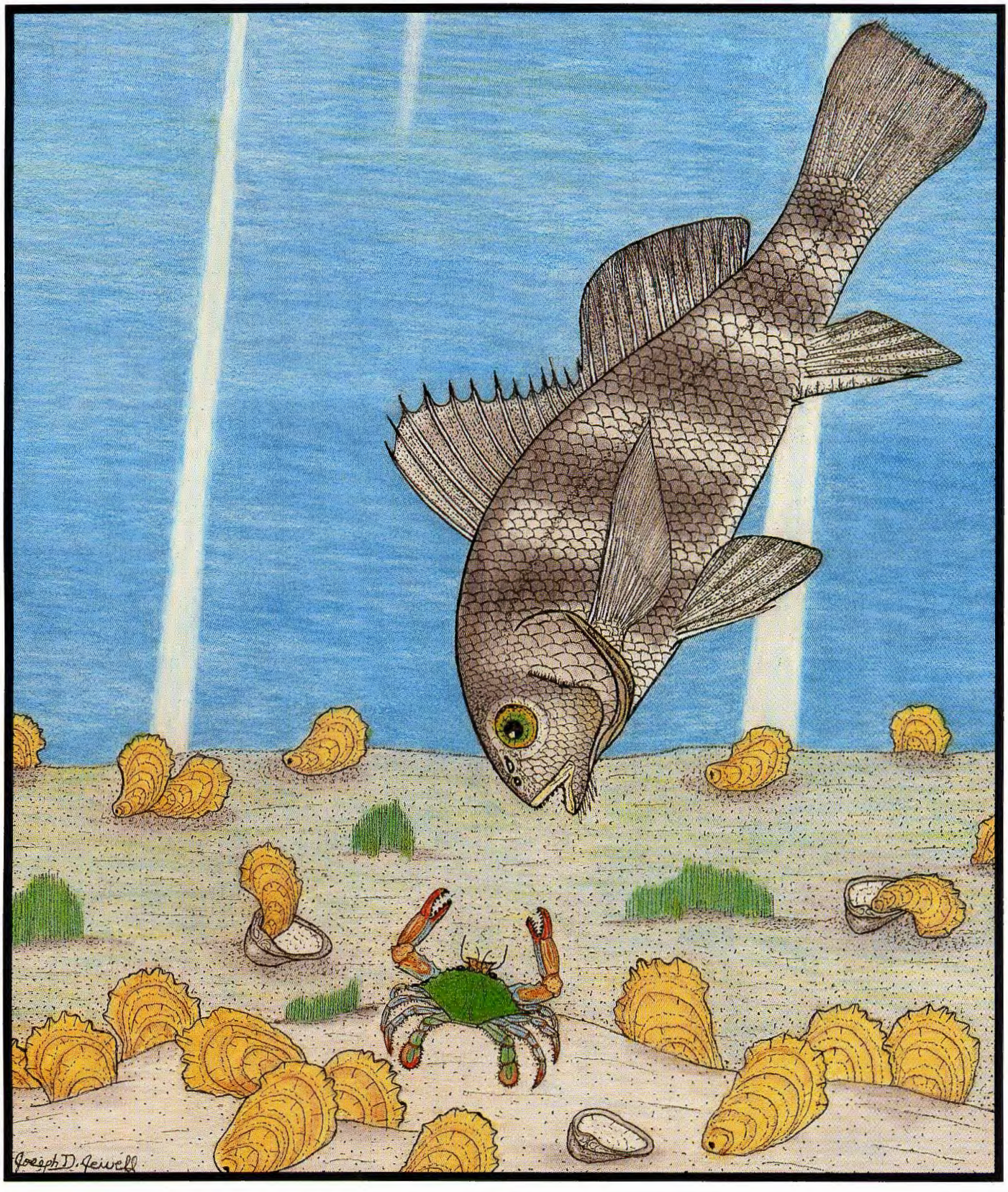
The Black Drum Fishery of the Gulf of Mexico, United States: *A Regional Management Plan*



Gulf States Marine Fisheries Commission

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No. 28

THE BLACK DRUM FISHERY OF THE GULF OF MEXICO, UNITED STATES:

A REGIONAL MANAGEMENT PLAN

by

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The Black Drum TTF also wishes to acknowledge the special help from the Draft Black Drum Management Plan for Louisiana and its authors, Mr. Clarence Luquet, Mr. John Roussel, Mr. Joseph Shepard and Mr. Harry Blanchet.

Finally, the TTF herein expresses its most heartfelt appreciation for the effort, skill and dedication provided by Ms. Cynthia Bosworth in assuring the quality of this document and to Mrs. Lucia Hourihan for her special and invaluable attention to its review and publication.

Preface

The Gulf States Marine Fisheries Commission (GSMFC) was established by the Gulf States Marine Fisheries Compact under Public Law 81-66 approved May 19, 1949. Its charge was to promote the 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; however, the states do not relinquish any of their rights or responsibilities in regulating their own fisheries by being members of the Commission.

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

The black drum fishery management plan is a cooperative planning effort of the five Gulf States under the IJF Act. All members of the task force contributed by drafting individually assigned sections. In addition, each contributed personal expertise to discussions that resulted in revisions and led to the final draft of the plan.

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

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1.0 SUMMARY

The black drum, Pogonias cromis, has received little attention from biological researchers relative to other members of the family Sciaenidae. Most studies have focused on the description of various life stages, reproduction, food and feeding and geographic distribution. Some data are also available on the age, growth and movements/migration of black drum.

Black drum have been found in a wide range of habitats throughout the U.S. Gulf of Mexico. They appear to be most predominant in shallow estuarine areas where major food items such as benthic crustaceans and mollusks are most abundant. Black drum are also capable of eating significant amounts of oysters, and oyster fishermen report severe depredation on bedded oysters. They are found in a wide range of salinities and temperatures in the gulf, but drum are most abundant at median values coinciding with nearshore areas.

Being distributed throughout the U.S. Gulf area, black drum populations may be affected by the jurisdictions and authorities of a large number of federal and state agencies. Because they are predominantly found in the territorial waters of the five Gulf States, the individual states, and not the Gulf of Mexico Fishery Management Council, exercise the most direct management authority. Other federal agencies including the National Park Service, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration and the Environmental Protection Agency are also involved directly or indirectly with the management of black drum. These agencies along with various state agencies administer programs to regulate land and water use, pollution control, wetlands protection and other activities that could affect black drum populations.

Black drum fishery management by the Gulf States includes the promulgation of various laws, regulations and policies. Most states require licenses and restrict the use of gear in certain areas. Others have regulations on size, bag/possession limits, seasons and quotas. All states collect data and enforce their laws and regulations.

The commercial black drum fishery in the U.S. Gulf of Mexico is both old and new. It was a relatively stable fishery in Texas from the early 1960s to the mid 1980s, and landings from Texas led the gulf throughout most of this period. In the rest of the Gulf States, drum were relatively undesirable and underutilized until about 1979. With the exception of Texas, the fishery grew rapidly from 1979 to 1987, and landings exceeded historical highs by more than five-fold. This increase occurred primarily as a result of the large demand for "blackened" fish in restaurants and the ability of black drum to substitute for red drum, Sciaenops ocellatus (the most desired species). Since 1988 the demand has diminished, and gulf landings have returned to pre-1979 levels, with the exception of Texas where landings have declined. Black drum also have a relatively low value that accounts for their lack of utilization, except for the "blackened" fish period.

With the exception of seasonal pulse fishing in certain areas, black drum have never been a species of choice for recreational fishermen in any of the Gulf States. They are targeted by a relatively small percentage of anglers who are probably fishing more for food than sport.

A perceived problem in the fishery originally centered on the concern that rapidly escalating catches from approximately 1979 to 1988 in the north central gulf were resulting in overfishing, particularly of adult, spawning stock. Although the

spawning stock biomass per recruit (SSB/R) ratio from the stock assessment showed evidence of declines from approximately 1986 to 1990, there was no determination that either growth or recruitment overfishing was occurring. It is noted, however, that few data were available for these analyses, and they included relatively few years.

Other problems that have been identified include loss of habitat, inconsistency of regulations and the need to increase data collection and monitoring programs.

The stock assessment and analyses conducted in this plan assumed that the black drum population in the gulf was a unit stock. Some of the analyses used in the assessment were, however, based on isolated data sets; consequently conclusions may not uniformly reflect trends in the fishery for all Gulf States. Considering the limitations of the data, the analyses and conclusions should be applied with caution in management programs of individual states.

The present stock assessment concludes that the black drum population in the gulf is healthy; however, states should continue to monitor their fisheries to maintain a conservation standard that is at least equivalent to a 20% SSB/R ratio. States should adopt gear restrictions, size limits, bag limits, seasonal quotas or other restrictions as needed, and they should work cooperatively to enact regulations that are consistent among states to the maximum extent possible. States should also evaluate the impacts of regulations and their effects on solving problems and accomplishing management objectives. This evaluation should include effects on black drum from restrictions used to protect other fisheries.

All fish should be landed whole, with heads, tails and flesh naturally attached, and only licensed commercial fishermen should be allowed to sell drum.

2.0 INTRODUCTION

The State-Federal Fisheries Management Committee (S-FFMC) of the GSMFC first addressed the need for a fishery management plan (FMP) for black drum at their meeting held June 21-22, 1988. Other interjurisdictional plans for Spanish mackerel, menhaden, blue crab and oysters were either completed or under development at that time. The S-FFMC concluded that a black drum FMP was needed to address a number of accumulating concerns regarding the fishery. The primary concern prompting the FMP development was the effect of substantially increased demand and subsequent commercial landings that occurred in the early to mid 1980s on black drum stocks in the gulf.

Very little information was available on the biology, habitat requirements and other aspects of the fish and the fishery. The paucity of data coupled with increasing pressure prompted the need and priority for FMP development. In late 1989 a technical task force (TTF) was formed to initiate FMP development. The TTF held its first meeting February 7-8, 1990.

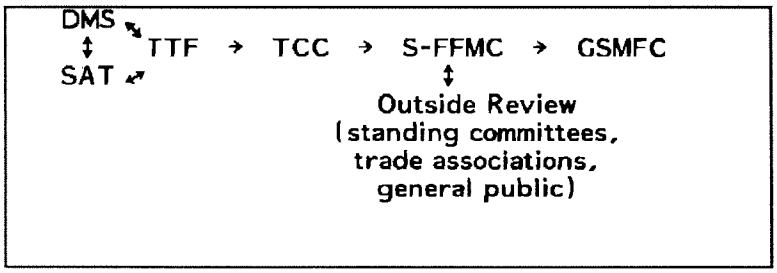
2.1 IJF Program and Management Process

The Interjurisdictional Fisheries Act of 1986 (Title III, Public Law 99-659) was established 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 FMPs by the GSMFC and the other marine fishery commissions.

After passage of the act, the GSMFC initiated the development of a FMP planning and approval process. The GSMFC decided to pattern its plans after those of the Gulf of Mexico Fishery Management Council under the Magnuson Fisheries Management Act of 1976. This decision ensured compatibility in format and approach to management among states, federal agencies and the council.

The GSMFC also established the requirement that each plan be developed by a TTF of experts from each state. These members were to be appointed by each states' representative on the S-FFMC. Each of the standing committees of the GSMFC (Commercial Fisheries Advisory, Law Enforcement and Recreational Fisheries Advisory) also appointed one member or delegate to the TTF.

The GSMFC established a review and approval process for FMPs as follows[1]:



Once approved by the GSMFC, plans are recommended to the individual states for consideration of adoption and implementation.

2.2 Black Drum Technical Task Force Members

Christopher Dyer	University of South Alabama (sociology)
Scott Gordon	Mississippi Department of Wildlife, Fisheries and Parks/Bureau of Marine Resources
Doug Horn	Clark Seafood (industry)
Walter Keithly	Coastal Fisheries Institute, Louisiana State University (economics)
Rita R. Scheffler	William J. Scheffler's (recreational liaison)
Clarence Luquet	Louisiana Department of Wildlife and Fisheries
Richard Matheson	Florida Marine Research Institute
Karen Meador	Texas Parks and Wildlife Department
Jim Robertson	Texas Parks and Wildlife Department (law enforcement)
Mark Van Hoose	Alabama Department of Conservation and Natural Resources

2.3 GSMFC Interjurisdictional Fisheries Program Staff

Larry B. Simpson	Executive Director
Richard L. Leard	Program Coordinator
Cynthia D. Bosworth	Staff Assistant

[1]DMS = Data Management Subcommittee
SAT = Stock Assessment Team
TTF = Technical Task Force
TCC = Technical Coordinating Committee
S-FFMC = State-Federal Fisheries Management Committee
GSMFC = Gulf States Marine Fisheries Commission

2.4 Authorship and Support for Plan Development

Section 3.0 - Matheson, Leard
Section 4.0 - Matheson, Leard
Section 5.0 - Van Hoose, Leard
Section 6.0 - Meador, Leard
Section 7.0 - Keithly, Luquet
Section 9.0 - Dyer
Section 10.0 - Leard
Section 11.0 - Leard
Section 12.0 - All
Section 13.0 - All

2.5 FMP Management Objectives

The objectives of the black drum FMP are:

1) To summarize, reference and discuss relevant scientific information and studies regarding the management of black drum in order to provide an understanding of past, present and future efforts.
2) To describe the biological, social and economic aspects of the black drum fishery.
3) To review state and federal management authorities and their jurisdiction, laws, regulations and policies affecting the black drum.
4) To ascertain optimum benefits of the black drum fishery of the U.S. Gulf of Mexico to the region while perpetuating these benefits for future generations.
5) To describe the problems and needs of the black drum fishery and to suggest management strategies and options needed to solve problems and meet the needs of the stocks.

3.0 DESCRIPTION OF STOCK(S) COMPRISING THE MANAGEMENT UNIT

3.1 Biological Description and Geographic Distribution

The black drum is the largest member of the family Sciaenidae found in the U.S. Gulf of Mexico, but it has historically been overshadowed in terms of economic value by the red drum, Sciaenops ocellatus, and spotted seatrout, Cynoscion nebulosus. The relatively low value of the black drum fishery has led to a small number of studies of the ecology and life history of this species when compared to those of several other sciaenids.

3.1.1 Classification and Morphology

The scientific name for the black drum is Pogonias cromis (Linnaeus) (Robins et al. 1991). The following synonymy is taken from Chao (1978):

Labrus cromis Linnaeus, 1766
Pogonias fasciatus Lacepède, 1802
Pogonathus courbina Lacepède, 1803
Mugil grunniens Mitchill, 1814
Mugil gigas Mitchill, 1814
Sciaena fusca Mitchill, 1815

The species is classified as follows (based on Nelson 1984):

Superorder: Acanthopterygii
Order: Perciformes
Suborder: Percoidei
Family: Sciaenidae
Genus: Pogonias
Species: cromis

Common names in addition to black drum that are currently in use include drum, sea drum, gray drum, banded drum, big drum, puppy drum, bull drum, tambour (Louisiana French), grand tambour (French), roncador, tonton and corvinón negro (Spanish) (M. Rosado, personal communication; Gowanloch 1933; Chao 1977; Hoese and Moore 1977). Throughout this document we will primarily use the terms black drum or simply drum to refer to this species.

The black drum is one of 23 members of the family Sciaenidae recorded along the Atlantic and gulf coasts of the United States (Robins and Ray 1986, Miller and Woods 1988). Members of this family are commonly known as drums or croakers due to sounds they produce. [Sounds produced by black drum were described by Mok and Gilmore (1983).] Chao (1978) reviewed the sciaenids of the western North Atlantic and presented a phylogeny based on external morphology and the morphologies of the swimbladder and otoliths. Diagnoses and descriptions of the black drum are found in various works including Jordan and Evermann (1898), Hildebrand and Schroeder (1928), Pearson (1929), Simmons and Breuer (1962), Joseph et al. (1964), Jannke (1971), Miller and Jorgenson (1973), Scotton et al. (1973), Lippson and Moran (1974), Chao (1976, 1978), Johnson (1978), Powles and Stender (1978), Darovec (1983), Fahay (1983), Holt et al. (1988) and Ditty (1989).

Early life history stages of black drum have been described by various authors. Wild-caught black drum eggs were described by Joseph et al. (1964) from the Chesapeake Bay region and by Holt et al. (1988) from Texas. Both studies concluded that no morphological characters separated black drum eggs from those of all other sciaenids spawning in the area. Holt et al. (1988) described black drum

eggs as follows: 0.90-1.20 mm in diameter; positively buoyant at normal spawning salinities; semitransparent; with one oil globule in later developmental stages; and with both oil globule and embryo heavily pigmented, primarily with yellow chromatophores.

Early larvae have been most recently described by Holt et al. (1988) and Ditty (1989). The former authors described yolk-sac larvae as having three chromatophore bands posterior to the anus; yellow chromatophores above the abdomen, on the nape, and on the head; and small chromatophores outlining the posterior end of the notochord. The latter author described early larvae [2.6-3 mm standard length (SL)] as follows: pigment along the dorsal midline near the nape and about midway between the anus and the tip of the notochord; generally a lateral melanophore dorsal to the anus, several melanophores ventrally between the anus and the tip of notochord; and pigment along the sides and tip of the lower jaw. The bands mentioned by Holt et al. (1988) were not mentioned by Ditty (1989), but the latter author did illustrate heavy pigment in the regions of these bands in a 5.2 mm SL larva.

Based on information from various sources, Johnson (1978) indicated that larvae at about 8 mm SL possess a profusion of melanophores both dorsally and laterally extending from the nape to the caudal peduncle. These melanophores are arranged in definite groups and are the forerunners of the six black bars that appear at about 15 mm SL and persist until adult size. General adult shape is also attained by about 15 mm SL. Figure 3.1 shows various developmental stages of black drum at specified lengths.

Adult black drum are described in several of the works listed above. Johnson (1978) described adult black drum as follows:

> "Body oblong, moderately compressed, back much elevated; ventral outline nearly straight; head moderately short, snout blunt; mouth horizontal, inferior, lower jaw included; maxillary scarcely reaching below middle of eye; chin with 5 pores and 12 to 13 pairs of barbels along inner edges of lower jaw ..., the series usually extending back to below middle of eye. Scales firm, ctenoid. Dorsal fin continuous, with a deep notch in between the spinous and soft portions ... ; dorsal spines stiff and slender, the third longest; anal fin short, the second spine much enlarged; caudal fin subtruncate; pectoral fins about as long as head.
>
> Pigmentation: Color in life blackish with brassy luster, dark above ...; grayish white below; all fins dusky or black. Color varies somewhat with habitat; in Gulf of Mexico almost uniformly silvery, lose crossbars early; in bays and lagoons darker, often bronze along back and dirty white on sides and belly.
>
> Easily recognized by numerous chin barbels, the entire preopercular margin, and the elevated back and straight ventral profile."

