the "crabeater" due to the commonness of this prey item in their diet (Randall 1983, Meyer and Franks 1996). Crustaceans occurred in 100% of the Cobia stomachs examined by Darracott (1977), and 29 out of 40 organisms found in Cobia stomachs by Miles (1949) were crabs.

Results from more recent feeding studies varied, possibly due to differences in study areas and sample sizes. Meyer and Franks (1996) discovered that Cobia from the northcentral Gulf of Mexico fed mostly on crustaceans [77.2%N (N = percent numeric abundance)], mainly portunid crabs (60.7%N), with fish (20.2%N) and squid (2.2%N) making up the rest of the diet. Their comparison of diets among size classes revealed the importance of teleost fish, mainly Hardhead Catfish (*Ariopsis felis*), with increasing size of Cobia. In contrast, Smith (1995) found Cobia in North Carolina weighing less than 4.5 kg mostly preyed upon teleost fish, mainly Blackcheek Tongue Fish (*Symphurus plagiusa*) and pipefish (Syngnathus sp.) and with increasing size gradually switched to elasmobranchs, mostly Smooth Dogfish (*Mustelus canis*) and dasyatid sting rays. Portunid crabs (35.0%N) were much less important in this study as Cobia fed on several other crustaceans (58.2%N). Portunids (78.4%N) were the dominant species in the Chesapeake Bay study by Arendt et al. (2001), with fish (14.8%N) and bivalves (6.6%N) comprising the remaining diet. As in North Carolina, elasmobranchs became important with increasing size of Cobia, although only Cownose Rays (*Rhinoptera bonasus*) were consumed. The diet of Cobia collected off the coast of Karnataka, India consisted of teleost fish (55%), crustaceans (35%) and molluscs (10%) (Rohit and Bhat 2012). Of these more recent studies, Meyer and Franks (1996), which analyzed the most stomachs (287) with prey items, reported the highest prey diversity with 34 different families of marine organisms identified from Cobia stomachs. Smith (1995), who analyzed 101 stomachs with prey items, found 23 families and Arendt et al. (2001) who analyzed 78 stomachs with prey items found 18 families from the stomach analysis.

Even though most food items were in good condition, each study contained a percentage of unidentifiable prey items. This could be attributed to the Cobia's tendency to associate with rays, sharks, and other large fish when they feed on scraps as these items would be smaller and decompose at a higher rate than whole prey. Also, these larger fish, especially rays, stir up benthos upon which the Cobia feed (Smith and Merriner 1982). The oddest reported prey of Cobia was a Diamondback Terrapin which apparently was still alive as the fish was being cleaned by a fisherman and owner of a local seafood market in Biloxi, Mississippi (Franks personal communication). The turtle was kept alive and eventually released.

Like adults, juvenile wild Cobia feed on fish, crustaceans, and squid in the Gulf of Mexico, and diel feeding analysis revealed juveniles feed primarily during the day according to Franks et al. (1996). They also found that smaller juveniles (236-338 mm FL) fed mostly on crustaceans, and larger juveniles (340-440 mm FL) fed mostly on fish.

Water temperature is directly correlated to Cobia feeding intensity. When water is lowered to 18.3°C, 90-day-old laboratory-reared juvenile Cobia cease feeding according to a study by Hassler and Rainville (1975).

Growth and temperature research determined that maximum ration levels increase from 23°C to 31°C and then decrease at 35°C (Sun et al. 2006, Rohit and Bhat 2012). Spawning also has an effect, as Richards (1967) reported Cobia may stop feeding during spawning. In addition, Cobia may arrange the timing of their migrations with the availability of certain prey species, such as crustaceans (Darracott 1977).

Very little is known about predators of Cobia, but they are presumably eaten by larger pelagic fish (Shaffer and Nakamura 1989). Dolphin *(Coryphaena hippurus)* have been reported to prey upon small Cobia (Rose 1965, Shaffer and Nakamura 1989) and Shortfin Mako Shark (*Isurus oxyrinchus*) are believed to feed on adults. One Cobia was actually found in the stomach of a Nurse Shark (*Ginglymostoma cirratum*) (Castro 2000). The Nurse Shark likely found a Cobia carcass to scavenge.

Table 3.13. Organisms found in Cobia stomachs by various authors, water body, and number of prey in stomachs in parentheses (*modified from* Shaffer and Nakamura 1989).

Taxonomic Group	Gulf of Mexico					Atlantic Ocean		Indian Ocean
	Miles (1949)	Knapp (1951)	Christmas et al. (1974)	Meyer and Franks (1996)	Franks et al. (1996)	Smith (1995)	Arendt et al. (2001)	Darracott (1977)
	Texas (13)	Texas (24)	Mississippi (11)	Mississippi (287)	Mississippi (39)	North Carolina (101)	Virginia (78)	Tanzania (22)
Crustacea	X	X	X	X	X	X	X	X
Albuneidae						X		
Callianassidae				X				
Calappidae				X				
Canceridae							X	
Crangonidae						X		
Majidae				X				
Menippidae				X		X		
Paguridae				X			X	
Palaemonidae						X		
Palinuridae								X
Panopeidae					X		X	
Penaeidae	X	X	X	X	X	X		
Portunidae	X	X	X	X	X	X	X	X
Sicyoniidae				X	X	X		
Stomatopoda		X		X	X	X	X	X
Upogebiidae						X		
Hydrozoa							X	
Bivalva							X	
Cephalopoda		X		X	X	X		X

Table 3.13. Continued

Taxonomic Group	Gulf of Mexico					Atlantic Ocean		Indian Ocean
	Miles (1949)	Knapp (1951)	Christmas et al. (1974)	Meyer and Franks (1996)	Franks et al. (1996)	Smith (1995)	Arendt et al. (2001)	Darracott (1977)
	Texas (13)	Texas (24)	Mississippi (11)	Mississippi (287)	Mississippi (39)	North Carolina (101)	Virginia (78)	Tanzania (22)
Loliginidae				X	X	X		
Octopodidae				X	X			
Gastropoda	X							
Elasmobranchii				X		X		
Dasyatidae				X		X		
Carcharhinidae						X		
Myliobatidae							X	
Squatinidae				X				
Torpedinidae				X				
Actinopterygii	X	X	X	X	X	X	X	
Anguilliformes			X	X				
Arridae	X	X		X				
Balistidae				X		X		
Batrachoididae						X	X	
Bothidae			X	X			X	
Carangidae				X				
Clupeidae				X		X	X	
Cynoglossidae					X	X		
Diodontidae						X	X	
Engraulidae				X	X	X		

Table 3.13. Continued

Taxonomic Group	Gulf of Mexico					Atlantic Ocean		Indian Ocean
	Miles (1949)	Knapp (1951)	Christmas et al. (1974)	Meyer and Franks (1996)	Franks et al. (1996)	Smith (1995)	Arendt et al. (2001)	Darracott (1977)
	Texas (13)	Texas (24)	Mississippi (11)	Mississippi (287)	Mississippi (39)	North Carolina (101)	Virginia (78)	Tanzania (22)
Lutjanidae				X				
Mugilidae				X				
Ophidiidae				X			X	
Ogcocephalidae				X				
Pomatomidae							X	
Pomacentridae					X			
Sciaenidae		X	X	X			X	
Scombridae		X						
Serranidae		X		X	X			
Soleidae				X		X	X	
Sparidae				X	X			
Stromateidae	X			X				
Syngnathidae				X		X	X	
Synodontidae	X				X	X		
Tetraodontidae				X		X		
Trichiuridae				X	X			
Triglidae			X		X			
Uranoscopidae				X		X	X	

Chapter 4
DESCRIPTION OF THE HABITAT OF THE STOCK(S) COMPRISING THE MANAGEMENT UNIT

Circulation Patterns

Cobia (*Rachycentron canadum*) are a pelagic species that have a worldwide distribution in tropical and temperate regions aside from the eastern Pacific (Shaffer and Nakamura 1989, Kaiser and Holt 2005). A short description is provided here of the major ocean currents and circulation patterns for the Atlantic Ocean, the Sargasso Sea, and the Gulf of Mexico proper.

Circulation patterns in the Gulf of Mexico are dominated by the influence of the upper-layer transport system of the western North Atlantic. Driven by the northeast trade winds, the Caribbean Current flows westward from the junction of the Equatorial and Guiana currents (Figure 4.1), crosses the Caribbean Sea, continues into the Gulf of Mexico through the Yucatán Channel, and eventually becomes the Loop Current. The flow (volume) of water through the Yucatan Straits into the Gulf of Mexico is estimated to be between 2.38-2.8M m^3/sec (Johns et al. 2002, Sheinbaum et al. 2002).

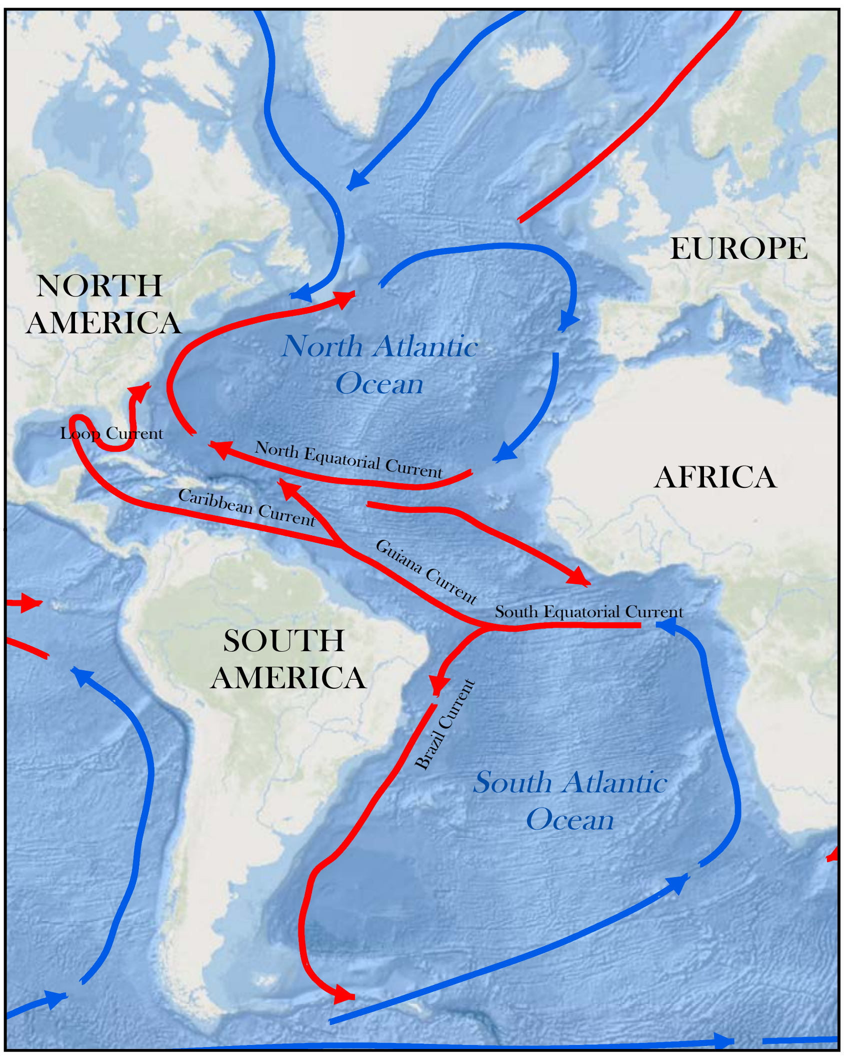

Figure 4.1 The major currents of the Atlantic Ocean.

Equatorial Currents

There are two equatorial currents which contribute to the flow both north and south as they approach Cape São Roque, Brazil. The Atlantic North Equatorial Current makes up the southern component of the North Atlantic subtropical gyre. The northern current becomes the Antilles, Caribbean (via the Guiana), and Florida currents, which eventually become the Gulf Stream (Bischof et al. 2004). The Atlantic South Equatorial Current splits as it approaches the coast of Brazil into the Guiana Current flowing to the north and the Brazil Current to the south, eventually becoming the South Atlantic Current (Stramma 1991).

Caribbean Current

The Caribbean Current is fed from the equatorial currents as they join along with the Brazil and Guiana currents. It enters from the southern Lesser Antilles and tends to meander producing many eddies (Alvera-Azcarate et al. 2009). The Caribbean Current flows generally northwest through the Caribbean Sea and into the Gulf of Mexico via the Yucatan Straits (Centurioni and Niiler 2003).

Loop Current

Moving clockwise, the Loop Current dominates surface circulation in the northeastern Gulf of Mexico and generates eddies that move over the northwestern Gulf of Mexico (Figure 4.2). During late summer and fall, the typical progressive expansion and intrusion of the Loop Current reaches as far north as the continental shelf off the Mississippi River Delta. The Loop Current directly affects species dispersal throughout the Gulf of Mexico (including tropical species from the Caribbean) while discharge from the Mississippi and Atchafalaya Rivers creates areas of high productivity used by many commercially and recreationally important marine species.

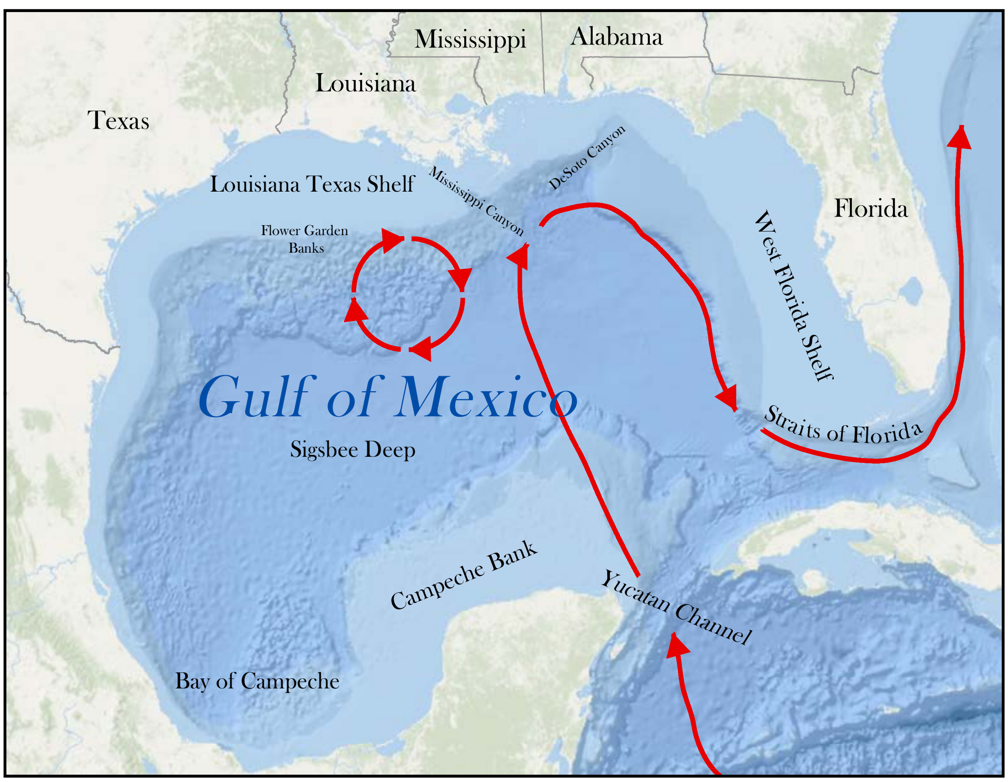

Figure 4.2 Generalized circulation pattern of the Loop Current in the Gulf of Mexico. Also included are some geologic features of the Gulf of Mexico, including shallower continental shelf regions and geologic breaks such as DeSoto Canyon off the Florida Panhandle and Mississippi Canyon off the Mississippi River Delta.

Gulf of Mexico

Galtsoff (1954) summarized the geology, marine meteorology, oceanography, and biotic community structure of the Gulf of Mexico. Later summaries include those of Jones et al. (1973), Beckert and Brashier (1981), Holt et al. (1982), and the Gulf of Mexico Fishery Management Council (GMFMC 1998). In general, the Gulf of Mexico is a semi-enclosed basin connected to the Atlantic Ocean and Caribbean Sea by the Straits of Florida and the Yucatan Channel, respectively. The Gulf of Mexico has a surface area of approximately 1,510,000 km^2 (Wiseman and Sturges 1999), a coastline measuring 2,609 km, one of the most extensive barrier island systems in the United States, and is the outlet for 33 rivers and 207 estuaries (Buff and Turner 1987). Water depths of the Gulf of Mexico basin are 1,615 m on average but have maximum depths approaching 4,400 m (Turner 1999). Continental shelf areas are generally less than 200 m deep and the intertidal regions are less than 20 m on average (Turner 1999). Oceanographic conditions throughout the Gulf of Mexico are influenced by the Loop Current and major episodic freshwater discharge events from the Mississippi and Atchafalaya Rivers, resulting in high productivity which benefits numerous finfish and invertebrate species that use the northern Gulf of Mexico as a nursery ground. Nearshore currents are driven by the impingement of regional Gulf of Mexico currents across the shelf, passage of tides, and local and regional wind systems. The orientation of the shoreline and bottom topography may also place constraints on speed and direction of shelf currents. Hydrographic studies depicting general circulation patterns of the Gulf of Mexico include those of Parr (1935), Drummond and Austin (1958), Cochrane (1965), Jones et al. (1973), and Ochoa et al. (2001).

Commercial fishing accounted for an estimated 1.73B lbs of harvested fish and shellfish in 2016, or 18% of the nation's total commercial landings (NOAA unpublished data). These landings were worth an estimated $848M in dockside value (NOAA unpublished data). Gulf of Mexico coastal wetlands, estuaries, and barrier islands also provide important feeding, breeding, and cover habitat to wildlife species such as waterfowl, shorebirds, and wading birds; improve water quality; and play a significant role in lessening flood and storm surge damage in addition to minimizing erosion.

Gulf of Mexico tides are smaller than those along the coasts of the Atlantic or Pacific. Tides range from 0.5-1.0 m and are driven mostly by atmospheric pressure and wind direction (Solis and Powell 1999). Despite the small tidal range, tidal current velocities are occasionally high, especially near the constricted outlets that are associated with many bays and lagoons. Tide type varies widely throughout the Gulf of Mexico with diurnal tides (one high tide and one low tide each lunar day of 24.8 hours) existing from St. Andrew's Bay, Florida, to western Louisiana. The tide is semidiurnal from Apalachicola Bay, Florida through Florida Bay and mixed in western Louisiana and Texas.

Estuaries

The U.S. Gulf of Mexico coastline contains 31 major estuarine systems extending from the Rio Grande River in Texas eastward to Florida Bay off South Florida. Estuaries typically include wetlands and open bay waters in which nutrients from river inflows, adjacent runoff, and the sea support a productive community of plants and animals. Estuarine tidal mixing is limited by the small tidal ranges that occur within the Gulf of Mexico, but shallow estuarine depths tend to amplify the mixing effect. Estuaries in Florida and South Texas generally are clearer and have lower nutrient concentrations than those in other parts of the Gulf of Mexico.

A detailed description of the estuaries in each Gulf of Mexico state can be found in the *Blue Crab Fisheries Management Plan* (Perry and VanderKooy 2015). Additional information on the Gulf of Mexico in general can be found in the Commission's Habitat Profile for the Gulf of Mexico (Rester in prep).

U.S. South Atlantic

Cobia frequent a number of barrier islands from Palm Beach, Florida in the south to Tybee Island, Georgia in the north. The chain of islands develops multiple high energy beaches along the seaward coasts, brackish water estuaries, or lagoons along the inside and estuarine marshes along the mainland coasts. Florida's northern and central nearshore environments contain hardbottom derived from coquina and worm reefs, and between the hardbottoms are long stretches of sand bottom with periodic corals interspersed (Watson 2005). Beginning near the St. Lucie Inlet, natural corals comprise the Florida Reef Tract, which runs south throughout the Florida Keys and Dry Tortugas (Walker and Gilliam 2013). Floating *Sargassum* is a common pelagic habitat along the South Atlantic Coast (Coston-Clements et al. 1991).

Throughout the northern coast of Florida, the natural estuarine coasts are dominated by large expanses of tidal marshes of emergent plant species such as smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemerianus*) (Watson 2005, Wiegert and Freeman 1990). These low marshes tend to have exposed mudflats on low tides and are driven by periodic inundation. Below the freeze line near St. Augustine, Florida, a shift occurs towards a shoreline surrounded by mangrove forest, and in areas with deeper water bottoms, a variety of seagrasses (Wiegert and Freeman 1990, Yarbro and Carlson 2011). Mangrove communities in the Indian River Lagoon and Mosquito Lagoons include three species: red (*Rhizophora mangle*), black (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*). Red mangrove is the most common species and forms large clumps which extend far into the waters of tidal rivers and channels. It is recognized by its tangled prop roots that form high above the water's surface and grow down into substrate forming legs. Mangroves stabilize the shoreline and help prevent storm surge and erosion damage to coastal property as well as help maintain water quality and clarity by trapping sediments and absorbing nutrients from runoff. Although mangrove forests have been protected for several decades or longer, many estuaries in Florida have been highly degraded from decades of altered water flow and, as a result, are impaired by poor water quality such as high nutrient loads, poor light penetration for seagrass growth, and high suspended solids leading to an accumulation of muck (Ogden et al. 2005, Sime 2005). There are currently large restoration efforts to restore South Florida's estuaries by restoring more natural freshwater flows (Ogden et al. 2005).

Sargassum

The pelagic *Sargassum* community is an Atlantic Ocean phenomenon, comprising a unique and diverse association of organisms (Dooley 1972) and can be found in both nearshore and offshore waters. Pelagic *Sargassum* is a brown macroalgae complex consisting of two holopelagic species (*Sargassum natans* ≈ ~90% and *S. fluitans* ≈ ~10%), but estimated percent composition of each species can vary depending on occurrence in different regions of the Atlantic Ocean. *Sargassum* provides a dynamic structural habitat in surface waters of the Gulf of Mexico (Hernandez 2011). The high physical complexity of pelagic *Sargassum* enables the formation of dense mats or rafts which tend to remain interlocked until storms or prevailing winds cause them to disassociate and fragment, dispersing the algae widely on the Equatorial, Caribbean, and Yucatan currents (Franks personal communication, Comyns et al. 2002). *Sargassum* provides habitat and food resources that would not otherwise be present to a variety of organisms. For a more extensive description of *Sargassum* habitat see the *Biological Profile for Tripletail in the Gulf of Mexico and the Western Central Atlantic* (VanderKooy 2017).

Cobia Habitat

Spawning Habitat

Cobia are day broadcast spawners, with a protracted spawning season from April through September in the Gulf of Mexico and West Atlantic (Shaffer and Nakamura 1989, Brown-Peterson et al. 2001, Arnold et al. 2002, Lefebvre and Denson 2012). While the specific spawning location or habitat type has yet to be fully determined, there is evidence to suggest spawning occurs both within estuaries (Ditty and Shaw 1992, Lefebvre 2009) and offshore in waters where salinity is similar to oceanic water (Hassler and Rainville 1975, Finucane et al. 1979, Shaffer and Nakamura 1989). Cobia eggs have been collected 25-50 km offshore (Hassler and Rainville 1975) and larvae 3.8-6.8 mm have been collected 50-90 km off Texas (Finucane et al. 1979). However, both eggs and yolk-sac larvae were collected together in the Gulf of Mexico from the Crystal River estuary at depths of 3-6 m (Ditty and Shaw 1992). Furthermore, inshore spawning in both Port Royal Sound and St. Helena Sound in South Carolina has been suggested by egg and larvae collections, including the collection of eggs 15 km up the Broad River of Port Royal Sound which were estimated to be only two to three hours old (Lefebvre 2009). These collections occurred in waters with surface temperatures ranging from 20-30°C and salinities from 28 to 34 ppt (Lefebvre 2009). The collection of both eggs and larvae, in estuaries and offshore, in the Gulf of Mexico, has occurred primarily in waters >25°C and salinities >27 ppt, with data suggesting that eggs will hatch in 24 hours at 29°C, while hatching may take up to 56 hours in cooler waters of the mid-Atlantic Bight and northward (Ditty and Shaw 1992, Kaiser and Holt 2005).

Larval Habitat

Ditty and Shaw (1992) reported that Cobia larvae first begin appearing in Gulf of Mexico collections during late May, with 98% collected between June and September in water temperatures from 25-30°C and at salinities >27 ppt and 75% at station depths <100 m (median 50 m, range 3.1-300 m). Kaiser and Holt (2005) found that most of the larvae were collected at the surface from June to September in surface water temperatures >25°C and salinity >27 ppt, from offshore and estuarine waters. Planktonic larvae hatch at about 3 mm standard length (SL), undergo flexion at 5–10 mm SL, and develop via a gradual transition into the juvenile stage within 30 days, 15–30 mm SL (Shaffer and Nakamura 1989). Experiments described by Faulk and Holt (2006) suggest that 90% of larvae would be expected to survive for at least 18 hours in salinities of 20 ppt three days post hatch, with Hassler and Rainville (1975) stating that larval growth and survival in salinities of 24 ppt was similar to that of larvae reared at 33 or 35 ppt. Experimental data on the rearing and culture of Cobia suggests that larvae are able to tolerate a wide range of salinities without severe adverse effects; however at salinities below 15 ppt at 10 to 13 days post-hatch, larvae showed an increased incidence of disease eventually leading to mortality (Faulk and Holt 2006).

Juvenile and Adult Habitat

Juvenile and adult Cobia have a nearly worldwide distribution in tropical and sub-tropical waters, except for in the central and eastern Pacific (Hassler and Rainville 1975, Ditty and Shaw 1992). Cobia in the western Atlantic occur from Massachusetts to Argentina; however, Cobia are most common in the Gulf of Mexico from Key West to Campeche, Mexico (Dawson 1971, Shaffer and Nakamura 1989, Franks et al. 1996). In both the Gulf of Mexico and the western Atlantic, it is believed that two groups of fish comprise the fishery: an offshore "migratory" group that over-winters near the Florida Keys, moving north and west in the spring, and an inshore "residential" group that moves inshore in the spring from deeper winter depths (Caylor and Franks 1991, Ditty and Shaw 1992, Lefebvre 2009).

Juvenile Cobia occur over a wide range of nearshore and offshore habitats, with early juveniles moving inshore to inhabit coastal, high saline, and estuarine areas (Dawson 1971, Swingle 1971, Hoese and Moore 1977, Hammond 2001, Kaiser and Holt 2005). Data indicate that smaller juveniles less than 45 mm are more common offshore, while larger juveniles are more frequently encountered in the nearshore coastal waters (Dawson 1971, Kaiser and Holt 2005). Juveniles ranging from 42 to 129 mm total length were collected in a boat slip in Charleston Harbor, South Carolina in waters averaging 15.6 ppt and 29.4 °C in August of 1973 (Hammond 2001), and 20 juveniles between 120-200 mm were collected in the summers of 2003 and 2004 in waters 4-17 m deep near Port Aransas, Texas (Kaiser and Holt 2005).

The use of habitat by juvenile Cobia is uncertain. Both nearshore and offshore juvenile Cobia in the Gulf of Mexico have been found associated with floating Sargassum, with larger juveniles up to 250 mm found near inlets, barrier islands, and bays (Kaiser and Holt 2005, Turner and Rooker 2005). This association with Sargassum most likely functions with multiple roles, including providing shelter from predators and serving as a source of food by attracting prey.

Adult Cobia are a pelagic species which inhabit a wide range of waters from coastal regions including bays and estuaries, to offshore waters of the continental shelf. Cobia are a seasonally migratory species, driven by increasing water temperatures in the spring, which exhibit mixing both within and between the Gulf of Mexico and the Atlantic Ocean (Shaffer and Nakamura 1989, Franks et al. 1991, Howse et al. 1992, Brown-Peterson et al. 2001, Hammond 2001). Furthermore, tagging and genetic studies on Cobia have provided evidence of two groups of fish, an inshore residential group, and an offshore group (Hrincevich 1993, Darden et al. 2014).

As adults, Cobia are primarily found in coastal waters and offshore around the continental shelf, occasionally entering bays and estuaries for spawning (Shaffer and Nakamura 1989, Lefebvre 2009). Cobia have been found over a wide variety of benthic habitat types including mud, rock, sand, coral reefs, and in mangrove sloughs (Shaffer and Nakamura 1989). Additionally, Cobia are commonly associated with both floating and submerged structures including mats of Sargassum, buoys, shipwrecks, artificial reefs, oil and gas platforms, jetties, and drifting objects (Shaffer and Nakamura 1989, Ditty and Shaw 1992, Franks 2000, Hammond 2001).

Salinity

Cobia are known to tolerate a wide range of salinities from 5 to 45 ppt; however Cobia generally occur in high salinity water, predominately collected between 22 and 44 ppt (Shaffer and Nakamura 1989, Denson et al. 2003, Kaiser and Holt 2005). Previous studies and sampling have shown that Cobia can tolerate water down to 5 ppt; however, they begin to show signs of stress and disease below 15 ppt (Hassler and Rainville 1975, Denson et al. 2003, Faulk and Holt 2006, Resley et al. 2006).

Larval and juvenile Cobia can tolerate a wide range of salinities similar to the adults; however, like the adults, they appear to prefer higher salinity waters. Kaiser and Holt (2005) reported that most Cobia eggs and larvae collected in inshore and offshore surface waters in the Gulf of Mexico came from areas with salinities greater than 27 ppt. Denson et al. (2003) cultured juvenile Cobia in waters at salinities of 5 and 15 ppt, reporting that these fish exhibited significantly lower survival rates and body condition compared to fish which were cultured at 30 ppt.

Cobia are rarely encountered by any gear type employed by the five state fisheries-independent monitoring programs during any life history stage. For the Cobia that were encountered throughout the years by each state, the salinity data collected has been collated and presented in Table 4.1 (unpublished state data).

Temperature

The movement and range of Cobia is believed to be primarily determined by water temperature, with Cobia generally occurring in cooler portions of their range only during warm months of the year (Shaffer and Nakamura 1989, Kaiser and Holt 2005). Cobia are year-round residents in the Gulf of Mexico, but are predominately found off Texas and the northern Gulf of Mexico in nearshore and coastal waters March-October, and most often caught by recreational anglers (Franks et al. 1991, Arnold et al. 2002, Kaiser and Holt 2005). Kaiser and Holt (2005) have reported that, while Cobia have been collected in waters between 16 and 32°C, they appear to prefer temperatures above 20°C. Richards (1967) observed that Cobia did not appear in Chesapeake Bay until the water temperatures exceeded 19°C.

Juvenile Cobia, in studies by Hassler and Rainville (1975), were reported as having a lethal maximum temperature of 37°C, with juveniles able to tolerate temperatures down to 17°C; however, feeding ceased

Table 4.1 Compiled salinity, temperature, and dissolved oxygen data from each Gulf state, by gear types, which encountered Cobia during routine resource sampling. (N = sample size).

State	Gear Type	N	Salinity (ppt)			Temperature (°C)			Dissolved oxygen (ppm)		
			Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Texas	TR	31	6.4	42.3	**27.3**	31.1	31.1	**28.4**	2.0	9.5	**6.0**
	BS	4	13.0	32.1	**22.2**	29.9	32.6	**30.7**	4.8	9.0	**6.4**
	GN	22	9.0	45.0	**26.3**	17.5	30.3	**27.1**	3.0	10.0	**7.0**
Louisiana	TR	24	9.3	32.2	**18.8**	22.9	32.3	**29.9**	3.5	9.9	**6.3**
	BS	3	9.0	30.4	**19.4**	28.0	31.2	**29.3**	--	--	**--**
	GN	35	11.7	27.4	**20.3**	19.6	31.7	**29.5**	--	--	**--**
Mississippi	TR	5	20.0	27.0	**23.2**	23.0	30.0	**27.0**	5.2	7.4	**6.4**
	HL	8	17.3	27.5	**23.0**	27.2	32.0	**29.8**	5.7	8.4	**7.0**
	GN	25	9.7	31.9	**24.6**	24.9	32.8	**29.1**	4.0	9.4	**6.6**
Alabama	TR	11	12.0	36.0	**24.5**	24.1	32.1	**28.4**	2.8	7.6	**5.3**
	GN	6	11.2	28.7	**21.5**	25.4	32.3	**29.6**	4.5	7.3	**5.7**
Florida (Gulf)	TR	12	16.3	30.7	**23.7**	19.7	31.8	**26.9**	4.1	8.2	**6.3**
	BS	6	16.0	31.2	**23.1**	28.1	33.2	**29.6**	4.5	8.5	**6.1**
	160	92	8.2	36.1	**25.6**	20.7	33.2	**26.8**	2.6	10.3	**6.6**
Florida (Atlantic)	TR	5	20.7	35.9	**30.4**	22.1	30.7	**28.0**	3.2	6.4	**5.0**
	BS	1	--	--	**31.8**	--	--	**30.0**	--	--	**5.3**
	160	23	8.4	36.8	**29.0**	22.7	31.0	**27.6**	4.7	9.9	**6.6**

Gear type: Trawl (TR), Bag seine (BS), Gill net (GN), 600 ft seine (160; FL only), Handline (HL; MS only)

at 18.3°C. Atwood et al. (2004) conducted laboratory experiments to look at the resistance of juvenile Cobia to temperature and salinity, observing a lower total lethal temperature of 10.4°C, with a median lethal temperature of 12.1°C.

Temperature data recorded at sites where Cobia were encountered by individual Gulf state fisheries-independent resource monitoring programs can be found in Table 4.1 (unpublished state data).

Dissolved Oxygen (DO)

Information regarding Cobia-specific dissolved oxygen (DO) parameters is extremely limited; however, it has been reported that Cobia show signs of stress at levels below 5 mg/L , also represented as parts per million (ppm) (Kaiser and Holt 2005). Though rarely encountered, Cobia are collected at various life history stages by state fisheries-independent monitoring programs utilizing multiple gear types. Hydrology data, including DO, is collected at each of these sites, and has a wide range of values for Cobia (Table 4.1; unpublished state data).

Depth

Cobia are known to inhabit a wide depth range, with adults found inside bays and estuaries being taken at 50 m depth in waters as deep as 1,200 m (3,900 ft) (Springer and Bullis 1956, Freeman and Walford 1976, Shaffer and Nakamura 1989, Kaiser and Holt 2005).