Figure 3.2 shows a typical adult black drum. Potential identification problems arise due to the marked transition from between four and six pronounced, black, vertical bars in juveniles to a more uniform dark color with obscure bars in large adults (Hoese and Moore 1977, Johnson 1978). Johnson (1978) gave the following ranges for meristic characters: dorsal-fin rays X-I, 19-23; anal-fin rays II, 5-7; scales 41-45 in lateral series; gill rakers 4-6+12-16.

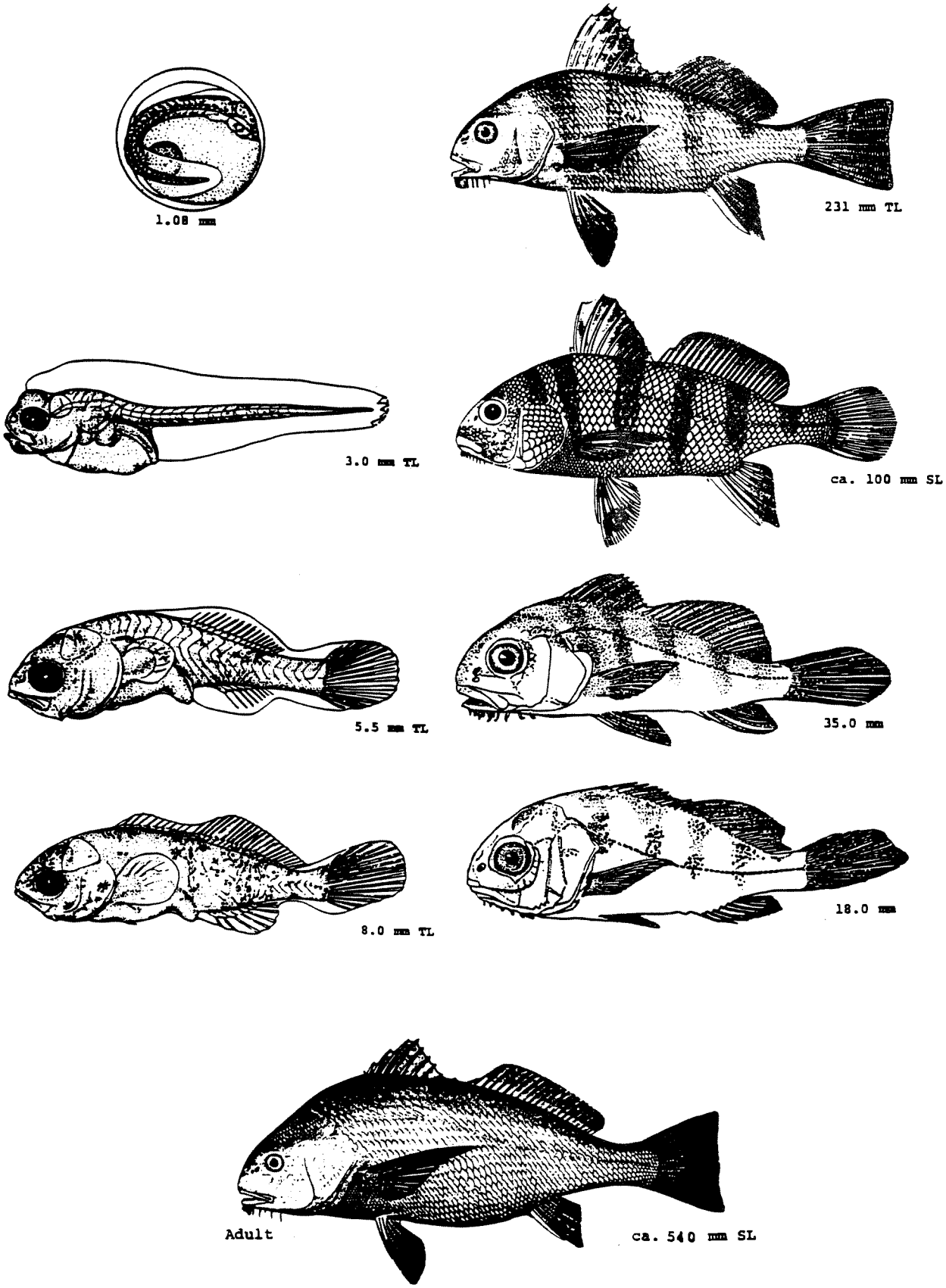


Figure 3.1. Developmental stages of black drum at specified lengths [developed from Johnson (1978)].

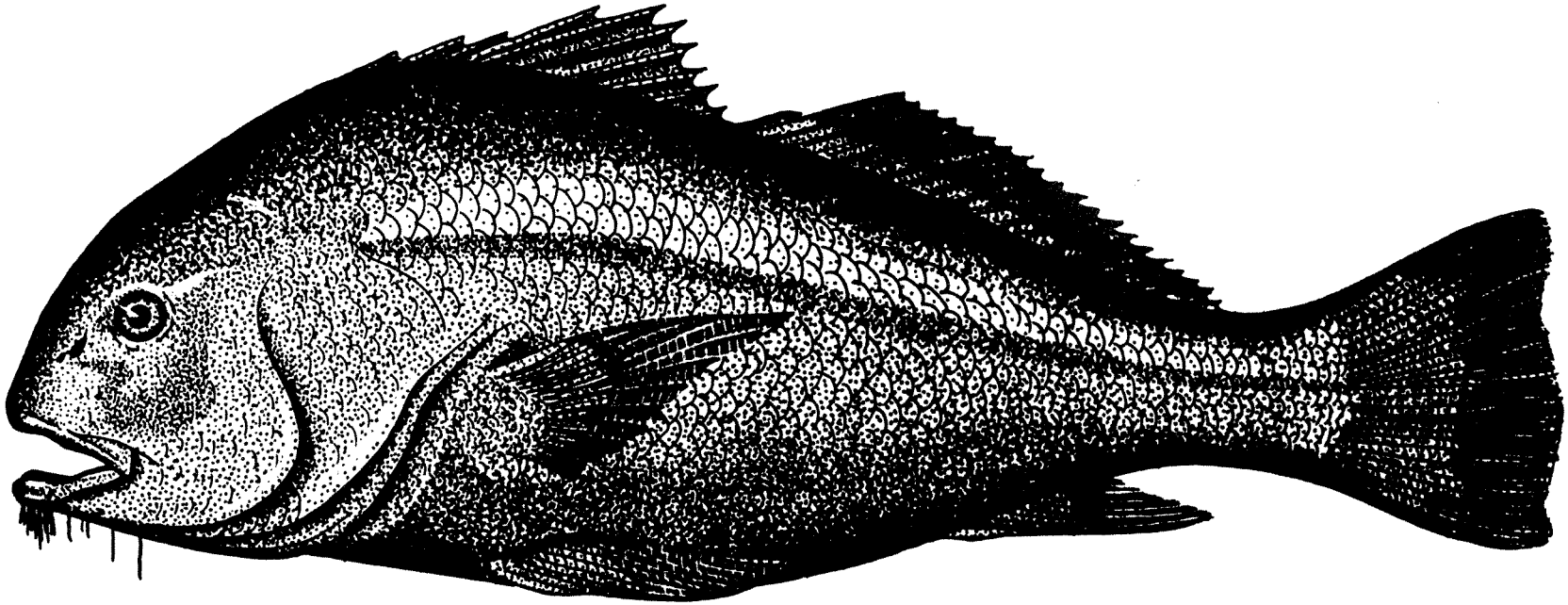


Figure 3.2. Adult black drum [original publication unknown].

3.1.2 Biological Description

3.1.2.1 Age, Growth, and Maturation

In order to compare size data from various sources, Harrington et al. 1979, Hein et al. (1980) and Murphy and Taylor (1989) provided equations relating standard length (SL), fork length (FL), and total length (TL) in black drum. These equations are as follows:

TL = 25.10 + 1.16 SL (Murphy and Taylor 1989)
TL = 10.43 + 1.20 SL (Hein et al. 1980)
TL = 18.2 + 1.18 SL (Harrington et al. 1979)
TL = -3.8 + 1.03 FL (Murphy and Taylor 1989)

Harrington et al. (1979) based their equation on specimens from Texas ranging from 40-990 mm SL. Hein et al. (1980) based their equation on specimens from Louisiana ranging from 44 to 1061 mm TL, and Murphy and Taylor (1989) based their equations on specimens from northeast Florida ranging from 202 to 1275 mm TL. Unless otherwise stated in this section, we will utilize measurements converted to TL by the formulas of Murphy and Taylor (1989).

Black drum exhibit rapid growth throughout their first three to four years of life and reach ages of 13 to 60 years and sizes of more than 1300 mm TL (Murphy and Taylor 1989, Beckman et al. 1990a, Matlock 1990). Murphy and Taylor (1989) reviewed age and growth studies of this species, and Beckman et al. (1990a) provided the most recent published contribution on this subject. Data of varying completeness and quality are available from numerous localities including Delaware (Thomas 1971), Virginia (Richards 1973), Georgia (Music and Pafford 1984), northeast Florida (Murphy and Taylor 1989), Louisiana (Hein et al. 1980; Beckman et al. 1988, 1990a, 1990b), and Texas (Pearson 1929, Simmons and Breuer 1962, Cornelius 1984, Doerzbacher et al. 1988, Matlock 1990). Three basic types of data were utilized in these studies: cyclical markings on hard parts (i.e., scales and/or otoliths), length-frequency modes, and tag-recapture data. Comparisons of ages based on scale examination with those based on length frequencies, as well as marginal-increment analysis of scale readings, indicated the value of scales as ageing structures in fish one or two years old and less than 493 mm TL (Pearson 1929, Simmons and Breuer 1962, Music and Pafford 1984). Marginal-increment analyses of the heavily calcified scales of fish >600 mm TL, however, failed to reveal annual periodicity in growth checks. Murphy and Taylor (1989) indirectly verified the annual periodicity of opaque bands in thin sections of black drum otoliths from age classes 1-4 using marginal-increment analysis, while Beckman et al. (1990a) used the same technique to demonstrate annual periodicity in fish with as many as 43 supposed annuli.

Some geographic variation is evident in black drum age and growth data. Murphy and Taylor (1989) and Beckman et al. (1990a) compared growth rates calculated for populations in Texas, Louisiana, northeast Florida, Georgia, and Virginia (Table 3-1). Sizes at age 1 ranged from 187 mm TL in Texas to 288 mm TL in northeast Florida. Texas and northeast Florida populations generally exhibited similar length-at-age patterns except for a south Texas population (Cornelius 1984) that seemed to be smaller (especially after age 4). Fish from Georgia appeared to reach sizes comparable to those from northeast Florida by age 6 but were smaller thereafter. Lengths for Virginia populations were less than those for northeast Florida at age 1, similar at age 2, and much greater at ages greater than 2. Louisiana specimens exhibited more rapid growth than northeast Florida specimens

from ages two to approximately 5 but grew much more slowly thereafter. Parameter estimates for von Bertalanffy models of black drum growth suggested more rapid growth to a larger maximum size in Virginia populations relative to those from either northeastern Florida or Louisiana and more rapid growth to a smaller maximum size in Texas populations. Comparisons of these parameters for northeastern Florida and Louisiana indicated slower growth and a slightly smaller maximum size in Louisiana. Estimated maximum TL for Atlantic coast populations ranged from 1207 mm (Music and Pafford 1984) to 1514 mm (Richards 1973). These estimates for gulf coast populations ranged from 798 mm for Texas populations (Doerzbacher et al. 1988) to 1794 mm for Louisiana populations (Beckman et al. 1988). [It should be noted, however, that Beckman et al. (1990a, 1990b) found markedly lower maximum size estimates of 1026-1129 mm TL for Louisiana fish]. Matlock (1990) reported maximum age of black drum based on tag returns as 13 years, but estimated maximum ages based on age-and-growth studies ranged from 35 years in Virginia (Richards 1973) to 43 years in Louisiana (Beckman et al. 1990a), 46 years in Georgia (Music and Pafford 1984), and 58 years in northeast Florida (Murphy and Taylor 1989).

Table 3.1. Comparison of estimated total length (mm) versus age for black drum from various localities along the Atlantic and gulf coasts of the United States (modified from Murphy and Taylor 1989).

	Age									
State	1	2	3	4	5	6	7	8	9	10
VA[1]	198	405	569	687	774	833	889	926	955	984
VA[2]	226	414	575	712	829	929	1015	1088	1151	1203
GA[3]	198	336	440	538	625	662	666	716	763	809
FL[4]	288	388	477	555	625	687	742	790	834	872
LA[5]	265	443	545	606	643	669	686	702	714	725
LA[6]					632	650	668	685	703	718
TX[7]	255	378			616		---771-874---			
TX[8]	187-234	361-408	489-524							
TX[9]	246	375	443	505	557	605	642	675		

[1]Richards (1973) (uncorrected; back-calculated)
[2]Richards (1973) (corrected; von Bertalanffy model)
[3]Music and Pafford (1984) (back-calculated)
[4]Murphy and Taylor (1989) (Atlantic coast; von Bertalanffy model)
[5]Beckman et al. (1990a) (von Bertalanffy growth model)
[6]Beckman et al. (1990b) (sloped asymptote model)
[7]Pearson (1929) (length frequency and scales)
[8]Simmons and Breuer (1962) (length frequency)
[9]Cornelius (1984) (back-calculated)

Length-weight relationships for black drum have been calculated for populations ranging from Delaware to Texas (Table 3.2). Murphy and Taylor (1989) used relationships based on Virginia, Georgia, northeast Florida, Louisiana, and Texas populations to calculate expected weights for fish 300 mm, 600 mm, 900 mm and 1200 mm TL. These data revealed that Georgia fish were heaviest at a given length and Louisiana fish were lightest. Texas and northeast Florida populations were similar in weight.

Table 3.2. Length-weight relationships for black drum populations from various localities along the Atlantic and gulf coasts of the United States.

Study	Locality	Equation
	Atlantic	
Thomas (1971)	DE	$W = 0.48 \times 10^{-5}\ FL^{3.2405}$
Richards (1973)	VA	$W = 1.23 \times 10^{-5}\ FL^{3.066}$
Music and Pafford (1984)	GA	$W = 1.07 \times 10^{-5}\ FL^{3.075}$
Murphy and Taylor (1989)	FL	$W = 1.16 \times 10^{-5}\ FL^{3.05}$
	Gulf	
Harrington et al. (1979)	TX	$W = 1.39 \times 10^{-5}\ TL^{3.001}$
Hein et al. (1980)	LA	$W = 1.52 \times 10^{-5}\ FL^{2.971}$
Beckman et al. (1990a)	LA	$W = 1.14 \times 10^{-5}\ FL^{3.05}$
Cornelius (1984)	TX	$W = 1.07 \times 10^{-5}\ FL^{3.053}$

W = weight
FL = fork length
TL = total length

Reported ages and sizes at maturity for black drum were similar for most U.S. localities with the exception of Texas. Females reached maturity at ages ranging from 2 years in Texas (Pearson 1929; Simmons and Breuer 1962) to 4-6 years in Georgia, northeast Florida, and Louisiana (Music and Pafford 1984, Murphy and Taylor 1989, Beckman et al. 1990b). Female sizes at maturity were listed as 275-320 mm TL for Texas (Pearson 1929) and approximately 600-700 mm TL elsewhere (Music and Pafford 1984, Fitzhugh et al. 1987, Murphy and Taylor 1989, Beckman et al. 1990b). Mature males have been reported at ages as young as 2 years and sizes as small as 250-340 mm TL (Pearson 1929, Murphy and Taylor 1989), but two separate studies reported that 50% maturity in males is not reached until ages 4 or 5 and sizes of 590-640 mm TL (Murphy and Taylor 1989, Beckman et al. 1990b).

The age structure of black drum populations is discussed in Section 9.3 and Appendix 1.

3.1.2.2 Reproduction

Reproduction and reproductive behavior appear to be influenced by a number of factors. Egg development and spawning may vary both seasonally and geographically. Limited data are available in the literature regarding behavior patterns associated with reproduction.

3.1.2.2.1 Gonadal Development

Murphy and Taylor (1989) provided a detailed classification scheme for black drum gonads. This scheme included eight classes for both ovarian and testicular development: immature, developing/resting virgin, maturing, mature, gravid, spawning, spent, and recovering. For ovaries these classes were based primarily on stages of oocyte development (i.e., oogonia, primary oocytes, oocytes, oocytes with yolk vesicles and hydrated oocytes). Classification of testes was based

primarily on stages of spermatogenesis (i.e., spermatogonia, primary spermatocytes and spermatozoa) and location of spermatozoa (i.e., in tubules and central lumen, in efferent ducts and in the main collecting duct). Other descriptions of stages of black drum gonadal maturation included those of Fitzhugh et al. (1987) and Beckman et al. (1988, 1990b).

3.1.2.2.2 Fecundity

Fecundity of black drum has been estimated at 6 to 11.4 million eggs (Pearson 1929, Cornelius 1984, Music and Pafford 1984), but Beckman et al. (1990b) explained that in multiple spawning fishes batch fecundity is a more meaningful estimate of annual reproductive output. Batch fecundity is defined as the number of oocytes in the batch just prior to spawning. Estimates of batch fecundity range from 0.74 to 3.8 million ova (Fitzhugh et al. 1987, Beckman et al. 1988, 1990b). Few data exist regarding the relationships among fecundity, age, and size, but the unpublished data of D.L. Nieland and R.M. Parker show no indication of senescence, or loss of fecundity, among older, larger females (Beckman et al. 1989). Also, Beckman et al. (1990b) recorded positive correlations between fecundity and TL, weight, and age.

3.1.2.2.3 Spawning

Black drum are group-synchronous, batch spawners (Wallace and Selman 1981) in which two populations of oocytes in ovarian tissues can be distinguished during the spawning season: (1) a synchronous population of late stage oocytes comprising the leading clutch or batch; and (2) a population of smaller less mature oocytes from which the batch is recruited (Fitzhugh et al. 1987; Beckman et al. 1988, 1990b). The result is a bimodal distribution of oocyte maturation stages within the ovary.

As batch spawners, black drum may spawn numerous times in a given spawning season, and several authors have attempted to calculate spawning frequency for this species. Fitzhugh et al. (1987) used postovulatory follicles (POF) and hydrated ova to indicate recent or imminent spawning and calculated a spawning frequency of approximately seven days. Beckman et al. (1988 and 1990b) used POF, but not hydrated ova, to calculate a spawning frequency of 2.8 to 3.8 days. (These estimates are the inverse of the ratio of the number of individuals spawning to the total number of individuals in the sample.) The latter authors used this spawning frequency, a calculated mean batch fecundity of 1.45 million ova and a spawning season of 14 weeks to determine that a single female black drum could spawn as many as 40,000,000 ova per spawning season. (A compilation of data from other studies indicates that a 14-week spawning period is reasonable but perhaps conservative). It is, however, unknown whether any one individual spawns over the entire reproductive season.

Various studies have utilized seasonality of such parameters as gonadal development, occurrence of early life-history stages, and drumming behavior to document reproductive and spawning seasonality in black drum. Examples of these studies from coastal waters of the U.S. include Frisbie (1961), Joseph et al. (1964), Thomas (1971), and Richards (1973) from the Chesapeake and Delaware Bay regions; Allen and Barker (1990) from South Carolina; Music and Pafford (1984) from Georgia; Jannke (1971), Mok and Gilmore (1983), Collins and Finucane (1984), Herrema et al. (1985), Murphy and Taylor (1989), and Peters and McMichael (1990) from Florida; Fontenot and Rogillio (1970), Ditty (1986), Beckman et al. (1988, 1990b), and Cowan and Shaw (1988) from Louisiana; and Pearson (1929), Simmons (1957), Simmons and Breuer (1962), More (1964), King (1971), Ross et al. (1983),

Cody et al. (1984), and Cornelius (1984) from Texas. Data from these studies are summarized by region in Table 3.3.

Considering the entire coastal U.S., black drum spawning has been recorded during every month of the year. Gulf populations generally exhibited peak spawning from January through May. On a regional basis, black drum in more northern localities tended to spawn more during the warmest portions of the year (late spring to summer) than did those from more southern localities. For the two states that include the most southern localities (Florida and Texas), spawning has been recorded during ten and twelve months, respectively, and at the single most southern locality, the waters outside the Florida Everglades, peak spawning was one or two months earlier than in any other area.

Table 3.3. Spawning season of black drum from various localities along the Atlantic and gulf coasts of the United States.

	MONTH											
Locality	J	F	M	A	M	J	J	A	S	O	N	D
Delaware, Maryland Virginia		----------***-------										
South Carolina			----------***********-------									
Georgia		**********-------										
Florida (Atlantic Coast)	----------**********-------							-------------------------				
Florida (Everglades)	*********-----			---				------			**********	
Florida (Gulf Coast)	----------***----------										----------	
Louisiana	-----**********											-----
Texas	**********----------											

-denotes seasonal range of spawning
*denotes peak spawning season

A review of literature sources indicates that black drum may utilize both inshore and offshore environments for spawning. Spawning in inshore bays and sounds has been reported by Mok and Gilmore (1983) in Florida; Beckman et al. (1988) in Louisiana; and Simmons (1957) and Cornelius (1984) in Texas. Spawning in nearshore marine waters (often near inlets and the mouths of bays) has been reported by Frisbie (1961) and Joseph et al. (1964) in the Delaware and Chesapeake Bay regions; Jannke (1971), Collins and Finucane (1984), and Peters and McMichael (1990) in Florida; Ditty (1986), Beckman et al. (1988), and Cowan and Shaw (1988)

in Louisiana; and Pearson (1929), Simmons (1957), Ross et al. (1983), Cody et al. (1984), and Holt et al. (1985) in Texas. In several of the latter studies spawning location was inferred based on the distribution of early larvae and could have been either just outside or just inside a coastal embayment.

Although the act of mating has not been documented, several authors have presented data relating to spawning behavior in black drum. Silverman (1979) indicated that this species forms schools prior to spawning and that these schools disperse after spawning. Sound production may be an indication of reproductive activity. The drumming muscle is associated with the swimbladder and is present in both sexes (Fish and Mowbray 1970, Chao 1976). The drumming of migrating schools is audible from boats, and, although sound is produced by immature as well as mature fish, peak drumming behavior occurs during the spawning season among fishes in spawning schools (Pearson 1929, Fish and Mowbray 1970, Mok and Gilmore 1983). Based on maximum production of loud drumming sounds spawning appears to occur from late afternoon to just past sunset (Fish and Mowbray 1970, Mok and Gilmore 1983), but, based on developmental stages of eggs in estuarine and nearshore samples, spawning appears to occur from one to two hours after sunset (Holt et al. 1985).

3.1.2.3 Parasites and Disease

The internal parasite most commonly found in large black drum is the tapeworm larvae Poecilancistrium sp. (Simmons and Breuer 1962). Overstreet (1977) found musculature of black drum in Mississippi Sound infected with Poecilancistrium caryophyllum. Cave (1978) observed P. robustum in drum. Overstreet (1977) also noted that Pseudogrillotia pleistacantha selectively infected large drum. Although these parasites are not harmful to humans, they are unappetizing and may reduce the marketability of large drum (Overstreet 1978).

Deardorff and Overstreet (1980) described a new species of nematode (Goezia kliksi sp. n.) with a black drum being the type host and Lake Borgne, Louisiana, being the type locality for probable infections. The observed infection was in the wall of the stomach and free in the lumen of the fish.

Silverman (1979) reported that ectoparasites are fairly common on black drum and included copepods, Caligus repax, C. bonito, C. latifrons, C. pelamydis, C. haemulonis and perhaps other Caligus species. Caligus peiamyois and C. productus have also been observed (A. Lawler, personal communication), and Brachiella gulosa was reported by Simmons and Breuer (1962). Isopods, Nerocila acuminata, were taken from drum by Bere (1936) and Simmons and Breuer (1962), and Thomas (1971) found Livonica ovalis on fish collected in Delaware. Breuer (1957) noted that the entire population of drum in Baffin and Alazan Bays, Texas, was infested with the parasitic copepod, Caligus repax. Infestation rates varied from one to several hundred per fish, but these parasites did not seem to harm the fish.

Van Duljn (1956) noted the presence of the protozoan, Cryptocaryon irritans (commonly referred to as white spot" or "ich") on fins and skin of drum. Parasites of the gills including the dinoflagellate Amyloodinium ocellatum, and the monogenetic trematode Aspinatrium pogoniae have been reported by Lawler (1977) and Lawler and Cave (1978), respectively.

3.1.2.4 Predator/Prey Relationships

After an initial planktonic feeding stage, black drum consume mainly polychaetes, molluscs, crustaceans, insects, and fishes found on or near the substrate. Peters and McMichael (1990) presented data on the feeding habits of larval and juvenile black drum and reviewed previous studies. The primary food of larvae was copepods, while small juveniles (<60 mm SL) fed primarily on amphipods, mollusks, polychaetes, and small fish. The latter data agreed with those of Pearson (1929), de Sylva et al. (1962), Simmons and Breuer (1962), Thomas (1971), and Music and Pafford (1984). Peters and McMichael (1990) also reported for the first time that small juveniles consumed siphon tips of bivalves. Larger juveniles ate greater quantities of shrimp, crabs, fish, and molluscs. These authors also mentioned that juveniles rely on soft-bodied prey until their pharyngeal molars develop at sizes greater than 200 mm SL.

Various studies have documented the utilization of benthic, often hard-bodied prey by large juvenile and adult black drum. These studies include Welsh and Breder (1924), Pearson (1929), Gunter (1945), Simmons (1957), Darnell (1958), de Sylva et al. (1962), Pullen (1962), Simmons and Breuer (1962), Fontenot and Rogillio (1970), Thomas (1971), Diener et al. (1974), Moffett (1975), Cave and Cake (1980), Overstreet and Heard (1982), Matlock and Garcia (1983), Music and Pafford (1984), and Dugas (1986). A review of the findings of these studies indicates that molluscs, decapods, and fishes were the most frequently reported taxa in black drum diets, while molluscs, decapods, and annelids (in that order) demonstrated the highest frequency of occurrence (Table 3.4). Molluscs, decapods, and annelids, also had the highest mean and maximum frequency of occurrence.

Table 3.4. Relative importance of major food items in the diet of large juvenile and adult black drum (majority of specimens >100 mm TL).

Taxa	Number[1]	Dominance[2]	Frequency of Occurrence (%)*	
			Mean	Maximum
Annelids	8	2	13	40
Isopods	4	0	1	8
Amphipods	8	0	6	24
Decapods	11	4	24	38
Penaeids	5-6	-	3	13
Callinectes	4-6	-	6	22
Insects	5	0	3	17
Molluscs	11	6	36	75
Crassostrea	6	-	2	9
Other bivalves	10	-	17	75
Pisces	10	0	9	22

*Due to variability in terms of taxonomic resolution and data presentation, all values are approximate.
[1]Number=number of studies reporting the item in black drum diets.
[2]Dominance=number of studies in which each taxon was the dominant food item in terms of frequency of occurrence.

Ontogenetic variation in black drum diets has been documented in a few studies. In addition to the feeding differences noted above for larval and small juvenile fish (Peters and McMichael 1990), authors such as Pearson (1929) and Dugas (1986) have noted dietary changes among several size classes of larger juveniles and adults. Pearson (1929) divided his specimens into three size classes: (1) less than 202 mm TL; (2) 213-511 mm TL; and (3) greater than 820 mm TL. Among these classes the smallest fish consumed annelids and fishes (relatively soft-bodied prey) more often than they did decapods or molluscs (relatively hard-bodied prey). As fish increased in size, however, the frequency of occurrence of molluscs in stomachs increased from 20% in the smallest fish to 74% in the largest fish. Dugas (1986) considered five size classes of drum: (1) less than 141 mm TL; (2) 142-257 mm TL; (3) 258-373 mm TL; (4) 374-489 mm TL; and (5) greater than 489 mm TL. Over the entire size range of the five classes, arthropods (insects and crustaceans) were the most frequently eaten food items. The smallest size group consumed insects, molluscs, and annelids most frequently, while the largest size group consumed mostly molluscs, decapods, and fishes. The frequency of occurrence of molluscs in drum diets ranged from 18% for fish less than 141 mm TL to 47% for fish greater than 489 mm TL. These values for annelids ranged from 16% to 28% for fish in the three smallest size classes and from 5% to 10% for fish in the two largest size classes. Dugas (1986) attributed many of the observed differences among size classes to the enlargement of the pharyngeal molars and the strengthening of the associated muscles that allowed for the consumption of more hard-bodied prey items by larger fish.

The ability of black drum to consume large number of oysters is well documented (Cave 1978, Cave and Cake 1980, Dugas 1986), and large drum may destroy large numbers of these valuable shellfish, especially in planted seed beds (Dugas 1986). Several authors have indicated that black drum destroy large numbers of oysters; however, data are inadequate to confirm this statement (Dugas 1986). Moore (1899) noted depredation of planted reefs in Louisiana soon after planting. Cary (1907), Wesh and Breder (1924) and Schlesselman (1955) also reported predation of planted reefs; however, Schlesselman (1955) observed that large oysters on natural reefs were less likely food sources because they caused lacerations to the lips of drum during feeding attempts. Hofstetter (1959, 1977) concurred with Schlesselman's (1955) findings.

Dugas (1986) reported that oysters occurred in less than 1% of stomachs from fish less than 373 mm TL, 5% of those from fish ranging from 373 to 489 mm TL, and 17% of those from fish greater than 489 mm TL. In feeding experiments Cave (1978) noted that drum caught near oyster reef areas preferred oysters over other bivalve mollusks tested. He also observed that drum preferred single oysters over clusters; however, they could crush virtually any size or group of oysters that would fit inside the pharyngeal chamber.

Available stomach-contents data indicate an equal or somewhat stronger preference for other bivalves such as members of the genera Rangia, Ensis and Mulinia (Darnell 1958, Simmons and Breuer 1962, Cave 1978, Overstreet and Heard 1982, Dugas 1986). In fact, stomachs taken from drum feeding on or near oyster reefs by Simmons and Breuer (1962) contained no oysters. Darnell (1958) and Cave (1978) observed that black drum crush oysters and discard the shell, retaining only the soft parts. (Such material would probably be indistinguishable during stomach analysis).

These discrepancies between observational reports and data could be due in part to the paucity of food-habits studies including larger, adult fish. Very few

dietary studies that have documented the size range of their specimens have included fish much larger than 500 mm TL. More research is needed on this subject.

Several studies have included observations on the behavior of black drum during feeding. Thomas (1971) indicated that drum feed both day and night, but feeding was less intensive in early morning hours. As they dig in the bottom sediments during feeding, black drum have been observed nearly standing on their heads. In shallow water this behavior (termed "flagging") often caused the caudal fins of drum to be exposed and frequently allowed commercial fishermen to locate fish (Pearson 1929, Darnell 1958). Dredging of the bottom by feeding drum has been observed to create turbid plumes in the water column, and these plumes were often easily visible from the air (Darnell 1958).

Drum may on occasion leave the bottom in pursuit of more active prey. Studies such as those of de Sylva et al. (1962), Diener (1974), and Dugas (1986) have recorded active fishes that would normally occur well off of the bottom in the diet of black drum. Some of these fishes include Anchoa sp., Chaetodipterus faber, Menidia sp. and Brevoortia sp.

Although no literature was found documenting specific black drum predators during this planning effort, it is likely that drum are a food source for various unspecific marine predators during their life cycle. Possible predators include other Sciaenidae, Carangidae and Scombridae as well as sharks. Filter feeders such as the Clupeidae are possible predators of larval black drum.

3.1.3 Geographic Distribution

Black drum are found in the western Atlantic Ocean from the Bay of Fundy, Nova Scotia, southward through the Gulf of Mexico and Caribbean Sea to Argentina (Gilhen 1986). In U.S. waters they are more common from New Jersey southward and are abundant from the Chesapeake Bay through the Gulf of Mexico to the mouth of the Rio Grande. Maximum abundance of black drum occurs along the Texas and Louisiana coasts (Welsh and Breder 1924, Silverman 1979).

3.1.4 Migration

Larval black drum apparently utilize tidal currents to travel to shallow, estuarine, nursery areas, because they have often been taken while entering estuaries through inlets or the estuary mouth itself (Frisbie 1961, King 1971, Powles and Stender 1978, Peters and McMichael 1990). The latter authors also hypothesized progressive movement of larvae further into the bay based on the occurrence of older larvae in samples further from the bay mouth. In the Gulf of Mexico, larvae were found offshore from December through May with maximum numbers from February through April (Ditty 1986, Ditty et al. 1988). Inshore larvae were most abundant in March and April in Tampa Bay, Florida (Peters and McMichael 1990) and in April in Mesquite Bay, Texas (King 1971).

Postlarval and juvenile black drum recruit to shallow, estuarine, nursery areas soon after the spawning season, but they may leave these areas by the end of their first summer. Peters and McMichael (1990) found early juveniles in Tampa Bay moving into rivers and creeks during May and June; dispersing throughout the bay by the time they reach >100 mm SL; and moving to open waters at river mouths, bays, passes, and the nearshore gulf in fall at lengths of 150 to 200 mm SL. Thomas and Smith (1973) noted that young drum in Delaware entered a ditch accessible to them only on a flood tide. They hypothesized that the young were responding to

higher temperatures and chemical cues from the marsh water flowing out of the ditch. "In earlier collections most young drum taken along the beach were near the outflow of the ditch, indicating a positive response to marsh water" (Thomas and Smith 1973). These juveniles moved out of the creeks in June or July at lengths >40 mm SL.

Adult black drum exhibit complex patterns of movement and seasonality. Drum are present in Louisiana estuaries year-round, with an apparent increase in numbers inshore during May through July east of the Mississippi River, according to commercial catch per effort data reported by Bane et al. (1985). Fontenot and Rogillio (1970) recorded peak catch per effort from trammel net samples in the Biloxi marsh complex from April through August with a lesser peak in December. Inshore commercial gill net fishermen in southeast Louisiana reported decreased fishing effort in late fall and winter for black drum due to migration of these fish from Lake Pontchartrain and Lake Borgne to offshore waters. (An increase in availability of red drum at this time also reduced the netters' efforts for black drum.) Black drum landed during cooler months were primarily harvested by purse-seine vessels fishing in waters greater than three miles offshore (Bane et al. 1985).

Tagging studies by Osburn and Matlock (1984) provided some data on black drum movements along the Texas coast, but they cautioned that these movement patterns may only apply to fish less than 4 years old. They noted substantial intrabay movements with 44% of tagged fish being recaptured more than 10 km from the tagging site. This movement was suspected to be induced by the drum's constant search for sessile molluscan foods. Little interbay movement was observed with an average of 85% remaining in the bay of original capture and tagging. Of the fish that left the bay where originally tagged, 75% were recaptured in adjacent bays. Only 17% of recaptures came from open gulf waters.

Osburn and Matlock (1984) stated that large black drum reside principally in gulf waters; however, large numbers of bull drum have been reported in lakes and bays in some areas at particular times of the year (M. Murphy, H. Pierce and J. Black, personal communication). Cody et al. (1984) caught drum 505-1000 mm TL in the Gulf of Mexico at depths from 5 to 37 m from October to April. They caught none in the summer but suggested that higher metabolic rates allowed the fish to escape the gear. Ross et al. (1983) captured black drum 221-991 mm TL each month of the year except July and October while working in Texas coastal waters. These drum were in the deepest waters (27 m) from January through March, and they were less common from July through November.

Simmons and Breuer (1962) noted some short-term movement patterns among black drum in Texas waters. These authors indicated that most movement was random and associated with feeding, but many individuals congregated at the mouths of rivers after floods. They also noted a mass exodus of drum from the Laguna Madre in 1953 when high temperature and salinity destroyed most bivalves, but these emigrating fish later returned to the area. Finally, they mentioned that decreasing temperatures will lead to movement into deeper water.

Adult black drum have been reported to school for the purpose of feeding over particularly rich feeding grounds or for the purpose of spawning. Breuer (1957) believed that schools of black drum moved in and out of Texas bays in search of food. Schools of black drum may , however, stay in some locations for extended periods. Osburn and Matlock (1984) found that from a group of 68 drum tagged at one site, three were recaptured approximately two months later, and three others were captured almost five months later. All of these recaptures were within 2 km of

the tagging site. Pearson (1929) noted a well-defined movement of adults out of Texas bays during the spawning season, and Richards (1973) noted that drum in the Chesapeake Bay region gathered into spawning schools in late spring and early summer and dispersed throughout the bay thereafter.

4.0 DESCRIPTION OF THE HABITAT OF THE STOCK(S) COMPRISING THE MANAGEMENT UNIT

Black drum occur and thrive in a wide range of habitats throughout the U.S. Gulf of Mexico. They exist over a broad range of salinity, temperature, and substrates, but they appear to prefer relatively shallow estuarine areas. Although rapid and extreme fluctuations in temperature may cause mortalities, the overall amount of estuarine habitat and the accompanying availability of food appear to be the most limiting habitat requirements.

4.1 General Conditions

Nursery habitat of black drum usually includes areas of low current velocity such as creeks, ditches, channels, stagnant sloughs and boat basins. In the Delaware and Chesapeake Bay regions, juveniles seemed to prefer nutrient rich marshes with muddy, or occasionally sand and gravel, substrates (Thomas 1971, Richards 1973). Thomas and Smith (1973) found young black drum in salinities of 0-28 ppt, but they suggested that factors such as bottom type, current, and temperature were more critical than salinity in determining habitat of young. Allen and Barker (1990) found recently-settled juveniles in tidal creeks within a Spartina sp. marsh at salinities from 10-40 ppt and over substrates of sand and muddy, sand-shell mixture. Small juveniles in Tampa Bay were most common in rivers and tidal creeks with low to moderate salinity and open, mud substrate (Peters and McMichael 1990). In Texas waters, black drum nursery habitats have been described as inshore, salt-marsh areas with mud or shell substrates (Pearson 1929, More 1964, Moffett 1975, Pullen 1962).