Howse et al. (1992) reported that Cobia have been caught at depths of ~100-125 m off Louisiana in the winter and from 100 m depth in the summer. This supports the belief that in the Gulf of Mexico, the inshore “residential” group of Cobia move inshore to shallower waters in the warmer spring months and overwinter in deeper waters (Caylor and Franks 1991, Ditty and Shaw 1992).

Smith (1995) describes winter trawl surveys performed during January and February by South Carolina’s Marine Resources Monitoring, Assessment and Prediction Program between Cape Fear, North Carolina and Cape Canaveral, Florida in waters between 31-75 m depth which captured Cobia, suggesting that Cobia off the South Atlantic Coast of the U.S. may overwinter on the outer half of the continental shelf.

Substrate

Cobia are frequently observed at the surface; however, the fact that Cobia do not have a swim bladder means that they easily navigate the entire water column, spending significant time on or near the bottom (Franks et al. 1996, Resley et al. 2006, Benetti et al. 2007). Cobia are commonly associated with a wide variety of bottom substrates including mud, rock, sand, gravel, grass, mangroves, and coral as well as artificial bottom structures such as wrecks, artificial reefs and oil/gas platforms (Shaffer and Nakamura 1989, Ditty and Shaw 1992, Smith 1995, Franks 2000, Hammond 2001, Bignami 2013). Cobia have been observed by divers on or near the bottom around both coral and artificial reefs, and are described as having a “bottom-cruising” behavior (Hammond 2007). In captive studies, Cobia are frequently found “resting” at the bottom of the tanks when not feeding (Denson et al. 2003, Resley et al. 2006, Franks personal communication).

Anthropogenic Factors Affecting Localized Abundance

Cobia are infrequently encountered and are a generally solitary species or found only in small groups that potentially aggregate for reproduction (Shaffer and Nakamura 1989, Kaiser and Holt 2005, Sajeevan and Kurup 2011, Darden et al. 2014). Since Cobia do not tend to aggregate, there is no large scale directed commercial fishery.

Increasing ocean acidification and eutrophication has the potential to affect the growth, development, survival, and reproduction of fish and shellfish in the Gulf of Mexico and elsewhere (Caldeira and Wickett 2003, Feely et al. 2008, Lüthi et al. 2008, Cai et al. 2011). Experiments performed on the response of Cobia to increasing pCO2 indicate that they exhibit an increased resistance to decreasing pH levels, particularly for the pH levels forecasted to occur in the future (Bignami et al. 2013a, 2013b).

Additionally, recent work has described potential biological impacts of bioaccumulated total mercury, and methylmercury (the majority of mercury in fish muscle) concentration in Cobia in the Gulf of Mexico and South Atlantic (Adams 2018). While direct health effects on Cobia are unknown, the effect of high mercury concentrations in fish is well studied (Adams et al. 2010, Depew et al. 2012). Total mercury concentrations described in Adams (2018) show that Cobia in the Gulf of Mexico have a mean total mercury concentration of 0.808 mg/kg, and a mean total mercury concentration of 0.673 mg/kg in the Atlantic Ocean off East Florida. These levels are above the threshold, concentrations >0.5 mg/kg wet weight, where potential negative effects on reproductive function, fish behavior impairments to gross motor function and predator evasion, and other significant health effects impact fish populations (Adams 2018). Further work to determine the direct health effects of mercury on Cobia is suggested.

Fish Aggregating Devices (FADs)

Fish aggregating devices (FADs) are any natural or manmade objects and/or materials that attract and aggregate fish species (VanderKooy 2017). In the Gulf of Mexico, as of 2018, there are approximately 2,000 active and decommissioned oil/gas platforms which form one of the, if not the largest, array of FADs in the world. These oil and gas platforms simultaneously provide shelter for prey and also concentrate Cobia in a way previously not seen before and increase angler opportunities to catch Cobia while reducing search time (Franks 2000). The solitary nature of Cobia has historically made them a target of opportunity by most anglers, with Cobia being an incidental catch while anglers are targeting another species (TPWD personal communication). Since Cobia are known to aggregate around floating and stationary objects including buoys, Sargassum mats, oil and gas platforms, and floating debris, these are targeted by recreational anglers as areas of highest likelihood of encountering Cobia (Shaffer and Nakamura 1989, Stephan and Lindquist 1989, Franks 2000, Castro et al. 2002, Sajeevan and Kurup 2011). Recreational anglers, as well as guides, have reportedly taken advantage of this aggregation behavior by deploying homemade FADs in Gulf waters to attract Cobia and other species (VanderKooy 2017, FWC personal communication). While most of these FADs are known to be illegal by recreational, commercial, and charter anglers, the capacity of these devices to attract Cobia and other species is so great, that the potential consequences resulting from being caught placing one of these structures is not enough of a deterrent to prevent their placement by anglers. These FADs are intensively used during the Cobia run, especially off the Florida panhandle, to the point that all of the major Cobia tournaments (i.e. Cobia World Championships, Crab Cruncher Classic, Destin Cobia Tournament, etc.) have banned the deployment of FADs and any fish caught around a FAD (see Chapter 6 – Tournament Fishing for Cobia).

The design and placement of FADs to target Cobia vary in style. FADs are either floating or submerged and are constructed of different materials. FADs can take on a variety of shapes and sizes and be constructed with varying levels of complexity and, while some FADs are legal, the majority are not. An example of a potentially-legal FAD is a blue crab or pinfish trap where fish are attracted to the trap's buoy. Although a FAD of this type is not illegal in principle, it still must conform to all regulations for each type of trap, such as closed season, closed areas, marking requirements, dimensions, and tending requirements.

Another type of legal FAD is a permitted artificial reef. In 1985, NOAA and several regional marine agency partners developed a National Artificial Reef Plan (NARP) under the provisions of the National Fishing Enhancement Act of 1984 that defined and managed the materials placed in the ocean for the purpose of enhancing fishing. Many coastal states throughout the U.S. have adopted their own plans based on NARP guidance. In 2007, the NARP was revised and updated to further the development and management of these structures (NARP 2007). As of today, there are no provisions in any of the state artificial reef plans or the NARP for use of FADs; however, state artificial reef plans may provide guidance for what items may be appropriate for placement in the marine environment when following proper processes such as obtaining required permits.

A simple internet search of "Cobia FADs" can yield an abundance of information on the construction, deployment, and angling of homemade FADs. Cobia fishing forums contain significant discussion on the construction, materials, and styles of FADs to assemble. Illegal FADs have a wider range of design possibilities than legal FADs. In their simplest form, they can consist of intentionally-placed, floating debris such as wooden pallets; floating barrels; and plastic materials, such as PVC or plastic fencing, lashed together so that they form a floating mat or subsurface structure. Although simple FADs that utilize buoys are likely used, quantifying the scale of their use and enforcement of them is very difficult since they resemble regular trap gear from the surface (FWC personal communication). Other reports include towels, tarps, sheets of roofing tar-paper, etc. attached to floats of some sort and weighted so that they float at or just below the surface, like the "Destin Magic Carpet" (Figure 4.3). These types of illegal FADs are considered marine debris and, depending on their materials, may be a violation of MARPOL which has strict limitations on the at-sea disposal of trash, specifically plastics [MARPOL REVISED MEPC.201(62) 2011]. As noted in Chapter 5, the MARPOL revision includes specific language defining plastics as:

> "a solid material which contains as an essential ingredient one or more high molecular mass polymers and which is formed (shaped) during either manufacture of the polymer or the fabrication into a finished product by heat and/or pressure. Plastics have material properties ranging from hard and brittle to soft and elastic. For the purposes of this annex, 'all plastics' means all garbage

that consists of or includes plastic in any form, including synthetic ropes, synthetic fishing nets, plastic garbage bags and incinerator ashes from plastic products."

This definition would make the majority of free-floating FADs described above illegal and would allow prosecution by marine enforcement.

Each Gulf state's artificial reef plans contain specific descriptions of the materials that are approved and appropriate for the purpose of creating reefs and developing fishing opportunities. The FADs which have been encountered and recovered to-date include a number of materials which would not be appropriate in the approved state plans. Table 4.2 lists materials that states have recovered which were being used as FADs. These materials are not approved for placement in the Gulf of Mexico and some FADs recovered combined multiple materials into a single FAD. There are also structures which have been attached to existing reefs and structures, such as permitted vessels and ships to enhance the structures.

In addition to the use of unapproved materials, many of the FADs currently being used are illegal because the anchoring of materials is strictly regulated and managed by the U.S. Army Corp of Engineers

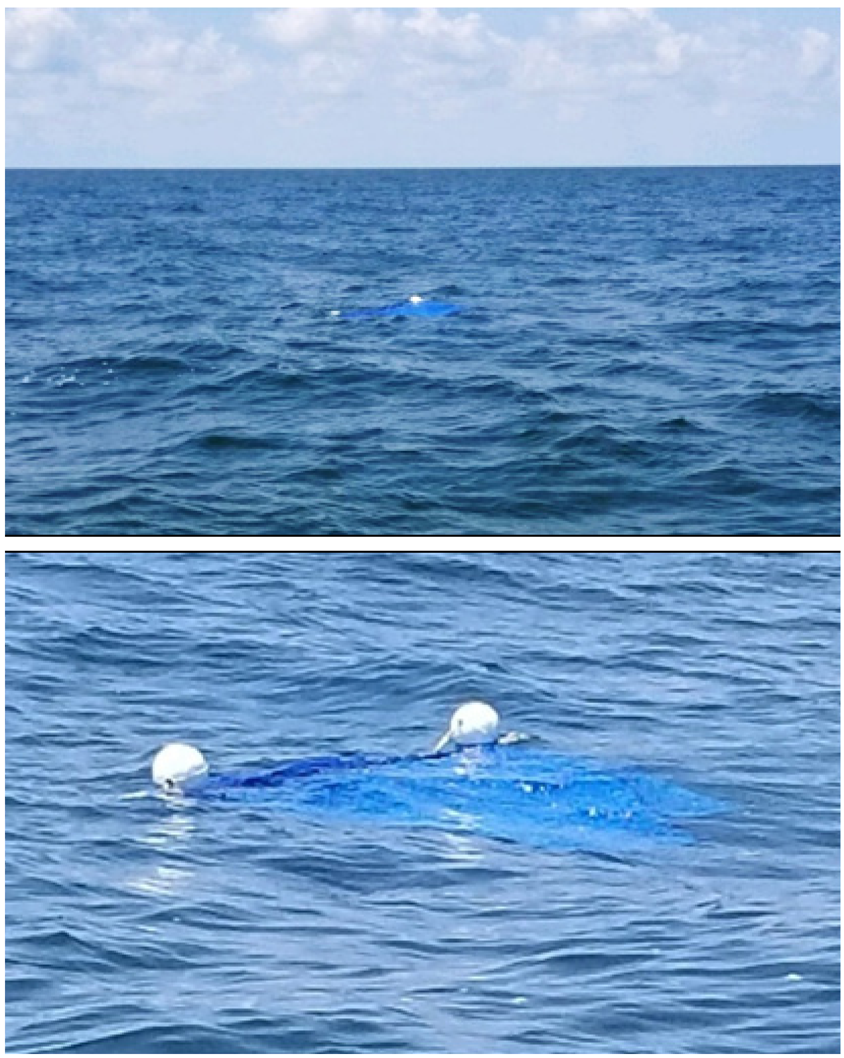

Figure 4.3 Illegal fish aggregating devices (FADs) found deployed off Alabama. The FAD is comprised of a section of blue polyethylene tarpaulin attached to two white plastic floats, creating an artificial floating habitat for sport fishing (photos courtesy Bannon).

(USACE), the U.S. Coast Guard, and the state marine agencies. Any materials anchored and deployed in the water column must be permitted by the appropriate agencies in legally permitted areas. USACE requires prior approval of any construction activities that take place in the waters of the U.S.; however, these are typically related to the sea bottom, not the water column [Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403); Section 404 of the Clean Water Act of 1972 (33 U.S.C. § 1344); Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. § 1413)]. U.S. Coast Guard requirements include the placement of structures outside of navigable waterways and any areas, including the subsurface, which would pose a hazard to navigation. This would require the marking and use of aids for navigation of those permitted structures or materials that could impact ocean transit. In addition, it is required that the structure or material remain on station, not moving or being a drifting hazard (Title 33 CFR 74 – July 1999).

The ASMFC and the GSMFC provide recommendations on appropriate materials for artificial reef development through the *Guidelines for Marine Artificial Reef Material* published in 1997 and revised in 2004 (GSMFC 2004). Until the guidelines were published, most artificial reef development was dependent on scrap materials due to their low cost and ready availability. They were often referred to as 'materials of opportunity'. More recent interpretations refer to these materials as 'secondary use' and the guidelines outline those materials that are appropriate to meet the long-term goals of responsible reef building for fisheries enhancement. Therefore, FADs placed anywhere in the ocean environments should follow the reef building procedures laid out in the NARP and utilize materials that allow any FADs to meet the U.S. Coast Guard safety requirements and objectives of the NARP.

The current issue with illegal FADs of these types is the use of materials that do not have long-term compatibility in the aquatic environment, unknown and unapproved placement, and that maintenance of these structures is usually absent. In most cases, these are materials that are essentially dumped into the ocean, fished on for a short time, and essentially become lost.

Table 4.2 Cumulative list of materials encountered in state and federal waters by marine agencies deployed as fish aggregating devices (FADs).

Materials Encountered or Recovered to Date	
Snow Fencing	Construction Bricks and Cinder Blocks
PVC Pipe	Mushroom Anchors
Foam Pool Noodle	Yellow Polypropylene Ropes
Newspaper Pages	Household Carpeting
Cotton Beach Towels	Black Polyethylene Plastic Sheeting
Square Mesh Netting	High Density Polyethylene Drums
Blue Polyethylene Tarpaulin	Closed Pore Styrofoam
Roofing Tar Paper	Polyethylene Plastic Strips (Streamers)
5-Gallon Plastic Bucket	Sheet Plywood
Black Polyethylene Plastic Trash Bags	Sheet Cardboard

Chapter 5
FISHERY MANAGEMENT JURISDICTIONS, LAWS, AND POLICIES AFFECTING THE STOCK(S)

Cobia in the Gulf of Mexico spend the majority of their lives as a migratory species but a large portion of the commercial and recreational fisheries occur in nearshore, state territorial waters. Considering their wide range throughout the world, a number of state and federal management institutions have jurisdiction over this species. The following is a partial list of some of the important agencies and a brief description of the laws and regulations that directly or indirectly affect Cobia throughout the Gulf of Mexico and the U.S. Exclusive Economic Zone (EEZ). 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. Additional U.S. laws, treaties, and agencies may have jurisdiction over the habitat and environment affecting Cobia and can be found in detail in the Commission's other fishery management plans.

Federal

Management Institutions

Cobia are found throughout the EEZ of both the Gulf of Mexico and the South Atlantic and, in recent years, have been found through the Mid-Atlantic as far north as New York. Cobia are primarily managed in the Gulf by the regional fishery management councils but, on the Atlantic, are jointly managed by the Atlantic States Marine Fisheries Commission and South Atlantic Council (see *Regional Fishery Management Councils* below).

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 federal fishery management plans (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 Magnuson-Stevens Fishery Conservation and Management Act of 1996 (Mag-Stevens), the Lacey Act, 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 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 educational activities relating to coastal management issues.

The NMFS exercises no management jurisdiction with regard to Cobia in any of the regions in which it occurs. Under Section 306 of the Mag-Stevens, states have the authority to regulate vessels fishing in the EEZ for stocks where there is no federal FMP.

> "(3) A State may regulate a fishing vessel outside the boundaries of the State in the following circumstances:

(A) The fishing vessel is registered under the law of that State, and (i) there is no fishery management plan or other applicable Federal fishing regulations for the fishery in which the vessel is operating; or (ii) the State's laws and regulations are consistent with the fishery management plan and applicable Federal fishing regulations for the fishery in which the vessel is operating."

Therefore, a state would have the right to require that state regulations apply to vessels registered in that state landing any unregulated species caught in the EEZ.

Regional Fishery Management Councils

Eight regional fishery management councils were established by Mag-Stevens to advise the NOAA Fisheries Service on federal fishery management issues. The regional councils include the Gulf, Caribbean, South Atlantic, Mid-Atlantic, New England, Pacific, Western Pacific, and North Pacific Fishery Management Councils. These Councils develop fishery management plans and submit recommended regulations to the U.S. Secretary of Commerce based on public comment and scientific data. NOAA and the councils have jurisdiction in the EEZ to manage species that occur in federal waters.

Cobia are currently managed jointly by the Gulf Council and South Atlantic Council in the Coastal Migratory Pelagic (CMP) Fishery Management Plan, implemented in 1982, which includes King Mackerel and Spanish Mackerel, as well as Cobia. Similarly, the Atlantic States Marine Fisheries Commission (ASMFC) and South Atlantic Council co-manage Cobia in state and federal waters (respectively) of the Atlantic. The current stock boundary separating the Atlantic and Gulf Cobia stocks was set in Amendment 18 (GMFMC/SAFMC 2012). This amendment set the stock boundary at the boundary between the Gulf Council and South Atlantic Council, essentially the Florida Keys. Upon completion of a new stock assessment in 2013 (SEDAR 2013), the stock boundary was redefined to occur at the Georgia/Florida line. This placed all of Florida's Cobia into the Gulf migratory group and management of that stock was split between the Gulf and South Atlantic Council's through CMP Amendment 20B (GMFMC/SAFMC 2014). The overlapping jurisdiction is referred to as the Florida East Coast Zone (Figure 5.1). This Management Profile, therefore, includes all Cobia data and information from the Gulf of Mexico and East Florida as part of a single 'Gulf' stock.

South Atlantic Fishery Management Council

The South Atlantic Fishery Management Council manages fisheries in federal waters (beyond three nautical miles) off East Florida, Georgia, South Carolina, and North Carolina.

Gulf of Mexico Fishery Management Council

The Gulf of Mexico Fishery Management Council manages fisheries in federal waters (beyond nine nautical miles) off West Florida and Texas and the federal waters (beyond three nautical miles) off the coasts of Alabama, Mississippi, and Louisiana.

Caribbean Fishery Management Council

The Caribbean Fishery Management Council manages fisheries in federal waters (beyond three nautical miles) off the Commonwealth of Puerto Rico and the U.S. Virgin Islands (St. Thomas, St. John, St. Croix, and Water Island).

Treaties and Other International Agreements

There are no treaties or other international agreements that affect the harvesting or processing of Cobia. No foreign fishing applications to harvest Cobia 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 Cobia.

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

Figure 5.1 The Gulf and Atlantic Cobia groups and the current division at the Georgia/Florida state line. The Florida East Coast Zone is included in the Gulf Group for management purposes.

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 three interstate marine fisheries commissions 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 fishing and boating programs (user benefits) and provides equitable distribution of funds between freshwater and saltwater projects in coastal states.

Marpol Annex V and United States Marine Plastic Research and Control Act of 1987 (MPRCA), Revised MEPC.201(62) 2011

MARPOL Annex V is a product of the International Convention for the Prevention of Pollution from Ships, 1973/1978. Regulations under this act prohibit ocean discharge of plastics from ships; restrict discharge of other types of floating ship's garbage (packaging and dunnage) for up to 46 km from any land; restrict discharge of victual and other recomposable waste up to 22 km from land; and require ports and terminals to provide garbage reception facilities. The MPRCA of 1987 and 33 CFR, Part 151, Subpart A, implement MARPOL V in the United States.

The revision includes specific language prohibiting the at sea disposal of 'plastics' as:

> "a solid material which contains as an essential ingredient one or more high molecular mass polymers and which is formed (shaped) during either manufacture of the polymer or the fabrication into a finished product by heat and/or pressure. Plastics have material properties ranging from hard and brittle to soft and elastic. For the purposes of this annex, 'all plastics' means all garbage that consists of or includes plastic in any form, including synthetic ropes, synthetic fishing nets, plastic garbage bags and incinerator ashes from plastic products."

Joint Enforcement Agreements (JEAs)

All five of the Gulf of Mexico state marine agencies participate in the NOAA Cooperative Enforcement Initiative for Joint Enforcement Agreements (JEAs) with NOAA's Office of Enforcement (OLE). State partner agencies provide fully trained, equipped and deputized officers who perform at-sea and dockside patrols, outreach, and public education in federal waters where OLE presence is limited. Since its creation in 2002, 27 coastal states and territories have entered into JEA partnerships with NOAA and are receiving JEA funds. The JEAs have led to significant progress in creating uniform enforcement databases, identifying regional and local fishery enforcement priorities, and extending coordination to other areas, such as investigations. The JEA program has been particularly effective because state agents are familiar with local waters, know when and where enforcement infractions are likely to occur, and provide opportunities for significant public outreach and education. The JEA program also serves as the mechanism to provide the region with funding for federal fishery enforcement efforts. These efforts provide NOAA OLE visibility and routine interaction with the regulated industry, ensure stakeholders' understanding, establish enforcement in EEZ, and ultimately achieve prevention with resource user group support and compliance with Federal marine resource conservation mission.

Federal Cobia Regulations

Cobia are primarily managed in the Gulf by the regional councils (see below) but on the Atlantic are jointly managed by the Atlantic States Marine Fisheries Commission and South Atlantic Council. The restrictions discussed in this section are current through the publication of this profile, and are subject to change at any time thereafter.

Gulf of Mexico Fishery Management Council
4107 West Spruce Street
Suite 200
Tampa, FL 33607

South Atlantic Fishery Management Council
4055 Faber Place Drive
Suite 201
North Charleston, SC 29405

Recreational Landings Data Reporting Requirements

§622.374 (b) Charter vessel/headboat owners and operators -

(1) General reporting requirement -

(i) Charter vessels. The owner or operator of a charter vessel for which a charter vessel/headboat permit for Gulf or Atlantic coastal migratory pelagic fish has been issued, as required under §622.370(b)(1), or whose vessel fishes for or lands Gulf or Atlantic coastal migratory fish in or from state waters adjoining the Gulf, South Atlantic, or Mid-Atlantic EEZ, who is selected to report by the Science and Research Director (SRD) must maintain a fishing record for each trip, or a portion of such trips as specified by the SRD, on forms provided by the SRD and must submit such record as specified in paragraph (b)(2)(i) of this section.

(ii) Headboats. The owner or operator of a headboat for which a charter vessel/headboat permit for Gulf coastal migratory fish or Atlantic coastal migratory pelagic fish has been issued, as required under §622.370(b)(1), or whose vessel fishes for or lands Gulf or Atlantic coastal migratory pelagic fish in or from state waters adjoining the Gulf, South Atlantic, or Mid-Atlantic EEZ, who is selected to report by the SRD must submit an electronic fishing record for each trip of all fish harvested within the time period specified in paragraph (b)(2)(ii) of this section, via the Southeast Region Headboat Survey.

(2) Reporting deadlines (ii) Headboats. Electronic fishing records required by paragraph (b)(1)(ii) of this section for headboats must be submitted at weekly intervals (or intervals shorter than a week if notified by the SRD) by 11:59 p.m., local time, the Sunday following a reporting week. If no fishing activity occurred during a reporting week, an electronic report so stating must be submitted for that reporting week by 11:59 p.m., local time, the Sunday following a reporting week.

Commercial Landings Data Reporting Requirements

§622.374 (a) The owner or operator of a vessel that fishes for or lands coastal migratory pelagic (CMP) fish for sale in or from the Gulf, Mid-Atlantic, or South Atlantic EEZ or adjoining state waters, or whose vessel is issued a commercial permit for King or Spanish Mackerel, as required under §622.370(a)(1) or (3), respectively, who is selected to report by the SRD, must maintain a fishing record on a form available from the SRD. These completed fishing records must be submitted to the SRD postmarked not later than 7 days after the end of each fishing trip. If no fishing occurred during a calendar month, a report so stating must be submitted on one of the forms postmarked not later than 7 days after the end of that month. Information to be reported is indicated on the form and its accompanying instructions.

Additionally, all states have mandatory commercial reporting requirements which are detailed in the State sections below. The landings occur at the dock so state reporting must be followed.

Penalties for Violations

§600·735 Penalties. Any person committing, or fishing vessel used in the commission of a violation of the Magnuson-Stevens Act or any other statute administered by NOAA and/or any regulation issued under the Magnuson-Stevens Act, is subject to the civil and criminal penalty provisions and civil forfeiture provisions of the Magnuson-Stevens Act, to this section, to 15 CFR part 904 (Civil Procedures), and to other applicable law.

License Requirements

Recreational: Federally permitted for-hire vessels must possess a Gulf or Atlantic Charter/Headboat Permit for Coastal Migratory Pelagics to retain the bag limit of Cobia. In the Gulf, these permits are limited access (no new permits are available, but existing permits are transferable), while in the South Atlantic, these permits are open access (622.370(b)(1). For a person aboard a vessel that is operating as a charter vessel or headboat to fish for or possess, in or from the EEZ, Gulf coastal migratory pelagic fish or Atlantic coastal migratory pelagic fish, a valid charter vessel/headboat permit for Gulf coastal migratory pelagic fish or Atlantic coastal migratory pelagic fish, respectively, must have been issued to the vessel and must be on board.

For recreational anglers in most states, a state saltwater fishing license for the location where the angler originates is the only requirement to fish for Cobia recreationally from the EEZ (§622·370)· Louisiana requires that anglers must obtain a recreational offshore landing permit (ROLP) to possess and land Cobia in Louisiana.

Commercial: Commercial harvesters fishing for Cobia require the proper commercial licenses for their respective state. There are no federal permits for commercial harvest of Cobia from the EEZ but they must be reported in their commercial logbooks. However, to sell Cobia, it must have been harvested by a vessel with a commercial permit, as only a federal dealer may buy Cobia that was caught from the Gulf EEZ and a dealer with a federal permit may only buy Cobia from a vessel with a federal permit.

Laws and Regulations

The following is a general summary of these laws and regulations and is current through the publication of this profile. Each respective state agency and NOAA should be contacted for specific and up-to-date information on regulations for Cobia.

Gear Restrictions

In the Gulf, Cobia may be commercially harvested in federal waters with bandit gear, handline, rod-and-reel, spear, and powerhead. With some minor exceptions for King Mackerel, the use of drift gillnets are prohibited for CMP species in the EEZ. Spears are not allowed for commercial harvest of Cobia in the Florida East Coast Zone. Recreational harvest of Cobia with spear is allowed in the Gulf and Atlantic (§622.375).

Closed Areas and Seasons

Limited fishing for Cobia or any species of fish is allowed in the Marine Sanctuaries in the Gulf of Mexico and includes the Flower Garden Banks National Marine Sanctuary, McGrail Bank, Florida Keys National Marine Sanctuary, Madison Swanson, Steamboat Lumps, the Edges, the Middle Grounds, and Pulley Ridge.

In the Flower Garden Banks, no gear other than conventional hook-and-line may be used to harvest fish from the Sanctuary. Possessing (except while passing through the sanctuary without interruption) any fishing gear (including spear guns), device, equipment, or means except conventional hook-and-line gear is prohibited. Within the Madison and Swanson sites and Steamboat Lumps, during May through October, surface trolling is the only allowable fishing activity. Surface trolling is defined as fishing with lines trailing behind a vessel which is in constant motion at speeds in excess of four knots with a visible wake. Such trolling may not involve the use of down riggers, wire lines, planers, or similar devices. In the Florida Keys Sanctuary, the EEZ portion of the Tortugas North Ecological Reserve and the Tortugas South Ecological Reserve are completely off limits to all fishing. The Edges is closed to all fishing from January 1 - April 30. In most of the other sanctuaries, conventional hook-and-line is allowed but specific closures and restrictions should be checked with the NOAA South East Regional Office (SERO) or the various Sanctuary offices.

Size Limits

All size limits are minimum size limits unless specified otherwise. A fish not in compliance with its size limit, in or from the Gulf, South Atlantic, or Mid-Atlantic EEZ, as appropriate, may not be possessed, sold, or purchased. A fish not in compliance with its size limit must be released immediately with a minimum of harm. The operator of a vessel that fishes in the EEZ is responsible for ensuring that fish on board are in compliance with the size limits specified.

- In the Gulf:
    33” (83.8 cm) fork length for commercial and recreational sectors.
    NOTE: At the October 2018 Gulf Council meeting, the Council approved an increase in size limit from 33” to 36” fork length. At the time of publishing this document, that change was pending approval by the U.S. Secretary of Commerce.

- In the Mid-Atlantic or South Atlantic, including the Florida East Coast Zone:
    33” (83.8 cm) fork length for commercial sector.
    33” (83.8 cm) fork length for recreational sector in the Florida East Coast Zone.
    36” (91.4 cm) fork length for recreational sector outside the Florida East Coast Zone.

Quotas and Bag/Possession Limits

Recreational

Atlantic migratory group Cobia – The recreational bag and possession limit is one per person, not to exceed six fish per vessel per day. A person who is on a trip that spans more than 24 hours may possess no more than two daily bag limits, provided such trip is on a vessel that is operating as a charter vessel or headboat, the vessel has two licensed operators aboard, and each passenger is issued and has in possession a receipt issued on behalf of the vessel that verifies the length of the trip (§622.382).

Gulf migratory group Cobia – No person may possess more than two fish per day in or from the EEZ, regardless of the number of trips or duration of a trip (§622.383). There is no vessel limit.

An ACT was established in 2012 for the recreational fishery in the Gulf migratory group at 1.31M lbs annually which increased in subsequent years to the current level of 1.5M lbs in 2017 (NOAA unpublished data). The combination of recreational ACT and a commercial ACL are used to manage the fishery, although there is no allocation between the recreational and commercial sectors.

Commercial

Gulf migratory group

(i) Gulf zone. For the 2016 fishing year and subsequent fishing years, the stock quota is 1,500,000 lbs (680,389 kg).

(ii) Florida east coast zone. The quota for the Gulf migratory group of Cobia in the Florida east coast zone is 70,000 lbs (31,751 kg).

Atlantic migratory group. The quota for the 2016 fishing year and subsequent fishing years is 50,000 lbs (22,680 kg) (§622.384). Until the commercial ACL specified in §622.384(d) (2) is reached, two fish per person, not to exceed six fish per vessel.

Other Restrictions

Cobia must be landed intact and all Cobia commercial harvested from the EEZ must be sold to a federal wholesale dealer (§622.381).

Historical Changes to Regulations in Federal Waters Affecting Cobia

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

1983 Cobia was added to the Coastal Migratory Pelagics FMP and a 33” FL minimum size limit was established throughout the fishery conservation zone from North Carolina to Texas.

1987 Permits required for charter boats fishing for CMP species for hire but allowed to hold commercial permits to fish on the commercial quotas when not under charter.

1990 Drift gillnets were prohibited for harvest of CMP species. In addition, a two fish per person per day and 1-day possession limit was established in both the Gulf and the Atlantic.

1998 The management area for Cobia was extended to New York. Allowable commercial gears for Cobia were restricted in the South Atlantic EEZ to only include automatic reel, bandit gear, handline, rod-and-reel, and pelagic longline.

2014 Quota for the Gulf migratory group was set at 1,420,000 lbs with 70,000 lbs allotted to the Florida East Coast zone. The Atlantic quota was 60,000 lbs.

2015 Quota for the Gulf migratory group increased to 1,450,000 lbs.

2016 Quota for the Gulf migratory group increased to 1,500,000 lbs and Atlantic migratory group reduced to 50,000 lbs.

2017 Increased minimum recreational size limit for state and federal waters from North Carolina to Georgia for the Atlantic migratory group to 36’’ fork length. This action was applied to state and federal waters through the co-management with ASMFC

2018 The Gulf Council approved an increase in size limit from 33” to 36” fork length for Cobia in the Gulf from East Florida to Texas. At the time of publishing this document, that change was still pending approval by the U.S. Secretary of Commerce.

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
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 Management is empowered to manage marine and anadromous fisheries in the interest of the people of Florida. The Division of Law Enforcement is responsible for enforcement of all marine-resource-related laws, rules, and regulations of the state.

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 authority over all aspects of rulemaking concerning marine life with the exception of requiring fees and establishing penalties.

Florida has habitat protection and permitting programs, and a federally-approved Coastal Zone Management (CZM) program.

Legislative Authorization

Prior to 1983, the Florida Legislature was the primary body that enacted laws regarding management of marine species in state waters. 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. Beginning June 13, 1985, Title 46, Chapter 19 contained regulations regarding Cobia. 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 Division 68B, Florida Administrative Code (FAC).

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 Cobia fishery with the exception of a Restricted Species Endorsement (RS). In order to receive an RS, an individual must be at least 16 years old and meet the qualification requirements designed to demonstrate that the individual is a professional commercial fisher. The primary means of qualifying is to demonstrate that the applicant has harvested and sold at least $5,000 worth of saltwater products during one of the previous three years or that at least 25% of that person's income for one of the previous three years was attributed to the sale of saltwater products, whichever is less. All RS qualification criteria and exemptions can be found in 68B-2.006, FAC.

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 (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 as to why their saltwater license should not be suspended or revoked.

License Requirements

In the state of Florida, a license is required to land Cobia recreationally or commercially along either the Gulf of Mexico or Atlantic. Recreational saltwater fishing licenses are required of residents and non-residents fishing in state territorial waters or the EEZ off the state and current regulations must be adhered to. Check with the FWC for current Cobia regulations. All children under the age of 16, regardless of residency, and resident seniors who are 65 or older are not required to purchase most recreational licenses. Other exemptions exist for active military and individuals with disabilities. Check with the FWC for details.

A commercial fishing license (Saltwater Products License; SPL) and additional endorsements are required to harvest commercial quantities and/or to sell Cobia from Florida waters or from the EEZ and landed in Florida. There are also reporting requirements (outlined above). Check with the FWC prior to participating in any commercial harvest of Cobia.

Laws and Regulations

Florida's laws and regulations regarding the harvest and retention of Cobia vary by region. 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 publication of this profile, and are subject to change at any time thereafter.

Size Limits

A minimum size limit of 33” fork length for both commercial and recreational harvest.

Quotas and Bag/Possession Limits

No recreational or commercial harvester shall harvest in or from Gulf state waters (north of the Monroe/Collier county line) more than one Cobia per person per day or possess more than two per vessel.

No recreational harvester shall harvest in or from Atlantic state waters more than one Cobia per person per day or possess more than six per vessel. Within Atlantic State waters, no commercial harvester shall harvest in or from state waters more than two Cobia per person per day, nor possess while in or on Atlantic state waters more than six such fish per vessel, regardless of the number of licensed or license-exempt persons on board.