Pearson (1929) indicated that most of the larger juvenile and adult black drum populations along the Texas coast were in small, shallow, muddy bays such as Oso and Nueces Bays. Fox and Mock (1968) collected black drum from Barataria Bay in a habitat described as shallow, turbid water with emergent marsh vegetation (Spartina sp.) and with shell reefs on a fine-silt bottom.

Although Rogillio (1975) noted larger catches in low-turbidity waters, black drum were not generally considered to be adversely affected by turbid waters. Pearson (1929) reported that black drum attained their greatest abundance in turbid areas, and Simmons and Breuer (1962) observed black drum apparently thriving in turbid water only four inches deep.

4.2 Salinity and Temperature Requirements

Black drum are considered euryhaline because they can quickly adapt to a wide range of salinities (Simmons and Breuer 1962). Black drum have been found in salinities ranging from 0 to 80 ppt; however, adults found at 80 ppt often had glazed eyes or were blind and often had lesions on their bodies (Simmons and Breuer 1962). Simmons and Breuer (1962) noted that adults were commonly found in salinity ranges from 25 to 50 ppt. Gunter (1945) caught black drum of various sizes in Texas bays in salinity ranges from 2.6 to 34.9 ppt, and they were most abundant between 10 and 15 ppt. In coastal Louisiana from April 1968 through March 1969, black drum ranging in size from 45 to 370 mm TL were taken in salinities from 0.2 to 24.9 ppt (Perret et al. 1971). Barrett et al. (1978) collected black drum 160-870 mm TL from Timbalier Island area and offshore at salinities ranging from 0.7 to 20.7 ppt and temperatures from 8.6° to 31.5° C (47.5°-88.7° F).

Fontenot and Rogillio (1970) reported no correlation between salinity and sampling success, but peak catches were observed in salinities from 15 to 20 ppt. Thompson and Fitzhugh (1985) noted that prior to 1981 the "peaks and valleys" in black drum landings coincided with high and low salinities. Rogillio (1975) noted that salinity had little effect on black drum, and Frisbie (1961) found no apparent correlation between size of fish and salinity.

Black drum have been observed in water temperatures ranging from 3° to 35° C (37.4°-95.0° F). Frisbie (1961) reported an observation by T.H. Bean (1902) that a water temperature of 3.3° C (37.9° F) killed young black drum in captivity. Simmons and Breuer (1962) reported that a freeze in 1951 killed more black drum than spotted seatrout or red drum, but the black drum populations apparently recovered much more rapidly. They also observed that after a sudden decrease in water temperature to 3° C in the Laguna Madre black drum moved to deeper water. According to Pearson (1929), however, black drum were extremely hesitant to move from shallow intercoastal waters of Texas, and drastic decreases in water temperature often resulted in great mortalities. McEachron et al. (in press) reported significant mortalities from three freezes in the 1980s.

5.0 FISHERY MANAGEMENT JURISDICTION, LAWS AND POLICIES AFFECTING THE STOCK(S) AND THE FISHERY

5.1 Management Institutions

Black drum occupy various habitats depending upon the physiological requirements of each particular life history stage. The fishery targets juveniles and adults within the territorial sea and internal waters of the Gulf States, and an offshore purse seine fishery has from time to time targeted adults in the Exclusive Economic Zone (EEZ). Because of their broad distribution, various federal agencies through their administration of laws, regulations and policies may affect the black drum fishery, but actual management is primarily accomplished by individual states. The following is a partial list of some of the more important agencies and regulations that affect black drum and their habitat. Individual state management agencies should be consulted for specific and current state laws and regulations.

5.1.1 Federal

At present, virtually all black drum harvests are occurring in state waters; however, in the recent past significant numbers of black drum have been harvested in the EEZ. A variety of federal agencies through their administration of laws, regulations and policies may influence black drum abundance.

5.1.1.1 Regional Fishery Management Councils

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

Among the guidelines under which the councils must operate are standards that require, to the extent practicable, an individual stock of fish to be managed as a unit throughout its range and management shall promote efficiency, minimize costs and avoid unnecessary duplication (MFCMA Section 301a).

The Gulf of Mexico Fishery Management Council has not developed a management plan for black drum.

5.1.1.2 National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA)

The Secretary of Commerce, acting through the NMFS, has the ultimate authority to approve or disapprove all fishery management plans 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 Congress and international treaties. The NMFS has the authority to enforce the Magnuson Act and Lacey Act and is the federal trustee for living and nonliving natural resources in coastal and marine areas. The NMFS

exercises no management jurisdiction other than enforcement with regard to black drum in the Gulf of Mexico; however, it conducts some research and data collection programs and comments on all projects that affect marine fishery habitat.

5.1.1.3 Office of Ocean and Coastal Resource Management (OCRM, NOAA)

The OCRM has authority to manage marine fishery resources through the National Marine Sanctuaries Program. Each sanctuary established under this program has a specific management plan that may include restrictions on the harvest or use of marine fishery resources, and such plans could affect the harvest of black drum.

The OCRM may influence fishery management for black drum indirectly through administration of the Coastal Zone Management Program and by setting standards and approving funding for state coastal zone management programs. Some states in the gulf utilize a portion of these monies in their habitat protection and enhancement programs including habitat maintenance and enhancement.

5.1.1.4 National Park Service (NPS), Department of the Interior (DOI)

The NPS under the DOI may regulate fishing activities within park boundaries. The NPS has authority to manage black drum through the establishment of coastal and nearshore national parks and national monuments; however, no restrictions on black drum harvests are known to exist in the parks of the U.S. Gulf of Mexico.

5.1.1.5 Fish and Wildlife Service (FWS), DOI

The FWS has little direct management authority over black drum. The ability of the FWS to affect the management of black drum is based primarily on the Fish and Wildlife Coordination Act. Under this act, the FWS, in conjunction with the NMFS, reviews and comments on proposals to alter habitat. Dredging, filling and marine construction are examples of projects that can seriously affect black drum populations.

5.1.1.6 Environmental Protection Agency (EPA)

The EPA through its administration of the Clean Water Act, National Pollutant Discharge Elimination System (NPDES) may provide protection to black drum habitat. Applications for permits to discharge pollutants into estuarine waters may be disapproved or conditioned to protect fishery habitat.

5.1.1.7 Corps of Engineers (COE), Department of the Army (DOA)

Black drum populations may be influenced by the COE's responsibilities pursuant to the Clean Water Act and Section 10 of the Rivers and Harbors Act. Under these laws, the COE issues or denies permits for proposals to dredge, fill and construct in wetland areas and navigable waters. Some proposals could affect black drum populations. The COE is also responsible for planning, construction and maintenance of navigation channels and other projects that may affect black drum populations.

5.1.1.8 U.S. Coast Guard

The U.S. Coast Guard is responsible for enforcing fishery management regulations adopted by the DOC and recommended by the regional fishery management councils. The Coast Guard also enforces other laws regarding marine fisheries including but not limited to marine pollution and marine safety. They also assist commercial and recreational fishing vessels in times of need.

5.1.2 State

Table 5.1 outlines the various state management institutions and authorities.

5.1.2.1 Florida Marine Fisheries Commission and Florida Department of Natural Resources

Florida Department of Natural Resources
Division of Marine Resources
3900 Commonwealth Boulevard
Tallahassee, Florida 32303
Telephone: (904) 488-6058

Florida Marine Fisheries Commission
2540 Executive Center Circle West, Suite 106
Tallahassee, FL 32301
Telephone: (904) 487-0554

The agency charged with the administration, supervision, development and conservation of natural resources is the Florida Department of Natural Resources (FDNR) headed by the Governor and Cabinet. The governor and cabinet serve as the seven-member board that approves or disapproves all rules and regulations promulgated by the FDNR. The administrative head of the FDNR is the executive director. Within the FDNR, the Division of Marine Resources, through Section 370.02(2), Florida Statutes, is empowered to conduct research directed toward management of marine and anadromous fisheries in the interest of all people of Florida. The Division of Law Enforcement is responsible for enforcement of all marine resource related laws and all rules and regulations of the department.

The Florida Marine Fisheries Commission, a seven-member board appointed by the governor and confirmed by the senate, was created by the Florida legislature in 1983. This commission was delegated rule-making authority over marine life in the following areas of concern: gear specification; prohibited gear; bag limits; size limits; species that may not be sold; protected species; closed areas; seasons; quality control codes with the exception of specific exemptions for shellfish; and special considerations relating to oyster and clam relaying. All rules passed by the commission require approval by the governor and cabinet. The commission does not have authority over endangered species, license fees, penalty provisions or over regulation of fishing gear in residential saltwater canals.

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

Table 5.1. State management institutions - Gulf of Mexico.

	Administrative body and its responsibilities	Administrative policy-making body and decision rule	Legislative involvement in management regulations
FLORIDA	DEPARTMENT OF NATURAL RESOURCES · administers management programs · enforcement · conducts research · makes recommendations to legislature and Marine Fisheries Commission	MARINE FISHERIES COMMISSION · creates rules that must be approved by the governor and cabinet · seven member commission	· can override any rule of the commission · responsible for licensing, management of fishing in man-made canals and limited entry
ALABAMA	DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES · administers management programs · enforcement · conducts research	· Commissioner of department has authority to establish management regulation · Conservation Advisory Board is a thirteen-member board and advises the commissioner · has authority to amend and promulgate regulations	· authority for detailed management regulations delegated to commissioner · statutes concerned primarily with licensing
MISSISSIPPI	DEPARTMENT OF WILDLIFE, FISHERIES AND PARKS · administers management programs · enforcement · conducts research	COMMISSION ON WILDLIFE, FISHERIES AND PARKS · five-member board · establishes ordinances on recommendation of deputy director (BMR)	· authority for detailed management regulations delegated to commission · statutes concern licenses and taxes
LOUISIANA	DEPARTMENT OF WILDLIFE AND FISHERIES · administers management programs · enforcement · conducts research · makes recommendations to legislature	WILDLIFE AND FISHERIES COMMISSION · seven-member board establishes policies and regulations based on majority vote of a quorum (four members constitute a quorum) consistent with statutes	· detailed regulations contained in statutes · authority for detailed management regulations delegated to commission
TEXAS	PARKS AND WILDLIFE DEPARTMENT · administers management programs · enforcement · conducts research · makes recommendations to Texas Parks & Wildlife Commission (TPWC)	PARKS AND WILDLIFE COMMISSION · nine-member body establishes regulations based on majority vote of quorum (five members constitute a quorum) · granted authority to regulate means and methods for taking, seasons, bag/possession limits and size limits.	· licensing requirements and penalties are set by legislation

5.1.2.2 Alabama Department of Conservation and Natural Resources

Alabama Department of Conservation and Natural Resources (ADCNR)
Alabama Marine Resources Division (AMRD)
P.O. Box 189
Dauphin Island, Alabama 36528
Telephone: (205) 861-2882

Management authority of fishery resources in Alabama is held by the Commissioner of the Department of Conservation and Natural Resources. 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 a pubic 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 of the ADCNR. The board consists of the governor, the ADCNR commissioner and ten board members.

The AMRD has responsibility for enforcing state laws and regulations, for conducting marine biological research and for serving as the administrative arm of the commissioner with respect to marine resources. The division recommends regulations to the commissioner.

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

5.1.2.3 Mississippi Department of Wildlife, Fisheries and Parks

Mississippi Department of Wildlife, Fisheries and Parks (MDWFP)
Bureau of Marine Resources (BMR)
2620 Beach Boulevard
Biloxi, Mississippi 39531
Telephone: (601) 385-5860

The MDWFP administers coastal fisheries and habitat protection programs through the BMR. Authority to promulgate regulations and policies is vested in the Mississippi Commission on Wildlife, Fisheries and Parks, the controlling body of the MDWFP. The commission consists of five members appointed by the governor. The commission 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.

5.1.2.4 Louisiana Department of Wildlife and Fisheries

Louisiana Department of Wildlife and Fisheries (LDWF)
P.O. Box 98000
Baton Rouge, Louisiana 70898
Telephone: (504) 765-3617

The LDWF is one of 21 major administrative units of the Louisiana government. A seven-member board, the Louisiana Wildlife and Fisheries Commission (LWFC) is appointed by the Governor. Six of the members serve overlapping terms of 6 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 sole authority to establish management programs and policies; however, the legislature has delegated certain authority and responsibility to the LDWF. The Secretary of the LDWF is the executive head and chief administrative officer of the department and is responsible for the administration, control and operation of the functions, programs and affairs of the department. The secretary is appointed by the Governor with consent of the Senate.

Within the administrative system, an Assistant Secretary is in charge of the Office of Fisheries. In this office a Marine Fisheries Division, headed by the Division Administrator, performs "the functions of the state relating to the administration and operation of programs, including research relating to oysters, waterbottoms and seafood including, but not limited to, the regulation of oyster, shrimp and marine fishing industries" (Louisiana Revised Statutes 36:609). The Enforcement Division, in the Office of the Secretary, is responsible for enforcing all marine fishery statutes and regulations.

Louisiana has habitat protection and permitting programs and a federally approved CZM program.

5.1.2.5 Texas Parks and Wildlife Department

Texas Parks and Wildlife Department
Coastal Fisheries Branch
4200 Smith School Road
Austin, Texas 78744
Telephone: (512) 389-4863

The Texas Parks and Wildlife Department 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. The commission consists of 9 members appointed by the Governor for 6-year terms. The commission selects an Executive Director who serves as the chief administrative officer of the department. A Director of the Fisheries and Wildlife Division and a Director of the Law Enforcement Division are named by the Executive Director. The Coastal Fisheries Branch, headed by a branch chief, is under the supervision of the Director of Fisheries and Wildlife.

5.2 Treaties and Other International Agreements

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

5.3 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 black drum.

5.3.1 Magnuson Fishery Conservation and Management Act of 1976 (MFCMA)

The MFCMA mandates the preparation of fishery management plans 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.

5.3.2 Sport Fish Restoration Act (SFRA) (Wallop-Breaux Act)

The SFRA provides funds to states, the USFWS and the GSMFC to conduct research, planning and other programs geared at enhancing and restoring sport-fishing populations.

5.3.3 Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), Titles I and III and The Shore Protection Act of 1988 (SPA)

The MPRSA provides protection of fish habitat through the establishment and maintenance of marine sanctuaries. The MPRSA and the SPA regulate ocean transportation and dumping of dredged materials, sewage sludge and other materials. Criteria for issuing such permits include consideration of effects of dumping on the marine environment, ecological systems and fisheries resources.

5.3.4 Federal Food, Drug and Cosmetic Act of 1938 (FDCA)

The FDCA prohibits the sale, transfer of importation of "adulterated" or "misbranded" products. Adulterated products may be defective, unsafe, filthy or produced under unsanitary conditions. Misbranded products may have false, misleading or inadequate information on their labels. In many instances the FDCA also requires FDA approval for distribution of certain products.

5.3.5 Clean Water Act of 1981 (CWA)

The CWA requires that an EPA approved National Pollution Discharge Elimination System (NPDES) permit be obtained before any pollutant is discharged from a point source into waters of the United States including waters of the contiguous zone and the adjoining ocean. Discharges of toxic materials into rivers and estuaries that empty into the Gulf of Mexico can cause mortality to marine fishery resources and may alter habitats.

Under Section 404 of the CWA the Corps of Engineers is responsible for administration of a permit and enforcement program regulating alterations of wetlands as defined by the act. Dredging, filling, bulk-heading and other construction projects are examples of activities that require a permit and have potential to affect marine populations. The NMFS is the federal trustee for living and nonliving natural resources in coastal and marine areas under United States jurisdiction pursuant to the CWA.

5.3.6 Federal Water Pollution Control Act of 1972 (FWPCA) and MARPOL Annexes I and II

Discharge of oil and oily mixtures is governed by the Federal Water Pollution Control Act (FWPCA) and 40 Code of Federal Regulations (CFR), Part 110, in the navigable waters of the U.S. Discharge of oil and oily substances by foreign ships or by U.S. ships operating or capable of operating beyond the U.S. territorial sea is governed by MARPOL Annex I.

MARPOL Annex II governs the discharge at sea of noxious liquid substances primarily derived from tank cleaning and deballasting. Most categorized substances are prohibited from being discharged within 12 nautical miles of land and at depths of less than 25 meters.

5.3.7 Coastal Zone Management Act of 1972 (CZMA), as amended

Under the CZMA, states receive federal assistance grants to maintain federally-approved planning programs for enhancing, protecting and utilizing coastal resources. These are state programs, but the act requires that federal activities must be consistent with the respective states' CZM programs. Depending upon the individual state's program, the act provides the opportunity for considerable protection and enhancement of fishery resources by regulation of activities and by planning for future development in the least environmentally damaging manner.

5.3.8 Endangered Species Act of 1973, as amended

The Endangered Species Act provides for the listing of plant and animal species that are threatened or endangered. Once listed as threatened or endangered a species may not be taken, possessed, harassed or otherwise molested. It also provides for a review process to ensure that projects authorized, funded or carried out by federal agencies do not jeopardize the existence of these species or result in destruction or modification of habitats that are determined by the Secretary of the DOI to be critical.

5.3.9 National Environmental Policy Act of 1970 (NEPA)

The NEPA requires that all federal agencies recognize and give appropriate consideration to environmental amenities and values in the course of their decision-making. In an effort to create and maintain conditions under which man and nature can exist in productive harmony, the NEPA requires that federal agencies prepare an environmental impact statement (EIS) prior to undertaking major federal actions that significantly affect the quality of the human environment. Within these statements, alternatives to the proposed action that may better safeguard environmental values are to be carefully assessed.

5.3.10 Fish and Wildlife Coordination Act of 1958

Under the Fish and Wildlife Coordination Act, the FWS and NMFS review and comment on fish and wildlife aspects of proposals for work and activities sanctioned, permitted, assisted or conducted by federal agencies that take place in or affect navigable waters, wetlands or other critical fish and wildlife habitat. The review focuses on potential damage to fish, wildlife and their habitat; therefore, it serves to provide some protection to fishery resources from activities that may alter critical habitat in nearshore waters. The act is important because federal agencies must give due consideration to the recommendations of the FWS and NMFS.

5.3.11 Fish Restoration and Management Projects Act of 1950

Under this act, the DOI is authorized to provide funds to state fish and game agencies for fish restoration and management projects. Funds for protection of threatened fish communities that are located within state waters could be made available under the act.

5.3.12 Lacey Act of 1981, as amended

The Lacey Act prohibits import, export and interstate transport of illegally-taken fish and wildlife. As such, the act provides for federal prosecution for violations of state fish and wildlife laws. The potential for federal convictions under this act with its more stringent penalties has probably reduced interstate transport of illegally-possessed fish and fish products.

5.3.13 Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or "Superfund")

This CERCLA names the NMFS as the federal trustee for living and nonliving natural resources in coastal and marine areas under United States jurisdiction. It could provide funds for "clean-up" of fishery habitat in the event of an oil spill or other polluting event.

5.3.14 MARPOL Annex V and United States Marine Plastic Research and Control Act of 1987 (MPRCA)

MARPOL Annex V is a product of the International Convention for the Prevention of Pollution from Ships, 1973/78. 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 25 nautical miles from any land; restrict discharge of victual and other recomposable waste up to 12 nautical miles 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.

5.3.15 Fish and Wildlife Act of 1956

This act provides assistance to states in the form of law enforcement training and cooperative law enforcement agreements. It also allows for disposal of abandoned or forfeited property with some equipment being returned to states. The act prohibits airborne hunting and fishing activities.

5.4 State Authority, Laws, Regulations and Policies

5.4.1 Florida

5.4.1.1 Legislative Authorization

Prior to 1983, the Florida Legislature was the primary body that was responsible for enactment of laws regarding management of black drum in state waters. Chapter 370 of the Florida Statutes, annotated contained the specific laws directly related to harvesting, processing, etc. both statewide and in specific areas or counties. In 1983 the Florida Legislature established the Florida Marine Fisheries Commission and provided the commission with various duties, powers and authorities to promulgate regulations affecting marine fisheries including black drum.

5.4.1.2 Reciprocal Agreements and Limited Entry Provisions

5.4.1.2.1 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.

5.4.1.2.2 Limited Entry

Florida has no statutory provisions for limited entry in the black drum fishery.

5.4.1.3 Commercial Landings Data Reporting Requirements

On a monthly basis, processors are required to report the volume and price of all saltwater products received and sold. These data are collected and published by the Florida Department of Natural Resources, Marine Fisheries Information System.

5.4.1.4 Penalties for Violations

Penalties for violations of Florida laws and regulations are established in Florida Statutes, Section 370.021. 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 reasons why his saltwater license should not be suspended or revoked.

5.4.1.5 License Fees

The following is a list of license fees applicable to the capture, sale and transport of black drum in Florida. They are current only to the date of publication and are subject to change at any time.

Resident wholesale seafood dealer	
• county	$ 300.00
• state	450.00
Nonresident wholesale seafood dealer	
• county	500.00
• state	1000.00
Alien wholesale seafood dealer	
• county	1000.00
• state	1500.00
Resident retail seafood dealer	25.00
Nonresident retail seafood dealer	200.00
Alien retail seafood dealer	250.00
Saltwater products license	
• resident-individual	50.00
• resident-vessel	100.00
• nonresident-individual	200.00
• nonresident-vessel	400.00
• alien-individual	300.00
• alien-vessel	600.00
Recreational saltwater fishing license	
• resident	
10 day	11.50
annual	13.50

• nonresident	
3 day	6.50
7 day	16.50
annual	31.50
Annual commercial vessel saltwater fishing license (recreational for hire)	
• 11 or more customers	801.50
• 5-10 customers	401.50
• 4 or less customers	201.50
Optional pier saltwater fishing license (recreational users exempt from other licenses)	501.50
Optional recreational vessel license (recreational users exempt from other licenses)	3001.50

5.4.1.6 Laws and Regulations

Florida's laws and regulations regarding the harvest of black drum include primarily size limits, possession limits and commercial vessel limits. The following discussions are general summaries of laws and regulations; therefore the FDNR or the Florida Marine Patrol should be contacted for more specific information. The restrictions discussed in this FMP are current to the date of publication and are subject to change at any time thereafter.

5.4.1.6.1 Size Limits

A minimum size of 14 inches TL and a maximum size of 24 inches TL are established for the commercial black drum fishery in Florida. Recreational fishermen are restricted to these same size limits except that they may possess one (1) fish per person per day that is larger than 24 inches.

5.4.1.6.2 Gear Restrictions

Purse seines and pound nets are prohibited throughout Florida territorial waters. Restrictions on other nets vary by region, and the FDNR or the Florida Marine Patrol (FMP) should be contacted for regulations regarding use of specific gear.

5.4.1.6.3 Closed Areas and Seasons

There are no closed areas or seasons for the taking of black drum except for local restrictions on the placement of commercial net gear. The FMP should be consulted for these restrictions by area to be fished.

5.4.1.6.4 Quotas and Bag/Possession Limits

A daily bag/possession limit of 5 fish per person per day is established for the recreational fishery in all Florida waters. Commercial fishermen are required to have a "Restricted Species Endorsement"[1] to their saltwater products license in order to

[1]"Restricted Species Endorsement" requires commercial fishermen to show by bona fide means (i.e., trip tickets, sales receipts, etc.) that a minimum of $5,000 of their gross income has come from the sale of "restricted species" during at least one of the past three years.

possess black drum in excess of the daily bag/possession limit. Commercial vessels are also restricted to a daily possession limit of 500 pounds.

5.4.1.6.5 Other Restrictions

All black drum must be landed in a "whole" condition, but the gills and internal organs may be removed. The use of multiple hooks and snagging are prohibited.

5.4.2 Alabama

5.4.2.1 Legislative Authorization

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

5.4.2.2 Reciprocal Agreements and Limited Entry Provisions

5.4.2.2.1 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.

5.4.2.2.2 Limited Entry

Alabama has no statutory provisions for limited entry in the black drum fishery.

5.4.2.3 Commercial Landings Data Reporting Requirements

Alabama law requires that wholesale seafood dealers file monthly reports at quarterly intervals to the department; however, thorough records were not collected prior to 1982. Under a cooperative agreement, records of sales of seafood products are now collected jointly by NMFS and ADCNR port agents.

5.4.2.4 Penalties for Violations

Violations of the provisions of any statute or regulation are considered Class C misdemeanors and are punishable by fines up to $500 and up to 3 months in jail.

5.4.2.5 Annual License Fees

The following is a list of license fees current to the date of publication; however, they are subject to change at any time. Nonresident fees may vary based on the charge for similar fishing activities in the applicant's state of residence. All licenses expire on September 30 of each year and are nontransferable.

Commercial Hook and Line	
• resident	$ 26.00
• nonresident	51.00
Commercial Gill Nets, Trammel Nets, Seines*,**	
0-1200 feet in length	
• resident	101.00
• nonresident	501.00
1201-2400 feet in length	

• resident	151.00
• nonresident	751.00
Purse Seine	501.00
Recreational Nets	
0-300 feet in length	51.00
Recreational Saltwater Fishing License	
• resident***	
saltwater	16.00
combination (salt & fresh)	26.00
• nonresident	
7 day	8.00
annual	21.00
Seafood Dealer****	126.00

*Seines used for taking bait, 25 feet or less, in length are exempt from licensing.
**Two or more nets may be tied together and considered one net, but the total length may not exceed 2400 feet.
***Persons under 16, over 65 or fishing with ordinary hook and line are exempted.
****Required for cast nets if used commercially, or for anyone selling fish to a nonresident dealer.

5.4.2.6 Laws and Regulations

Alabama laws and regulations regarding the harvest of black drum primarily address the type of gear used and area closures for the commercial fishery. 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 ADCNR, MRD should be contacted for specific and up-to-date information.

5.4.2.6.1 Size Limits

Alabama has no minimum or maximum size limit for black drum in either the commercial or recreational fishery.

5.4.2.6.2 Gear Restrictions

During the period January 1 through February 28/29 of each year, gill nets, trammel nets, and other entangling nets used in Alabama coastal waters must have a minimum mesh size of 2 3/4" stretched mesh. A minimum mesh size of 3 1/2" stretched mesh is required for these nets during the period March 1 through October 31 of each year. A minimum mesh size of 3 3/4" stretched mesh is required for such nets from November 1 through December 31 of each year. Recreational nets may not exceed 300 feet in length, and commercial nets may not exceed 2,400 feet in length.

The above restrictions do not apply to coastal rivers, bayous, creeks or streams. In these areas (with the exception of those portions of the Blakely and Apalachee Rivers south of the I-10 Causeway), the minimum mesh size shall be 6" stretched mesh. The minimum mesh for nets used in the Blakely and Apalachee Rivers south of I-10 shall be the same as previously described by season for other coastal waters.

The use of purse seines to catch black drum is prohibited.

All nets must be tagged with the name and license number of the licensee, and they must be constantly attended.

No hook and line device may contain more than five hooks when used in Alabama saltwaters.

5.4.2.6.3 Closed Areas and Seasons

Gill and trammel nets are prohibited within 150 yards of the gulf beaches and Sand Island from June 15 through Labor Day. Gill and trammel nets are prohibited (between November 1 and December 31 of each year) in waters of Bon Secour Bay south of the Gulf Intracoastal Waterway (ICW) from Oyster Bay west to the last ICW navigational marker and from that point southwestward to the northwestern tip of the Fort Morgan Peninsula.

Nets may not be set within 100 yards above or below the mouth of any river, stream, bayou or creek emptying into any salt waters of the state, and they shall not extend more than halfway across any river, stream, bayou or creek.

Nets and seines may not be used within 300 feet of any public boat ramp, man-made canal, public pier, marked navigational channel, or Little Lagoon Pass. Nets may not be used in any manner to prevent ingress or egress to or from any pier, dock or marina.

5.4.2.6.4 Quotas and Bag/Possession Limits

There are no quotas or bag/possession limits for black drum in Alabama.

5.4.2.6.5 Other Restrictions

Black drum must be landed "whole" with the heads and tails attached, except that the viscera and gills may be removed. It is unlawful to discard dead fish into any river, stream, bayou or creek; within 500 feet of any shoreline, other than the gulf beaches; and within three (3) miles of the gulf beaches.

5.4.3 Mississippi

5.4.3.1 Legislative Authorization

Title 49, Chapter 15 of the Mississippi Code of 1972, annotated, contains various restrictions regarding the harvest of marine species. This chapter also authorizes the MDWFP to promulgate regulations affecting the harvest of marine fishery resources. Title 49, Chapter 27 contains the Wetlands Protection Act and its provisions are also administered by the MDWFP.

5.4.3.2 Reciprocal Agreements and Limited Entry Provisions

5.4.3.2.1 Reciprocal Agreements

Section 49-15-15 provides statutory authority for the MDWFP to enter into interstate and intrastate agreements for the purposes of protecting, propagating or conserving seafood. Such agreements may provide for reciprocal agreements for licensing, access or management provided that they do not conflict with other statutes.

5.4.3.2.2 Limited Entry

Mississippi has no specific statutory provisions for limited entry in the black drum fishery.

5.4.3.3 Commercial Landings Data Reporting Requirements

Ordinance Number 9.001 of the Mississippi Department of Wildlife, Fisheries and Parks establishes reporting requirements for various fisheries and types of fishery operations. It also provides for confidentiality of data and penalties for falsifying or refusing to supply such information.

5.4.3.4 Penalties for Violations

Penalties for violations of Mississippi laws and regulations are provided in Section 49-15-63, Mississippi Code of 1972, annotated.

5.4.3.5 Annual License Fees

The following is a list of license fees for activities related to the capture, sale or transport of black drum. They are current only to the date of publication and may change at any time. Nonresident fees may vary based on the charge for similar fishing activities in the applicant's state of residence.

Commercial Hook and Line	$100.00
Charter Boats and Party Boats	100.00
Trammel Nets, Gill Nets and Seines*	
• resident	100.00
• nonresident	300.00
Purse Seine (other than menhaden)	
• resident	100.00
• nonresident	300.00
Seafood Processor	200.00
Wholesale Dealer	100.00

*Small mesh beach seines (less than $\frac{1}{4}$" bar, $\frac{1}{2}$" stretched mesh) not exceeding 100 feet in length are exempt from licensing.

5.4.3.6 Laws and Regulations

Ordinance Number 5.007 of the MDWFP, BMR contains regulations regarding the harvest of black drum from Mississippi territorial and inland waters. 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 MDWFP, BMR should be contacted for specific and up-to-date information.

5.4.3.6.1 Size Limits

There are no minimum or maximum size limits for black drum in either the commercial or recreational fisheries.

5.4.3.6.2 Gear Restrictions

Gill nets, trammel nets and seines (other than purse seines) that are used to capture black drum must have a minimum mesh size of $1\frac{1}{2}$" bar, 3" stretch, and they

may not exceed 1,200 feet in length. Nets must be marked by visible buoys every 100 feet containing the owners license number or full name. No boat or vessel may carry more than one such net. Purse seines must have a minimum mesh size of ½" bar, 1" stretch, and they may not exceed 1,500 feet in length.

5.4.3.6.3 Closed Areas and Seasons

Gill nets, trammel nets, purse seines and other commercial nets may not be used within 1,200 feet of any public pier or hotel/motel pier, and they are prohibited within 300 feet of private piers that are at least 75 feet in length. These nets are also prohibited within 1,200 feet of the shoreline of Deer Island and within 1,500 feet of the shoreline between the U.S. Highway 90 bridge and the north shore of Bayou Caddy in Hancock County. The aforementioned nets are also prohibited in and within 100 feet of the mouth of rivers, bays, bayous, streams, lakes and other tributaries to Mississippi saltwaters, except as follows:

Point aux Chenes Bay; Middle Bay; Jose Bay; L'Isle Chaude; Heron Bay; South Rigolett; Pascagoula Bay south of a line beginning near Camp Lamotte and running southeasterly to Twin Islands; then to Rabbit Island, Litton Shipbuilding and terminating at the entrance to Yazoo Lake; and Biloxi Bay south of a line between Marsh Point and Grand Bayou. They must not be used in a manner that would block any of these bays, bayous, rivers, streams or other tributaries.

Gill nets, trammel nets, purse seines and other commercial nets are prohibited within 1 mile of the shoreline of Cat Island, Ship Island, Horn Island, Petit Bois Island, Round Island and the shoals of Telegraph Keys and Telegraph Reef from May 15 to September 15 of each year.

Purse seines are prohibited within 1 mile of the shoreline in Harrison and Hancock Counties. Recreational cast nets may be used only in saltwater areas as defined by MDWFP Public Notice Number 2276. There are no closed seasons for black drum fishing in Mississippi.

5.4.3.6.4 Quotas and Bag/Possession Limits

There are no quotas, bag limits or possession limits in effect for the black drum fishery in Mississippi.

5.4.3.6.5 Other Restrictions

Commercial nets must be attended with at least one person located within 100 yards of the net at all times while it is in the water. Commercially and recreationally caught black drum must be landed "whole" with heads, tails and flesh attached. They may, however, be eviscerated, gilled and scaled.

5.4.4 Louisiana

5.4.4.1 Legislative Authorization

Title 56, Louisiana Revised Statutes contains rules and regulations adopted by the legislature that govern marine fisheries in the state and empower the Louisiana Wildlife and Fisheries Commission (LWFC). Title 36, Louisiana Revised Statutes creates the LDWF and designates the powers and duties of the department. Title 76 of Louisiana Administrative Code contains all rules and regulations adopted by the LDWF that govern marine fisheries.

5.4.4.2 Reciprocal Agreements and Limited Entry Provisions

5.4.4.2.1 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 commission is also authorized to enter into reciprocal licensing agreements.

5.4.4.2.2 Limited Entry

Louisiana has no statutory provisions for limited entry in the black drum fishery.

5.4.4.3 Commercial Landings Data Reporting Requirements

Wholesale/retail dealers and commercial fishermen who sell black drum directly to the consumer must report each previous month's purchases by the tenth of the following month. The quantity, vessels, owners and other dealers from whom black drum are purchased must be included in the reports. Wholesalers, processors and first purchasers are also required to report sales and to whom black drum are sold.

5.4.4.4 Penalties for Violations

Violations of Louisiana laws and regulations regarding black drum are all Class 2. First offenses are punishable by fines of $100-350 or up to 60 days in jail or both. Second offense convictions carry fines from $300-550 and 30-60 days in jail. Third offense violations have fines ranging from $500-750 and 60-90 days in jail and forfeiture of all equipment involved in the illegal activity. Civil penalties may also be imposed, especially for restitution.

5.4.4.5 Annual License Fees

The following is a list of license fees that are current to the date of this publication. They are subject to change any time thereafter. Also, nonresident fees may vary based on the charge for similar fishing activities in the applicant's state of residence.

Commercial	
Commercial Fisherman License	
• resident	$ 55.00
• nonresident	400.00
Vessel License	
• resident	15.00
• nonresident	60.00
Saltwater Gill Net	
• resident	250.00
• nonresident	1,000.00
Trammel Net	
• resident	25.00
• nonresident	100.00
Fish Seine	
• resident	25.00
• nonresident	100.00

Wholesale/Retail Dealer (Business)	
• resident	105.00
• nonresident	405.00
Wholesale/Retail Dealer (Vehicle)	
• resident	105.00
• nonresident	405.00
Wholesale/Retail Dealer (Restaurant & Retail Grocer)	30.00
Transport License	30.00
Recreational	
Basic Recreational Fishing License	
• resident	5.50
• nonresident	15.50
Saltwater License*	
• resident	5.50
• nonresident	25.50

*Required in waters designated as saltwater in Louisiana.

5.4.4.6 Laws and Regulations

Louisiana laws and regulations regarding the harvest of black drum include size limits, bag limits, gear restrictions, quotas and other provisions. Louisiana regulations are based on recommendations contained in the Louisiana Black Drum Management Plan. This plan was compiled by the Department of Wildlife and Fisheries, and contains a biological and fishery profile, a stock assessment and a conservation standard that were developed from source documents developed by the Louisiana Black Drum Technical Working Group and Stock Assessment Subcommittee of the Louisiana Finfish Panel. The Finfish Panel was a group of interested citizens who met under a Departmental and Stock Assessment Committee consisting of technical personal who developed information and distributed it to the panel or other public bodies. 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.

5.4.4.6.1 Size Limits

A minimum size limit of 16 inches TL, and a maximum size limit of 27 inches TL are established for the commercial black drum fishery in Louisiana. A special black drum permit allows commercial harvesters to take a limited number of black drum over 27 inches TL.

Recreational fishermen are restricted by a 16" TL minimum size limit and a 27" TL maximum size limit, except that one (1) fish per person per day may exceed 27 inches TL.

5.4.4.6.2 Gear Restrictions

Gill nets, trammel nets and seines [other than small mesh ($\frac{1}{4}$" maximum) beach seines less than 100 feet in length used for catching bait] are required to have a minimum mesh size of 1 3/4" bar, $3\frac{1}{2}$" stretched mesh; however, when the 1.0 million pound annual commercial quota for spotted seatrout is reached, the minimum mesh size changes to $4\frac{1}{2}$" stretched, except for nets being fished as strike nets. These nets may not exceed 1,200 feet in length, and no more than two 1,200 foot nets may be used from a vessel. Gill nets and trammel nets must be tagged at each end with

a waterproof tag bearing the fisherman's full name, commercial fisherman's license number and an international orange buoy at least 6" in diameter.

Monofilament nets and purse seines are prohibited for the taking of black drum, except that purse seining operations for menhaden or other herring-like species may have a maximum of 5% by weight of other species.

Recreational cast nets may have a maximum radius of 8.5 feet.

5.4.4.6.3 Closed Areas and Seasons

The commercial fishing season for black drum is September 1 through August 31 of each year. There is no season on the recreational fishery.