Gear Restrictions

Cobia does not have any gear-specific regulations in Florida waters and may be harvested with any gear that is allowable under general gear-related rules, including but not limited to spears, gigs, hook-and-line, seine, or cast net.

Closed Areas and Seasons

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

Other Restrictions

Cobia must be landed in a whole condition.

Historical Changes to Regulations in Florida Affecting Cobia

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

1985 Established a minimum size limit of 37” total length (equivalent to 33” fork length).

1990 Established a minimum size limit of 33” fork length. Bag limit: two per person daily for all fishermen, commercial and recreational. Must be landed in a whole condition.

1991 Prohibited use of gill or trammel nets with a total length greater than 600 yards. No more than two nets to be possessed aboard a boat and no more than one net to be used from a single boat. Required net to be tended and marked according to certain specification in the waters of Brevard through Palm Beach Counties.

1993 Set a maximum mesh size for seines at two-inches stretched mesh, excluding wings. 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. Prohibited the harvest of marine fish from any waters of the Warren Bayou (Bay County) from November through February each year. 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 and prohibited the use of any net with a mesh area greater than 500 ft^2.

1998 Prohibited the sale of undersized Cobia.

2001 Designated Cobia as a restricted species. Established a one fish per day bag limit per person and a six fish per day vessel limit (whichever is less) for recreational fishermen. Established a two fish per day bag limit per person and a six fish per day vessel limit (whichever is less) for commercial fishermen.

2013 Chapter reorganized and reformatted as part of phase one of the rule cleanup process.

2018 Defined the "Gulf Region" for the purpose of managing Cobia in Florida State waters as state waters north of the Monroe- Collier county line and the "Atlantic Region" as all other state waters. Reduced the commercial bag limit from two to one Cobia per harvester per day in the Gulf Region. Reduced the commercial and recreational vessel limits from six to two Cobia in the Gulf Region.

Alabama

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

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 ten 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 MRD 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 apply, 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

In Alabama waters, a license is required to land Cobia commercially or recreationally. Recreational saltwater fishing licenses are required of residents and non-residents fishing in state territorial waters as well as the EEZ and current regulations must be adhered to. Check with the ADCNR MRD for current Cobia limits and license requirements.

Residents and non-residents under the age of 16 and residents over the age of 65 are exempt from the purchase of a recreational license. Saltwater angler registration is required for residents who are not required to purchase an annual saltwater license such as those 65 or older, have a lifetime saltwater license, or fish exclusively on a pier that has purchased a pier fishing license. Resident and non-resident anglers under the age of 16 do not have to register.

Laws and Regulations

Alabama laws and regulations regarding the harvest of Cobia are very limited. The following is a general summary of these laws and regulations and are current through the publication of this profile. The ADCNR MRD should be contacted for specific and up-to-date information.

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 is six-inch stretch mesh.

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

Cobia may also be taken by ordinary hook-and-line, cast net, gig, spear, and bow and arrow.

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.

Size Limits

Alabama has a 33" fork length minimum size limit for recreationally and commercially caught Cobia.

Quotas and Bag/Possession Limits

There is a bag/possession limit of two fish/person for the recreational and commercial Cobia 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.

Historical Changes to Regulations in Alabama Affecting Cobia

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

1988 Established a 37” total length minimum size on Cobia.

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 MCMR consists of five 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 CZM program approved by NOAA. The CZM program 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 CZM program.

Legislative Authorization

Title 49, Chapter 15 of the Mississippi Code of 1972, 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 Magnuson-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 provide: "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 Provisions

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 non-resident will be issued a commercial fishing license for the taking of fish using any type of net, if the non-residents 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 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 Cobia in Mississippi.

License Requirements

A license is required to land Cobia recreationally harvested from all Mississippi marine waters and the EEZ. Recreational saltwater fishing licenses are required of residents and non-residents fishing in state territorial waters as well as the EEZ and current regulations must be adhered to. A saltwater fishing license is required to fish south of Highway 90. Above Highway 90 and below Interstate 10, either a saltwater or freshwater license will suffice. Above Interstate 10 a freshwater license is required. Persons under the age of 16 are exempt. Residents 65 years of age or older can purchase a lifetime license for a one-time fee. Check with the MDMR for all current license requirements.

Laws and Regulations

Mississippi laws which regulate the harvest of Cobia are primarily limited to size and creel as well as geographical locations under Mississippi Title 22 Part 7 Chapters 08 and 09 and apply statewide. Further, Section 49-15-3 designates Cobia as a game fish and Section 49-15-76 prohibits the commercial sale or landing of gamefish. They are current to the date of this publication and are subject to change at any time thereafter. The MDMR should be contacted for specific and up-to-date information.

Size Limits

Mississippi has a 33" FL minimum size limit for recreationally caught Cobia. Cobia are a gamefish in Mississippi so there is no commercial harvest.

Quotas and Bag/Possession Limits

There is a bag/possession limit of two fish/person for the recreational Cobia fishery. Cobia are a gamefish in Mississippi so there is no commercial harvest.

Closed Areas and Seasons

With the exception of those areas where commercial fishing is prohibited, there are no closed areas or seasons related to recreationally caught Cobia in Mississippi waters. Cobia are a gamefish in Mississippi so there is no commercial harvest.

Historical Changes in Regulations in Mississippi Affecting Cobia

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

1983 33" minimum fork length size regulation was established for Cobia (throughout the fishery conservation zone (FCZ) from North Carolina to Texas). Fishery Management Plan-Coastal Migratory Pelagic Resources. GMFMC. Mississippi implemented this regulation.

1987 Federal: Permits were required for charter boats fishing for coastal migratory pelagic species for hire but allowed them to hold commercial permits to fish on the commercial quotas when not under charter.

1989 The commercial sale of Cobia caught in Mississippi territorial waters or landed in Mississippi is prohibited.

1990 Two Cobia per person per day bag limit was established.

1997 Cobia designated as a 'Mississippi Game Fish'.

Louisiana

Louisiana Department of Wildlife and Fisheries

Louisiana Department of Wildlife and Fisheries
P.O. Box 98000
Baton Rouge, Louisiana 70898-9000
Marine Fisheries: (225) 765-2384

Law Enforcement: (225) 765-2989
www.wlf.state.la.us

The Louisiana Department of Wildlife and Fisheries (LDWF) is one of 21 major administrative units of the Louisiana government. The Governor appoints a seven-member board, the Louisiana Wildlife and Fisheries Commission (LWFC). 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 Governor, with consent of the Senate, appoints the Secretary.

Within the administrative system, an Assistant Secretary is in charge of the Office of Fisheries. This office 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."

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 that 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 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.

Section 320 of Title 56 (L.R.S.) establishes methods of taking freshwater and saltwater fish. Additionally, Sections 325.1 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 finfish based upon biological and technical data.

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.

Louisiana seniors, 65 years of age and older, are not required to purchase a non-resident license to fish in all public waters in Texas. These anglers will be allowed to fish Texas water bodies with a Louisiana Senior fishing license but shall comply with Texas law. Senior anglers are advised that anglers turning 60 before June 1, 2000 are also required to possess a Louisiana Senior fishing license when fishing in Texas, except in border waters. Louisiana residents from 17-64 years of age will still be required to purchase a non-resident fishing license when fishing in Texas, except when fishing in border waters.

In all border waters, except the Gulf of Mexico, Texas and Louisiana anglers possessing the necessary resident licenses, or those exempted from resident licenses for their state, are allowed to fish the border waters of Louisiana and Texas without purchasing non-resident licenses. Border waters include Caddo Lake, Toledo Bend Reservoir, the Sabine River, and Sabine Lake.

Louisiana is also allowing Texas senior residents 65 years of age and older, to fish throughout Louisiana's public waters if they possess any type valid Special Texas Resident licenses for seniors as issued by Texas Parks and Wildlife, any type of water, saltwater or freshwater. Even Texas residents born before September 1, 1930 must possess the Texas Special Resident Fishing license when fishing in Louisiana, except in border waters.

Limited Entry

No limited entry exists to commercially take Cobia with legal commercial gear other than with a commercial rod-and-reel. Louisiana has adopted limited access restriction for the issuance of a commercial rod-and-reel license. Sections 325.4 and 305B (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.

Commercial Landings Data Reporting Requirements

Wholesale/retail seafood dealers who purchase Cobia from fishermen are required to report those purchases by the tenth of the following month on trip tickets supplied by the Department for that purpose. Commercial fishermen who sell Cobia directly to consumers must be licensed as a wholesale/retail seafood dealer or Fresh Products Licensee and comply with the same reporting requirements.

Penalties for Violations

Violations of Louisiana laws or regulations concerning the commercial or recreational taking of Cobia by legal commercial gear shall constitute a Class 2 violation which is punishable by a fine from $100 to $350 or imprisonment for not more than 60 days, or both. Second offenses carry fines of not less than $300 or more than $550 and imprisonment of not less than 30 days or more than 60 days. Third and subsequent offenses have fines of not less than $500 or more than $750 and imprisonment for not less than 60 days or more than 90 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.

Laws and Regulations

Louisiana laws and regulations regarding the harvest of Cobia include gear restrictions and other provisions. The following is a general summary of these laws and regulations. They are current to the date of this publication and are subject to change at any time thereafter. The LDWF should be contacted for specific and up-to-date information.

Size Limits

There is a 33” fork length recreational and commercial size limit for Cobia in Louisiana.

Gear Restrictions

Licensed commercial fishermen may take Cobia commercially with a pole, line, yo-yo, hand line, trotline wherein hooks are not less than 24” apart, trawl, skimmer, butterfly net, cast net, scuba gear using standard spearing equipment, and rod-and-reel (if permitted).

Licensed recreational fishermen may take Cobia recreationally with a bow and arrow, scuba gear, hook and line, and rod-and-reel.

Closed Areas and Seasons

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

Quotas and Bag/Possession Limits

There is a two fish recreational bag limit and two fish per person commercial trip limit (no more than one vessel trip limit per day) on Cobia.

Recreational Offshore Landing Permit

Louisiana requires that anglers must obtain a recreational offshore landing permit (ROLP) to possess and land Cobia in Louisiana. The permit was created in 2013 “to better quantify and characterize the charter and recreational fishermen that fish beyond Louisiana’s territorial waters” and pertains to a variety of species encountered offshore of Louisiana. Minors under 16 are not required to obtain the permit. Paying customers aboard a for-hire charter trip are also not required to obtain the permit, however the captain of the vessel is required to do so.

Other Restrictions

The use of aircraft to assist fishing operations is prohibited. Cobia 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 in Louisiana Affecting Cobia

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

1991 Louisiana established a 37” minimum total length size limit for all harvested Cobia and a two fish per person commercial and recreational bag limit for Cobia.

2000 Louisiana established the 33” minimum fork length (previously 37” total length) for commercially and recreationally harvested Cobia as the measurement standard for Cobia.

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.texas.gov

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 TPWC consists of nine members appointed by the Governor for staggered six-year terms. The TPWC selects an Executive Director who serves as the administrative officer of the department. The Executive Director 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 Chief Operating Officer.

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 11-member group whose members consist of a chairman (the head of TGLO) and representatives from Texas Commission on Environmental Quality, 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 a 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 TPWC 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, bag, and possession limits, and means and methods pertaining to fish and marine life are adopted by the TPWC and included in the Texas Statewide Recreational and Commercial 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

Wholesale/retail seafood dealers who purchase Cobia from fishermen are required to report those purchases by the tenth of the following month on trip tickets supplied by the TPWD for that purpose. Commercial fishermen who sell Cobia directly to consumers must be licensed as a wholesale/retail seafood dealer and comply with the same reporting requirements.

Penalties for Violations

Penalties for violations of Texas' proclamations regarding Cobia 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.

Annual License Fees

A license is required to land Cobia recreationally or commercially from all Texas marine waters and the EEZ. Recreational saltwater fishing licenses are required of residents and non-residents fishing in state territorial waters as well as the EEZ and current regulations must be adhered to. Check with the TPWD for current Cobia regulations. Residents of Texas under the age of 17 and residents who were born before January 1, 1931, are not required to obtain a recreational fishing license. Other exemptions may exist for active military and the disabled. Check with the TPWD for details.

Senate Bill 1303 authorizes the TPWC under Parks and Wildlife Code 47, to establish a license limitation plan for the Texas commercial finfish fishery. Commercial fishermen must have appropriate fishing licenses and permits, gear licenses, and vessel permits to be properly licensed whenever taking or possessing fish for sale in Texas saltwater areas. Contact the TPWD for specific regulations regarding the commercial harvest and/or sale of Cobia from Texas waters.

Laws and Regulations

Various provisions of the Statewide Hunting and Fishing Proclamation adopted by the TPWC affect the harvest of Cobia in Texas. The following is a general summary of these laws and regulations. It is current through the end of August 2018 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 37" minimum total length has been established for Cobia in Texas.

Quotas and Bag/Possession Limits

The recreational daily bag for Cobia is two fish per person and the possession limit is equal to two times the daily bag limit. The same daily bag and possession limit applies to all commercial fisherman since Cobia are a gamefish in Texas. The bag limit for Cobia retained incidental to a legal shrimping operation is equal to a recreational bag limit.

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. Cobia is a game fish and may be legally taken by pole and line only.

Closed Areas and Seasons

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

Other Restrictions

Cobia 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 in Regulations in Texas Affecting Cobia

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

1983 Federal minimum size limit established at 33" (fork length) (37" total length).

Parks and Wildlife Commission adopted changes to §65.72 setting the minimum size for Cobia at 37" (total length).

1991 72nd Legislature approved changed to Parks and Wildlife Code §66.020 making it unlawful to receive Cobia directly from another state without a Texas Finfish Import License.

Parks and Wildlife Commission adopted changed to §65.72 setting the daily bag limit for Cobia at two fish per person per day and the possession limit equal to the daily bag.

Parks and Wildlife Commission adopted changes to §§57.371-57.376 listing Cobia as a commercially protected finfish requiring a Texas Finfish Import License of dealers who bring the species into the state for sale.

1992 Parks and Wildlife Commission adopted changes to §65.72 increasing the possession limit for Cobia to twice the daily bag limit (the current daily bag limit was two fish per person per day) and removed Cobia from the list of commercially protected finfish.

2005 Parks and Wildlife Commission adopted changes to Texas Administrative Code (TAC) 57.971 to list Cobia as a game fish and established bag (two per person per day), set the possession limit equal to the daily bag and set the minimum total length limits to 37" for both recreational and commercial harvest. There is no maximum length limit for this species.

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.

Cobia Technical Task Force

The Cobia Technical Task Force (TTF) is organized with one scientific representative from each of the five Gulf states who is appointed by each state's director serving on the State-Federal Fisheries Management Committee (SFFMC). In addition, the TTF includes 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 addition, other experts and specialists 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 TTFs, the committee becomes inactive until there is a need for revision of a profile or work on specific issues related to Cobia 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 Cobia 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 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

Cobia are found throughout tropical, subtropical, and warm-temperate regions worldwide. Along the Atlantic, they range from Nova Scotia in the north to Argentina in the south (Briggs 1958). As with many of the highly migratory pelagics, Cobia are rarely found in high densities and tend to be somewhat solitary in nature (Moe 1970, Benson 1982). As a result, their behavior is not conducive to supporting a dedicated commercial fishery. Due to their wide range and long migrations, there is considerable question about the stock unit that makes up the population along the U.S. Atlantic and the Gulf of Mexico despite the lack of diversity in genetics research (Gold et al. 2013, Darden et al. 2014, McDowell et al. 2018, Darden et al. 2018), but tagging data (*Chapter 3 - Migration*) suggests little movement between the Atlantic migratory group (north of Canaveral) and the Gulf migratory group (south of Canaveral and west to Texas). For the purposes of this Management Profile, the Gulf migratory group extends from the Texas/Mexico border to the Georgia/Florida border and includes the entire Florida peninsula based on previous stock assessments (Williams 2001, SEDAR 2013, SEDAR 2018).

In other regions of the world, Cobia do occur with more frequency and are popular, but are still a relatively minor component of most fishing activities (Figure 6.1). Despite the numbers of Cobia landed recreationally, the FAO reports the U.S. is ranked 15th (as of 2015) when compared to the global commercial landings. In addition, Cobia generated by aquaculture places the U.S. even lower on the global list.

Commercial Fishery

Cobia do not make up a large component of the total commercial landings in the U.S., averaging only about 0.002% of the total commercial landings since 1950 (NOAA unpublished data). Their seasonal occurrence and solitary nature do not make them easy to harvest using traditional commercial gears,

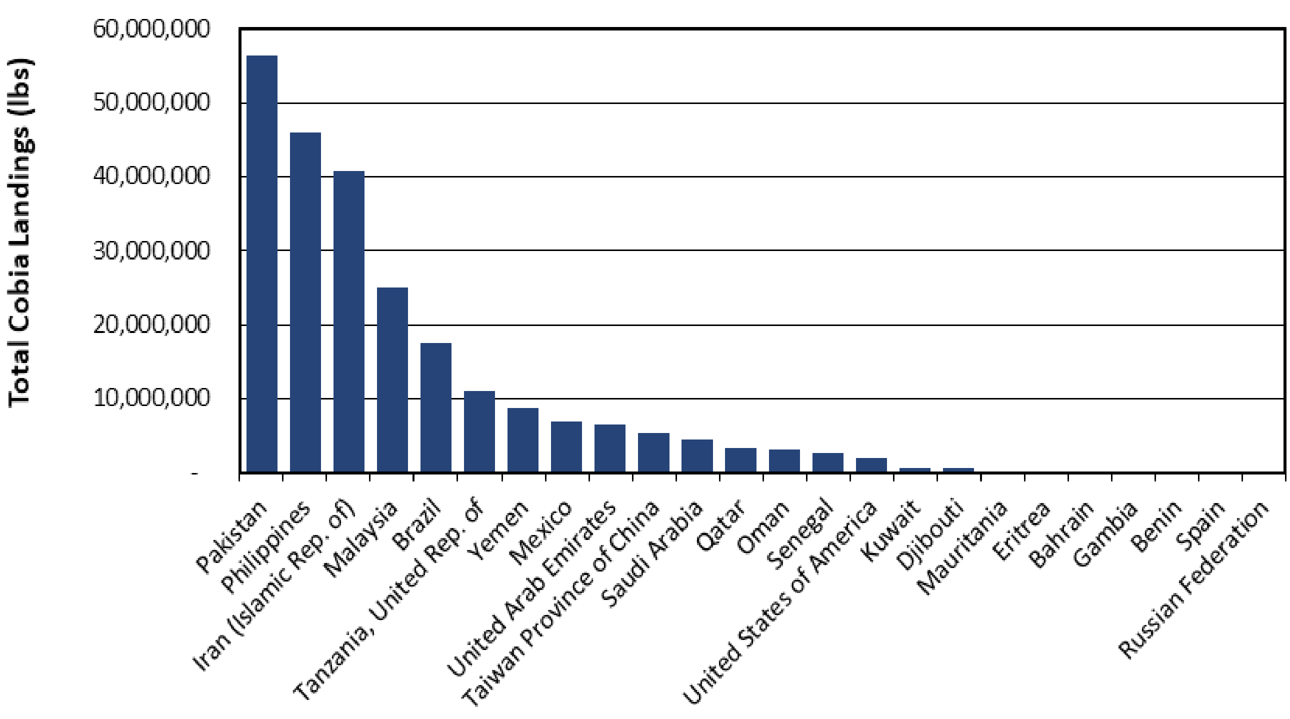

Figure 6.1 Total world commercial landings of wild caught Cobia from 2006-2015 (FAO unpublished wild data).

such as nets, although a few Cobia were landed by entangling nets (gill and trammel) historically and by spear more recently (NOAA unpublished data). The majority of landings are derived by commercial hand lines, long lines (NOAA unpublished data) and from rod-and-reel recreational anglers or charter boats targeting Cobia and selling the fish under a commercial license (GMFMC/SAFMC 1985).

In the U.S., most commercial Cobia landings originate from the Gulf and East Florida with the rest of the South Atlantic making a larger contribution in the last decade (Table 6.1; Figure 6.2). Since the year 2000, landings from the Gulf and East Florida have comprised about 80% of the total U.S. commercial landings and average just over 160,000 lbs annually. In 2015 and 2016, total commercial landings for Cobia declined slightly in the region and the rest of the South Atlantic region has seen increases. In 2015, around 56,000 lbs of Cobia were landed in Georgia and the Carolinas. Very few fish (typically 2,000 lbs or less) are landed in the Mid-Atlantic and Northeast combined (NOAA unpublished data).

In 2011, a quota was set for the Atlantic population (Florida to New York) which the commercial fishery exceeded in each subsequent year except for 2013. The quota was modified in 2015 for the Atlantic to only include Georgia to New York with the Gulf East Coast Florida Zone considered a separate quota. Both in 2015 and 2016, the Atlantic quota was again exceeded and the commercial season was closed in 2017 (NOAA unpublished data). During that time, the Florida quota on the Atlantic was not reached so fishing continued in 2017.

History

Commercial Cobia landings have never been very large compared to other important species in part due to their life history and pelagic nature. Those who target Cobia know when their migrations will bring

Table 6.1 Total U.S., Gulf of Mexico, and East Florida commercial landings (lbs) of Cobia and the percent of the total contribution to the total U.S. landings from 2000-2017 (NOAA unpublished data).

Year	Total U.S. (lbs)	Gulf of Mexico		East Florida	
		(lbs)	(%)	(lbs)	(%)
2000	243,475	152,569	63	58,620	24
2001	206,346	112,252	54	65,499	32
2002	214,050	122,378	57	61,336	29
2003	221,101	141,681	64	53,282	24
2004	203,231	117,345	58	62,188	31
2005	160,225	99,909	62	37,004	23
2006	176,197	93,237	53	57,875	33
2007	174,335	86,462	50	60,805	35
2008	173,267	82,743	48	57,003	33
2009	179,778	71,491	40	65,953	36
2010	249,248	91,430	37	101,564	47
2011	274,386	84,466	31	156,069	56
2012	181,437	60,507	33	78,725	44
2013	205,667	92,286	45	59,845	30
2014	233,864	86,947	37	77,755	35
2015	217,169	76,310	35	56,492	23
2016	213,744	80,350	38	42,324	20
2017	176,531	72,956	41	37,344	21

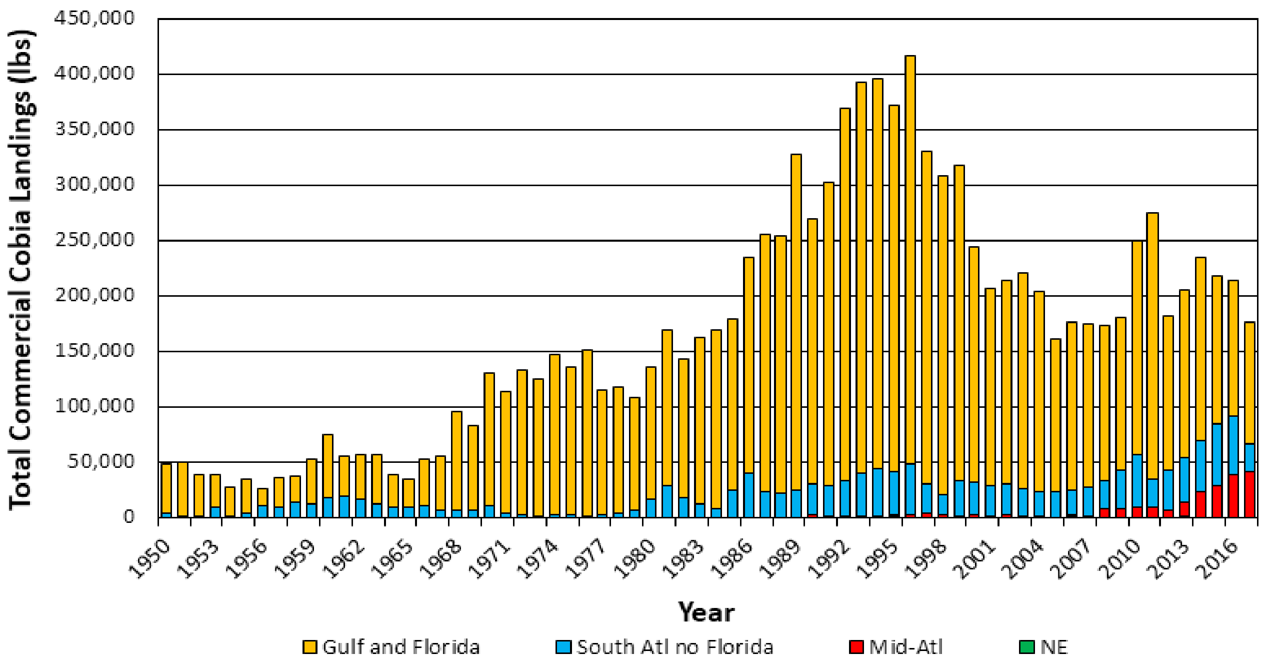

Figure 6.2 Total landings (lbs) of commercial Cobia by region from 1950-2017 (NOAA unpublished data).

them into the area and how long they will be available for harvest. However, Cobia tend to be solitary with only a few fish occurring together at any time.

There is virtually no history of Cobia being targeted by commercial fishermen other than as incidental catches (GMFMC/SAFMC 1985). A search of newspaper articles available through online subscription services date the only mention of a commercial harvest of Cobia in the Gulf region to 1947 (VanderKooy personal communication). The article in the Times-Picayune from New Orleans mentioned shrimp trawlers in the Gulf occasionally harvested Cobia (Times-Picayune May 11, 1947). The article stated:

> "Gulf trawlers report, too, that the cobia are often seen swimming along beneath their slowly dragging nets, oft-times, beneath the sterns of their boats. They do not seem to mind the wash of fast turning propellers and many have been gaffed from the fantails of fishing boats even though they were free and had not been hooked." Times-Picayune May 11, 1947

The SEAMAP (Southeast Area Monitoring and Assessment Program) survey data from 1982-2016 indicate that a surprising number of Cobia (n≈900) were encountered during the regular cruises in various trawl gears. SEAMAP is a State/Federal/university program for collection, management and dissemination of fishery-independent data and information in the southeastern U.S. The Cobia reported during the cruises from Texas to Florida ranged in size from less than 100 mm TL to as large as 1,351 mm TL so, although infrequent, their occurrence in the gear suggests that harvest by commercial shrimpers likely does occur *in* their nets. This is likely due in part to the behavior documented by Franks (personal communication) and others (Howse et al. 1992, Denson et al. 2003, Resley et al. 2006) that Cobia can and do lie motionless on the bottom for hours (*Chapter 3 - Behavior* and *Chapter 4 - Substrate*). In tanks, Franks (personal communication) found them frequently 'resting' on the bottom while conducting captive spawning experiments and reported that the fish simply 'rolled from side to side' on the bottom. The likelihood of large Cobia simply being scooped up in a traditional otter trawl is not impossible and based on SEAMAP sampling, seems to occur infrequently but does in fact occur (SEAMAP unpublished data).

While there are landings reported by NOAA going back continuously to 1950, the quality of those estimates is questionable since so few Cobia were probably witnessed by port agents. Since the implementation of mandatory reporting of commercial catches through trip ticket programs in each state, the estimates of Cobia landings since about 2000 are much more reliable and accurate. NOAA landings by gear suggest that the majority of Cobia landed in the Gulf and East Florida were dominated by a variety of hook-and-line gears (46%) which includes hand lines, rod-and-reel, mechanical and hydraulic lines, and various longlines (Figure 6.3).

A large percentage (46%) of the Cobia landings from the late 1970s to the mid-1990s were not identified or reported as 'Combined Gear' and do not improve the resolution for potential changes in gear over time. In the last decade, 'Spear' has begun to be reported as a source for commercial Cobia and the contribution is growing as more people have access to basic snorkeling and dive gear as well as access to rigs, buoys, and other habitats which Cobia frequent.

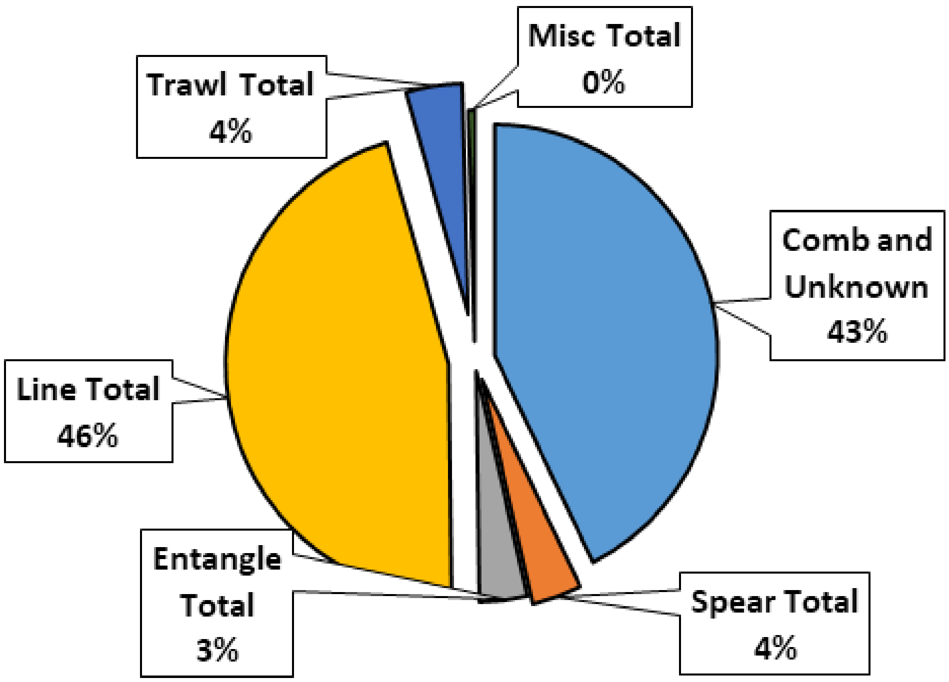

Figure 6.3 Total Cobia landings in the Gulf and East Florida from 1950-2016 combined by gears (NOAA unpublished data).

State Commercial Fisheries

Commercial landings of Cobia are highly uncertain in the U.S. Gulf of Mexico, not because of poor data but generally due to minimal directed effort. The following provides a state-by-state description of Cobia that are landed and sold commercially in the five Gulf states.

Florida (East and West)

Florida dominates the region's Cobia landings with West Florida landing as much as 80-90% of all the Cobia in the state from the early 1960s to the mid-1980s (Figure 6.4A). Since that time, the two coasts have shared a roughly 60:40 split on average with East Florida landing more than half starting in 2009 (NOAA unpublished data).

Commercial landings of Cobia in Florida remained rather low, around 21,000 lbs or less, through the late 1950s but began to increase steadily until the mid-1990s, reaching the record high of just over

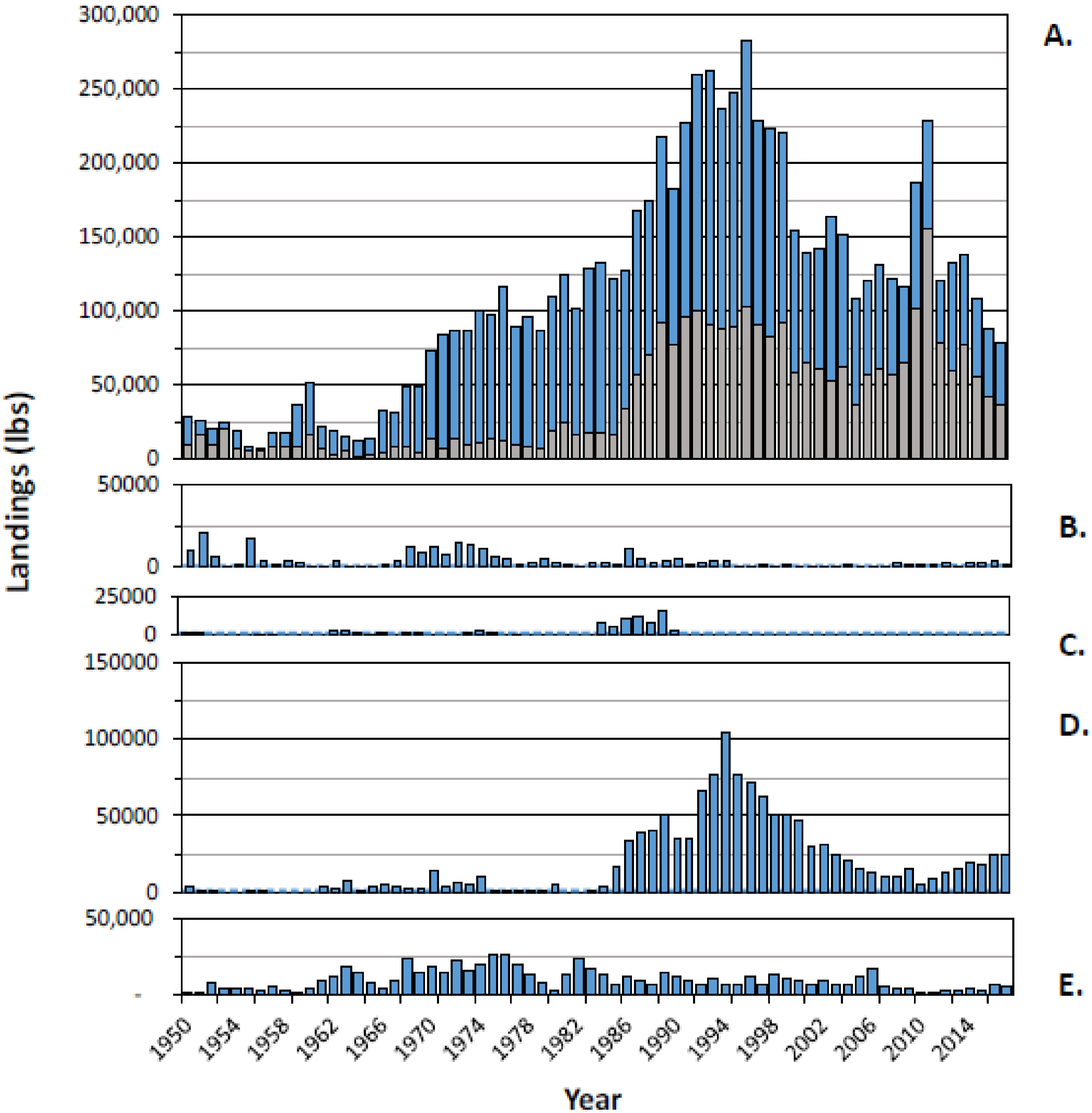

Figure 6.4 Commercial landings (lbs) of Cobia in A) Florida (East gray, West blue), B) Alabama, C) Mississippi, D) Louisiana, and E) Texas from 1950-2016 (NOAA unpublished data).