Commercial netting is prohibited in all waters of Lake Catherine, Lake Charles, Moss Lake, Prien Lake, Lake Pontchartrain and Sabine Lake. "Pompano nets" may be used to take pompano and black drum in areas near Chandeleur and Brenton Islands from May 1 through October 31 of each year provided that they are set only during daylight hours and in water at least 2,500 feet from land and 7 feet or more in depth. Commercial netting is prohibited in Calcasieu Lake from sunset on Friday to sunset on Sunday during the period May 1 through September 30 of each year. The LDWF should be contacted for more specific information on local restrictions to the use of certain gear in specific areas.

5.4.4.6.4 Quotas and Bag/Possession Limits

An annual commercial black drum quota for fish 16 inches to 27 inches TL is established at 3.25 million pounds. The quota for black drum over 27 inches TL under special black drum permits is 300,000 fish per year, and monthly reports are required of permit holders.

5.4.4.6.5 Other Restrictions

The use of aircraft in any form to assist fishing operations is prohibited except for menhaden and other herring-like fish. Fishermen must be within sight of their net(s) at all times while they are being fished.

Black drum must be kept in a "whole" condition with heads and caudal fins attached until they are brought to shore or sold; however, viscera and gills may be removed.

5.4.5 Texas

5.4.5.1 Legislative Authorization

Chapter 11, Texas Parks and Wildlife Code establishes the Texas Parks and Wildlife Commission (TPWC) and provides for its make-up and appointment. Chapter 61 provides the TPWC with responsibility for marine fishery management and authority to promulgate regulations. All regulations adopted by the TPWC to manage the state's black drum fishery are included in the Texas Statewide Hunting and Fishing Proclamations.

5.4.5.2 Reciprocal Agreements and Limited Entry Provisions

5.4.5.2.1 Reciprocal Agreements

Texas statutory authority allows the TPWC to enter into reciprocal licensing agreements. Specific authority is granted for waters that form a common boundary between Texas and Louisiana. Texas has no statutory authority to enter into reciprocal management agreements.

5.4.5.2.2 Limited Entry

Texas has no specific statutory provisions for limited entry in the black drum fishery.

5.4.5.3 Commercial Landings Data Reporting Requirements

All aquatic-product dealers who purchase directly from fishermen are required to file monthly marine-products reports with the TPWD. These reports must include species, poundage, gear utilized and location of fishing activity.

5.4.5.4 Penalties for Violations

Penalties for violations of Texas' proclamations regarding black drum are provided in Chapter 61, Texas Parks and Wildlife Code, and most are Class C misdemeanors punishable by fines ranging from $25 to $500.

5.4.5.5 Annual License Fees

The following is a list of licenses and fees that could be applicable to black drum harvesting and processing in Texas. They are current to the date of this publication and are subject to change at any time thereafter.

Commercial	
General Commercial Fisherman's License	
• resident	$ 20.00
• nonresident	150.00
Commercial Finfish Fisherman's License	
• resident	75.00
• nonresident	150.00
Commercial Fishing Boat License	
• resident	15.00
• nonresident	60.00
Wholesale Fish Dealer (Business)	
• resident	500.00
• nonresident	500.00
Wholesale Fish Dealer (Truck)*	
• resident	300.00
• nonresident	300.00
Retail Fish Dealer (Business)	
• resident	40.00
• nonresident	40.00
Retail Fish Dealer (Truck)*	
• resident	75.00
• nonresident	75.00

Recreational	
Resident Fishing License	13.00
Non-resident Fishing License	20.00
Temporary License (14-day) Resident Fishing	5.00
Temporary License (5-day) Non-resident Fishing	10.00
Saltwater Sportfishing Stamp**	7.00
Gear	
Saltwater Trotline Tag	3.00

*Refers to the use of a truck as a place of business.
**Required in addition to fishing license when fishing in saltwater.

5.4.5.6 Laws and Regulations

The following is a general summary of the laws and regulations regarding black drum in Texas. They are current to the date of this publication and are subject to change at any time thereafter. The TPWD should be contacted for specific and up-to-date information.

5.4.5.6.1 Size Limits

Texas has a 14 inch TL minimum size limit and a 30 inch TL maximum size limit for black drum.

5.4.5.6.2 Gear Restrictions

The capture of black drum using gill nets, trammel nets, seines, purse seines and other types of nets or fish traps is prohibited in the coastal waters of Texas. Cast nets that do not exceed 14 feet in diameter and small mesh beach seines not exceeding 20 feet in length may be used for taking fish for bait purposes only.

Nonmetallic trotlines that do not exceed 600 feet in length may be set below the waters surface in most inland and bay waters of Texas provided that they conform to the following restrictions: (1) stagings must be at least 3 feet apart, and each end of the trotline must be marked with a yellow, floating buoy at least 6"x6" or a yellow jug, 1 gallon capacity or larger; (2) metallic stakes are prohibited, and trotlines must be at least 200 feet from the Gulf Intracoastal Waterway and 50 feet apart; (3) only natural baits on $\frac{1}{2}$" minimum gap circle-type hooks may be used, and trotlines must be marked with gear tags according to applicable regulations; and (4) trotlines are prohibited in waters of the Gulf of Mexico and all trotlines and their components, excluding poles or stakes must be removed from the water between 1:00 p.m. Friday and 1:00 p.m. Sunday of each week.

5.4.5.6.3 Closed Areas and Seasons

There are no closed seasons for the taking of black drum. TPWD agents should be consulted for information on local restrictions on the use of gear within specific areas.

5.4.5.6.4 Quotas and Bag/Possession Limits

Recreational fishermen are limited by a bag limit of 5 fish per person per day and a possession limit of 10 fish.

5.4.5.6.5 Other Restrictions

Black drum 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.

6.0 DESCRIPTION OF FISHING ACTIVITIES AFFECTING THE STOCK(S) IN THE U.S. GULF OF MEXICO

Black drum are caught commercially, recreationally and incidentally throughout the Gulf of Mexico. Although their commercial and recreational value is perhaps not as great as a number of other gulf species, their popularity increased significantly during the late 1970s and 1980s. There are many possible reasons for the increasing demand for black drum including: reduced abundance and increased regulations on other species; expanding markets for most all fish; and changes in consumer and sport fishermen's attitudes toward black drum.

Black drum are caught predominantly in state territorial waters. A wide variety of gear and vessels are employed, and fishing is accomplished year-round in most areas.

Data for the fishery are very limited. Most commercial data are recorded as landings. Recreational information has been collected by the individual states and as part of a national program, the Marine Recreational Fisheries Statistics Survey (MRFSS). Stock assessment efforts are impeded by the paucity of existing data and the relatively recent history of the fishery, except in Texas.

6.1 Commercial Black Drum Fishery

6.1.1 History

In the U.S., commercial production of black drum has historically occurred in the Gulf of Mexico (Simmons and Breuer 1962, Sutter et al. 1986). Silverman (1979) reported Gulf States' contributions from 1950-1976 as 84% of the total U.S. harvest.

Within the gulf, black drum were relatively "underutilized" until the early 1980s, except in Texas. Texas landings averaged approximately 71% of the total gulf throughout the 1960s and continued to exceed 60% of the total gulf catch until 1979. In 1979 the fishery dramatically expanded in the northern gulf, and landings increased greatly through 1988 (Table 6.1, Figure 6.1).

Increased markets for red drum (Sciaenops ocellatus) in the late 1970s contributed in part to the rapid increase in black drum landings (Doug Horn, personal communication). Soon after the expansion of the red drum fishery, concern about overfishing of red drum caused a rapid development of regulations on the commercial fishery. These regulations eventually prohibited the use of purse seines, the predominant gear used in the expanded red drum fishery. Because of the high market demand and its similarity to red drum, black drum became a suitable substitute.

6.1.2 State Commercial Fisheries

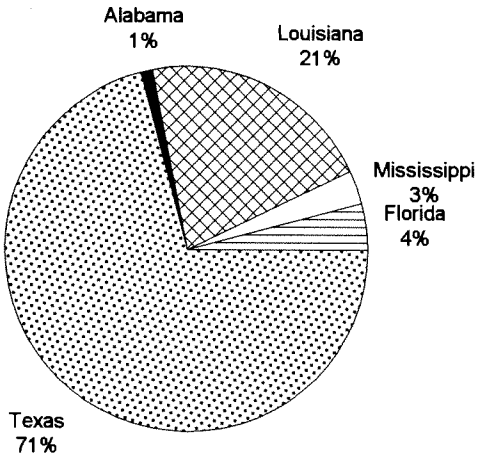
The black drum commercial fishery is quite different between states and regions of the gulf. It varies widely in historical landings, gear, vessels and traditions (Table 6.1, 6.2).

Table 6.1. Historical black drum landings (lbs x 1000) by Gulf States, 1961-1991.

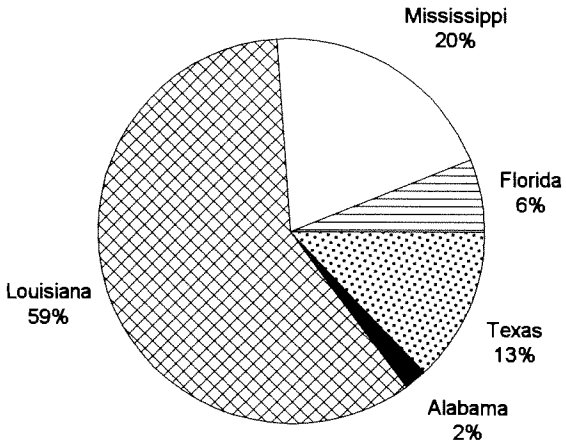
Year	State					Gulf
	FL	AL	MS	LA	TX	
1961	75	2	23	388	1,635	2,123
1962	58	2	22	390	1,375	1,815
1963	100	10	17	344	1,363	1,831
1964	88	17	46	306	1,409	1,866
1965	65	3	33	195	1,470	1,766
1966	65	4	20	247	1,007	1,343
1967	75	8	33	264	1,061	1,441
1968	84	16	75	360	677	1,212
1969	63	43	114	478	610	1,308
1970	50	24	53	434	783	1,344
1961-1970 average	**72**	**13**	**44**	**341**	**1,139**	**1,605**
1971	73	31	21	506	1,138	1,769
1972	96	44	23	540	1,165	1,868
1973	84	80	14	541	1,208	1,928
1974	60	53	10	440	1,357	1,920
1975	35	20	20	276	1,172	1,523
1976	27	19	48	579	2,091	2,764
1977	20	25	44	583	1,454	2,126
1978[1]	34	17	396	580	1,786	2,813
1979	215	31	1,934	536	1,531	4,247
1980	312	48	4,045	472	1,058	5,935
1971-1980 average	**82**	**37**	**656**	**505**	**1,396**	**2,689**
1981	750	89	2,122	2,889	664	6,514
1982	56	79	1,185	1,691	1,249	4,260
1983	404	96	1,417	1,859	1,493	5,269
1984	439	60	2,559	1,976	900	5,934
1985	369	34	2,543	3,421	644	7,011
1986	579	253	972	5,226	588	7,619
1987	436	370	959	8,021	858	10,644
1988	148	122	702	8,757	739	10,468
1989	204	56	119	4,406	703	5,488
1990	48	56	217	2,876	635	3,832
1981-1990 average	**343**	**122**	**1,280**	**4,112**	**847**	**6,704**
1991	49	22	21	1,573	460	2,125

Source: Compiled from data contained in Fisheries of the United States (various issues) and unpublished National Marine Fisheries Service data.

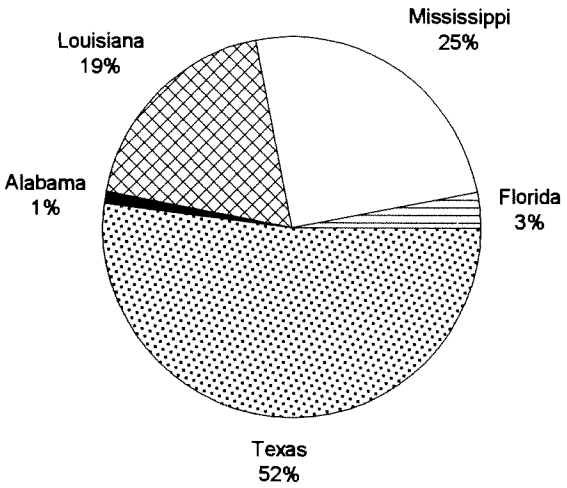
[1]Data from 1978 through 1991 are considered preliminary by the National Marine Fisheries Service.



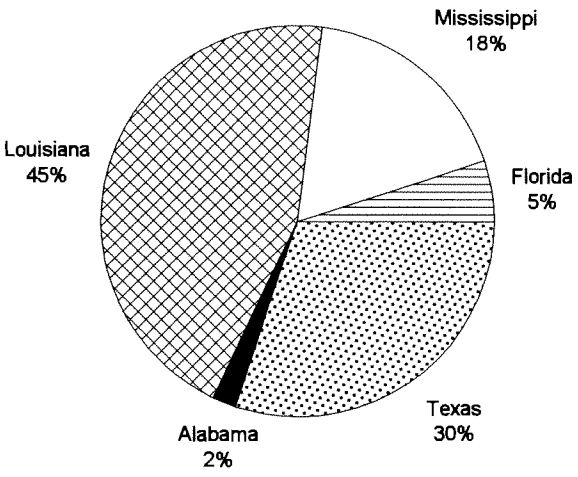
1961-70



1981-89



1971-80



1961-89

Figure 6.1. Black drum landings, percent of total gulf.

Table 6.2. Black drum landings by selected gear categories for the U.S. Gulf of Mexico, 1978-1989 (lbs).

	I[1]	II[2]	III[3]	IV[4]	Total
1978	1,870	996,558	29,003	1,785,493	2,812,924
1979	2,810	2,680,859	32,035	1,531,355	4,247,059
1980	578,610	5,274,993	80,420		5,934,023
1981	526,918	5,808,836	177,455	345	6,513,554
1982	1,063,373	3,003,036	191,901	2,031	4,260,341
1983	1,383,627	3,679,570	205,022	126	5,268,345
1984	312,731	5,306,978	313,677	252	5,933,638
1985	274,727	6,007,697	728,770		7,011,194
1986	311,504	6,345,166	961,341		7,618,011
1987	1,203,435	7,739,624	1,701,299		10,644,358
1988	478,678	8,628,111	1,361,903		10,468,692
1989	485,760	4,307,128	695,593		5,488,481

Source: Compiled from data contained in Fisheries of the United States (various issues) and unpublished National Marine Fisheries Service data.
[1]Handlines, longlines and spears
[2]Haul seines, purse seines, gill nets and trammel nets
[3]Trawls
[4]Unknown or unspecified gear

6.1.2.1 Florida

In Florida black drum have primarily been caught in the fall (August-November); however, other production peaks have been noted in March, April and May. Since the mid-1980s, production has been higher on the gulf coast. With the exception of 1988, gulf production has ranged between 5 and 10 times that of the Atlantic coast.

Historically the major landing areas include Gulf, Manatee, Pinellas, Dixie and Taylor counties on the gulf coast and Duval and Volusia counties on the Atlantic coast.

Run-around gill nets and haul seines have been the predominant gear used in the fishery over the past ten years. Purse seine bycatch, trammel nets, hand lines and entangling gill nets have also contributed to landings.

Florida's annual landings averaged 398,000 lbs for the period 1981-1989. These catches represented a 485% increase over the 82,000 lb yearly average recorded during 1971-1980 and reflected a significant increase in the levels of commercial fishing (Table 6.1, Figure 6.2). Florida's contribution to total gulf landings likewise increased from 3% for the 1971-1980 annual average to 6% for the 1981-1989 annual average (Figure 6.1). Florida is ranked fourth in the gulf in total black drum production.

6.1.2.2 Alabama

Prior to 1986, Alabama landings of black drum predominantly came from trawl bycatch and trammel nets. Run-around gill nets and entangling gill nets became the preferred gear after 1986.

Black drum are primarily caught in Mobile Bay in Alabama. Although there are no major landing areas in Alabama, small catches are sold to fish markets and other retail outlets throughout the coastal area.

Alabama landings for 1981-1989 annually averaged nearly three times those recorded for 1971-1980 (Table 6.1, Figure 6.3). Like Florida, this increase represents a significant increase in fishing effort, probably as a result of the introduction of run-around gill nets to the fishery. Although the increase was substantial in Alabama, the proportionate increase to the gulf total was only 1%, and Alabama remained fifth in total gulf landings.

6.1.2.3 Mississippi

Pascagoula is the primary landing port for black drum in Mississippi. Seafood markets and other retailers may receive small amounts of black drum caught by gill nets and incidental to shrimp trawling.

In the early to mid 1980s, black drum were predominantly caught by purse seines near the barrier islands off Mississippi. Prior to 1979, black drum were caught inshore with gill nets and as bycatch in the shrimp fishery.

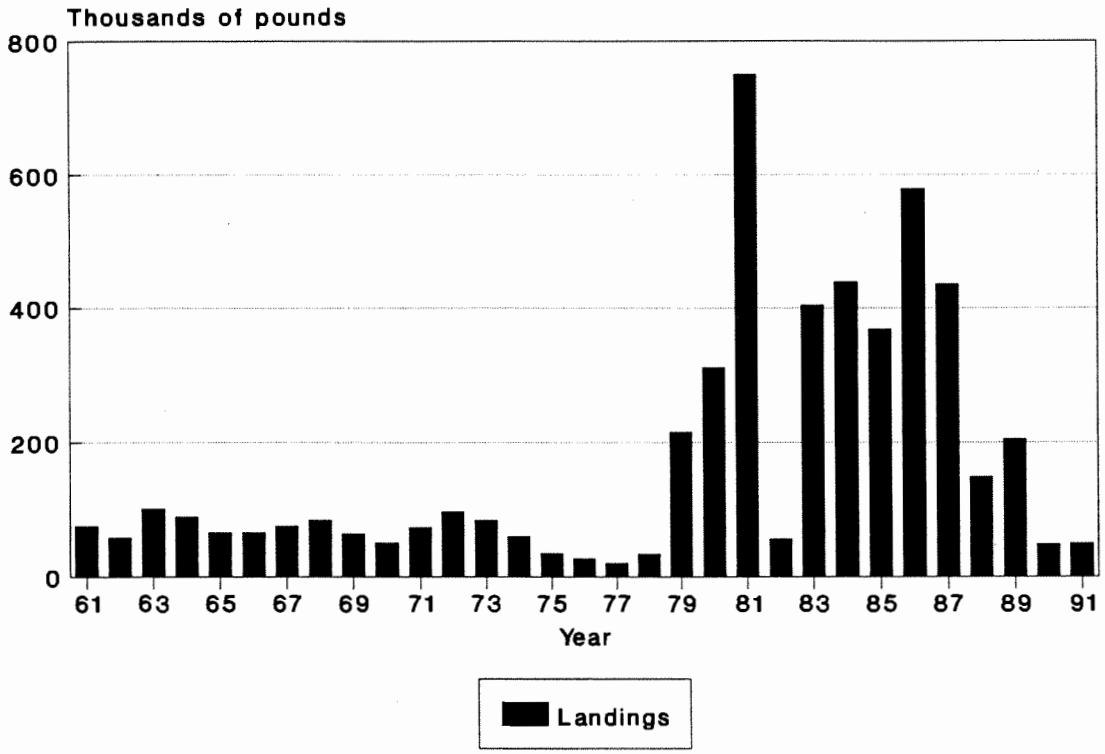


Figure 6.2 Black drum landings for Florida (West Coast), 1961 - 1991.

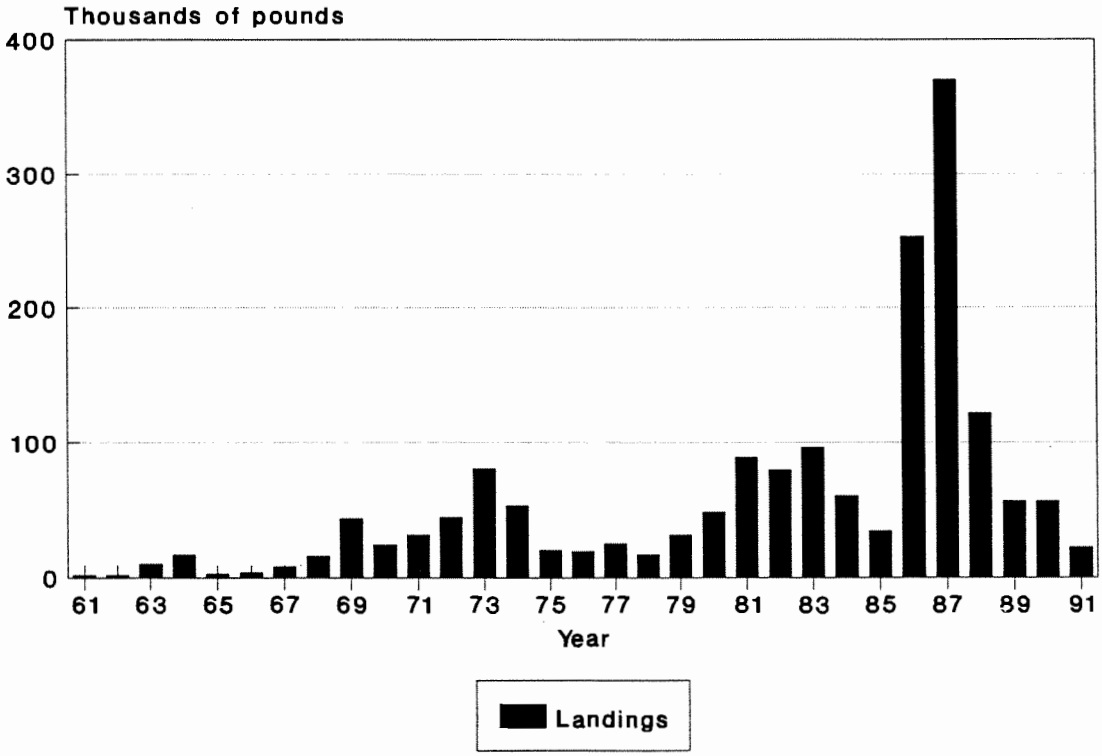


Figure 6.3 Black drum landings for Alabama, 1961 - 1991.

The growth of the black drum fishery in Mississippi was much more substantial than in Florida and Alabama in terms of landings. Average annual landings increased from 44,000 lbs for 1961-1970 to 656,000 lbs for 1971-1980 (Table 6.1, Figure 6.4). The most significant increase occurred between 1978 and 1979 and dramatically reflected the increase in marketability of black drum in the wake of greater fishery restrictions on red drum as previously discussed.

From 1981 through 1985, black drum landings stabilized near 2,000,000 lbs annually, then declined. The decline through 1988 was probably the result of market changes and not a reduction in stocks from overfishing because Louisiana landings continued to increase during the same period when Mississippi landings were declining (Table 6.1, Figures 6.4 and 6.5).

Mississippi's black drum production ranked fourth in the gulf during the 1960s. It jumped into second place in the 1970s and remained in this position through the 1980s.

6.1.2.4 Louisiana

In Louisiana large black drum are primarily caught in the summer, east of the Mississippi River. They are also caught in shrimp trawls during winter months. Smaller black drum are caught coast wide, but concentrations exist from Vermilion Bay east to Barataria Bay. With a large coastline, numerous ports are used to land black drum, but the primary cities are Venice and Leeville.

Gill nets and trammel nets have historically been the primary capture gear for black drum. Purse seines and haul seines were introduced to the fishery in the early 1980s. Recently, run-around or "strike" gill nets have been the primary gear used, and otter trawls have also contributed to landings.

The black drum fishery in Louisiana exhibited the most substantial and dramatic increase in landings during the 1980s of all the Gulf States. The 1981-1989 average annual landings of 4,249,000 lbs was ten times the annual average for the previous 20-year period (1961-1980, 423,000 lbs) (Table 6.1, Figure 6.5).

The introduction of additional gear, primarily gill nets, contributed most to the increased catch. The majority of the increased catch from 1981-1985 resulted from the introduction of purse seines and haul seines. During 1986, 1987 and 1988 entangling gill nets accounted for the majority of harvests. In 1987 and 1988 over one half of the total commercial harvest came from gill nets.

During the 1980s, Louisiana led the gulf in average annual landings of black drum garnering 59% of the total. Louisiana produced an average of only 20% during the 1960s and 1970s (Figure 6.1).

6.1.2.5 Texas

Pearson (1929) and Simmons and Breuer (1962) indicated that the historic black drum fishery in Texas has been relatively stable. From the early to late 1980s landings decreased (Table 6.1, Figure 6.6); however, causes for this decrease in landings have not been determined. In response to this decreasing trend, Texas enacted more restrictive regulations in 1988. Trotlines have been the most predominant capture devices while trammel nets and otter trawls made minimum contributions to landings.

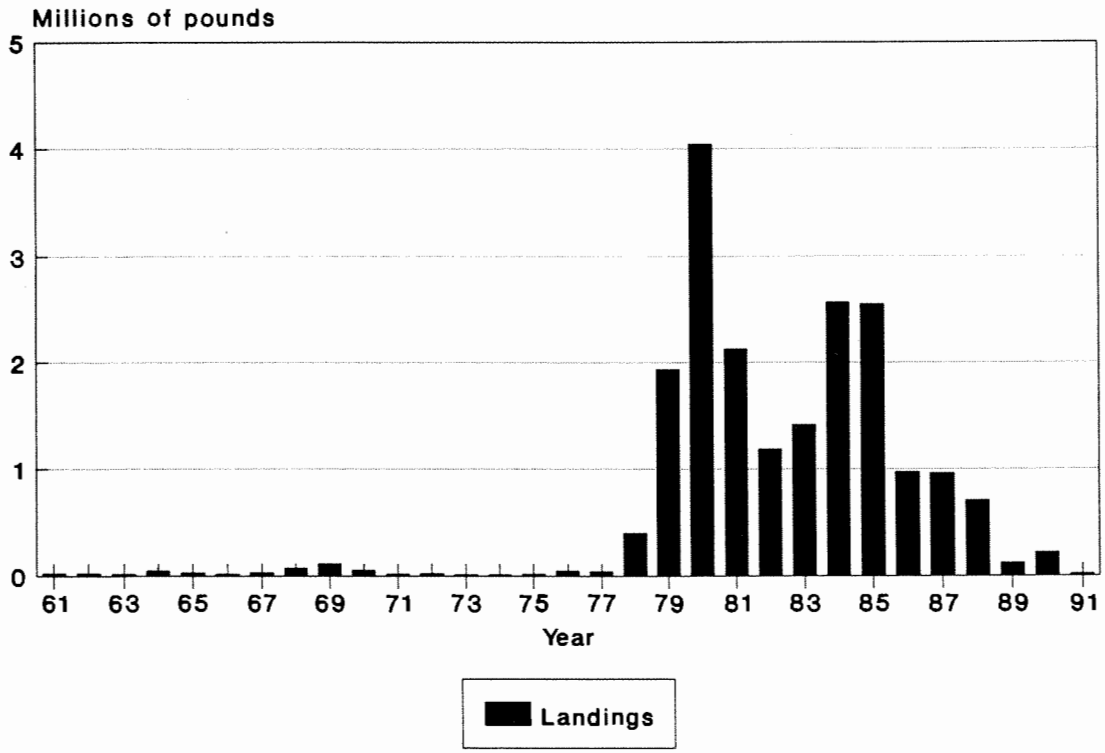


Figure 6.4 Black drum landings for Mississippi, 1961 - 1991.

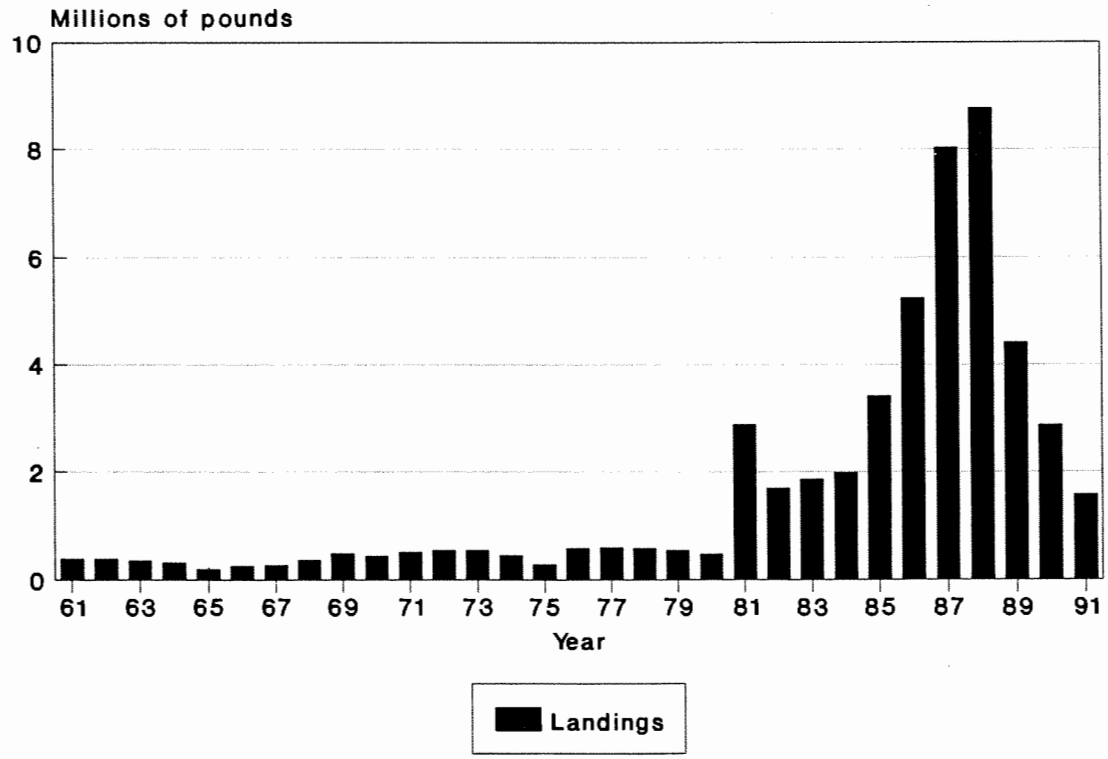


Figure 6.5 Black drum landings for Louisiana, 1961 - 1991.

Table 6.3. Texas commercial black drum landings (lbs) by area and percent of total (Quast et al. 1989).

Year	Sabine Lake	%	Galveston Bay	%	Matagorda Bay	%	East Matagorda Bay	%	San Antonio Bay	%	Aransas Bay	%	Corpus Christi Bay	%	Upper Laguna Madre	%	Lower Laguna Madre	%	Gulf of Mexico	%	Total (x 1000)	%
1977	980	<1	102,175	7.0	17,489	1.2	9,339	1.0	39,889	2.7	123,441	8.5	199,848	13.7	519,296	35.7	378,258	26.0	62,800	4.3	1,453.5	100
1978	0		161,887	9.1	16,503	1.0	9,593	<1	31,040	1.7	81,282	4.6	400,845	22.4	558,383	31.3	492,760	27.6	33,200	1.9	1,785.5	100
1979	556	<1	73,101	4.8	10,150	1.0	7,531	<1	8,679	1.0	24,064	1.6	383,315	25.0	562,558	36.7	434,749	28.4	26,700	1.7	1,531.4	100
1980	48	<1	55,999	5.3	11,364	1.1	4,248	<1	17,636	1.7	36,919	3.5	198,629	18.8	512,366	48.4	210,016	19.8	11,200	1.1	1,058.4	100
1981	219	<1	51,830	7.8	6,047	1.0	1,387	<1	9,887	1.5	19,638	3.0	58,074	8.7	343,717	51.8	157,654	23.8	14,300	2.2	663.8	100
1982	0		72,524	5.8	1,541	<1	1,975	<1	352	<1	36,491	2.9	58,262	4.7	778,749	62.3	274,561	22.0	24,500	2.0	1,249.0	100
1983	379	<1	53,458	3.6	1,696	<1	453	<1	6,694	<1	51,850	3.5	105,884	7.1	1,021,586	68.4	238,784	16.0	12,000	1.0	1,492.8	100
1984	244	<1	269,046	29.9	608	<1	199	<1	7,489	1.0	16,790	1.9	64,620	7.2	373,819	41.5	136,526	15.2	30,900	3.4	900.2	100
1985	486	<1	114,591	17.8	8,092	1.3	0	-	7,934	1.2	15,656	2.4	29,309	4.6	284,762	44.2	171,176	26.6	11,900	1.8	643.9	100
1986	154	<1	31,279	5.3	8,775	1.5	0	-	11,940	2.0	47,641	8.1	58,969	10.0	293,320	49.9	120,296	20.5	15,600	2.6	588.0	100
1987	153	<1	50,863	5.9	27,656	3.2	3,011	<1	16,273	1.9	46,396	5.4	105,461	12.3	335,407	39.1	177,004	20.6	96,400	11.2	858.7	100
1988	132	<1	61,297	8.6	2,249	<1	742	<1	4,396	1.0	37,447	5.2	132,638	18.6	188,508	26.4	78,463	11.0	208,600	29.2	714.4	100
1989	80	<1	21,821	3.6	1,049	<1	0	-	427	<1	2,094	<1	63,773	10.4	221,250	36.2	296,370	48.5	4,100	<1	610.9	100
1990	318	<1	22,338	3.7	440	<1	0	-	34	<1	26,170	4.4	63,318	10.6	218,050	36.4	256,313	42.7	12,700	2.1	599.7	100

Cornelius (1984) described increased catches during the 1970s for Baffin Bay, a tributary of the Laguna Madre. He attributed the increases to the development of snaglines (unbaited trotlines) in shallow water and the use of blue crabs, Callinectes sapidus, as bait for other trotlines. He also noted that these practices increased available area and lengthened the season in a practical sense. These increases in catch from Baffin Bay did not significantly increase total Texas catches (Table 6.1), but, Laguna Madre landings accounted for 57%-84% of the total Texas landings in those years before 1988. Annual commercial harvest along the Texas coast during the 1970s averaged over 1.3 million lbs. Table 6.3 shows commercial black drum landings for the various bay systems of Texas for the period 1977-1990.

During 1987 and 1988 there were significant increases in black drum landings from the Gulf of Mexico waters off Texas. In fact, this area was the major producer accounting for 29.2% of the total 1988 commercial harvest in Texas (Table 6.3). This marked increase probably resulted from the 1986 closure of the red drum fishery in the EEZ and the subsequent substitution of large black drum in the red drum markets (K. Meador and J. Robertson, personal observation). During this period, fishermen were receiving a profitable price for large black drum as a result of the demand for "blackened" fish.

Landings estimates for 1989 showed that commercial fishermen were no longer targeting black drum in the Gulf of Mexico (Johns 1990), with estimates showing that only 4,100 lbs of black drum were harvested offshore. This reduction probably resulted from declines in the market and the institution of a 30 inch TL maximum size limit for black drum on September 1, 1988 (Report to the Governor 1991).

The major landing ports for the offshore, large black drum fishery were the same as those for the shrimping industry: Orange, Galveston, Freeport, Port O'Connor, Port Aransas/Aransas Pass, Port Mansfield, Port Isabel and Brownsville (J. Robertson, personal observation). The smaller black drum harvested inshore in the Laguna Madre area were mainly landed at wholesale and retail fish markets located in Nueces, Kleberg, Cameron, Willacy and Kennedy counties.

Texas led the gulf in black drum production during the 1960s and 1970s with average annual landings of just over 1.2 million lbs. While the other states were expanding their drum fisheries during the 1980s, Texas landings declined from 1984 through 1988. Although the cause of this decline is unknown, environmental factors such as the freeze of 1983 and the red tide outbreak of 1986 may have contributed as substantial numbers of finfish were killed (McEachron et al. 1984, Hammerschmidt 1987).

Average annual black drum landings from Texas during the 1960s and 1970s were 71% and 52% of the gulf total, respectively. Texas dropped to third in production during the 1980s (Figure 6.1).

6.1.2.6 Total U.S. Gulf of Mexico

As shown in Table 6.1 and Figure 6.7, annual black drum landings in the gulf were relatively stable throughout the 1960s and into the mid 1970s averaging approximately 2,000,000 lbs. They increased rapidly from 1979 to 1987, peaking at 10,644,000 lbs. From 1988 to 1991, annual landings declined rapidly to levels approximately equal to those of the early 1970s.

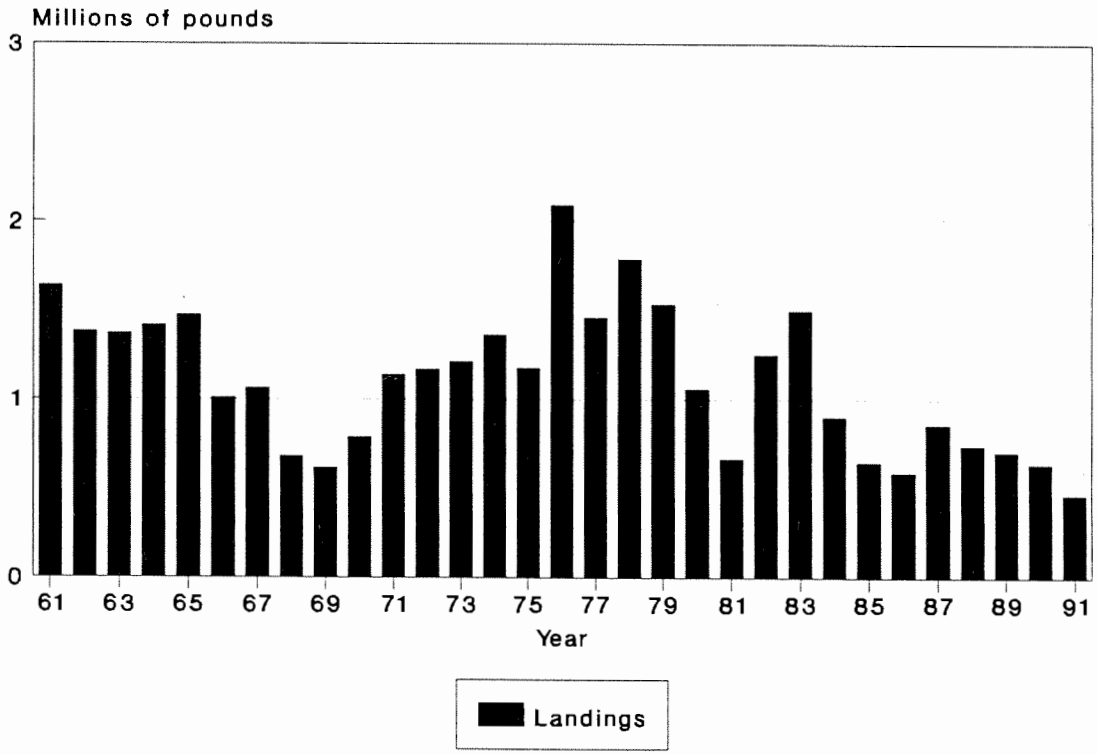


Figure 6.6 Black drum landings for Texas, 1961 - 1991.