280,000 lbs in 1996. A rapid decline, however, was seen in the early 2000s. This decline may have been attributed to some additional rule changes made by the Florida Fish and Wildlife Conservation Commission (FWC). In 2001, FWC designated Cobia a Restricted Species, meaning that any fishermen who want to commercially harvest Cobia must hold a Restricted Species permit. The requirements of this permit (for more information see FWC in Chapter 5 - *Enforcement*) and the thought that many recreational anglers were purchasing Saltwater Product Licenses (SPL) to legally sell Cobia commercially, may have contributed to this rapid decline (Shipley personal communication). Moreover, a commercial vessel limit was also established in 2001 at six fish per day, which may have also furthered this decline.

The majority of Cobia are landed by commercial fishermen using some sort of 'Line' which could include rod-and-reel, various longlines, mechanical and hydraulic lines, and hand lines. The largest provider of commercial Cobia from Jupiter Inlet to Cocoa Beach is the King Mackerel fleet who handline most of the fish and sell directly to restaurants (VanderKooy personal communication). The restaurants also buy imported Cobia to supplement the local catches.

In recent years, East Florida has seen an increase in the use of 'Spear' to land Cobia with average of 20,000 lbs landed starting in the mid-1990s which was about half of what was landed by 'Line'. Since 2005, 'Spear' landings of Cobia statewide has only averaged about 9,000 lbs. With the exception of uncoded or unknown gear, which are likely dominated by lines, Cobia landings in trawls and entangling nets are minimal.

In the Panhandle region of Florida, anglers anticipate the migration of Cobia to the northern Gulf in March and April (Figure 6.5). Zales (personal communication) indicated that during the migration, a number of anglers will take leave from their regular jobs to focus on fishing for Cobia in the Destin to Pensacola region. Those anglers have multiple license endorsements and sell their catch during that time as a second source of income. The commercial landings in the Panhandle occur during a very short window of time as a result, since the commercial hook-and-line fishermen only target Cobia for sale when the fish show up along the beaches. Once the Cobia move west, the recreational anglers land most of the fish and sales go down generally in the Panhandle (see *Recreational* below).

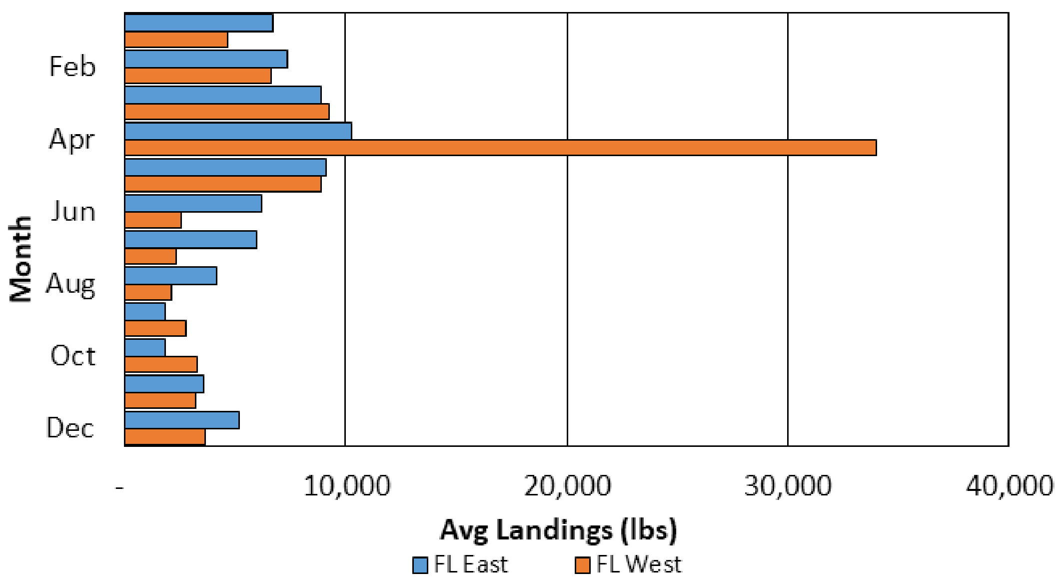

Figure 6.5 Average monthly commercial Cobia landings by Florida Coasts from 1996 to 2017 (NOAA unpublished data).

Examinination of the reporting of Cobia in the commercial landings through Florida's trip ticket program, there are some notable trends seasonally and spatially which match the migration pattern of Cobia generally. The Gulf population overwinters in the Florida Keys area with commercial encounters of Cobia appearing in November to May with a peak in March and April (Figure 6.6). The fish are not necessarily absent from all the other Gulf coastal counties but the commercial targeting may not be strong. Figure 6.6 only includes the highest monthly average of trip tickets submitted from 1990-2016. The counties that are not included may have some commercial reports but are minor compared to the seven counties listed from southwest Florida to the northwest through the Panhandle. The peak reported in Bay and Okaloosa counties match the directed effort in the Panama City and Destin region as the fish migrate through the area reported by Zales (personal communication).

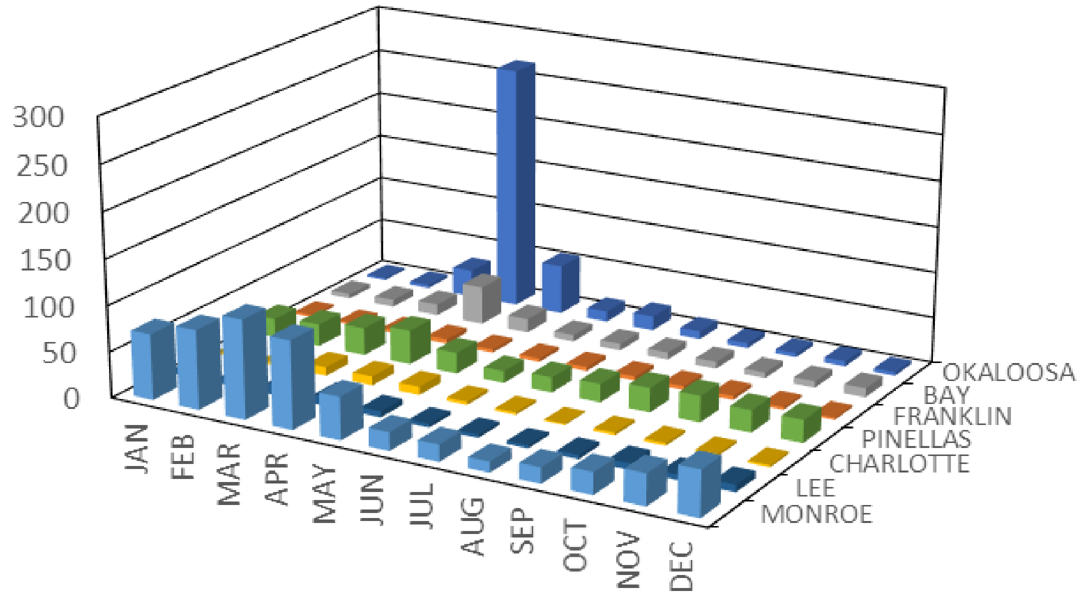

Figure 6.6 Summary of average numbers of Cobia reported by month on commercial trip tickets along West Florida to the Keys (Monroe County) from 1990-2016. **Note:** only the counties with the highest reported harvest are included. Monroe County is included in both the west and east coast figures for comparison only (NOAA unpublished data).

A similar approach was taken to examine the Florida Atlantic counties from the Florida Keys to Jacksonville (Figure 6.7). Along the Atlantic, there are two primary counties which contribute to the majority of the Cobia reported on trip tickets. Again, the most frequent commercial take of Cobia occurs in the winter in the Florida Keys and is likely the Gulf population. However, there is a second overwintering population which is encountered off Brevard and Volusia counties around Cape Canaveral during much of the winter with fish remaining in that region well into the summer when averaged from 1990-2016. There is speculation that this may represent the Atlantic Cobia population with both groups mixing to some extent in Palm Beach and Martin counties (Miami to Jupiter).

Regardless of the frequency of the commercial take, the commercial effort is low compared to the recreational landings in general. Florida has had a commercial daily bag of two Cobia per day for all commercial and recreational fishermen since 1990 which has probably contributed greatly to the overall small commercial harvest on both coasts. In addition, since Cobia do not school like many of the pelagics, they are just not seen in large enough numbers to encourage a directed commercial effort. They are primarily bycatch or opportunistically captured.

Alabama

Cobia landings in Alabama have historically been minimal compared to Florida and Louisiana, never exceeding 25,000 lbs (Figure 6.4B). The highest estimated landings were scattered throughout the 1950s, 1960s, and 1970s. Since that time, Cobia landings have only broken 10,000 lbs one time. In the last decade, total commercial harvest of Cobia in Alabama has only averaged 1,000 lbs (NOAA unpublished data). Since the early 1990s, virtually the only gear reported in Alabama to commercially land Cobia were various 'Lines'. With the exception of a short time in the 1950s, trawls were the primary contributor to Alabama landings of Cobia until the mid-1980s. There are no records of trawls taking Cobia after 1991 when the majority of the commercial landings in Alabama were reported as hook-and-line through present. It may be coincidence but the Atlantic Croaker food fish fishery, which was centered on Bayou La Batre, began in the 1960s to supply the mid-Atlantic with fish and then declined and ceased entirely in

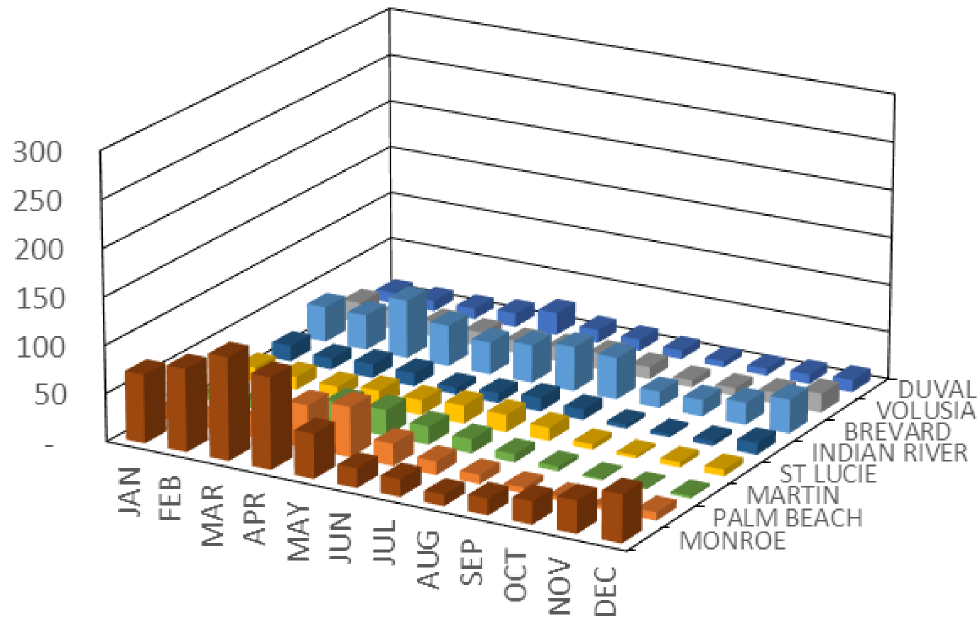

Figure 6.7 Summary of average numbers of Cobia reported by month on commercial trip tickets along East Florida to the Keys (Monroe County) from 1990-2016. **Note:** only the counties with the highest reported harvest are included. Monroe County is included in both the west and east coast figures for comparison only (NOAA unpublished data).

the late 1970s (VanderKooy 2017). The trawl gear used to harvest Atlantic Croaker was made of heavier webbing and was pulled specifically to target finfish and may have been a contributor to increased harvest of Cobia as bycatch, although there are no records to indicate the actual source of Cobia occurring in the gear (VanderKooy personal communication).

Commercial Cobia landings from 2004 through 2013 in Alabama were exceptionally low primarily due to a series of tropical storms and hurricanes which hit the northern Gulf in 2004 and 2005, causing significant damage to most of the fishing fleet and a number of recreational anglers as well. As the area was recovering from the physical damages, the BP Deepwater Horizon oil platform exploded and released record quantities of oil into the northern Gulf, shutting down virtually all fishing activities in 2010 during the peak Cobia fishing season. Commercial landings in Alabama have continued to be low for Cobia since the mid-1990s.

Mississippi

Commercial harvest and sale of Cobia in Mississippi was banned when it was declared a gamefish in 1990. Landings prior to 1990 were minor, rarely exceeding 10,000 lbs (Figure 6.4C). Landings did increase in the mid to late 1980s up to around 9,000 lbs annually, reaching 15,000 lbs in 1989. With the exception of three years (1950, 1951, and 1975), Cobia were only commercially landed using ‘Line’ in Mississippi (NOAA unpublished data). Since 1990, Mississippi has prohibited commercial catch and landing of Cobia from its waters.

Louisiana

Following Florida, Louisiana is the second largest producer of commercial Cobia. Landings were minimal until the mid-1980s when harvest began to increase, eventually reaching just over 100,000 lbs by 1994 (Figure 6.4D). Landings since 1994 have steadily decreased to the lowest numbers in recent years with a slight increase beginning in 2011 (NOAA unpublished data).

Incidental targeting of Cobia from the commercial Red Snapper fishery likely constituted a large portion of the commercial Cobia landings in Louisiana prior to regulatory changes in the reef fish fishery in the 1990s, at which time the commercial season was greatly reduced. It is also likely that the resulting "derby" style fishing during the first 10 or 15 days of a month, in which a daily limit of 2,000 lbs and one trip per day, led to less time available for commercial fishermen to land incidental catch. With commercial reef fish harvesters rushing to land 2,000 lbs of Red Snapper daily in a compressed time window, there was likely less time to pursue other commercially viable species such as Cobia during these trips. After the implementation of an IFQ system for Red Snapper in 2007, when season length and trip limits became moot, Cobia landings increased slightly from previous levels. A moratorium on commercial reef fish permits and overall reduction in the size of the fleet have likely kept Cobia landings from rebounding to historical levels.

The low commercial Cobia landings from 2004 through 2013 are likely the result of a number of tropical storms and hurricanes which battered the northern Gulf in 2004 and 2005, greatly reducing fishing opportunities as vessels, harbors, and onshore infrastructure were destroyed. As the region began to recover, the British Petroleum Deepwater Horizon disaster closed much of the Gulf during the prime Cobia fishing season in 2010, reducing the landings to a mere 1,500 lbs (NOAA unpublished data). Lingering concerns over residual oil and potential contamination of seafood products in general further complicated the commercial fishing industry and likely affected Cobia landings.

Since 2000, spears and various combinations of 'Lines' harvest the majority of Cobia in Louisiana with spears surpassing all other gears since 2014 (Figure 6.8; NOAA unpublished data). In recent years, the popularity of spear fishing has led to a slight increase in commercial Cobia landings. Nearly 25,000 lbs of Cobia were landed in 2016, with over 15,000 lbs of those landings coming from spear fishing (Figure 6.8, NOAA unpublished data).

Commercial landings of Cobia in Louisiana tend to peak during the summer months in July and August. Like in other states, a two fish daily bag limit both commercially and recreationally greatly reduce the effort on the part of most commercial fishermen. Much of the Cobia landed commercially in Louisiana are likely bycatch or opportunistically caught while targeting other species.

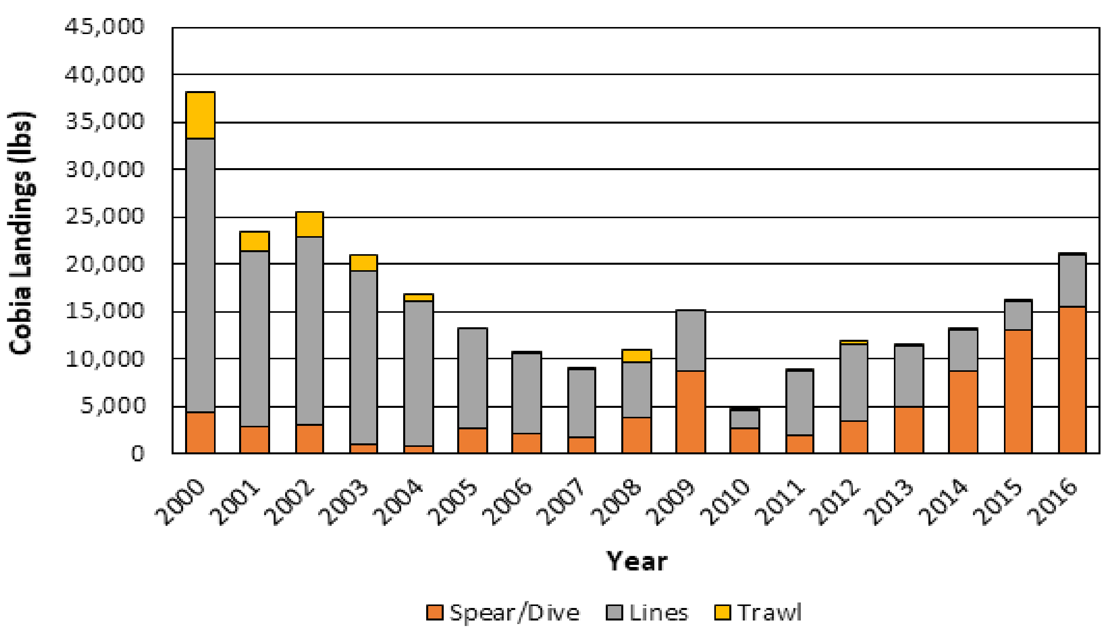

Figure 6.8 Breakdown by gear of commercial Cobia landings in Louisiana from 2000-2016 (NOAA unpublished data).

Texas

Beginning in about 1960, Cobia commercial landings from Texas began to increase, similar to Alabama, but rarely exceeded 25,000 lbs annually (Figure 6.4E). With the exception of a couple low years around 1980, landings in the 1980s through the early 2000s averaged just under 10,000 lbs (NOAA unpublished data). Since 2010, commercial Cobia landings in Texas have only reached about 2,500 lbs on average.

Prior to 1993, the majority of Cobia were landed by 'Line', with a few trawl landings in the early 1950s and early 1980s. Since 1993, gears have been combined in the NOAA data from Texas and do not separate the landings again until 2015 and 2016. Trip ticket data from Texas do provide some gear insight, which is not reported by the NOAA general landings, with nearly all the commercial Cobia landings harvested using a combination of 'Lines' and no other gear.

Recreational

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 in 2011, the previous MRFSS landings from 1994 forward have been revised using the new protocols and are reported below. Since 2014, Louisiana has employed its own recreational survey, the LA Creel program, to generate recreational harvest estimates. Together, these four programs provide the best estimates of landings and effort by recreational anglers in the Gulf of Mexico and southern Atlantic regions.

Unlike commercial landings information, the reported recreational landings in the MRFSS/MRIP include both retained (type 'A' and 'B1' that are 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 represent total harvest, as designated by the NMFS. All recreational landing estimates from NOAA include a measure of percent standard error (PSEs) which measures precision of the estimates. PSEs are derived, in part, based on the occurrence of the species in the angler intercepts. A low rate of intercept (or a rare species) prevents reliable estimates of harvest when expanding over the whole recreational fishery (NOAA personal communication). According to NOAA, estimates with PSEs above 50% indicate high variability around the estimate (therefore low precision) and should be viewed cautiously. Gulf-wide, the average PSEs for Cobia recreational landings are around 20% over the nearly 40 years of data provided. Each state varies in the PSEs with the higher contributing states having substantially better precision estimates. In the South Atlantic, the PSEs for Cobia are also regularly intercepted by samplers and thus have relatively good precision (≈25%) whereas the estimate for the Mid-Atlantic is poorer (≈50%) (NOAA unpublished data).

Recreational Cobia landings in the U.S. are dominated by the Gulf and East Florida with the South Atlantic (excluding East Florida catches) and Mid-Atlantic providing virtually all the remaining landings. Despite sparse information in the NOAA MRIP data for the other regions, Cobia are known to be harvested by anglers in the Chesapeake and throughout the Caribbean (Figure 6.9).

Recreational anglers in the Gulf and East Florida take advantage of the seasonal migrations of Cobia from the Florida Keys to the northern Gulf or up the Atlantic toward the Carolinas and back annually. Anglers in the Florida Panhandle expect fish to arrive to the area by early March and move towards Mississippi and Louisiana by April where they remain for much of the summer and early fall before returning south around October (Schwartz et al. 1981, Smith 1995, Biesiot et al. 1994, Franks et al. 1999, Franks personal communication). As a result, most of the Cobia in the northern Gulf are taken by hook-and-line during that time although Franks (unpublished data) has seen Cobia that remain all winter in offshore waters associating with the deep water oil and gas platforms.

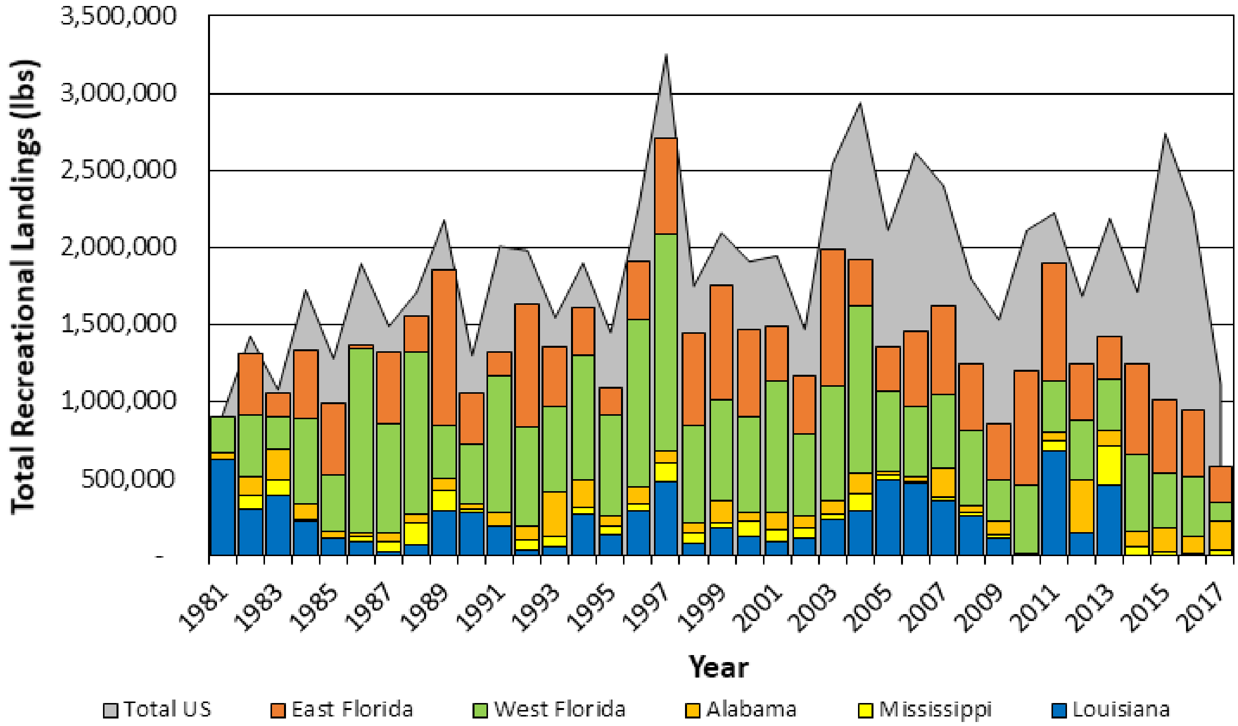

Figure 6.9 Recreational Cobia landings (A+B1) by state and total U.S. from 1981-2016 (NOAA unpublished data). **Note:** Louisiana recreational landings since 2014 were collected by LA Creel and are not included. Texas collects numbers of fish in their survey; total weight is estimated and is not part of the NOAA MRIP database.

Cobia that migrate up the Atlantic move north along the Florida coastline in March to May and return south by December and January. Anglers specialize on Cobia during these windows of opportunity, keying in on surface water temperatures, ideally 20-21°C (68-70°F), and the occurrence of schools of migrating Manta Ray (*Manta birostris*) which Cobia typically associate with.

Throughout their range, Cobia are known to associate with flotsam such as mats of *Sargassum*, other marine plants, or logs, as well as manmade debris such as trash bags, floating bottles, pallets, and other items which may be isolated or consolidated by opposing offshore currents that meet to form rips or weedlines. Like many of the highly migratory species, these random items on the ocean surface provide a shade oasis in the otherwise habitat-sparse pelagic zone as well as serve to attract bait. Just as Cobia can be found associated with large Manta Rays (*Manta birostris*), they may also be found in close proximity to schools of Cownose Ray (*Rhinoptera bonasus*) and sharks and have often been mistaken for sharks by anglers and divers (Smith and Merriner 1982, Shaffer and Nakamura 1989, Rogers et al. 1990). As noted above in *Commercial Fishery - History*, Cobia can often be found adjacent to shrimp boats, channel markers and buoys, and gas and oil platforms. Zales (personal communication) reported Cobia associating with sea turtles in the northern Gulf. Recreational anglers may run their vessels 100 miles or more moving from rig to rig searching for Cobia in the northern Gulf during the summer.

Cobia are known to be great fighting fish and most are landed on heavy gear. Cobia make very hard runs initially and will drag line into structure or roll and cut line with their powerful jaws and teeth. Most anglers recommend a heavy leader (40-50 lbs) and a stout conventional rod for jigging. When fishing around surface structures, a heavy spinning rod may be used since it is easier to cast and/or 'flip' a bait into an area without spooking the fish. Cobia are commonly known as 'crab-eaters' as they are a frequent food source but they consume other benthic organisms such as shrimp, eels, and other fish (Meyer and

Franks 1996, Franks et al. 1996, Arendt et al. 2001) but juvenile crabs and eels are the more popular live and cut bait for most anglers in the northern Gulf (Franks personal communication, VanderKooy personal observation). Artificial lures used for Cobia include any plastic version of crabs or eels and a number of jig configurations plain or tipped with cut bait, feathers, or plastic tails.

History

Fishing for Cobia is not mentioned often in the literature and what does exist generally describes smaller fish living in more inshore areas. Henshall (1903) described Cobia as an estuarine/lagoon associated sportfish achieving sizes of a few feet and up to 20 lbs. The account mentions Cobia utilizing mangrove habitats along East Florida in the Indian River Lagoon and south to Key West. It should be noted, Henshall (1903) did observe one specimen in Key West reaching five feet and noted it was the largest he had seen.

> "As might be imagined from its shape and habits, it is a good game-fish, and quite strong and vigorous on the rod. It requires all of the angler's skill to land it safely, especially when it is taken about the mangroves, among whose arching and numerous roots it is sure to take refuge if it can do so. It will take a small fish bait or a crab, going for it with a pikelike rush."
>
> "A strong, rather heavy rod is necessary for the cobia, which the Key West fishermen call cobi-d. A striped-bass chum rod of natural bamboo is a good and serviceable tool for the work, with multiplying reel and braided linen line, to which is affixed a Sproat hook, No. 3-0, on gimp snell, by a brass box-swivel. A sinker should not be used about the mangroves.
>
> A fiddler-crab, a mullet, or other small fish is hooked through the lips, and is cast from a boat to the edge of the mangroves or other bushes, in the same way as in casting for mascalonge in northern waters."
>
> "The cobia takes the bait with a fierce lunge, and turning quickly endeavors to return to his lair, a proceeding that must be thwarted by the angler at all hazards to his rod or tackle, for once under the arching roots of the mangroves he is as good as gone. The boat must be rowed to open water at once, while a strong strain is maintained by the rod on the fish. With open water the angler can play his fish with leisure, though he will be severely taxed by the struggles of as game a fish as he is likely to meet during a winter's sojourn in Florida."
>
> Henshall 1903

Turner-Turner (1902) described the giant fish of the Florida Gulf Coast around Punta Gorda, Florida and noted that:

> "The cobia grows to a length of four or five feet, and is a dashing fish when hooked, though it is not very common in the angler's catch."

Bradford (1908) described a number of fish of interest to sport fishermen and included Cobia in his extensive list. He reported that Cobia were caught in deep, clear waters on heavy tackle with small fish bait, are common in Florida, and ranged from the Gulf to the Northeast. Bradford indicated that Cobia "weigh up to twenty pounds" suggesting, like others reports, that he had access to juvenile and subadult fish nearshore, not adults.

However, based on the description of the Cobia appearance, behavior, and habitat by Henshall (1903), the species described sounds more like the Common Snook (*Centropomus undecimalis*) rather than Cobia. Bradford (1908) included 'snook' in his common name list along with 'sergent fish' and may have similar confusion although the species extensive range is not the same for Snook.

Hallock (1876) also described Cobia (Crab-Eater or Sergeant Fish *Elacate atlanticus* – a synonym of Cobia) as a mangrove associated sportfish which reminded him of the fresh-water Pike. He described the fish as having "a long under-jaw, full of sharp teeth" and gets its name from the long black stripe running the full length of the fish's "silvery" sides. It is difficult to confirm what species these authors were discussing and if they were indeed Cobia (*Rachycentron canadum*) but most of these reports are likely the Common Snook.

Smith (1907) described species off North Carolina and included Cobia, but noted some insight into the common name. He indicated that "the name cobia usually given this fish is not known to American fishermen, and may have originally been a misprint for cabio" and based on the other descriptions, that seems to be the case.

Like the question of species descriptions, the quality of Cobia as an edible fish was never completely clear in most of the early descriptions which may be based on the species actually described. Cobia was described as a "fairly good food-fish" by Henshall (1903), however, Gregg and Gardner's 1902 book *Where, When, and How to Catch Fish on the East Coast of Florida* described Cobia flesh as "barely edible". Likewise, Hallock (1876) noted that he found the flesh of Cobia "rather course and indifferent food".

State Recreational Fisheries

Cobia are common in all of the five Gulf states but, due to their solitary nature, they show up in the MRIP landings infrequently as they are not intercepted often. Much of the targeted effort is tied to the fishing tournaments and rodeos which will be presented later in this chapter. Most saltwater anglers have seen Cobia swimming around or near structures like oil rigs, buoys, and shrimp boats, but not all have successfully landed them. Saltwater angling (conventional tackle) fishing records for Cobia for each state are provided in Table 3.1. The current International Game Fish Association (IGFA) world record Cobia was landed in Shark Bay, Australia in 1985, but is not close to the Louisiana state record of almost 150 lbs which is not recognized by the IGFA. The largest Cobia ever taken by spear was listed by the International Underwater Spearfishing Association at 145.9 lb fish shot off Mexico in 2011 but a 172 lb was shot in 2014 which would have been the largest by spear or any other gear but took two anglers with three shots to capture it, therefore disqualifying it from the record (Figure 6.10).

Cobia are fished recreationally throughout the Gulf region during the summer months and many anglers await the arrival of Cobia along the Panhandle indicating the start of fishing in the northern Gulf. Anglers target Cobia around any structure they may pass, including oil rigs, channel markers, navigation buoys, and floating debris like weedlines or trash. Most anglers jig for Cobia, but Zales (personal communication) noted that they can catch them on bottom with live or cut up bait. If the fish is on the surface, it can also be caught with live bait. Anglers off Mississippi often sit on the sandbars off the barrier islands and chum as currents carry fish along the islands in shallow water. Off Horn and Ship Islands, recreational anglers will motor slowly around the shallow water areas looking for Cobia in clear water and sight cast to with feather jigs and plugs. They may also be seen in shallow water swimming with or under schools of rays.

One of the most common techniques used by recreational anglers is concentrating effort on and around fish-attracting devices (FADs). Anglers often deploy FADs in slightly deeper waters, sometimes called 'artificial turtles', to attract Cobia. Private FADs are illegal, but that does not stop some from deploying their homemade creations under the cover of darkness. A Cobia's affinity for sea turtles, rays, whale sharks, and natural structure makes the taboo practice highly effective. When fishing in tournaments, the temptation to utilize these structures can become quite profitable and often give an advantage over anglers using naturally occurring structures or debris to locate Cobia. Details on FAD design and deployment are discussed in *Chapter 4 - Fish Aggregating Devices (FADs)*.

Figure 6.10 A 172-pound Cobia shot by Cyrus Bravin and Marcelo Mello Lobato off Marataizes, Brazil (photo by Bradenton Herald).

While the Gulf region (including East Florida) has historically produced the majority of Cobia landed in the U.S., the South Atlantic (Georgia to North Carolina) and the mid-Atlantic (Virginia) have harvested a few more Cobia in recent years and since 2015, together, have surpassed the Gulf (Figure 6.11). It is not clear what changes may be occurring, but there are numerous reports in fishing magazines of Cobia migrating further north in the last several years. In 2014, several Cobia were landed by recreational anglers where they had rarely been reported before. In Rhode Island, a new Cobia record broke the previous state record which was set in 1995 by more than a pound (Monti 2014). In addition, more stringent regulations on other species have put more pressure on Cobia along the South Atlantic as charter boats and recreational anglers seek out other species (ASMFC 2017). In 2017, Cobia fishing on the Atlantic migratory group from Georgia to New England was shut down in all federal waters and most of the state waters due to concerns over the high landings and an exceeded quota for the Atlantic. The fishery reopened in 2018, but at much lower quotas and a reduced bag (NCDMR 2018).

Florida (East and West)

Recreational anglers in Florida have opportunity along both coasts to catch Cobia as they migrate north from their overwintering grounds around South Florida. Along both coasts of Florida, the number of directed trips, as reported in the MRIP data, follow the availability of fish during migration (Figure 6.12). Generally, recreational effort (trips targeting Cobia) in the Gulf begins in March and runs until the fish have passed through in April to May. Similar to the commercial landings, most of the recreational landings (around 75%) occur as Cobia are moving through the Panhandle to the west or up the Atlantic from February to May.

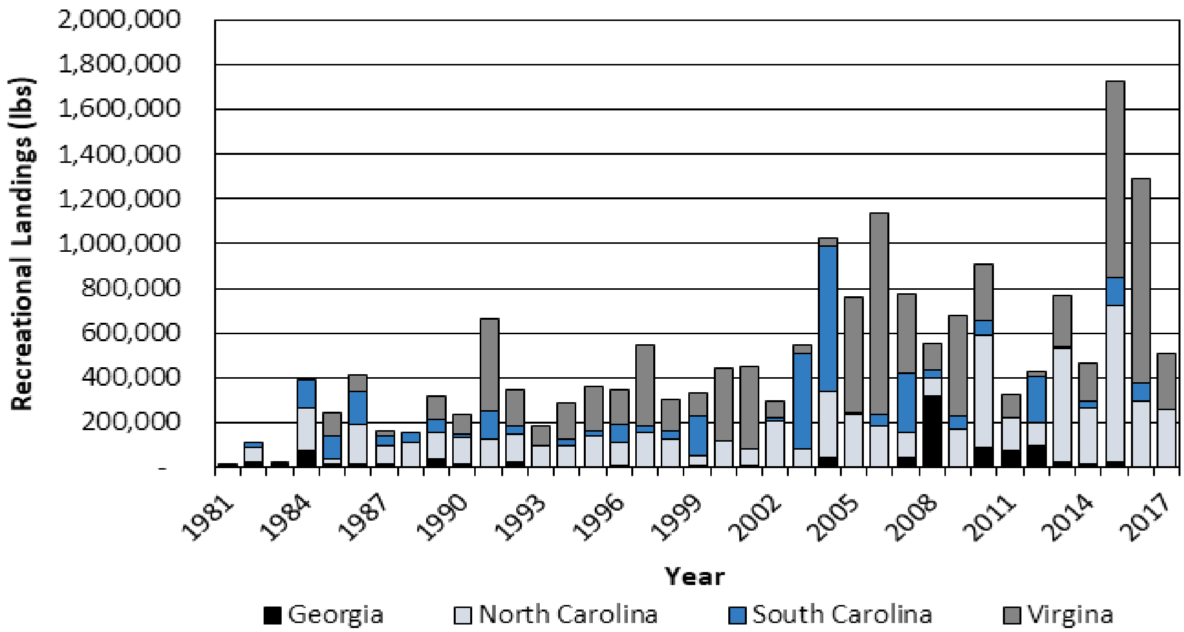

Figure 6.11 Recreational Cobia landings along the South Atlantic states (excluding Florida) from 1981-2017 (NOAA unpublished data).

The primary fishery for Cobia along East Florida is around Cape Canaveral through the winter months. The MRIP landings do not provide a great number of intercepts but, based on angler reports and the trends from the commercial harvest, most of the fish overwinter from West Palm to the Cape from December to June with people making directed trips targeting Cobia in May and June (Figure 6.12). While the stock break is still considered the Georgia/Florida line, acoustic tagging work provides some evidence of movement further south into Florida waters from the Atlantic migratory group (SEDAR 2013, Perkinson et al. 2018b).

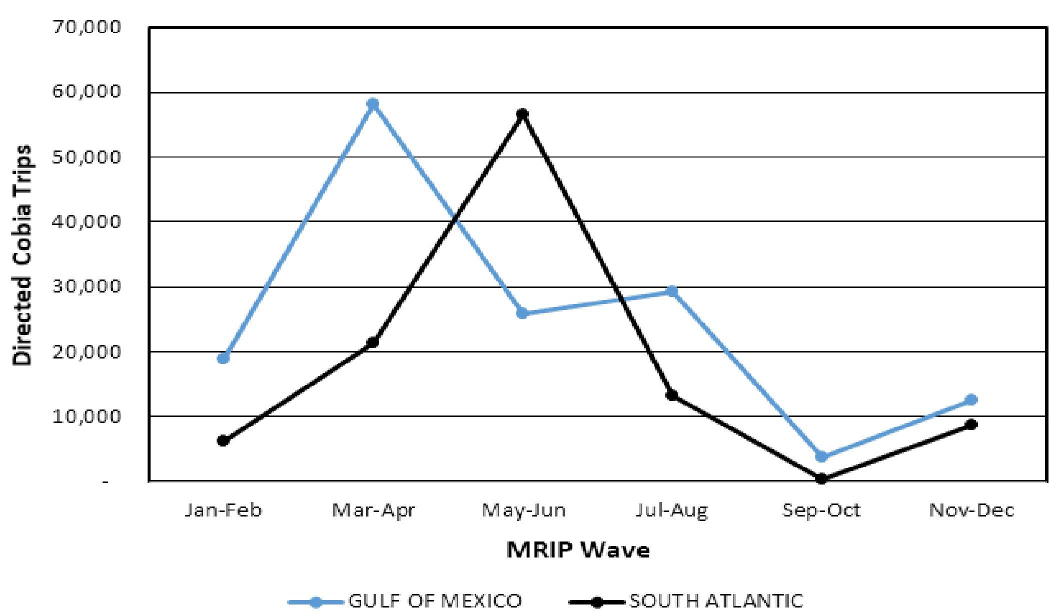

Figure 6.12 The total directed trips with Cobia listed as primary or secondary target for 2016 (NOAA unpublished data).

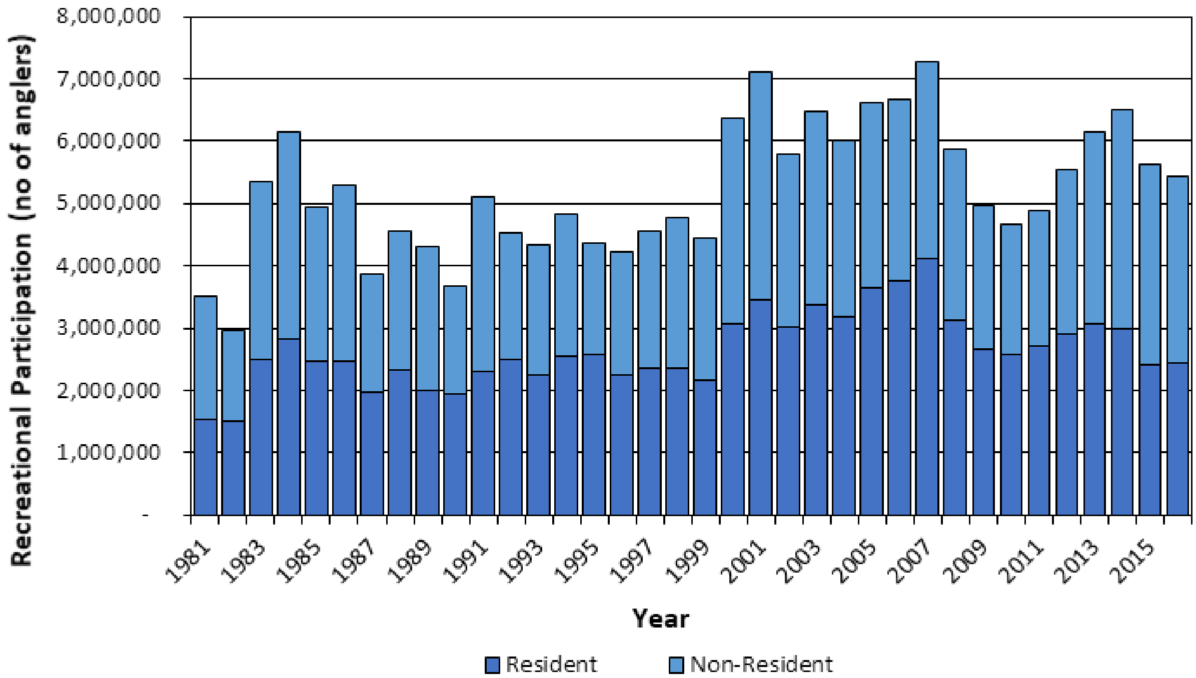

Figure 6.13 The recreational participation along both coasts of Florida of resident and non-resident saltwater anglers from 1981-2016 (NOAA unpublished data). **Note:** NOAA has eliminated this calculation so there is no estimate for 2017.

Participation in the fishery is not completely clear however. While a number of trips are made annually targeting Cobia, not all anglers in Florida are targeting Cobia other than perhaps in the winter in South Florida and the Panhandle and northeast coast in the spring. NOAA's historic estimates of participation by both resident and non-resident anglers from 1981-2016 are provided in Figure 6.13. License sales do not provide an indication of effort either since the majority of the fishing year is spent targeting a wide range of species both inshore and offshore. Other than the short window during migration, Cobia are likely harvested opportunistically as they are encountered by anglers targeting reef fish or other pelagic species.

Although there are a number of recreational trips made throughout the year to specifically target Cobia, they are likely during the winter in South Florida, and during the spring throughout the Panhandle and the northeast coast. Much of the Cobia harvested within Florida is harvested opportunistically, typically when targeting other pelagics like King Mackerel and Dolphin, or while transiting out to target reef fish.

There is a unique set of anglers who almost exclusively fish from piers during the Cobia migration runs along both coasts. The piers provide direct access to offshore Cobia as they pass through near the coast and anglers essentially use these structures as inexpensive charters, filling the piers shoulder to shoulder during a short period of time. These will be discussed later in the document under *Pier Fishing for Cobia.*

Landings of Cobia in Florida saw a slight rise in the 1990s and a slight decline through the early 2000s (Figure 6.14A). The landings since about 2008 or 2009 have remained lower in part due to fewer fish seen close to shore in the Panhandle according to anglers. The lack of consistent migrating fish in the spring has caused some concern about the Gulf's population levels; however, it has also been speculated

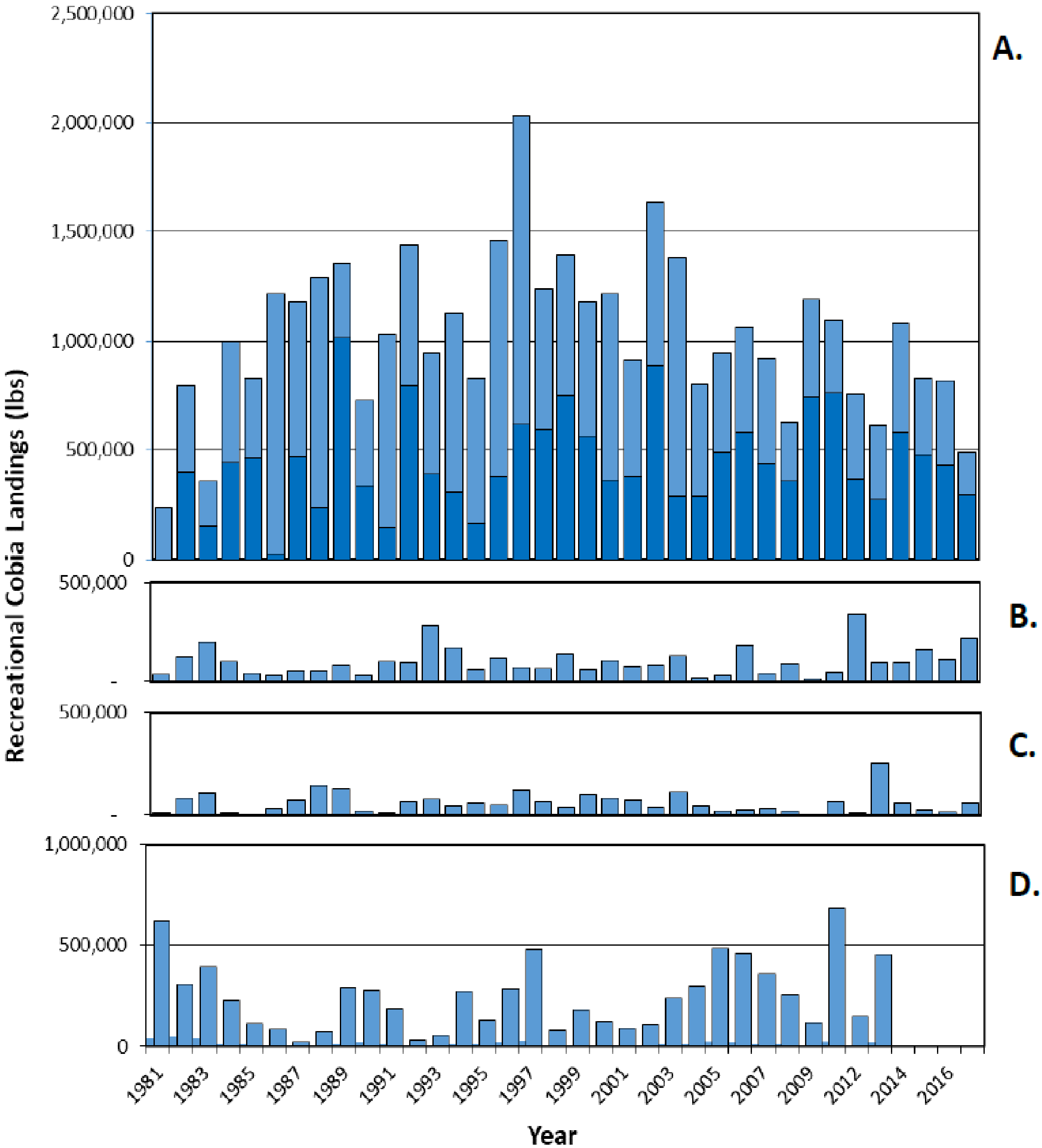

Figure 6.14 Recreational Cobia landings (lbs) in A) Florida (East dark blue, West light blue), B) Alabama, C) Mississippi, and D) Louisiana from 1950-2016 (NOAA unpublished data). **Note:** Louisiana began its own recreational survey, LA Creel, in 2014 and is no longer included in the NOAA MRIP estimates.

that migrating Cobia may be staying further offshore during their westerly run toward the northcentral Gulf (Franks personal communication). This could be due to a number of factors including warmer winter temperatures causing Cobia and potentially bait to stay further offshore in more preferred water temperatures. Again, the reliability of the recreational landings data should be considered, however, as percent error around these estimates can range from 20-50% due to infrequent sampling in the MRIP interviews.

Alabama

Recreational Cobia landings in Alabama have fluctuated widely over the last 30 years with a few higher punctuations (1983, 1993, and 2012), but typically averages around 100,000 lbs annually (Figure 6.14B). The state record in Alabama was landed in 1995 and weighed 117.6 lbs. Like the rest of the northern Gulf, Cobia are landed by recreational anglers off Alabama throughout most of the year, but peak in May-August as they migrate west (Figure 6.15). Anglers wait for the arrival along the beaches east of Mobile Bay and then target fish around the various petroleum platforms, navigation buoys, and channel markers in the nearby waters in the mouth of the Bay and south of Dauphin Island throughout the summer. The fall return migration in September and October is not as well-known; therefore, fewer people target Cobia in the fall.

Participation in recreational fishing in general has gone up steadily since 2000 with non-residents nearly surpassing residents since 2011 (Figure 6.16). While most of these anglers are targeting a wide range of species such as reef fish, nearly any fisherman will throw to a Cobia when they see one. It is

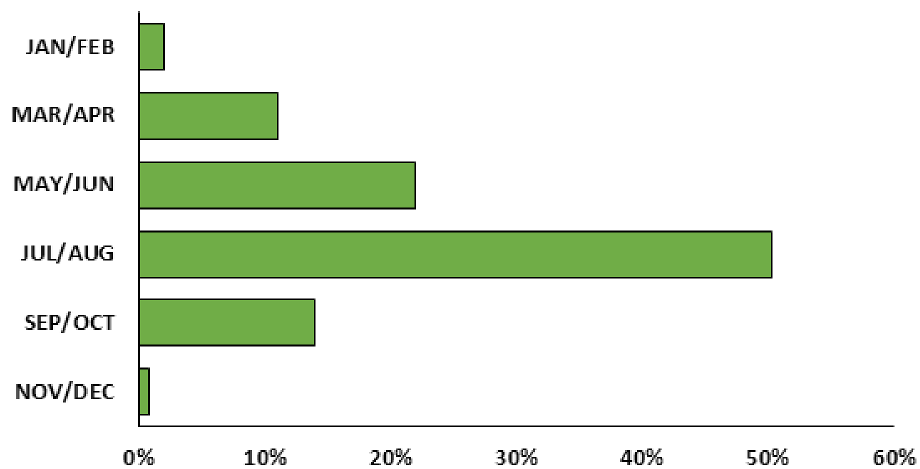

Figure 6.15 Recreational landings in Alabama by two-month wave averaged over the entire time series from 1981-2017 (NOAA unpublished data).

difficult to identify a ‘Cobia angler’ in Alabama when there is so much publicity and preference for Red Snapper. Most anglers will make a stop near a buoy or channel marker on their way offshore looking for a Cobia near the surface swimming around the structures. Most will have a fishing rod setup for jigging whenever they fish around the petroleum platforms in anticipation of fish showing up or following gear and/or fish up from depth.

In Alabama, about 17,500 trips were made on average since 2010 by anglers who declared to MRIP samplers that they were targeting Cobia as their first or second choice of species (NOAA unpublished data). For the same time period, approximately 2.3M total saltwater trips were made in Alabama waters for all species including Cobia.

Mississippi

Recreational anglers in Mississippi target Cobia around the barrier islands along the outside of Mississippi Sound and on most of the navigation and petroleum structures that dot the deeper water. During the summer months, anglers will anchor along the bars off Cat, Ship, Horn, and Petit Bois Islands, chum and fish with live Atlantic Croaker (*Micropogonias undulatus*), various eels, and Hardhead Catfish (*Ariopsis felis*) using corks or balloons while waiting for passing Cobia which forage around the shallow

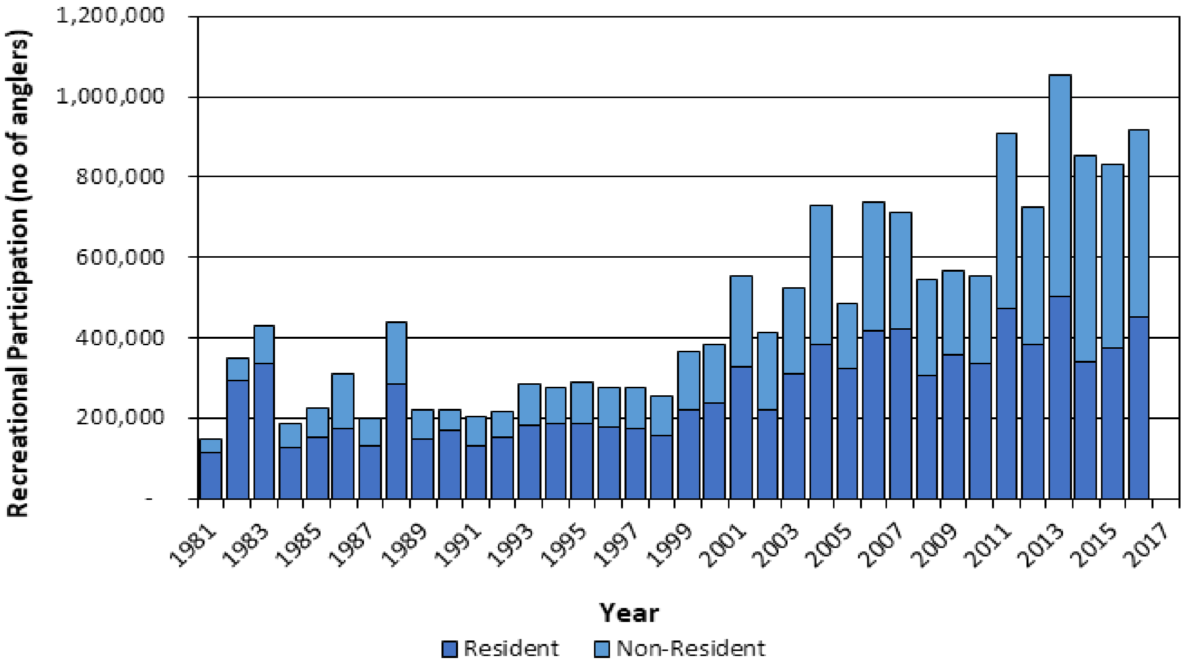

Figure 6.16 Number of resident and non-resident anglers participating in saltwater fishing in Alabama from 1981-2016 (NOAA unpublished data). **Note:** NOAA has eliminated this calculation so there is no estimate for 2017.

waters. Anglers may fish the high energy south side of the barrier islands looking for Cobia to sight cast as well. Cobia are frequently found swimming near, above, or below large rays. Anglers patrol these waters and spot from a high vantage point for solitary fish swimming in the clear water. In addition, nearly every vessel that passes the navigation buoys in the passes between the barrier islands will "jig the cans" in hopes of raising a fish or two. Unlike the Florida Panhandle region, Cobia will randomly distribute throughout the Mississippi waters all spring and summer peaking in June, offering most anglers a chance to take Cobia over the entire season, but at a less frequent encounter rate than during the migration runs when they can be schooled up more (Figure 6.17).

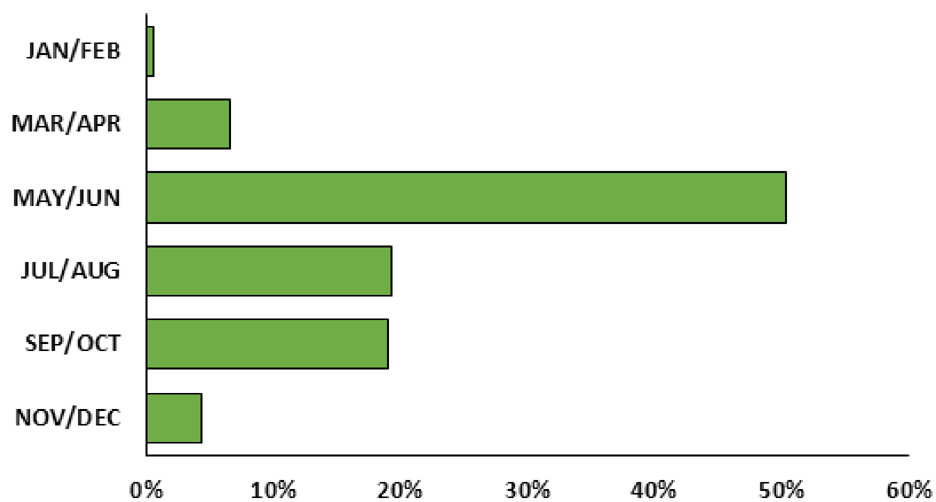

Figure 6.17 Recreational Cobia landings in Mississippi by two-month wave averaged over the entire time series from 1981-2017 (NOAA unpublished data).

The recreational landings off Mississippi have been relatively small compared to the other states, averaging around 57,000 lbs annually. There are three years with virtually no recreational Cobia landings in Mississippi waters. They include 1985 due to Hurricane Elena, 1991, and the fishing closures from the oiling of the northern Gulf of Mexico from the Deepwater Horizon disaster in 2010 (Figure 6.14C). A significant peak in Cobia landings occurred in 2013 although it is not clear if this is a real population increase in the area or a survey artifact.

The number of anglers who target Cobia is not easy to determine as most fish for other species and catch Cobia when they happen upon them. Although there are a few anglers who participate in local Cobia tournaments, those individuals will also fish for reef fish and other pelagics. The participation in saltwater

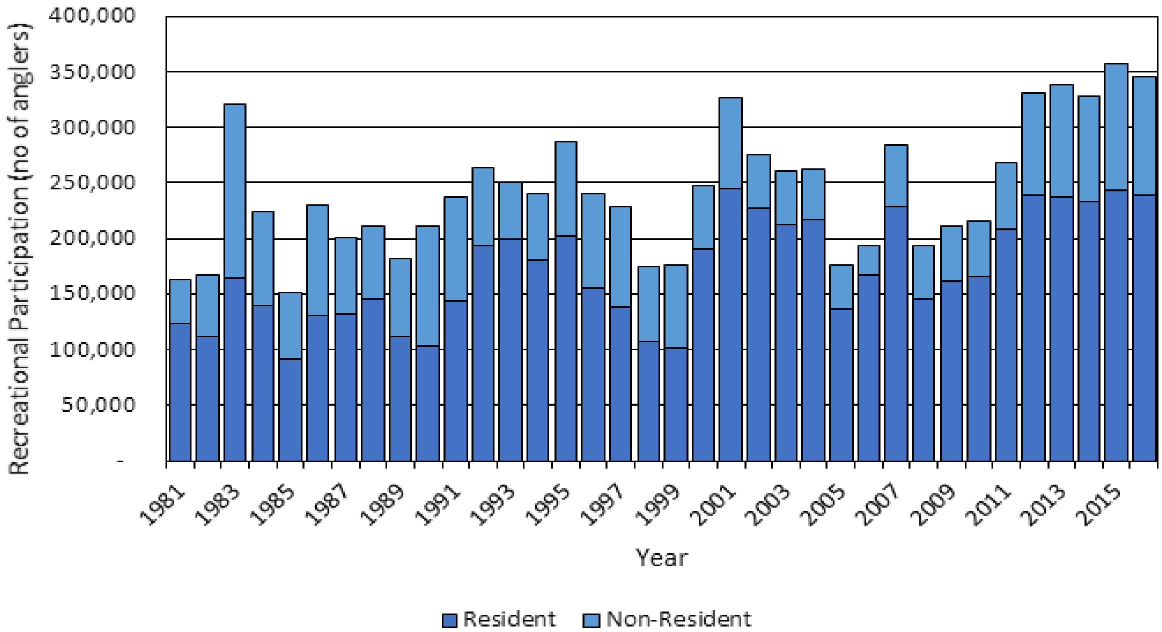

Figure 6.18 Number of resident and non-resident anglers participating in saltwater fishing in Mississippi from 1981-2016 (NOAA unpublished data). **Note:** NOAA eliminated this calculation so there is no estimate for 2017.

fishing in general has been fairly stable with a slight increase following the reduced numbers in 2005 (Figure 6.18). Over the last five years, the resident participation has been around 240,000 with another roughly 100,000 non-residents. Again, any of these anglers could catch Cobia but do not necessarily represent Cobia specific anglers. Since 2010, about 18,000 trips were made on average by anglers in Mississippi who declared to MRIP samplers that they were targeting Cobia as their first or second choice of species (NOAA unpublished data). In comparison, an average of 1.6M total saltwater trips were made during the same time period for all species including Cobia.

Louisiana

Recreational landings of Cobia in Louisiana waters occur from April through August as the fish settle into the northern Gulf to spawn (Figure 6.19). Anglers have the highest success around the numerous oil and gas structures that dominate the offshore waters both east and west of the Mississippi River. Anglers can find fish on nearly any structure i.e., fixed, like a rig, or a navigation piling or buoy, or free-floating such as debris and weedlines, and even sea turtles, sharks, and large rays. Jigging seems to be the favored technique, but according to charter captains, live bait will work well too, especially once one fish is hooked since others will often follow.

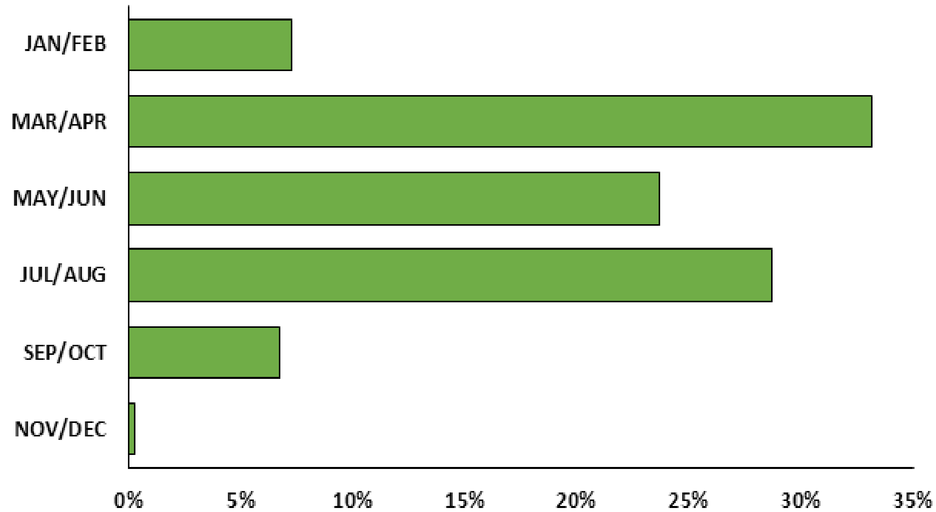

Figure 6.19 Recreational Cobia landings in Louisiana by two month wave averaged from 1981-2013 (NOAA unpublished data). **Note:** Louisiana began its own rec survey, LA Creel, in 2014 and is no longer included in the NOAA MRIP estimates.

Recreational landings in Louisiana have varied widely from year to year with peaks in 1981, 1996, 2005 and 2006, and 2011. The lowest estimated landings occurred in 1987, 1992/1993, and in 2009 and 2012 (Figure 6.14D). Due to the infrequency with which Cobia are targeted and caught, the proportional standard error for these estimates is high, and it is difficult to glean a pattern from the variations in landings.

The number of anglers targeting Cobia in Louisiana is difficult to determine. However, a little over 14,000 trips on average were estimated for anglers who reported to MRIP samplers that their primary

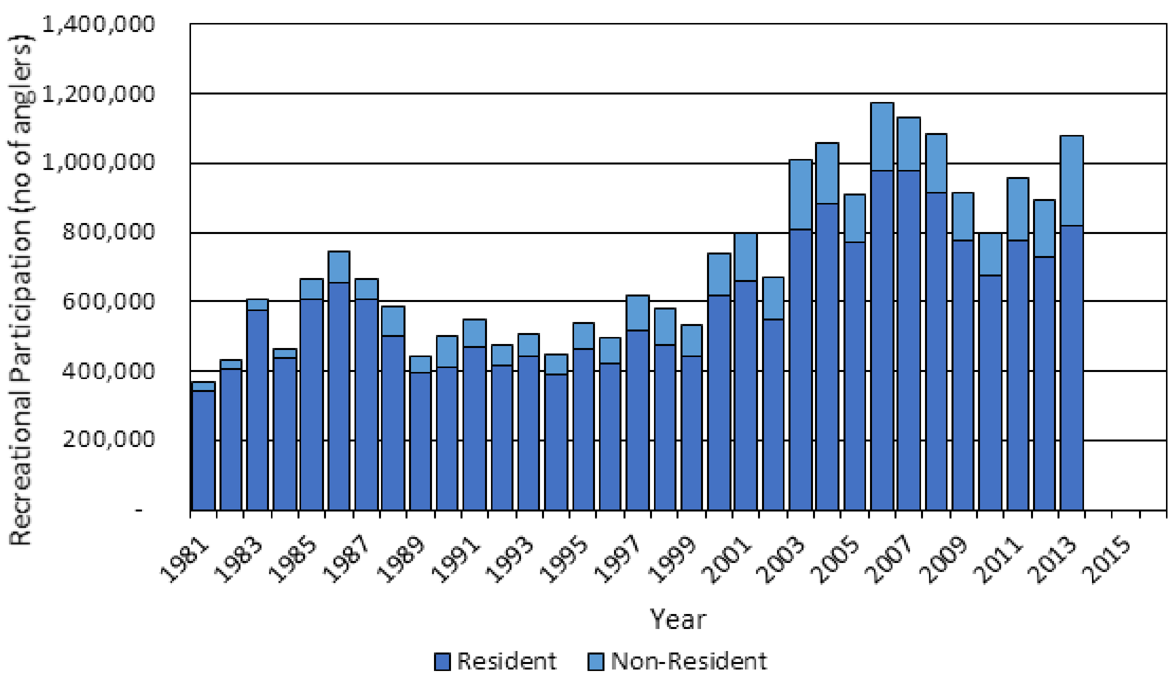

Figure 6.20 Number of resident and non-resident anglers participating in saltwater fishing in Louisiana from 1981-2016 (NOAA unpublished data). **Note:** Louisiana began its own recreational survey, LA Creel, in 2014 and is no longer included in the NOAA MRIP estimates.

and secondary target species were Cobia from 2010-2013 (NOAA unpublished data). An average of 1.6M trips were made during the same time period for all species including Cobia. The majority of saltwater anglers in Louisiana, around 800,000 annually since 2000, are residents according to NOAA estimates (unpublished data; Figure 6.20). With limited charter access other than a few locations, non-resident anglers have remained relatively stable since 2000 at around in 175,000 annually.

Texas

According to the TPWD, recreational anglers in Texas do not routinely make trips specifically to target Cobia; instead it is primarily an incidental catch when fishing for reef fish. Many anglers will go out prepared for Cobia in the event they encounter one but do not frequently seek them out specifically. Texas has a large number of wrecks and petroleum structures within their nine-mile state boundary which affords most anglers access to reef fish in nearshore waters, potentially reducing the recreational effort beyond the state boundary. In the last decade, the federal season for Red Snapper has been shortened every year, further reducing angler presence in those waters. Finally, the sea conditions in the western U.S. Gulf tend to be rough and do not allow as much access to waters further offshore due to safety (TPWD personal communication). TPWD staff also note that many of the Gulf anglers in Texas are not intercepted because many do not haul out at survey sites. Instead they will go directly to houses or slips and are not intercepted as a result. Any combination of these and other factors may be driving the lower intercepted recreational catches in Texas.

The recreational harvest of Cobia in Texas has varied widely over the duration of the time series (Figure 6.21). While the landings increased throughout the mid-1990s, the estimates are based on very few fish being intercepted by TPWD creel samplers. The landings peaked in 1992 and again in 1996 through 1998. A general increase occurred around 2008 but, since 2010, the landings have been relatively low, averaging around 940 fish annually.

The majority of recreational landings in Texas occur during the summer months, from June through August (Figure 6.22). In addition, the Cobia landings along the coast originate from the upper half of the state. A few fish are landed in the Corpus Christi region but most are reported from San Antonio Bay

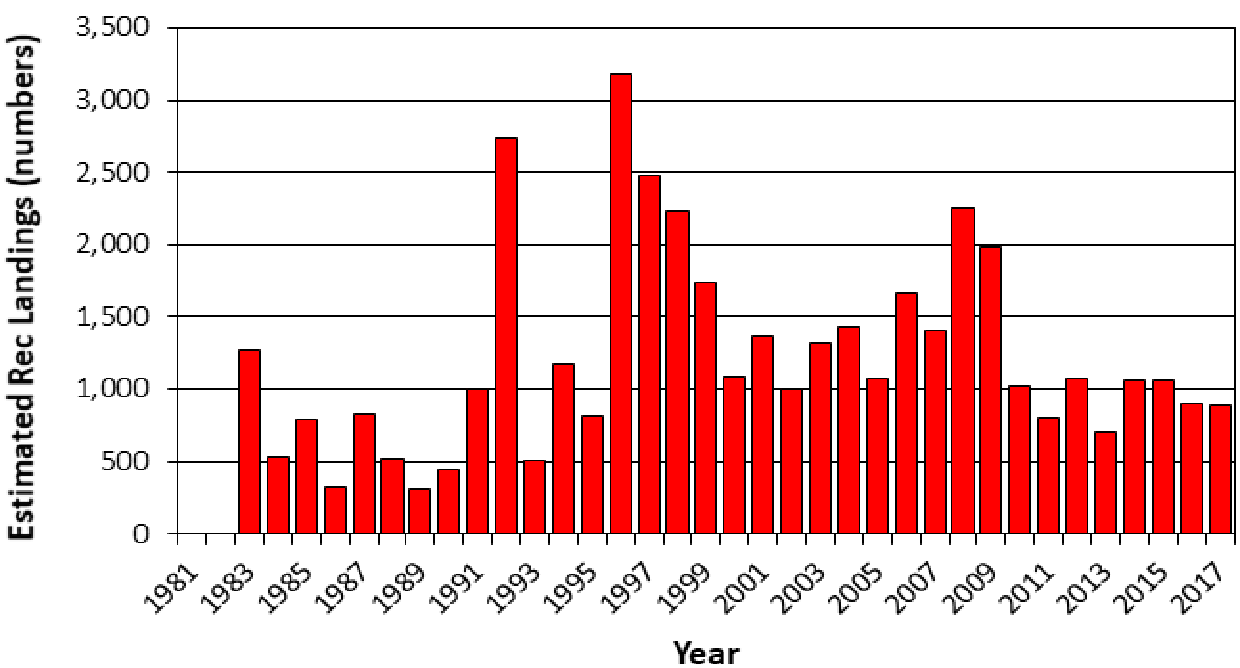

Figure 6.21 Estimated recreational Cobia landed (numbers of fish) in Texas waters from 1981-2017 (TPWD unpublished data).

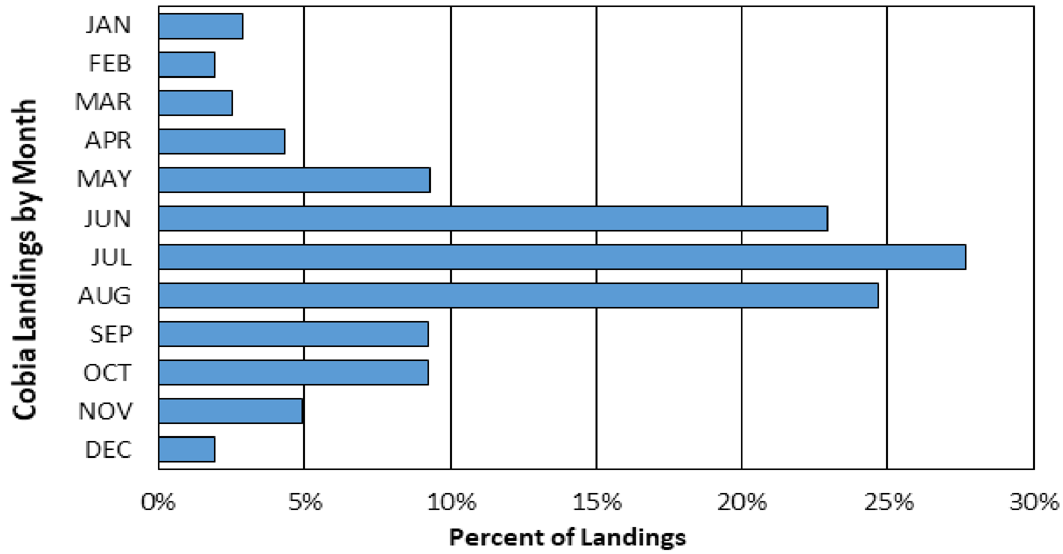

Figure 6.22 Percent of recreational Cobia landings by month from the Texas Survey (1978-2017) along the entire coast (TPWD unpublished data).

north (Figure 6.23). Fishing reports found online indicate that Cobia can be found along the upper coast beginning in May at rigs and structures just beyond state waters. The closer platforms are good targets in spring and early summer. During the summer (May through September) along the mid and lower coast, Cobia can be found much closer to shore and frequent the various jetties and piers. They also associate with weedlines, navigation markers, and shrimp boats (Texas Weekend Angler 2017).

Pier Fishing for Cobia

A unique opportunity exists in the eastern Gulf for anglers who do not have access to offshore vessels to fish for Cobia during the migration runs utilizing 'pay' fishing piers which punctuate the coastline of Florida and Alabama. These long piers stick out further from shore along high energy beaches where deep water is closely accessible allowing anglers to target Cobia and other species as they migrate past without

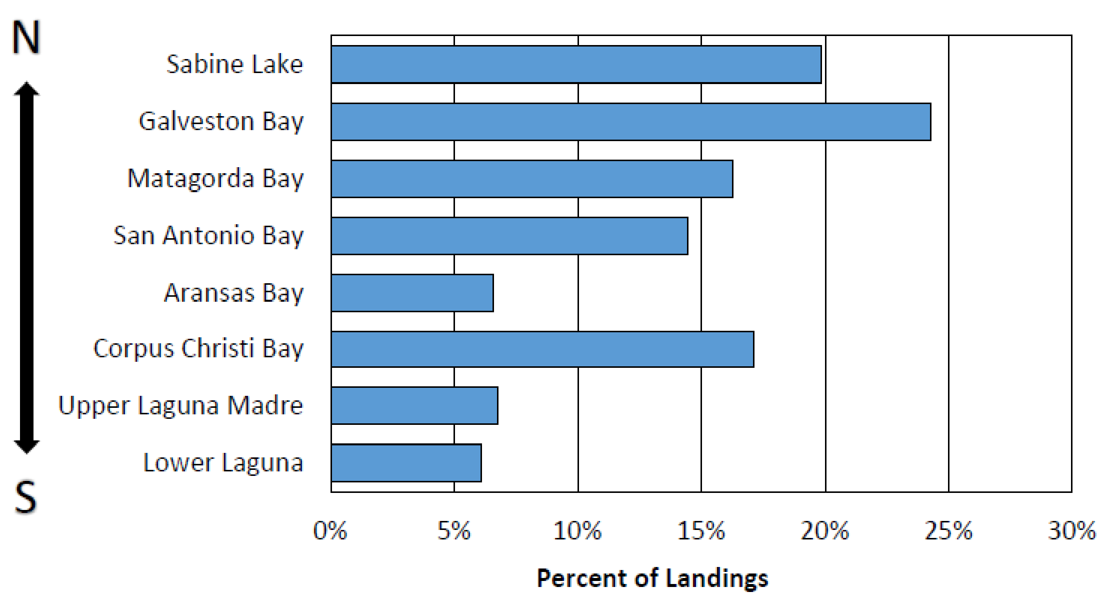

Figure 6.23 Percent of recreational Cobia landings by major bay system from the Texas Survey (1978-2017) along the entire coast (TPWD unpublished data).

the overhead of vessel cost, maintenance, and fuel. The purchase for access to many of these piers provides a daily permit for anyone to use it. The routine MRIP angler intercepts include pier anglers, at least in Florida, but there is little information on the total numbers of Cobia landed from these structures. An exploration of the number and timing of pier access purchases may provide some insight into the seasonality and effort associated with pier angling, especially during Cobia migration (*Chapter 7 – Cobia Angler Expenditures*).

Despite little published data on the use and success of Cobia anglers associated with piers, the sport fishing literature and internet have many examples of fish being harvested from these structures. Fishing from most of these piers is difficult due to the height of the structure itself. However, that height offers anglers a much better view of fish passing through the area. In the case of Cobia, once hooked, a green or fresh fish will run far from the pier or directly under it trying to shake-the-hook. A well-hooked Cobia needs to be fought for a considerable time until it nears exhaustion. A flying gaff or bridge gaff is generally used to land the fish and lift it up to the pier. An issue arises when fish that are near the minimum size limit are hooked and the angler must determine if it is a legal fish before they gaff it. Without enforcement personnel on-site, there may be a large take of undersized Cobia. Returning a gaffed fish to the water would be undesirable obviously and assumed to result in mortality. In this section, we will present how these structures operate and explore the potential effort associated with pier fishing, especially in the Florida Panhandle and Alabama.

According to various sport fishing sites and online fishing reports, the timing of Cobia arriving at these structures is carefully monitored by anglers around the start of migration. As reports begin to mention the sighting of fish in local waters and especially around the piers, anglers flock to the structures and the usage increases from a few people daily to potentially hundreds overnight. As more fish are seen, anglers begin to stake out a spot early in the morning along the railings and wait for someone to call out a fish. One of the best descriptions of this annual angler pilgrimage to the piers is reported by Mashburn (2018) in his article *Cobia Fishing Off the Pier* describing Cobia fishing from the Gulf State Park Fishing Pier in Gulf Shores, Alabama.

> "It's really simple to pier fish in March for cobia. You haul or roll your equipment to the end of the pier, stow it in a safe place, and take your rod and reel and jig to the rail and watch, and watch, and watch.
>
> The cobia will be moving from the east toward the west, and many times, they can be seen a long way off in the clear Gulf water. Quite often, the cobia is seen as just a dark shadow on the water.
>
> Cobia anglers soon learn to pay attention to any dark movement or shadows in the water. This is because these tend to turn into big cobia. When you see the fish, all you have to do is cast in front of it. Then, the fish eats the jig and the fun begins."
>
> "Anglers have to find a good place on the pier rail and occupy it as others come and go and fish around them. It goes without saying that good manners and patience are important when big cobia start swimming past the pier. Anglers need to be polite and give each other room.
>
> If an angler calls "First shot!", he or she needs to be allowed to make the first cast without having a few dozen "friends" cast over his or her line. Also, anyone who casts a lure at a cobia that an angler hooked and is working to the pier should expect to receive some very sharp comments about his family and personal life."

The proper fishing etiquette is likely different for each location but generally, most of the piers in the Florida Panhandle region are considered "first shot" piers. As one of the older Cobia anglers (KnotFor

Reel) reported in a blog, "[first shot] gives a slight advantage to those with younger eyes but levels the playing field when those youngins get nervous and blow their chance at first shot...However the youngins with both great eyes and nerves of steel..., well they're just downright unbeatable..." (Pensacola Fishing Forum 2012).

East Florida

Along East Florida, several long fishing piers exist but not all regularly land Cobia during their northerly migration in the spring and return in the fall. The 990 ft Juno Fishing Pier in Jupiter Beach and the 876 ft Anglin's Fishing Pier in Fort Lauderdale regularly have Cobia landings associated with them. Reports on the various fishing blogs and social media pages suggest that Cobia arrive at the East Florida piers around the first of April, attracted by the large schools of bait fish and stay through May. They return in the fall but are less frequently caught. There are many more access points along East Florida but few report regular visitation by Cobia.

The NOAA MRIP survey asks East Florida saltwater anglers about the type of fishing they participate in as well as what their target species may be. The data indicate that since 2010, an average of around 120,000 trips are made from the shore which target Cobia as the first or second preferred species. These trips could only be made from the various fishing piers and perhaps a few jetties and passes where Cobia could be occasionally caught. Based on the 'Shore' landings for Cobia along East Florida since 2010, an average of about 29,000 lbs were landed associated with shore fishing (NOAA unpublished data).

West Florida

There are several fishing piers along the Peninsular Gulf Coast of Florida which include the 700 ft Venice Fishing Pier, the 1,000 ft Gulf Pier at Fort De Soto Park, the Redington Long Pier in Redington Shores, and Pier 60 in Clearwater which extends 1,080 ft into the Gulf. Each of these piers has varying costs to access. The City of Venice purchased a single pier license so fishing is free to all with no access fee but Pier 60 has a daily pass of $8.00 to adults.

Along Florida's Panhandle, fishing piers that have reported Cobia landings in social media outlets include Okaloosa Island Pier in Fort Walton Beach, Russell-Fields (City) Pier in Panama City Beach, the M.B. Miller Pier (County) in Panama City, the St. Andrews State Park Pier in Panama City, and Santa Rosa County's Navarre Beach Fishing Pier. The Dan Russell-Fields Fishing Pier and M.B. Miller are 1,500 ft in length and allow access for fishing for $6.00. The St. Andrews State Park Pier extends 500 ft into Gulf and occasionally reports Cobia being landed. The Okaloosa Island Pier extends 1,262 ft off Fort Walton Beach and the Pensacola Beach Gulf Pier extends 1,470 ft. The Navarre Beach Fishing Pier is 1,545 ft long and offers daily fishing to adults for $7.00 per day with weekly and annual passes optional. The NOAA shore mode landings and participation estimates indicate that on average since 2010, about 130,000 dedicated Cobia trips landing around 55,000 lbs have been made from shore each year (NOAA unpublished data).

Alabama

In Alabama, the state owns and operates the Gulf State Park Fishing Pier in Gulf Shores, Alabama. The quarter mile long pier operates daily for anglers to have access to fishing beyond the surf-zone, and fishermen frequently land Cobia when they are moving from Florida further west toward the Mississippi River (Mashburn 2018). Mashburn reports that "some of the most knowledgeable veteran Cobia anglers to be found anywhere are in constant attendance at the pier once the big brown bombers start to show up in spring." For a nominal fee of $8.00 per day to residents and a valid state saltwater license, an angler can make the journey to the end of the pier and cast to the shadows as they pass. During the height of the Cobia season, which typically begins around the end of March or early April, many fish are taken by pier anglers. Paid entries to the pier indicate an increase each year in March/April and consistent peaks in June/July (Figure 6.24). The June/July peak coincides with an increase in commercial landings (Trip Tickets) and somewhat with the recreational landings which peak in May/June and July/August according to the

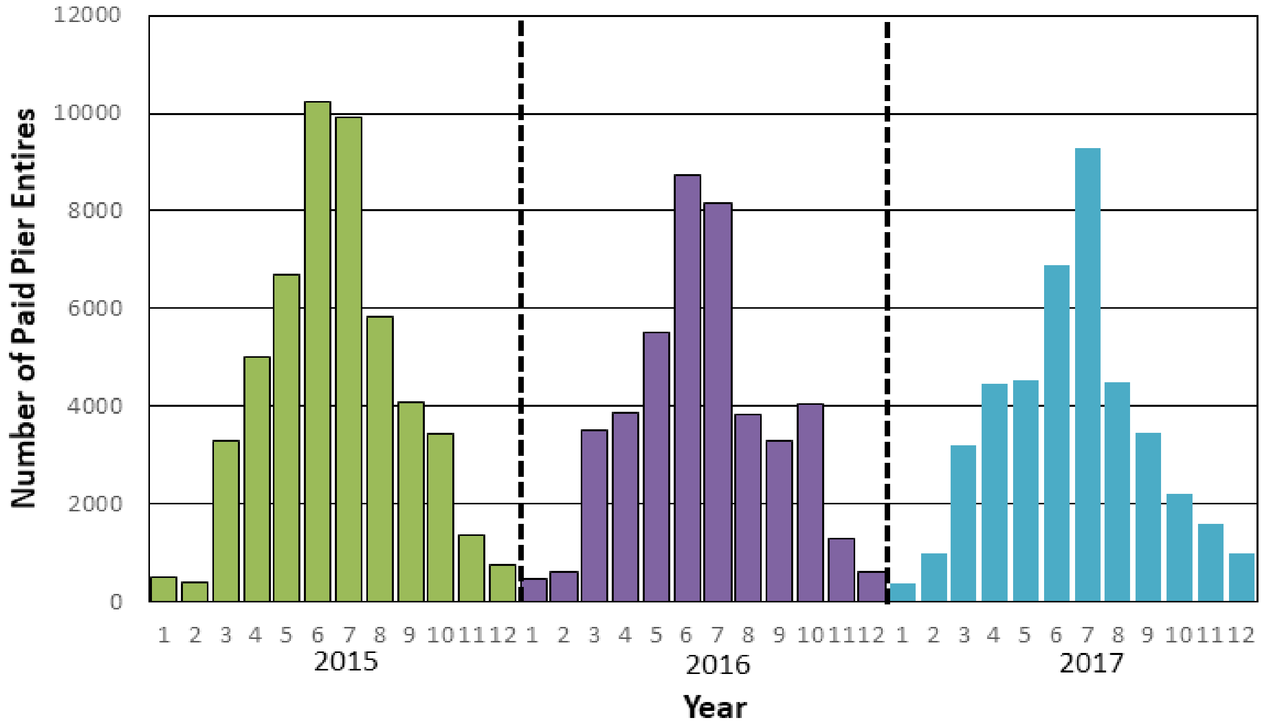

Figure 6.24 The number of paid angler admissions to the Gulf State Park Fishing Pier in Gulf Shores, Alabama by month for 2015-2017 (AMRD unpublished data).

MRIP Wave data. Because the pier usage is reported in two week intervals, it is impossible to detect when the Cobia actually show up off the Alabama beaches but usage is clearly tied to the species availability. Additional use occurs in later summer by anglers looking for King Mackerel which pass through the waters off the pier in July and August (Mareska personal communication).

Alabama anglers reported to MRIP that they had made an average of 17,500 shore trips each year targeting Cobia since 2010, the majority of which were likely associated with the Gulf State Park Fishing Pier. NOAA estimates indicate, based on the reported Cobia landings by these anglers, about 1,000 fish were taken during May/June averaging around 10,000 lbs since 2010. It should be noted that error around these estimates is very high but this is supported by information available on social media.

Mississippi and Louisiana

Although Mississippi and Louisiana do have public piers which occasionally report Cobia, they do not have exceptionally long piers that extend into waters that Cobia frequent. Anglers have reported Cobia around the Ship Island Pier in Mississippi and the Grand Isle Pier in Louisiana, however, a targeted pier fishery similar to those in the Florida Panhandle or Alabama does not exist in either state.

Texas

In Texas, there are two piers that occasionally produce Cobia - the Bob Hall Pier on Padre Island and the Galveston Fishing Pier. However, there are a number of jetties that frequently produce Cobia as well. Unfortunately, there is little information on the numbers of anglers using the pay fishing piers and no way to gauge the effectiveness of these structures to aid anglers in targeting Cobia from shore. Reports from TPWD indicate that, while Cobia are occasionally landed from piers, landings are infrequent and piers are not a primary tool used by most Cobia anglers.

Tournament Fishing for Cobia

In recent years, nearly every saltwater angler from the Gulf to Cape Cod has become familiar with Cobia and how to identify and fish for them. Sport fishing magazines, newspaper articles, fishing forums, internet blogs, and online fishing reports all tell how to fish, when to fish, and where to fish for Cobia. Throughout the Gulf of Mexico, fishing rodeos and tournaments list Cobia as a prize category species, often in a 'big money' category. A number of fishing tournaments include Cobia as one species in a suite of many but there are a few that only target Cobia. 'Shootouts' as they are often called, focus only on Cobia and anglers who enter may travel by boat hundreds of miles over one day or more in search of fish. Some of the longest running tournaments which list Cobia include the Mississippi Deep Sea Fishing 4th of July Rodeo held in Gulfport (71 yrs), the Southwest Louisiana Fishing Rodeo in Lake Charles (80 yrs), the Alabama Deep Sea Fishing Rodeo held each year on Dauphin Island (89 yrs), and the International Grand Isle Tarpon Rodeo in Louisiana (90 yrs). Additional events include the Crosthwait Fishing Tournament in Palmetto, Florida (36 yrs) and the Conde Cavaliers Mardi Gras Fishing Rodeo also on Dauphin Island, Alabama (37 yrs). Cobia-only tournaments include the Gorenflo's Cobia Tournament and the Gorenflo One Day Shootout (both 32 yrs) in Biloxi, Mississippi, the Cobia World Championships which includes the Frank Helton Crab Cruncher Tournament (29 yrs) and the Harbor Docks Summer Open Fishing Tournament (5 yrs) in Destin, Florida. Also in Destin is the Hog's Breath Cobia Shootout (18 yrs) and the HarborWalk Marina Cobia Tournament (21 yrs).

Tournament fishing has resulted in a number of state Cobia records being set and the amount of prize money available can be staggering, making it worth the effort for many anglers. The largest payouts have been the Outcast Cobia Classic in Pensacola, Florida with a $6,500 first place prize while the Texas Star Fishing Tournament offers new ATVs and trailers to the angler with the biggest Cobia. Additional prize money is often provided for breaking state and rodeo records. The Gorenflo Cobia Tournament in Biloxi, Mississippi awards an additional $25,000 and a new truck to a registered angler who breaks the records in their annual event. As a result, these tournaments have become highly incentivized for anglers to participate in and target Cobia during the spring and summer, increasing the effort on the species.

These tournaments may also provide a positive, indirect measure of management for Cobia populations in the region. In recent years, several tournaments have restricted the minimum size of Cobia they will allow to be entered and offer incentives to tag fish, rather than retain them all. For example, the Harbor Docks Frank Helton Crab Cruncher has implemented a minimum weight of 45 lbs for submission while the Texas Star Tournament has restricted submissions to a minimum of 50 lbs. The Outcast Classic and Gorenflo Cobia Tournament provide registered anglers with Cobia tagging kits and award prizes for successful tagging as incentive to release fish and help with regional scientific studies.

As of 2016, after growing concern among anglers, most of the Florida Panhandle Cobia tournaments implemented rules banning the use of, or fishing around FADs. These include the Harbor Docks Frank Helton Crab Cruncher, the Outcast Classic, the Cobia World Championships, the Boshamp's Flathead Classic, the Outcast Cobia Invitational, and the Destin Cobia Tournament. Any fish believed to be caught associated with illegal FADs would be disqualified and anglers found deploying FADs would be disqualified from the tournament and could be banned from future events.

Aquaculture

Cobia, *Rachycentron canadum*, is one of the highest priority marine species for aquaculture in the Western Central Atlantic. Cobia demonstrate extraordinary biological features conducive to aquaculture, including rapid growth, low mortality, low feed conversion rate, and good resistance to nitrogenous wastes (Benetti et al. 2007). Since there is not a large commercial fishery for wild-caught Cobia (~10,500 tons per year, worldwide), aquaculture offers a unique market to meet the emerging world demand.

Table 6.2 Annual world aquaculture production of Cobia from 1995-2016 (FAO unpublished aquaculture data).

Year	Kg	Pounds
1995	3,000	6,612
1996	13,000	28,652
1997	9,000	19,836
1998	961,000	2,118,044
1999	820,000	1,807,280
2000	2,626,000	5,787,704
2001	3,225,000	7,107,900
2002	2,419,000	5,331,476
2003	18,664,000	41,135,456
2004	18,461,000	40,688,044
2005	20,457,000	45,087,228
2006	23,234,000	51,207,736
2007	30,369,000	66,933,276
2008	26,576,000	58,573,504
2009	33,481,000	73,792,124
2010	39,329,000	86,681,116
2011	39,378,000	86,789,112
2012	51,517,000	113,543,468
2013	44,623,000	98,349,092
2014	41,233,000	90,877,532
2015	42,494,000	93,656,776
2016	43,107,000	95,007,828

The first countries that began intensive culture of Cobia were China and Taiwan. Between 2010 and 2015, aquaculture production of Cobia world-wide averaged nearly 42M kg annually, with the highest production occurring in China (FAO unpublished aquaculture data; Table 6.2). Most of the production in China was believed to be retained for domestic use (Pomeroy personal communication).

Taiwan has produced Cobia since the early 1990s and was the first Asian country to develop and adopt intensive Cobia culture methodology despite being one of the smallest producers overall today. Their nearshore cage techniques were adopted by most of the other Cobia producing countries in Southeast Asia as well as the Americas and Caribbean (Liao et al. 2004, Benetti et al. 2007, Benetti et al. 2008). As of 2002, Liao et al. (2004) reported that nearly 80% of all the cage culture efforts in Taiwan were dedicated to Cobia. Since the late 1990s, Taiwan's production has been dwarfed by China and Vietnam. Panama entered the list of Cobia producing nations in 2010 and as of 2015/2016 surpassed Taiwan's production volume (Tveteras 2016).

China became the leader in Cobia aquaculture to supply their domestic demand and received Cobia from both Taiwan and Vietnam to that end. Huang et al. (2011) report that China's Cobia production is primarily located in the Guangdong and Hainan provinces along the country's southern coast. By 1997, Cobia production was significant in China (Liao and Leano 2007), although production numbers were not recorded by the FAO until 2003 (14.4M kg; FAO unpublished Aquaculture data). Marine pen culture began

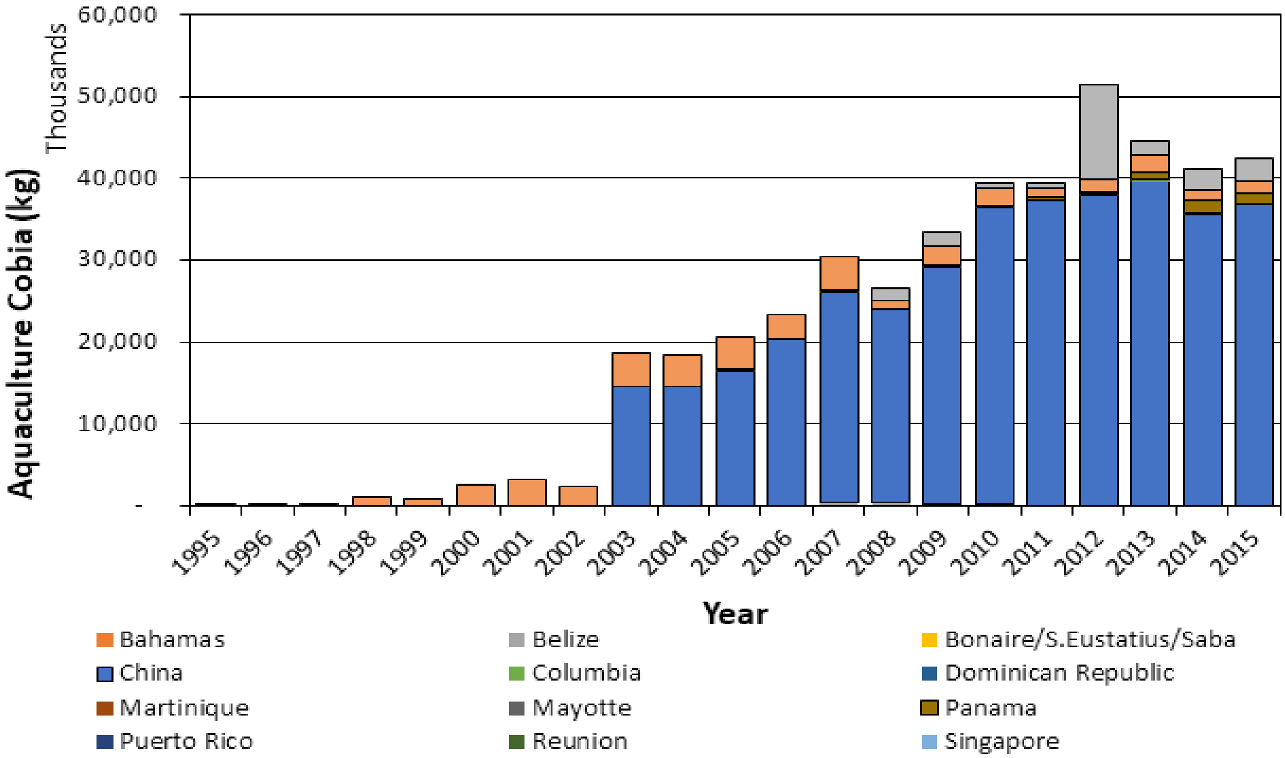

Figure 6.25 Estimated worldwide Cobia aquaculture production from 1995 to 2015 (FAO unpublished aquaculture data).

in Southeast Asia in the 1970s, and by the mid-2000s, nearly 40 species of finfish, including Cobia, were cultured in approximately 1.0M cage/pen units (Chen et al. 2007).

Cobia production in Vietnam has been relatively stable with the exception of a large production year in 2012 (Figure 6.25). Cobia cultured in Vietnam is a "product going primarily to domestic markets and China" (Pomeroy personal communication). Cobia culture was introduced to Vietnam in the mid-1990s as a livelihood alternative for fishers in Halong Bay. Extensive Cobia culture has occurred along the Vietnam Coast since that time with recent production expanding to more brackish waters of the Mekong Delta (Pomeroy personal communication). In general, Cobia produced in Southeast Asia, particularly Vietnam, remain for domestic use and are not exported to the U.S. (Pomeroy personal communication).

The Americas are a more recent addition to world Cobia production since about the late 2000s. Benetti et al. (2007) summarizes the efforts in several Central and South American countries that use a variety of ponds and tanks to produce commercially available Cobia. With the exception of Panama, most of these countries engaged in Cobia aquaculture have not produced a notable quantity of fish, but export their product to the U.S. where it can be found in the market (FAO unpublished aquaculture data, NOAA unpublished data).

Culture Operations

A variety of land-based culture systems are used in Cobia culture and generally reflect the available resources in a region. These systems include recirculating tanks, flow-through tanks, and pond culture.

In the U.S. and Caribbean, the dominant system used is based on the University of Miami's Experimental Hatchery design as described by Benetti et al. (2007). The system is comprised of circular

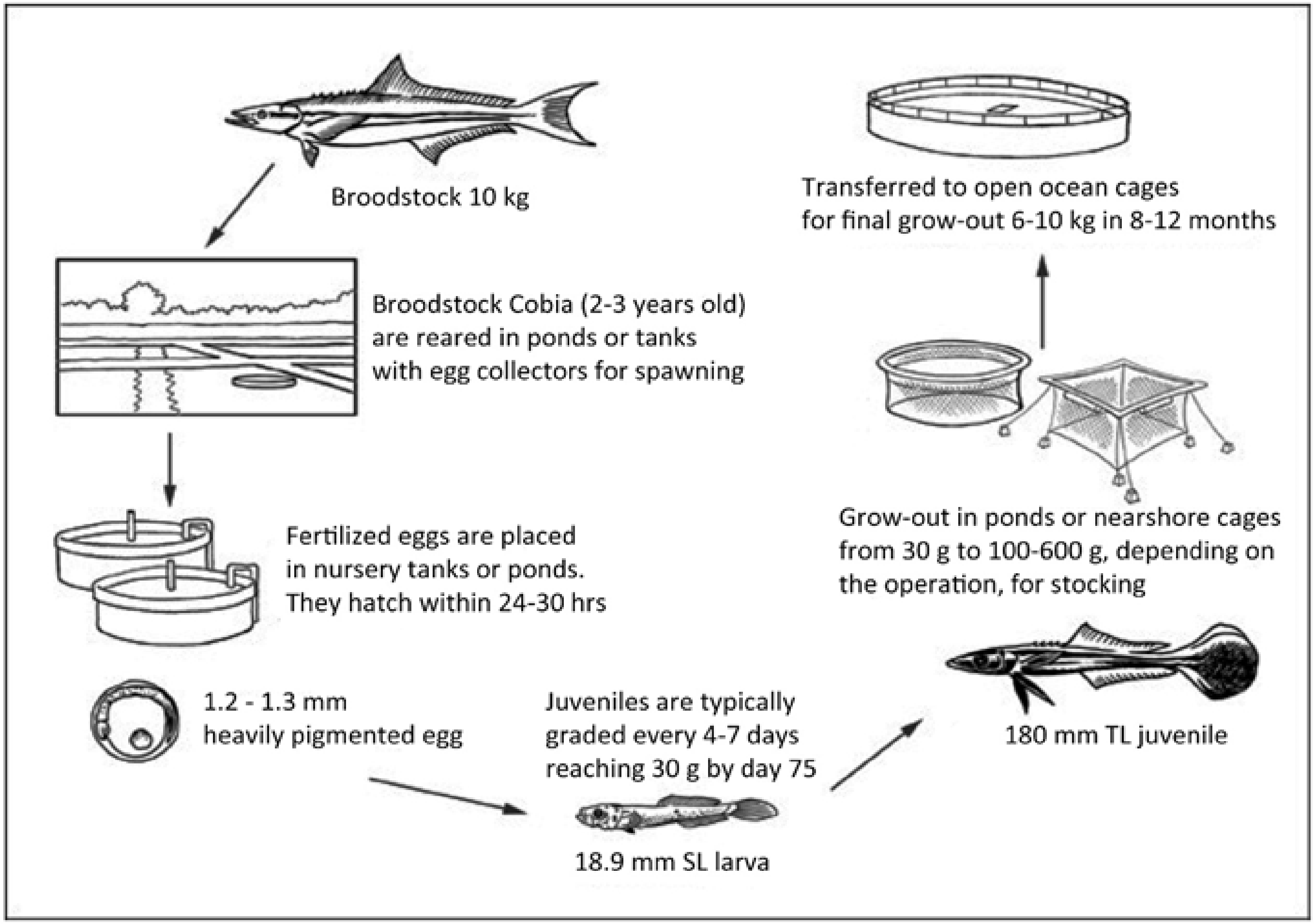

Figure 6.26 Production cycle recirculation system used for mass production *of Rachycentron canadum* (*modified from* FAO 2007).

recirculating tanks that hold brood fish. Each tank is part of an independent recirculating system. The water exits (by gravity) from the center of the tank, is filtered through bag filters, then enters a sump and passes through a glass media filter, a UV filter, and a heat pump. Before returning, the water is sent through a trickle biofilter and foam fractionator/protein skimmer. Broodstock are spawned in tanks, and fertilized eggs are collected and hatched. Hatchlings are held in tanks at varying densities as they grow. Once they reach the juvenile stage, the young fish may be stocked into outdoor ponds or nearshore net pens for final grow out (Figure 6.26).

Most of the Asian hatchery/grow out systems for Cobia use outdoor ponds for spawning and grow-out (Liao et al. 2004). Broodstock are subjected to natural photo-thermal cycles and spawn spontaneously year around, with a peak in spring and autumn. Once spawning and fertilization of eggs occur, the eggs are collected from the water's surface, and moved to outdoor larval rearing ponds which are nutrient enriched to support large zooplankton communities. Once hatched, larvae survive on natural productivity in the ponds and produce very little waste typically resulting in no major effects on water quality or dissolved oxygen levels. Three phases of fry nursing take place following larval production. The first phase takes place in the ponds where eggs are initially stocked and where fry (early juveniles) are weaned onto commercial floating pelleted feed. Fish are moved to grow-out ponds to begin the second phase where they are fed to satiation five to six times a day until they reach about 30 g in body weight. In the third phase, the juveniles remain in the outdoor ponds or are placed into nearshore net pens. At this point, grow-out methods using the two different techniques (i.e., Asian and U.S. systems) become very similar. For smaller scale operations, most grow-out is done in smaller, nearshore net pens as access to land for ponds is limited, or the cost of maintaining an offshore net pen is too high. The fish are placed in circular, near-shore net pens and remain for approximately two to three months to reach a midpoint size. They are then stocked into large pens at lower densities where they remain until they reach market size, typically four to five additional months (Liao et al. 2004).

Open ocean aquaculture is a relatively new and developing methodology, however it has been practiced throughout Asia to commercially raise Cobia (Taiwan, China, Vietnam, Thailand, Indonesia, and Japan). Benetti et al. (2007) described two different types of submersible open ocean cage systems currently in use which are 6,400 m^3, 14,000 m^3, and 21,000 m^3 in usable volume. The first is a bi-conical design constructed of a steel rim and central spar (Ocean Spar Technologies™; Figure 6.27A). The second is a geodesic sphere made up of fiberglass reinforced plastic panels covered in a vinyl coated steel mesh (Aquapod by Ocean Farm Technologies™; Figure 6.27B)

These systems provide optimal conditions for fish and negate environmental impact. The ocean currents can constantly flow water through the cage, resulting in natural ocean conditions for the fish as long as the mesh is kept clear of fouling agents. Cobia have shown reduced growth rates during the grow-out period when crowded (Liao et al. 2004). Open ocean systems may not be economically feasible and only plausible for large commercial operations since they require significant maintenance and support costs managing cages further from land-based operations.

Cobia as an Aquaculture Candidate Species

The average grow-out period for Cobia to reach market size, typically between six and ten kg (Liao et al. 2004), can be as short as four to eight months, but most operations find that Cobia reach market size between 8-12 months (Liao et al. 2004). Since Cobia can live up to 15 years in the wild, young broodstock (age-1.5 to age-2) are typically selected for culture operations (Kaiser and Holt 2005). Wild Cobia have elongated bodies that can reach lengths of 2 m and weights of 61 kg. It has been observed that Cobia held in culture systems may experience reduced growth in length but increased growth in weight when compared with their wild counterparts of similar age. Both wild and cultured female Cobia attain larger size at a faster growth rate than males (Kaiser and Holt 2005).

Although captive juvenile and adult Cobia are voracious feeders, they are generally non-aggressive. Young Cobia in culture systems have been observed to be cannibalistic, so grading throughout the production cycle is crucial in order to reduce cannibalism (Benetti et al. 2007).

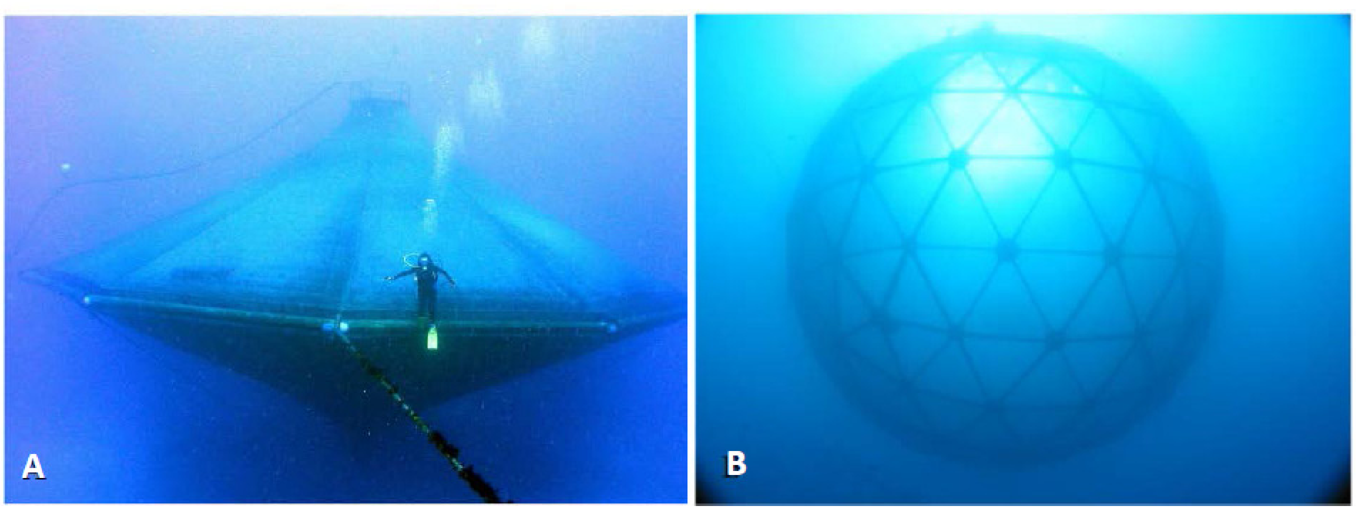

Figure 6.27 Two offshore submerged grow-out cages used in Cobia production: A) a bi-conical cage and B) a geosphere design (*from* Benetti et al. 2007).

After feeding, Cobia in tank culture tend to settle to the bottom and rest on their pectoral fins and tail. Cobia in open ocean culture systems are often exposed to heavy currents and therefore, maintain swimming patterns in formation with other Cobia which might represent additional energy demand compared to tank or pond culture.

Cobia broodstock are able to spawn spontaneously year-round in captivity, peaking in the spring and fall at water temps from 23-27°C (Chang et al. 1999). Cobia in captivity can produce over 1.0M eggs during a spawning event with an initial survival of about 5-10% for the first 20 days after which the average survival rate is 83% overall. This is a relatively high rate when compared to other saltwater species (Liao 2003). Kaiser and Holt (2005) report Cobia harvest density to be around 14 kg/m^3, however numerous studies have shown varying harvest results based on many different factors such as stocking density, temperature, salinity, design of the culture system, feed, and water quality.

Chapter 7
ECONOMIC CHARACTERISTICS OF THE COMMERCIAL AND RECREATIONAL FISHERIES

Cobia is an important component of the cadre of species that are being targeted by both commercial harvesters and recreational anglers in the Gulf of Mexico. Available reported landings and import data suggest that commercially harvested Cobia in the Gulf of Mexico are currently of modest economic importance to the domestic seafood market in the southeast U.S. region. However, Cobia may be assuming a role of greater importance to recreational anglers in the region. Available data dictate that this discussion will focus almost exclusively upon the economic values generated by market transactions associated with the commercial harvest and sale of Cobia during the 1950-2017 period.

For the purposes of the following discussion, the commercial economic value represents the total amount paid by the first handler to the harvester during the initial off-loading of Cobia. This is often referred to as ex-vessel, or dockside, value (dockside from this point forward). Markups that might occur in the subsequent market levels, from the first handler to the consumer, are not included in this discussion due to the paucity of data. Expenditures by recreational anglers are generally not available, though the few data available on recreational expenditures will be discussed. In addition, the nonmarket-related values for both commercial and recreational sectors are not available.

Annual and monthly nominal (not adjusted for inflationary changes) dockside values (USD) will be discussed for each Gulf state and for the Gulf in total. Annual and monthly nominal dockside prices (i.e., the price per pound received by the harvester for the whole fish) will be discussed for the Gulf region and by state. Landings by gear type will be described, as allowed by confidentiality concerns. Information on dockside prices and dockside value provides basic insight into the economic importance of the commercial Cobia harvest sector. Information describing trends in Gulf landings (lbs) of Cobia is found in Chapter 6 (Table 6.1 and Figure 6.4A-E).

The following discussion will focus on commercial dockside value and dockside prices within the Gulf of Mexico region (NOAA unpublished data). However, additional data are available that provide insight into commercial landings and sale of Cobia in the South Atlantic region. These data will be described where appropriate. This non-Gulf of Mexico information was included to provide a more complete picture of the commercial market for Cobia in the southeastern U.S. region, and to provide preliminary insight into the role Cobia landings within the South Atlantic region may play in sales and prices for Cobia originating from the Gulf of Mexico. Information pertaining to the economic values associated with the recreational harvest of Cobia are limited, but the data that are available will be discussed.

Commercial Sector

Annual Dockside Value

Annual Dockside Value by Region

Cobia are landed commercially throughout the Gulf of Mexico, as well as the New England, Mid-Atlantic, and South Atlantic regions. However, during the period from 1950 to 2017, the majority of the commercial landings of Cobia occurred in the Gulf of Mexico (Table 6.1). Note that for the purposes of this discussion, landings occurring on either coast of Florida are considered Gulf landings and part of the management unit (Chapters 5 and 6). Since 1950, approximately 88% of the total dockside value associated with Cobia landings has been reported in the Gulf region, while 88% of the cumulative dockside value of Cobia landed in the Gulf of Mexico has occurred since 1990.

The total annual dockside value for Cobia in the Gulf of Mexico (e.g., including both East and West Florida) did not exceed $100,000 until 1984, when total annual dockside value for that year was $110,680 (Figure 7.1). Dockside value increased steadily until reaching $680,060 in 1996. An erratic decline in value occurred during the following nine years, with a low of $314,340 being reached in 2005. Dockside value then rose dramatically to a record high of $748,700 during 2011. The following years have been characterized by an equally precipitous decline in value, with dockside value declining to $430,270 in 2012, increasing briefly to $558,590 in 2014, then decreasing again to $425,380 in 2017.

Commercial landings of Cobia also occur in the New England (Maine, Massachusetts, Rhode Island, Connecticut), Mid-Atlantic (New York, New Jersey, Delaware, Maryland, Virginia), and South Atlantic regions (North Carolina, South Carolina, Georgia), with the majority of landings occurring in the South

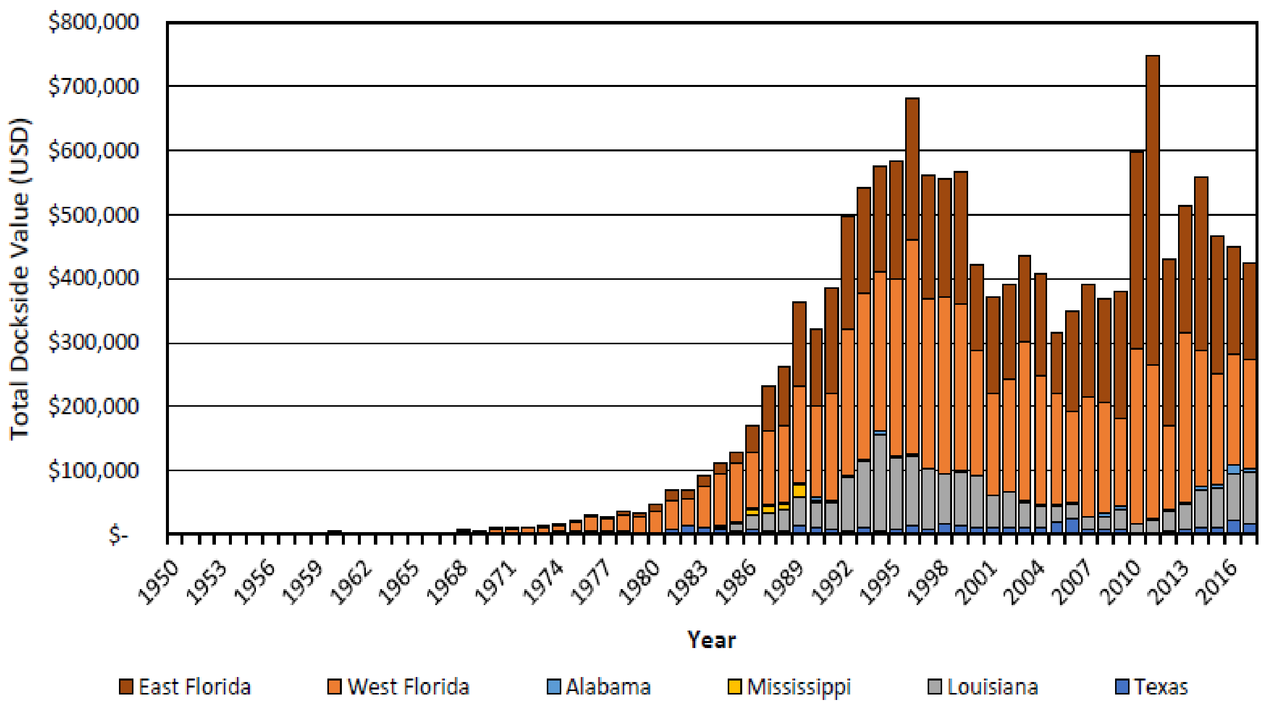

Figure 7.1 Total dockside value (USD) of commercial Cobia by state for the Gulf and East Florida from 1950-2017 (NOAA unpublished data).

Atlantic region (excluding East Florida) but still represent only around 20% of the total U.S. landings (Figure 6.2). Commercial landings of Cobia were not reported for the New England and Mid-Atlantic regions until the mid-1980s. Total dockside value for commercial Cobia landings during the 1985-2017 period was $6,610 and $514,200 for the New England and Mid-Atlantic regions, respectively (Figure 7.2). Prior to 2008, dockside value was less than $5,000 for the Mid-Atlantic region, but then increased to $14,500 in 2008. Dockside value then increased significantly from $32,460 in 2013 to $116,800 in 2017. The dockside value for Cobia landed in the South Atlantic remained below $5,000 until 1980. Dockside value in the Mid-Atlantic region then increased to $18,250 in 1985, followed by a somewhat steady increase to $124,840 in 2016. Cobia dockside value for the region then decreased to $67,570 in 2017.

Annual Dockside Values by State

The following discussions of dockside value by state refer to Table 7.1. Note that the East Florida is also included within the discussion of Gulf states. The reported aggregate dockside value of commercial Cobia landings in the Gulf did not exceed $100,000 until 1984. Following that benchmark year, West Florida,

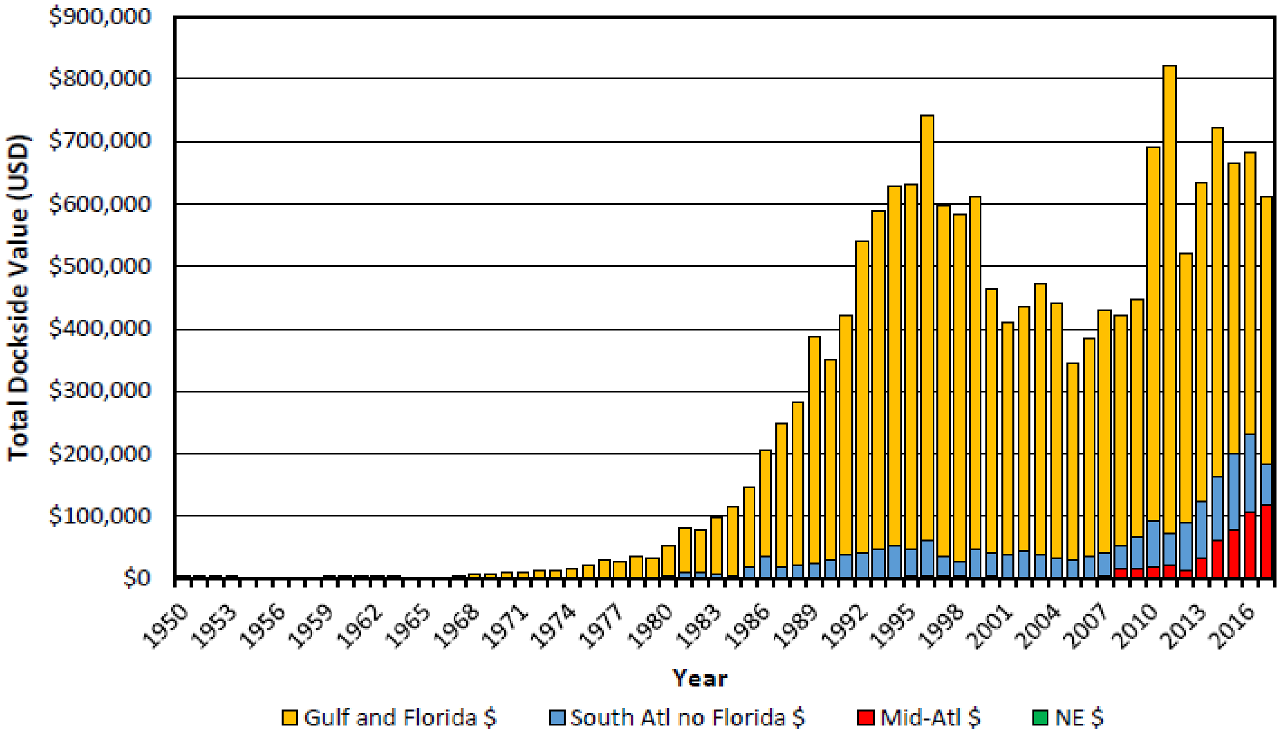

Figure 7.2 Total dockside value (USD) of commercial Cobia by region from 1950-2017 (NOAA unpublished data).

East Florida, and, to a lesser extent, Louisiana have been the most important sources of commercially caught Cobia. The other states have been minor contributors to the landings and dockside value of Cobia and Mississippi has had no commercial sale of Cobia since 1990. During the 1984-2017 period, West Florida and East Florida contributed 45% and 39%, respectively, of the total dockside value generated in the Gulf region during the 33-year period (Figure 7.3). Of the remaining 16% of the total, Louisiana, Texas, Alabama, and Mississippi contributed 12%, 2%, 1%, and 1%, respectively. A brief discussion for each state follows.

Florida (East and West)

Florida has been the leading producer of commercially caught Cobia in the U.S. Between 1950 and 2017, an average of 65% of the annual dockside value associated with Cobia landings can be attributed to West Florida (Figure 7.4A). Since 1988, however, the share associated with West Florida has averaged 55% and over the entire time series, East Florida and West Florida combined have generated 84% of the total dockside value associated with commercially harvested Cobia in the Gulf region (Figures 7.1 and 7.3).

The annual dockside value of Cobia for West Florida did not exceed $10,000 prior to 1975 and exhibited an average annual value of $2,340 during the 1950-1974 period. However, dockside value increased to $12,710 during 1975 and continued to increase steadily to $90,150 in 1985. In contrast to the previous 25-year period, the average annual dockside value during the 1975-1986 period was $45,630. The dockside value for West Florida Cobia continued to increase until reaching a record high of $336,900 in 1996. Dockside value then fell to $265,434 in 1997 and remained relatively stable during the 1997-2017 period, exhibiting an annual average of $201,910.

The annual dockside value of Cobia for East Florida did not exceed $10,000 until 1980, when dockside value reached $10,690. During the 1950-1979 period, the average annual dockside value for Cobia was

Table 7.1 Commercial Cobia landings value (USD) by state for the Gulf of Mexico from 1984-2017 (NOAA unpublished data). **Note**: Mississippi has had no commercial harvest of Cobia since declared a gamefish in 1990 and a dash (-) is confidential data.

Year	East Florida	West Florida	Alabama	Mississippi	Louisiana	Texas
1984	$15,700	$80,731	$605	$3,763	$1,066	$8,815
1985	$17,877	$90,147	$544	$4,050	$11,160	$4,182
1986	$40,091	$86,638	$4,960	$7,146	$22,652	$7,922
1987	$69,545	$114,493	$2,694	$10,617	$27,328	$6,487
1988	$93,207	$119,727	$2,167	$8,504	$33,954	$5,388
1989	$130,319	$151,204	$3,106	$19,011	$45,418	$12,591
1990	$117,539	$144,445	$4,660	$3,820	$38,833	$10,444
1991	$163,477	$169,008	$1,669		$42,175	$7,835
1992	$174,922	$228,504	$3,520		$83,169	$6,662
1993	$164,522	$259,105	$4,486		$103,328	$9,677
1994	$164,125	$249,818	$5,137		$149,576	$6,600
1995	$183,751	$277,398	$961		$113,587	$7,290
1996	$218,695	$336,897	$1,581		$109,524	$13,365
1997	$192,109	$265,434	$1,433		$95,172	$6,781
1998	$183,828	$276,529	-		$78,627	$16,224
1999	$206,761	$259,210	$1,986		$83,634	$14,621
2000	$134,263	$195,463	-		$79,995	$11,919
2001	$150,489	$160,067	$735		$50,511	$9,641
2002	$146,755	$176,616	$1,097		$53,840	$12,097
2003	$131,629	$250,833	$767		$41,196	$9,665
2004	$158,490	$202,378	$2,277		$34,879	$10,245
2005	$93,071	$173,964	$1,437		$27,801	$18,071
2006	$155,754	$143,275	$1,515		$22,433	$25,267
2007	$173,598	$187,202	$1,316		$18,596	$8,761
2008	$161,293	$173,001	$4,561		$21,824	$6,882
2009	$197,875	$138,199	$3,556		$33,322	$6,892
2010	$306,899	$274,304	-		$12,044	$3,488
2011	$484,274	$241,069	$2,504		$18,023	$2,829
2012	$261,180	$129,067	$4,324		$29,254	$6,441
2013	$198,476	$265,070	$1,989		$38,253	$8,686
2014	$272,259	$211,440	$6,141		$57,296	$11,451
2015	$213,706	$173,134	$4,918		$62,304	$11,085
2016	$169,853	$173,176	$11,568		$75,501	$20,618
2017	$152,539	$170,761	$3,648		$81,679	$16,748

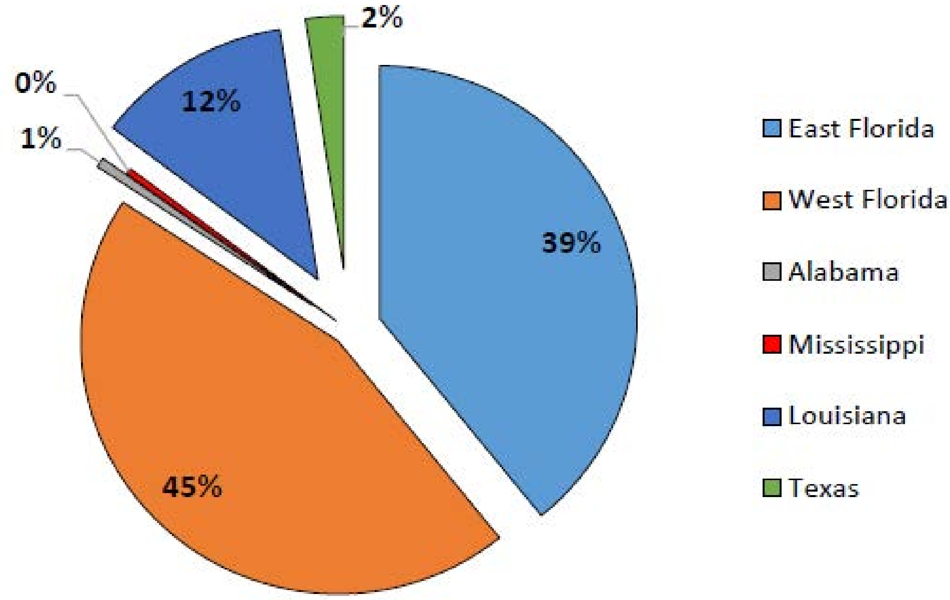

Figure 7.3 Percent combined contribution to total dockside commercial Cobia landings by state for the Gulf and East Florida from 1984-2017 (NOAA unpublished data).

$1,590. Dockside value then increased steadily through 1988, when annual dockside value was $93,210. Dockside value first exceeded $100,000 in 1989 and then continued to generally increase until reaching highs of $306,900 and $484,270 in 2010 and 2011, respectively. Dockside value for East Florida then declined to $152,540 in 2017. The average annual dockside value during the 1989-2017 period was $188,360.

Louisiana

The annual dockside value for Cobia landed in Louisiana was only sporadically reported during the 1950-1984 period, with values ranging from $320 in 1950, to $23 in 1976, and to $1,070 in 1984 (Figure 7.4D). For several years during this period, no values were reported. Dockside value increased to $11,200 in 1985 and continued on a general, erratic increase until a high of $274,300 was reached in 2010. Dockside value then decreased to $170,760 in 2017 (Table 7.1).

Alabama, Mississippi, and Texas

Alabama, Mississippi, and Texas have historically been minor contributors to the overall dockside value of Cobia landed commercially in the Gulf region (Table 7.1, Figure 7.3, and Figures 7.4B, 7.4C, and 7.4E). In fact, during the entire 1950-2017 period, the total dockside value of Cobia landed in Alabama and Mississippi totaled $104,820 and $58,410, respectively. The highest annual values for Alabama Cobia were $5,240 in 1994 and $6,140 in 2014. Dockside value was only sporadically reported for Mississippi during the 1950-1990 period, with the highest annual values being $10,620 for 1987 and $19,010 for 1989. Dockside value for Cobia has not been reported for Mississippi since 1990 when it was declared a game fish in Mississippi waters, eliminating commercial harvest and sale.

Dockside values for Cobia landed in Texas have been consistently reported during the entire 1950-2017 period, though the annual values are significantly lower than those reported for Florida and Louisiana. Annual dockside value for Cobia landed in Texas increased from $140 in 1950 to $13,060 in 1982. Dockside value has remained somewhat erratic ever since, with highs of $25,270 and $20,620 being reached in 2006 and 2016, respectively. Dockside value for Cobia in Texas fell to $16,750 in 2017.

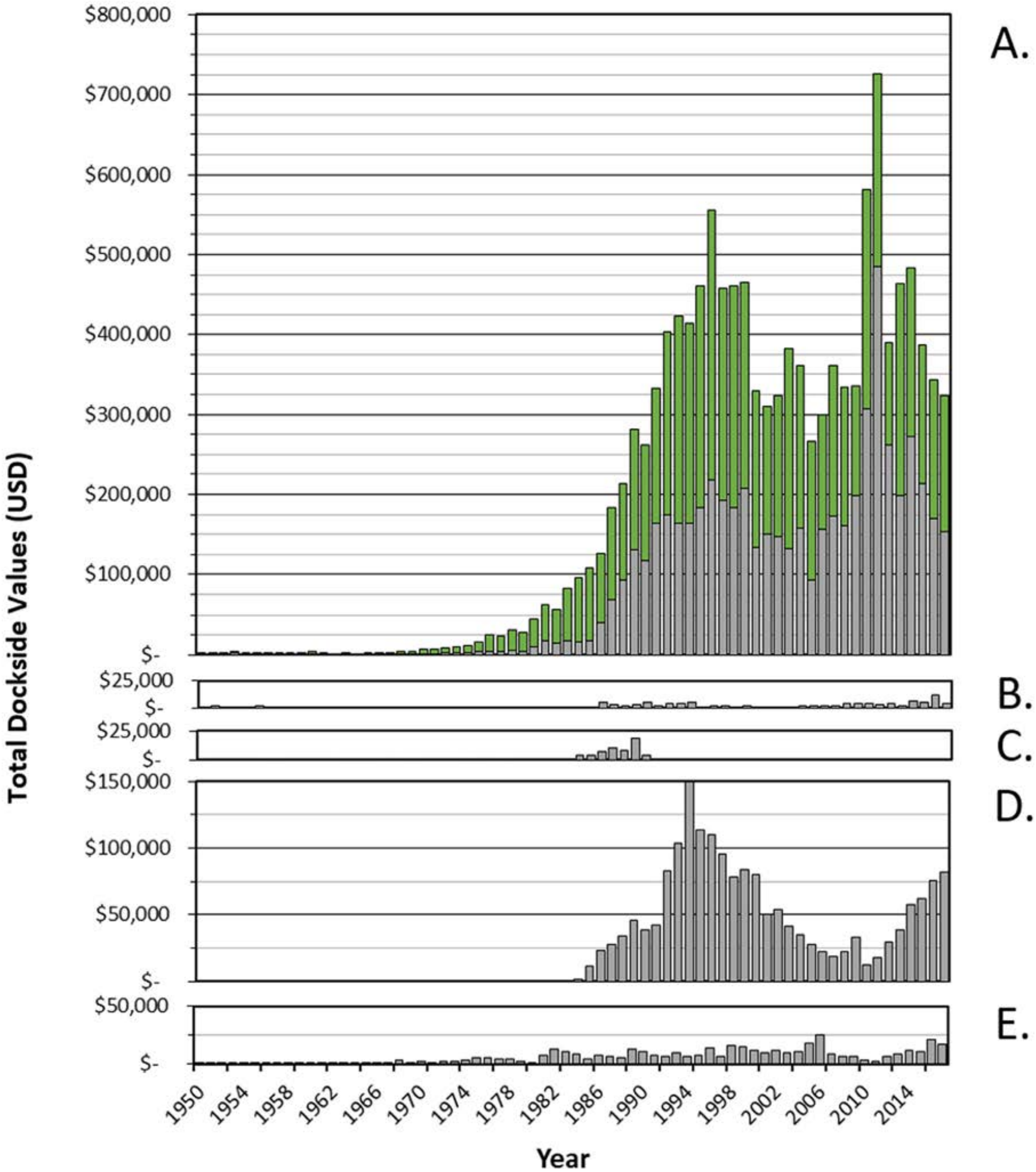

Figure 7.4 Total commercial Cobia dockside values (USD) in A) Florida (East gray, West green), B) Alabama, C) Mississippi, D) Louisiana, and E) Texas from 1950-2016 (NOAA unpublished data).

Atlantic States

Commercial Cobia landings and dockside value are non-existent or only intermittently recorded for most states on the Atlantic seaboard during the 1950-2017 period (Figure 7.2). Data are available for North Carolina, South Carolina, and Georgia. Data for East Florida have been previously discussed above.

Dockside value for Cobia landed in North Carolina totaled $1,722,410 during the 1950-2016 period. However, two distinct periods emerge during that 67 year period. During 1950-1985, the dockside value for Cobia landed in North Carolina averaged $780 per year, while the average annual dockside value during the 1986-2016 period was $38,550. Dockside value for South Carolina has only been reported since 1978, with the total value during the 1978-2016 period being $285,650. The average annual dockside value during this period was $7,320. The dockside value for commercial Cobia landings in Georgia has only been intermittently reported during the 1976-2007 period, with total value being $36,910 and average annual value being $1,540. The dockside value for other states within the Mid-Atlantic and New England regions is not available.

Average Monthly Dockside Value

Average monthly dockside value for Cobia in the Gulf of Mexico region was computed for the two 5-year periods; 2008-2012 and 2013-2017 (Table 7.2). These time periods were chosen to provide insight into the seasonal dynamics of Cobia dockside value during the last ten-year period. Average monthly dockside values are discussed on a state level. A discussion of monthly dockside value for the Atlantic region is not provided.

2008-2012

East Florida and West Florida dockside value peaked during March-May period, with April being the dominant month for West Florida (Table 7.2). The monthly dockside value for Louisiana and Texas peaked during July-August and January-February, respectively. Monthly values for Alabama were only intermittently reported.

2013-2017

Similar monthly patterns exist for West Florida and East Florida, as well as for Louisiana (Table 7.2). However, the average monthly dockside value for Texas during this latter period peaked later in the year, e.g., June-July. Monthly dockside values were also more consistently reported for Alabama, with the values peaking during June-July.

Annual Dockside Prices

Annual dockside prices are defined as those that are received by the harvester upon the sale of Cobia to the first buyer. Such prices are often recorded when the required Trip Ticket is completed by the first buyer, who most often is a licensed wholesale seafood dealer. However, the dockside prices utilized in this analysis are generated as the quotient of dockside value (USD) and landings volume (lbs). Thus, the prices generated are the average dollars per pound (USD/lb) for the region or time period of interest. In addition, the dockside prices for this discussion represent dockside sale of whole fish, not otherwise processed or altered (gutted, head-off, filets, etc.). Finally, the dockside prices in this discussion have not been adjusted for inflation (real) and are considered nominal prices.

Regional Dockside Prices

The nominal dockside price (whole weight) for Cobia has shown a steady increase over the period from 1950-2017 (Figure 7.5). The Gulf-wide (including East Florida and West Florida) dockside price remained equal to or less than $0.10/lb until 1973, when a more significant increase in dockside price for Cobia was initiated. Dockside price in the Gulf region continued to increase, with prices increasing to $0.99/lb by 1987 and then reaching $2.00/lb by 2000. Dockside prices for Cobia increased steadily during the 2001-2017 period, increasing from $2.09 in 2001 to an all-time high of $3.86 by 2017.

The pattern for dockside prices in the South Atlantic region (North Carolina – Georgia) has exhibited a similar trend as that for the Gulf region. Dockside price remained at or below $0.10 until 1991, when dockside price reached $1.33/lb. Dockside price then increased in an erratic trend, exceeding $2.00 only until 2011, when the regional dockside price was $2.16/lb. Price then continued to generally increase until reaching a high of $2.65 in 2017. In general, nominal per pound dockside prices for Cobia were relatively less in the South Atlantic region as compared to the Gulf region. For example, the average annual dockside

Table 7.2 Average total monthly dockside values (USD) by five-year period for the Gulf and East Florida by state (NOAA unpublished data). **Note**: Mississippi has no commercial harvest of Cobia since 1990 and is excluded.

2008-2012					
Month	AL ($)	EFL ($)	WFL ($)	LA ($)	TX ($)
Jan	-	20,329	8,707	1,538	1,332
Feb	-	24,359	11,812	942	1,133
Mar	469	42,458	18,955	2,471	375
Apr	1,668	46,535	98,116	1,384	421
May	251	50,585	16,104	1,180	762
Jun	1,106	25,255	6,338	1,866	617
Jul	841	22,530	4,758	4,471	510
Aug	153	13,612	3,351	4,986	641
Sep	-	5,623	5,255	1,368	231
Oct	-	4,894	5,680	2,496	131
Nov	-	8,681	5,303	3,033	-
Dec	541	17,445	6,750	2,421	617

2013-2017					
Month	AL ($)	EFL ($)	WFL ($)	LA ($)	TX ($)
Jan	167	10,704	7,605	954	934
Feb	253	9,602	9,946	2,192	354
Mar	166	21,394	17,820	2,360	599
Apr	708	35,540	101,702	1,789	853
May	703	25,372	16,035	3,355	1,848
Jun	2,267	31,614	4,393	7,330	2,400
Jul	1,146	27,833	4,832	10,603	3,161
Aug	724	14,386	3,739	7,088	1,688
Sep	714	6,961	6,890	13,222	424
Oct	553	4,528	8,229	7,948	396
Nov	132	4,859	8,211	6,746	192
Dec	541	8,575	9,315	1,413	1,164

price for Cobia during the 2000-2017 period was $2.75/lb for the Gulf region, as compared to $1.83/lb for the South Atlantic.

Dockside Prices by State

Dockside prices for Cobia in the Gulf region have exhibited a general upward trend during the past several decades (Figure 7.5). Prices for Florida (both coasts) stayed below $1.00/lb until the 1980s, while prices in the other states exceeded $1.00/lb only until the 1990s. In general, dockside prices in Florida tended to exceed the prices for the other states in terms of rate of increase and magnitude. A brief, detailed discussion of the dockside price trends for each Gulf state follows. Mississippi has not allowed commercial harvest of Cobia since 1990 and is excluded.

Florida (East and West)

Dockside prices for Cobia did not consistently exceed $0.10/lb until 1969 for East Florida and 1973 for West Florida (Figure 7.6). Prices then increased steadily, exceeding $1.00 for both coasts during 1983 and 1987, respectively. Prices again increased steadily, surpassing $3.00 in 2009 and 2010 for East Florida and West Florida, respectively. Prices further increased to highs of $4.08 and $4.10/lb during 2017 for East Florida and West Florida, respectively.

Alabama

Dockside price for Cobia in Alabama remained at or below $0.10/lb until 1981, when prices began to increase substantially (Figure 7.6). Dockside price reached $1.17 in 1992 and continued to increase erratically to a high of $3.13 in 2016. Dockside price then fell to $2.28/lb in 2017. Dockside price for Cobia in Alabama has typically been lower than that found in other Gulf states.

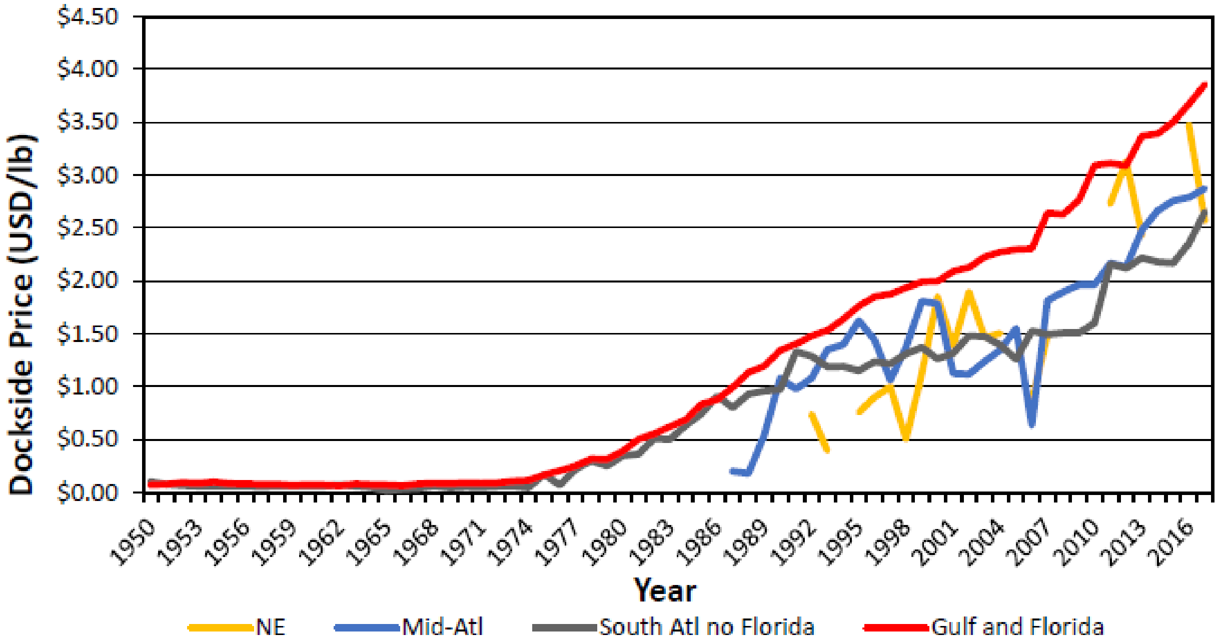

Figure 7.5 Average dockside prices (USD/lb) by region from 1950-2017 (NOAA unpublished data).

Louisiana

The dockside price for Cobia was somewhat erratic during the 1950-1980 period (Figure 7.6). Prices were not available during 1981 and 1982. However, dockside prices began a steady increase from $0.44 in 1983, $1.11 in 1990, then to $2.03/lb in 2008. Dockside prices continued to increase steadily to $3.36 in 2015, then declined moderately to $3.26/lb in 2017.

Texas

Although not displayed in Figure 7.6, dockside prices for Cobia in Texas were actually somewhat higher than most other Gulf states during the 1950s and 1960s although the prices only averaged around $0.10/lb. Beginning in the early 1970s, dockside prices steadily increased along with the rest of the Gulf, reaching $1.02 in 1994. Prices continued to increase thereafter, reaching $2.07/lb in 2011 and $3.70 in 2015 with a slight decline to $3.59 during 2017.

Average Monthly Gulf Dockside Prices

Average monthly dockside prices for Cobia in the Gulf of Mexico region were computed for the five-year periods; 2008-2012 and 2013-2017 (Table 7.3). Similar to the preceeding discussion for monthly dockside value, this ten-year time period was chosen because it reveals the most recent seasonal behavior of Cobia dockside prices in the Gulf region. Monthly dockside prices are not discussed on a state level, but rather on a Gulf-wide basis. Monthly dockside prices for the other regions are not provided.

Average monthly dockside prices during the 2008–2012 period were fairly consistent during the year for most states, with prices for Florida exhibiting notable exceptions. Average monthly dockside prices for East Florida were higher during the January–April period, while average prices for West Florida were higher during the March–May period. Prices for Louisiana also exhibited a slight increase during the months of November–December. During the latter period, 2013–2017, average monthly dockside prices for each state were more consistent during the year. For example, the monthly prices for East Florida exhibited virtually no seasonal pattern. However, monthly prices for West Florida continued to exhibit higher prices during the March–May period. In addition, monthly prices for Texas were found to be relatively higher during the September–December period.

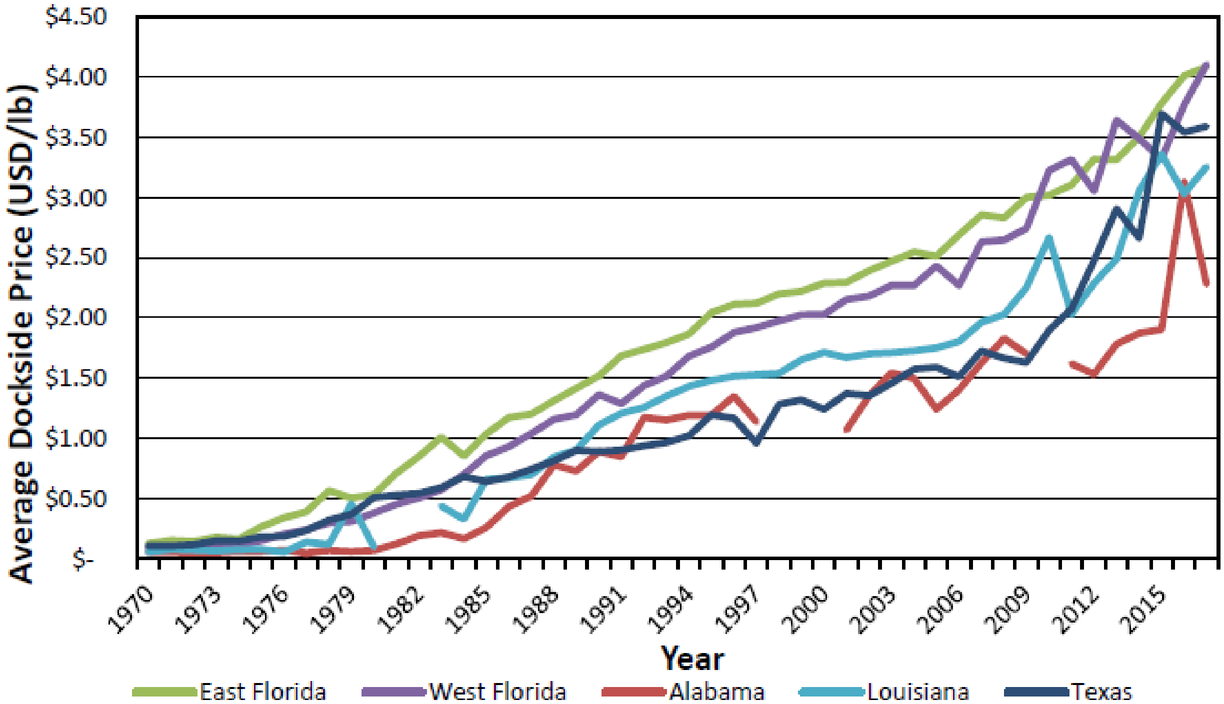

Figure 7.6 Average dockside prices (USD/lb) by state for the Gulf and East Florida from 1970-2017 (NOAA unpublished data).

Dockside Prices by Type of Gulf Harvesting Gear

Factors such as seasonal shifts in landings and demand, supply of closely substitutable species, and the region of harvest may affect per pound dockside prices for Cobia. In addition, the harvest gear used may have some influence on the dockside price received. For example, a gear which allows the individually harvested fish to be handled more gently (less damage through crushing, tearing, etc.) may result in a perceived higher quality product. In addition, a fish brought to shore more quickly, such as those harvested on short, “day” trips, may be less subject to thermal abuse than those that take longer to get back to the dock. If buyers recognize these quality attributes and a market for those attributes exists, a higher per unit price may result. Thus, a fish caught in an entangling net (which may be bruised and scarred), caught in a trawl and subjected to crushing in the cod-end of the trawl, and a fish kept on ice through a long duration trip may bring a lower price than a fish caught on a brief hook-and-line or spearfishing trip. The total landings by gear type from the Gulf region and East Florida over the entire time series (1950-2016) are represented in Figure 6.3 and Table 7.4 (2017 commercial landings by gear data were not available at the time of this analysis).

Nominal dockside prices were computed for landings of Cobia by gear type and reported on a decadal basis (Figure 7.7). These were computed for only the Gulf region (including East Florida) and represent aggregate dockside prices of Cobia landed across all states in the Gulf region during the 1950-2016 period. The prices were computed by dividing total nominal dockside value for each gear type category by the respective landings for each gear type category. The gear selected for comparison includes all the commercial landings but are combined by similar gears to represent a few ‘single’ gear types. The combined gear types included 1) Combined and Unknown Gear [gear type was undetermined by NOAA] 2) Spears, 3) Entangling Nets, 4) Lines, 5) Trawls and 6) remaining Miscellaneous Gears.

The prices by gear type are shown as the average annual price across the 1950-2016 period. For the Gulf of Mexico region, the majority of the landings reported by gear type are harvested with hook-and-line or other ‘Line’ type of gear. The ‘Combined and Unknown’ category dominated the late 1980s

Table 7.3 Average total monthly dockside prices (USD/lb) by five-year period by state for the Gulf and East Florida (NOAA unpublished data). **Note**: Mississippi has no commercial harvest of Cobia since 1990 and is excluded.

2008-2012					
Month	EFL	WFL	AL	LA	TX
Jan	$3.16	$2.49		$2.23	$1.83
Feb	$3.20	$2.53		$2.16	$1.75
Mar	$3.08	$3.08	$1.74	$2.17	$1.87
Apr	$3.21	$3.61	$1.94	$2.39	$1.69
May	$3.03	$3.01	$1.39	$2.33	$1.88
Jun	$3.01	$2.72	$1.74	$2.24	$2.01
Jul	$3.12	$2.63	$1.48	$2.07	$1.77
Aug	$3.06	$2.37	$1.62	$2.07	$2.17
Sep	$2.94	$2.11		$2.07	$1.80
Oct	$2.90	$2.09		$2.20	$1.22
Nov	$2.75	$2.05		$2.70	
Dec	$2.90	$2.29	$1.85	$2.41	$1.44

2013-2017					
Month	EFL	WFL	AL	LA	TX
Jan	$3.40	$2.95	$2.35	$2.83	$3.11
Feb	$3.45	$2.94	$3.33	$2.34	$2.32
Mar	$3.80	$3.41	$3.62	$2.76	$3.33
Apr	$3.80	$4.48	$3.41	$3.12	$3.29
May	$3.73	$3.70	$2.32	$3.10	$3.15
Jun	$3.73	$3.30	$3.30	$3.24	$3.02
Jul	$3.70	$3.39	$2.00	$2.80	$3.47
Aug	$3.74	$3.05	$1.62	$2.91	$2.98
Sep	$3.66	$2.64	$1.73	$3.37	$4.00
Oct	$3.32	$2.53	$2.79	$3.37	$3.20
Nov	$3.61	$2.62	$1.83	$3.24	$3.85
Dec	$3.31	$2.70	$1.85	$2.58	$3.85

through the 1990s as an artifact of NOAA port sampling, e.g., failure to designate gear types in reported landings data. In Figure 7.7, any landings less than 1,000 lbs on average for the decade were censored, as well as was an unrealistic price/lb associated with the 'Combined and Unknown' gear in the 2000s. Most of the landings in that gear category were likely attributed to lines, which has been the dominant gear historically (see *Chapter 6 – Commercial Fishery*).

The average, annual, per pound dockside prices by gear type reveal consistently higher prices for Cobia harvested with spear, entangling gear, or lines. Relatively lower prices are associated with Cobia harvested with gear identified as 'Combined and Unknown' and trawls. During the 1990s, Cobia harvested with spears, entangling gear, or lines exhibited average, annual dockside prices approaching $2.00/lb. The same gear types generated average dockside prices of approximately $2.25/lb and over $3.00/lb during the early 2000s and 2010s, respectively. These prices reflect a general increase in nominal prices for Cobia over the past two decades.

Processing and Marketing

Cobia enters into the domestic seafood market either as wild catch or cultured product. Anecdotal information suggests that Cobia is a popular seafood choice in restaurant and retail settings. However, there is no information available that allows for a formal description of the processing, product forms, or market channels for Cobia within the domestic seafood market.

Imported Cobia

The importation of Cobia into the U.S. is not extensive but it is well documented in the U.S. customs data. Foreign sources of Cobia are generally utilized to fulfill the demand by domestic restaurants consistently due to insufficient volume and the seasonal availability of domestically caught Cobia. Imported Cobia can originate from either wild caught fisheries or from aquaculture (Figure 6.1 and Figure

Table 7.4 Percentage of total commercial Cobia landings in the Gulf and East Florida combined by primary gear type from 1950-2016 and by decade (NOAA unpublished data; 2017 gear data was not available).

Decade	Comb and Unknown	Spear Total	Entangle Total	Line Total	Trawl Total	Misc Total
50s	0%	0%	2%	84%	13%	1%
60s	0%	0%	6%	82%	11%	1%
70s	17%	0%	16%	53%	14%	0%
80s	78%	0%	0%	16%	6%	0%
90s	77%	3%	1%	19%	0%	0%
00s	7%	9%	3%	80%	1%	1%
10s	2%	12%	1%	84%	0%	0%

6.25). Fishery products entering the U.S. market from outside the U.S. are typically tracked through the 10-digit Harmonized Tariff Schedule (HTS) code that is implemented by the United States International Trade Commission. Utilizing the HTS code, the volume and value of imported seafood products can be inferred. The NOAA Office for International Affairs and Seafood Inspection has a 10-digit HTS code for Cobia imported into the U.S. (Cobia, Fresh or Chilled 0302460000 and Cobia, Frozen 0303560000). The majority of the imports coming to the U.S. originates from farm raised Cobia shipped from Ecuador and Panama. Some of the other countries of origin include Indonesia, Mexico, and Vietnam. While China is the single largest producer of aquacultured Cobia worldwide, the majority of product is retained to meet domestic demand (Pomeroy personal communication).

Product arriving in the U.S. fresh is shipped by air from Panama primarily (valued at $7,427,884 USD) with some from Vietnam. Frozen Cobia arrives from Ecuador, and again from Panama (valued at $562,363

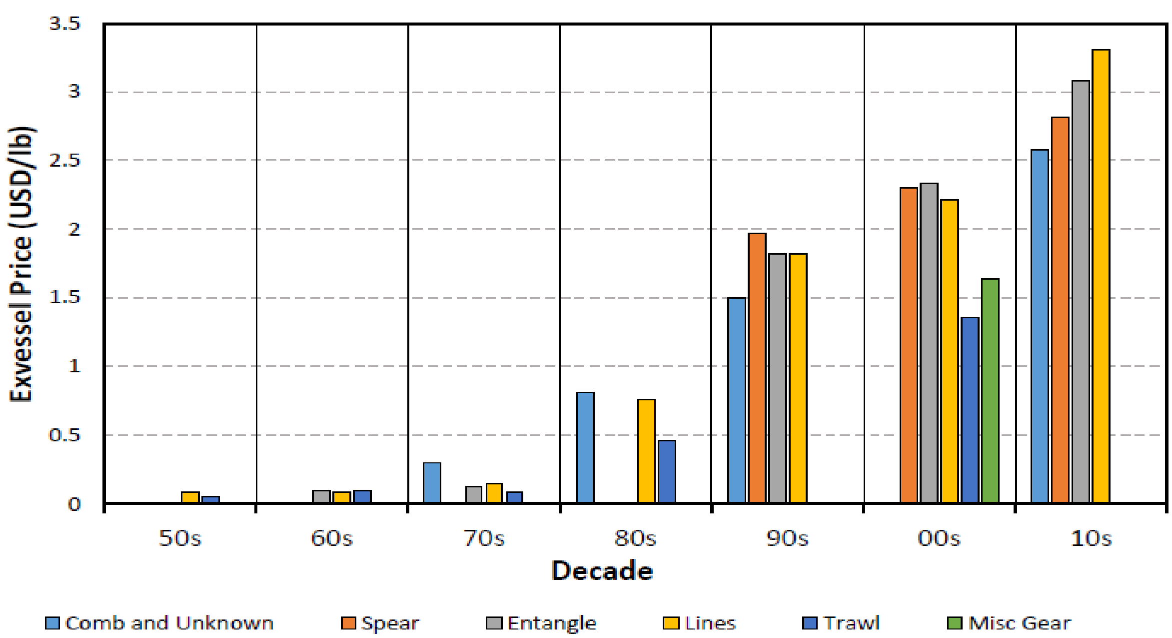

Figure 7.7 Average dockside price for commercial Cobia landed in the Gulf and East Florida by decade by gear types from 1950-2016 (NOAA unpublished data; 2017 date by gear was not available).

USD) and Vietnam (Table 7.5). While there are a number of aquaculture facilities in these countries which are the most likely sources, several in the Atlantic and Gulf/Caribbean have wild landings of Cobia as well and may contribute to the totals. Ecuador has several offshore culture operations raising Cobia but the coastal region of Ecuador is not the native range of that species in the Pacific.

Along East Florida, the majority of imported Cobia is reported as being wild caught from Mexico or farmed from Panama and nearby areas (Colombia) and used in the seafood restaurants when they cannot get local sourced Cobia. One restaurant owner provided a lot of detail on the fish he purchases for his stores. He indicated that most of the Cobia sold in local restaurants from Cape Canaveral to around West Palm Beach, Florida are brought in by air and not by freighter (anonymous). The Cobia arrive whole (head off), are delivered fresh, and then cleaned/prepped at the restaurants. The farmed Cobia range in size from 6-12 lbs for individual fish.

Recreational Sector

The recreational fishing sector is an important component of the natural resource-based engine that drives local economies in the coastal corridor of the Gulf region. Some finfish species are vitally important to the economic activity associated with saltwater angling. Though anecdotal information suggests that Cobia is an important species for Gulf anglers, there are no data to describe the economic contribution associated with the targeting of Cobia by recreational anglers in the region. However, though those data are scarce, the expenditures associated with the targeting of Cobia by recreational anglers generates economic activities associated with travel costs, trip expenses, charter fees and other expenses. These expenditures, combined with similar values associated with the mix of other targeted species, are an important source of economic activity in the region.

As noted in *Chapter 6 – Recreational*, there is a fairly wide interest in Cobia but most anglers who own a vessel and have access fish them opportunistically. There are a number of anglers who specialize in Cobia and participate in various tournaments and rodeos for substantial prize money (*Chapter 6 - Tournament Fishing for Cobia*) but identifying those individuals is difficult since most tournaments do not keep records of all participants, just those who submit fish for weighing and category winners. An additional group which heavily targets Cobia is those anglers that utilize shore-based piers during the spring and fall Cobia migrations (*Chapter 6 - Pier Fishing for Cobia*). Ironically, the largest component of Cobia landings are derived by recreational anglers, whose landings and effort are the least described. Without license designations or species endorsements, virtually any angler who owns a saltwater fishing license could have access to Cobia and potentially be part of the directed fishery.

Cobia Angler Expenditures in the Gulf of Mexico

Specific information on expenditures by the recreational fishery to target is sparse. However, as part of the MRIP survey in 2016, NOAA added an Intercept Economic-Add-On series of questions when interviewing anglers and asked about the primary species targeted. A number of respondents who indicated Cobia are their primary or secondary target provided answers to the expenditure questions. The data are weighted using the base MRIP intercept weights for all intercepts and are further adjusted for the non-responses to the questions. As such, the data are interesting but not completely representative of all the fishing sectors. Only 'Private Boat' had relatively high numbers of observations. 'Shore and For-Hire' had very few observations with Cobia as the target species.

Anglers were asked about their various expenses when making a trip. In the case of those specifically targeting Cobia, there is not a great difference between East Florida and West Florida but the mode of fishing (Shore, Private Boat, or For-Hire) varies greatly. Anglers using charters or guides to catch Cobia spent between $180 to $330 per day on average (West and East), which paid for the guide and crew while private boats spent around $50 in total, mostly boat fuel and bait. Along West Florida, shore based anglers spent around $16/day on everything (gas, bait, ice, and lodging). No respondents along East

Table 7.5 Sources for imported Cobia by country and product form for 2017 in A) total product (lbs), and B) total value (USD) (NOAA unpublished trade data).

Country of Origin	Product Form (lbs)			Grand Total
	Cobia Fresh	Cobia Fresh Not >15lbs (6.8kg)	Cobia Frozen	
Panama	1,478,158		113,381	1,591,539
Ecuador			137,641	137,641
Vietnam	53,700		37,300	91,000
Indonesia	21,043		20,421	41,464
Suriname	8,239			8,239
Mexico	6,892	811		7,703
Brazil	1,942			1,942
Grand Total	1,569,974	811	308,744	1,879,529

Country of Origin	Product Form Value (USD)			Grand Total
	Cobia Fresh	Cobia Fresh Not >15lbs (6.8kg)	Cobia Frozen	
Panama	$7,427,884		$562,363	$7,990,247
Vietnam	$305,438		$189,363	$494,801
Ecuador			$330,030	$330,030
Indonesia	$73,500		$81,180	$154,680
Suriname	$26,537			$26,537
Mexico	$14,778	$3,244		$18,022
Brazil	$13,345			$13,345
Grand Total	$7,861,482	$3,244	$1,162,936	$9,027,662

Florida indicated they were fishing for Cobia from shore (NOAA unpublished data). Again, only about 20 'For-Hire' and 30 'Shore' anglers targeting Cobia responded, compared to 250 private boat anglers state wide.

Economic Valuation of Recreational Cobia Fishing in the Gulf Region

There is little information which describes the contribution recreational Cobia fishing makes to the overall economy of the Gulf region. However, tournament fishing for Cobia, especially in the Panhandle region, generates a huge amount of tourism and provides a substantial value into the local economies through hotel and restaurant usage.

Recent landings data suggest that substantial changes in the occurrence of Cobia along the northern Gulf of Mexico during the northern migration has been lower in recent years (Figure 6.14A). The Florida Panhandle Cobia tournaments have reduced their duration and in some cases have cancelled events because of the lack of fish. Public testimony provided to the Gulf Council in recent years indicates private anglers and charter boat captains are not seeing Cobia throughout the Panhandle, resulting in loss of business and the request for significant changes in the federal management of Cobia in the Gulf. With fewer fish to target and fewer trips occurring, a reduction in Cobia-related expenditures would likely have a negative impact on local business revenues, unless the effort (and expenditures) could be directed to an alternative species.

Civil Restitution Values and Replacement Costs

The Florida Administrative Code (62 - 11.001) indicates that Cobia is valued at $33-$60 each for damage valuation purposes, regardless of the size of fish. Mississippi and Alabama do not have restitution values for Cobia. Title 56 of the Louisiana Revised Statutes authorizes LDWF to collect civil restitution payments for illegally harvested fish. Article 895.2 of the Code of Criminal Procedure states the restitution costs for species are to follow values decreed by the Louisiana Wildlife and Fisheries Commission. Louisiana uses a civil restitution value of $4.29 per pound for Cobia.

Texas does not publish restitution values by species for most of their species but will seek restitution and/or restoration for impacted wildlife and fish under Texas Administrative Code Title 31, Chapter 69.19. Commercial recovery value for Cobia in Texas is based on the ex-vessel or dockside price as determined by the most recent TPWD data on commercial harvest data.

Aquaculture

The culture of Cobia has been conducted in numerous regions around the globe. Cobia are apparently very amenable to high density culture. In addition, offshore pen culture appears to be the culture technology that holds the greatest promise for success. However, the financial characteristics and economic viability of commercial Cobia aquaculture is indeterminable. The literature simply does not provide the information needed to verify financial viability. There are regions of the world where Cobia farming has become common, such as China, Vietnam, and Taiwan (Miao et al. 2009, Huang et al. 2011, Nazar et al. 2013, Petersen et al. 2014, Bezerra et al. 2016) and the Caribbean region (Belize, Panama, and Dominican Republic; Benetti et al. 2008). Despite success elsewhere, farm raising of Cobia in the U.S. has yet to be fully explored and open-water finfish culture in general is still limited, especially in the Gulf region.

Offshore cage culture can be a capital and labor intensive culture method (Anderson et al. 2008, Benetti et al. 2008). The initial investment associated with the cage structure, vessels required for operation, etc. can be quite large. The labor required for feeding, maintenance, harvesting, biofouling control, and other activities can be substantial. In addition, the need to be located further offshore in relatively deep waters can increase the energy required for monitoring and maintenance. Finally, the risk associated with storm events in the high energy Gulf region must also be taken into account. In general, offshore cage systems will be expensive to locate and operate. The capital investment and maintenance cost required for offshore cage systems would need to be offset by the sheer volume of fish being produced. Although significant quantities of cultured Cobia are entering world markets, information is simply not available to allow a determination of whether or not such commercial Cobia culture would be appropriate, sustainable, and commercially viable in the Gulf of Mexico (*Chapter 6 – Aquaculture*).

Chapter 8
RESEARCH AND DATA NEEDS

Goals and Objectives for the Fishery

As demonstrated throughout this profile, there is a need for directed research on this species throughout its range in the western-central Atlantic to better inform management. The SEDAR 58 Stock ID Workshop concluded that there is insufficient recent life history information to suggest changes to the existing Cobia stock structure identified in SEDAR 28. Significant questions remain unanswered, particularly at a time when the stock status and stock recruit relationships are not well defined. Considerable uncertainty exists in aspects of the reproductive biology of Cobia from U.S. waters. A consensus statement from the SEDAR 58 Stock Assessment Workshop is as follows: "the reproductive biology of Cobia could not definitively define stock structure in the U.S. South Atlantic due to 1) the lack of reproduction data from East Florida and the Florida Keys and 2) the need for more comprehensive information on spawning locations" (SEDAR 2018).

Data Gaps and Considerations for Management

Management of Cobia between the U.S. South Atlantic and the Gulf of Mexico is based on limited genetics work and migration studies. The items below highlight current limitations in understanding Cobia in the Gulf of Mexico. They are separated into 'critical needs,' which are those data needs considered necessary to better define the management unit between the Atlantic and Gulf, and 'secondary needs,' which are items that would help our general understanding but may not be necessary for management.

Critical Needs

Distribution and Migration

- Genetics/Mixing - Given the identification of two stocks in U.S. waters (Atlantic and Gulf), the mixing of these two stocks into adjacent waters needs to be evaluated.

- Site Fidelity/Residency – Tagging and genetic studies have shown high site fidelity of Cobia in inshore waters off South Carolina (Darden et al. 2014). Cobia tagged near Port Royal Sound during the beginning of spawning season were recaptured within the sound up to three years later, and genetically identified stocked Cobia were captured within their estuary of release up to two years after release. These discoveries led Darden et al. to suggest the possibility of a two-tiered management approach to Cobia, in which offshore fishery activities are broadly managed as a single population and inshore populations are managed locally to protect vulnerable inshore aggregations such as spawning. The extent of onshore/offshore movements compared to nearshore movements in the Gulf of Mexico needs to be evaluated. The use of acoustic tags along the Atlantic has elucidated the alongshore range of Cobia off North Carolina/Virginia, South Carolina, and East Florida as well as documented the offshore movements. The movements of the stocks into the Caribbean, Bahamas, and the Gulf of Mexico need to be determined by use of acoustic or satellite tags.

- Western Stock ID - Migration of Cobia along and onshore/offshore of the western Gulf from Texas into Mexico and the southern Caribbean is unknown but must exist based on limited tag returns from several sources (Dippold et al. 2017, Qualia unpublished data). In addition, there appears to be limited movement of Cobia, conventionally tagged, along East Florida into the western Gulf beyond central Louisiana, yet fish tagged in the northcentral Gulf do move west to Texas (Perkinson et al. 2018a). The lack of returns from Central and South America suggest that Cobia do move south along a western route but the amount of movement is unknown with so few recaptures (three from Qualia and one from Franks).

Reproduction

- *Reproduction* – As indicated throughout Chapter 3, there is virtually no information, published or unpublished, regarding the location of spawning Cobia anywhere in the U.S. Atlantic or Gulf of Mexico other than anecdotal guesswork. In addition, Cobia larvae have been collected in offshore waters as well as in nearshore areas (Lefebvre and Denson 2012).

- *Reproduction* - The possible existence of an offshore population may result in different reproductive strategies as evidenced in the research by Brown-Peterson in other species which appear to skip spawn, only becoming reproductive every other year or intermittently over several years.

- *Age and Growth* – Conclusions of the SEDAR 58 Stock ID Workshop were that the available age data for Cobia in the Atlantic and Gulf regions were not conclusive in determining differences in growth between stocks. A concerted effort to age Cobia has not been forthcoming since the early 2000s and the mean age-at-capture is less than five years.

- *Natural Mortality* – Updates to natural mortality can be estimated through tagging studies and given recent concerns over stock status, this parameter should be re-evaluated.

Secondary Needs

Migration

- *Migratory Drivers* - Cobia that travel across stock boundaries may spawn and contribute to mixing of the stocks. There is a need to identify the drivers of these migrations and overlay Cobia migrations with other species that are tagged (e.g. sharks and turtles) to determine the degree of overlap.

Fishery-Related

- *Fish Aggregating Devices (FADs)* – As discussed briefly in Chapter 4, FADs are associated with floating material, therefore, Cobia are especially susceptible to harvest near FADs. Other than through anecdotal reports and social media, there is little known about how commonly FADs are used throughout the region. FADs are known to be used during tournament fishing which has prompted the majority of Cobia events in the Florida Panhandle to ban their use. Research is needed into the prevalence of FADs as well as their potential to affect harvest pressure for species like Cobia. Additionally, further information on the materials that anglers are using to construct FADs may give a fuller picture of the fishery.

- *Release Mortality* - Given the large size of fish that can be retained, post-release mortality of sub-legal Cobia needs to be estimated for numerous hook types and lure types. The implementation of single hook artificial lures or a hook type may reduce handling time and use of gaffs to restrain fish for hook removal.

Economics

- *Aquaculture* – As noted in Chapter 6, there is a lot of interest in developing cultured Cobia product in the Gulf region to meet domestic demand. The production of Cobia in other parts of the world is significant and attempts in Central and South America are showing some potential. However, the economic potential of these commercial endeavors remains uncertain. More research into the U.S. market demand for a cultured Cobia product is needed as well as a thorough examination of the viability of raising Cobia in a nearshore or offshore environment in the Gulf of Mexico.

- *Recreational Value* – A paucity of information exists regarding the economic value associated with Cobia targeted by recreational anglers. This information will be useful as managers attempt to allocate a finite stock amongst competing user groups. Information about trip expenditures, travel costs, and willingness to pay for targeting/catching/retaining Cobia is needed. Such information will help disaggregate and contrast economic value emanating from private boaters, charter/guides, and commercial harvesters.

- *Domestic Markets* – Data describing all sectors of the domestic market for Cobia are needed. Currently, considerable information exists for the domestic harvesting sector and the import brokerage sector. However, the ability to track how value is added to Cobia as the product moves through the various market levels and ultimately onto the consumer's plate is thwarted by a lack of sector level data. Fully describing the market margins throughout the entire domestic market will help managers better understand the full value of the resource. Included in this informational need is per capita consumption.

Life History

- *Abnormality Drivers* – There is a need to determine the background rates of developmental deformities in wild Cobia populations and for more research into the causes of both neutral and deleterious deformities observed in the region.

- *Juvenile Habits* – Little is known about juvenile Cobia in the wild especially related to migration, foraging, growth, recruitment, and mortality (shrimp trawls). Filling in these voids could help with the management of Cobia throughout their entire life history. Most research on juvenile Cobia is from cultured, not wild fish.

Chapter 9
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About the Artist

Craig Brumfield

Born in Biloxi, MS, raised across the bridge as a kid in Ocean Springs fishing and exploring what the neighborhood had to offer. Studied at local junior college and University of Mississippi in fine art.

His work evolves through the studies and sketches of marine life, wildlife, and trees along with any other gifts nature has to offer. Avid saltwater angler and outdoor enthusiast. Years of working and fishing at Chandeleur Islands and in the Gulf of Mexico added to his love of the water and nature.

His passion, whether turkey hunting in the spring or chasing saltwater fish year round is a reflection seen in Craig's work. Working in a variety of media (deep love of oils, also pencil, ink, and watercolor), helps to create his vision onto canvas, wood, or paper.

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