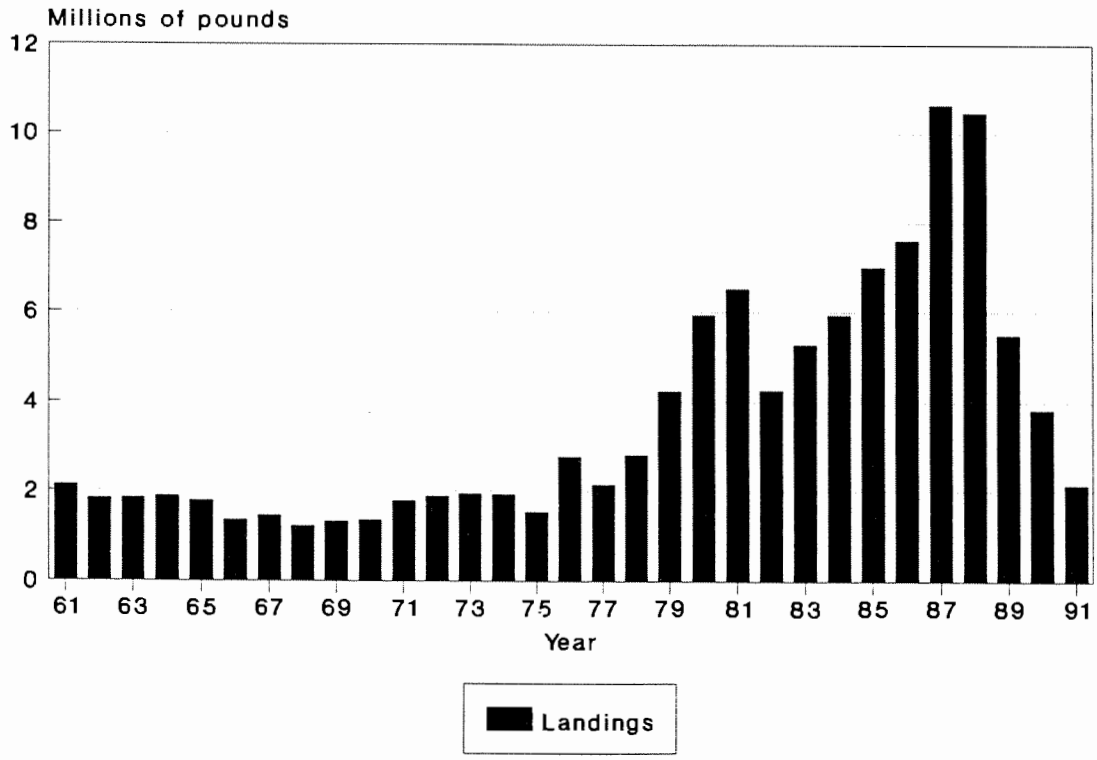


Figure 6.7 Black drum landings for the Gulf of Mexico, 1961 - 1991.

6.1.2.7 Mexico

In Mexico, black drum are primarily caught in the coastal lagoonal systems, and the Laguna Madre is the major production zone. The state of Tamaulipas records approximately 94% of Mexico's black drum production with remaining catches coming from the states of Veracruz, Campeche and Yucatan. Table 6.4 shows annual production of black drum from Tamaulipas for the period 1970-1988. Variations in landings are possibly due to changes in hydrological conditions within the Laguna Madre (M. Rosado, personal communication).

The fishing season for black drum in Mexico is November through February of each year. During this period the primary gears used are gill nets and chinchorros. (Chinchorros are a bag-type seine with 5" stretched mesh sizes for the wings, 3" stretched mesh in the middle and 2" stretched mesh in the "purse part." They range in length from 500 to 600 meters. Chinchorros are fished from a single boat by attaching one end to a fixed pole and the other end to the boat that runs around an area encircling the fish.)

6.2 Recreational Black Drum Fishery

6.2.1 History

Although black drum have never been the most sought after species by recreational anglers in the gulf, their popularity has increased during the 1980s. These increases were likely due to both an increase in the number of recreational fishermen and an increase in regulations with regard to more traditionally prized species such as spotted seatrout and red drum.

Black drum are primarily caught by anglers in nearshore bayous, bays, rivers and other estuarine tributaries. They are usually caught while fishing on the bottom using hook and line with rod and reel. Preferred baits are crabs, shrimp, clams and other benthic crustaceans and mollusks.

The percentage of recreational fishermen who actually target black drum is low (MRFSS 1979-1986). Figures indicate that the percent of gulf-wide fishermen who preferred black drum ranged from only 0.7% to 2.6%, averaging 1.3%. When targeted, smaller fish under five pounds are usually sought for personal consumption. Larger fish are also sought, especially for fishing rodeos. Many fishermen indicated no preference for a particular species. This group was the largest in the survey with a range of 36% to 64%.

The estimated recreational catch from the U.S. Gulf of Mexico for 1979 was 2.245 million fish. This catch contributed 84.2% of the total U.S. harvest. These fish were caught by an estimated 3,223,000 participants and had an average individual weight of 1.2 lbs (MRFSS 1979). In 1982, the catch declined to 1.505 million fish, but the percentage of the total U.S. harvest increased to 88.3%. In 1987, the catch was 1.303 million fish and constituted 80% of the U.S. harvest.

6.2.2 State Recreational Fisheries

Gear, vessels, seasons, fishing methods and other aspects of the recreational fishery vary from state to state. These variations are due at least in part to geographical and sociological diversity.

Table 6.4. Historical black drum catches (lbs x 1000) by Mexico, state of Tamaulipas, 1970-1988.

Year	lbs x 1000
1970	2,183
1971	2,831
1972	3,305
1973	3,120
1974	2,955
1975	3,544
1976	1,667
1977	2,068
1978	1,538
1979	1,989
1980	999
1981	819
1982	662
1983	423
1984	302
1985	388
1986	388
1987	414
1988	424

Data include both commercial and recreational catches.

6.2.2.1 Florida

Relatively few recreational fishermen along the Florida gulf coast target black drum. Some anglers fish oyster reefs for small black drum, and a few people specialize in catching large black drum off bridges in the Tampa Bay area. In northeast Florida, fishermen expend some effort in search of large black drum in channels. Among the Gulf States, Florida recreational catch of black drum ranks third (after Texas and Louisiana) with approximately 90,000 to 600,000 fish landed on the gulf coast each year from 1979 to 1990.

6.2.2.2 Alabama

Black drum have historically been considered of little value as a recreational fish in Alabama. A 1984-1986 creel survey in Alabama found that black drum were targeted by less than 1% of Alabama's fishermen. Small (less than 2 lbs) drum were usually caught in tidal rivers and creeks incidental to fishing for spotted seatrout and red drum. From 1987 to 1989, black drum were targeted by an increasing number of fishermen from late June to early September on a single pier at the north end of the Dauphin Island bridge. These were predominantly large fish (over 30 inches TL), and they were taken at night using blue crabs, Callinectes sapidus, for bait. It is likely that most of these large fish entered the commercial market, but estimating actual amounts is difficult because the fishermen who caught them were reluctant to say whether they intended to sell them. Catches of black drum off this single pier were, however, often 100-300 lbs/person/night. It was assumed that these individuals did not intend to personally consume that many black drum.

Recreationally-caught black drum are predominantly captured by hook and line, rod and reel gear. Catches from the previously mentioned pier are the only known directed fishery effort for black drum in Alabama. Other catches are either incidental or nondirected, and shrimp (Penaeus spp.) are the most common baits.

6.2.2.3 Mississippi

As in Alabama, black drum have never been a preferred species by the majority of anglers in Mississippi. The recreational harvest of black drum from Mississippi is predominantly incidental to directed fishing for spotted seatrout, red drum or southern flounder, Paralichthys lethostigma. There is also a percentage of anglers who have no species preference that take black drum.

Shrimp (Penaeus spp.), both live and dead, are the predominant baits used by fishermen taking black drum. It is likely that fishermen targeting large drum also use blue crabs; however, there are only a few observed instances of this occurrence. Hook and line with rod and reel is the principle harvest gear.

Most observed catches have come from bays, bayous, rivers and other tributaries to the Mississippi Sound. The fishery occurs primarily from late summer to early spring. Etzold and Christmas (1979) observed that drum was the most important fish of the winter sport fishery in Biloxi Bay.

6.2.2.4 Louisiana

Black drum are not a primarily targeted species of recreational fishermen in Louisiana. As evidenced from the results of the 1984 LDWF creel census, most fishermen land black drum as incidental catch, with only a small percentage citing them as a desired species. In the 1984 survey, 63% of Louisiana fishermen targeted

spotted seatrout and 49% sought red drum. No other species was targeted by more than 4% of those surveyed, and black drum was sought by only 0.6% of surveyed anglers.

Those Louisiana fishermen that targeted black drum preferred small fish (less than 5 lbs). They utilized a variety of small boats and tackle. Fishing was primarily inshore within short distances from the coast. Many black drum were also caught from the bank, near man-made structures, such as bridges and near oil rigs, both inshore and in gulf waters. Recreational fishermen caught black drum more frequently from October through February. The largest fish were caught April through September with larger fish being more heavily targeted for fishing rodeos. Of the black drum caught in the 1984 survey, 69% were kept. Commonly used baits were crabs, clams, shrimps and pieces of fish. Black drum were usually caught with bottom rigs utilizing casting equipment and occasionally hand lines.

Recreational landings data for Louisiana during most of the 1980s show wide variances in the numbers and pounds of fish landed. Catches appeared to be somewhat cyclical; however, no increasing or decreasing pattern in the landings was discernable.

Adkins et al. (1987) estimated that 105,778 black drum averaging 15.5 inches TL were harvested recreationally by Louisiana fishermen during 1984. During this period he conservatively estimated that there were 150,000 recreational saltwater fishermen in Louisiana. Saltwater licenses were required for approximately 105,000 fishermen while 45,000 were exempt due to age. These fishermen averaged fifteen days of saltwater fishing per year and 5.3 hours per trip. A total of 7,658,560 hours of fishing effort was estimated for the year. The range of catch per effort for black drum for the period was 0.01-0.25 black drum per trip. The average catch per trip was 0.014.

6.2.2.5 Texas

Although Texas has perhaps the largest directed recreational fishery for black drum of the five Gulf States, the popularity of the species within Texas is still low by comparison to other fish. Ditton et al. (1990) reported spotted seatrout, red drum and southern flounder as the first, second and third species of choice among saltwater anglers, respectively. They also reported unspecific "drum" (presumably black drum) as being the first choice of only 1.8% of the anglers surveyed. Additionally, Green et al. (1991) described the same order of preference among species but further noted that over 30% of the anglers surveyed indicated no species preference.

Catches were relatively stable until approximately 1983-1984 averaging approximately 145,000 fish per year from 1977-1978 to 1983-1984 (Table 6.5). From 1983-1984 through 1989-1990 catches averaged only approximately 72,000 fish per year. In response to reduced catches, Texas enacted size and bag limits in 1988.

The majority of black drum catches (95%-98%) were from bays and passes compared to the Texas Territorial Sea (TTS) or the EEZ off Texas (Table 6.5). Recreational catches of black drum varied geographically also. Galveston Bay had the highest annual percentage of coastwide landings in Texas during 1977-1990, followed by Matagorda Bay.

Table 6.5. Texas recreational black drum landings[a] (no. X 1000) by area (Cambell et al. 1991). (ND = no data).

Year	Sabine Lake	Galveston	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre	TTS	EEZ[b]	Total
1977-78	ND	111.9	26.2	8.1	5.2	5.6	8.3	12.8	ND	ND	178.1
1978-79	ND	94.8	20.4	5.6	1.8	2.8	6.2	18.0	ND	ND	149.6
1979-80	ND	37.2	13.4	2.0	9.8	3.6	7.1	4.3	ND	ND	77.4
1980-81	ND	87.1	44.7	2.5	1.7	8.3	7.0	6.4	ND	ND	157.7
1981-82	ND	59.9	24.8	9.0	15.6	8.6	9.2	5.5	ND	ND	132.6
1982-83	ND	105.8	24.6	4.2	8.2	11.5	9.0	7.9	ND	ND	171.2
1983-84	ND	29.3	22.2	3.5	11.3	10.7	3.0	8.8	0.7	0.4	89.9
1984-85	ND	25.7	13.7	1.5	5.5	4.1	0.7	5.6	1.2	1.4	59.4
1985-86	ND	28.3	8.9	1.0	2.9	13.3	8.1	4.9	0.6	0.6	68.6
1986-87	ND	27.2	13.1	1.6	5.3	5.2	4.6	7.1	1.2	0.6	65.9
1987-88	8.7	41.3	11.0	10.8	4.0	4.0	4.0	4.4	0.7	0.3	89.2
1988-89	3.7	19.9	6.0	1.2	5.0	9.8	8.8	6.6	0.5	0.2	61.7
1989-90	8.5	26.6	5.5	3.5	7.1	7.0	5.1	4.1	0.3	1.0	68.7

[a]includes private-boat, party boat and headboat estimates.
[b]excludes headboat estimates.

Black drum are caught primarily from private boats as opposed to party boats or headboats (Green et al. 1991). Black drum are also caught from shoreline (wade/bank) areas, bay and gulf piers, gulf jetties and bridges. The quantity of catch from bridges has not been surveyed in Texas, but it is probably very low. Coastwide data for black drum caught from shorelines and bay piers during September-August 1974-1976 and 1979-1980 (McEachron et al. 1981) reveal that largest catches occur in the Galveston area. Coastwide data from gulf piers and jetties during September-August 1978-1979 indicate highest catches occur on the southern coast in the area of Port Isabel (McEachron 1980).

Black drum may be captured throughout the year in Texas; however, summer and fall catches generally include smaller fish than winter or spring. The smaller "puppy drum" can be found on shallow bay flats in the summer and may be spotted by locating numerous craters or small holes on the bottom. They are referred to as "drum noodles" and are a result of the fish rooting and foraging for marine worms and mollusks while feeding in a head-down position (Breuer 1987, Becker 1989). In the cooler months, black drum of all sizes are caught along channels as well as in the surf.

The most notable recreational harvests of black drum in Texas are the annual runs of large drum that occur in the early spring when 20-40 pound fish are spawning. Campbell-Hostettler (1982) described recreational catches from Galveston, Matagorda and Corpus Christi bays during the 1981 spawning season (February-April.) Catch and effort estimates in this report showed Galveston Bay with the highest numbers of fish and man-hours, followed by Matagorda and Corpus Christi bays, respectively. The mean catch rate for all three bay systems was just under 1 fish/man-hour, while the mean weight of individuals landed was 21.2 pounds. Campbell-Hostettler (1982) further noted that the preferred baits of large-drum anglers were crabs (Callinectes spp.) followed by dead shrimp (Penaeus spp.).

6.3 Incidental Catch

Black drum may be caught by both commercial and recreational fishermen while directing their efforts toward other finfish species. Those efforts may include gill netting, trammel netting, purse seining, hook and line fishing and others. Trawling for shrimp may also result in the catching of black drum; however, the amount is quite small and insignificant, except in Texas during 1987-1988.

6.4 Foreign Activity

Currently, there is no foreign involvement in the fishing for black drum in the U.S. Gulf of Mexico. Additionally, no total allowable level of foreign fishing (TALFF) has been established.

7.0 DESCRIPTION OF THE ECONOMIC CHARACTERISTICS, PROCESSING, MARKETING, AND ORGANIZATIONS ASSOCIATED WITH THE FISHERY

Increasing market demands for black drum began in the mid 1970s as states increased restrictions on other commercial species (D. Horn, personal communication). Prior to 1980, black drum less than 10 lbs were sold gulf-wide as whole and gutted fish primarily to chain and independent grocery stores and to other seafood dealers, and small (2-5 lb) fish were preferred (K. Turner, personal communication).

In the early 1980s, sales of the largest "bull" drum escalated due to the increased demand for fish fillets in the restaurant and food service markets. (Note: "bull" drum when used in this document shall refer to black drum larger than 10 lbs, whole weight.) In most Gulf States the increased popularity and demand for black drum was linked initially to red drum (K. Turner, personal communication; S. Russell, unpublished data). This trend continued and gained momentum in 1984 as the demand for blackened "redfish" and other red drum preparations intensified. Black drum was considered an excellent substitute for red drum. In most cases, dealers sold black drum as "blackened fish," "blackfish" or simply as "drum" and touted the similar taste and texture qualities to red drum. In some cases it was sold to consumers as red drum.

7.1 Dockside Value

The historical dockside value for black drum harvested in the gulf increased significantly during 1970-1989 (Table 7.1). This increase reflected both increased annual harvests (Table 6.1) and increased per pound dockside price (Table 7.2). Overall, the dockside price of black drum in the gulf increased from an average of $0.11 per pound during 1970-1974 to $0.25 per pound during 1985-1989 while the corresponding value increased from $193 thousand to $2.8 million.

Much of the increased price and, hence, value is inflationary based (Table 7.3 and Table 7.4). The value of the black drum fishery in the gulf, after removing the effects of inflation using the 1980 Consumer Price Index as a base, increased by a factor of 4.7 from $365 thousand annually during 1970-1974 to $2.0 million annually during 1985-1989. Table 7.4 shows that the deflated dockside price of black drum landings increased only marginally when evaluated on a five-year basis, though annual prices fluctuated widely.

7.1.1 Florida

The deflated dockside value of black drum landed in Florida increased from an average of $12.1 thousand annually during 1970-1974 to $61.6 thousand annually during 1985-1989 (Table 7.3). Much of the increased value (deflated) reflected increased landings as opposed to an increase in deflated price. The most significant increase occurred during the latest three years of analysis.

7.1.2 Alabama

The deflated value of black drum landings in Alabama increased from an average of $5.4 thousand annually during 1970-1974 to $25.9 thousand in 1985-1989, a 4.8 fold increase. Pounds landed in Alabama, by comparison, increased by a factor of 3.1. The difference between the increased deflated value and poundage represents an increase in the deflated price of Alabama landed black drum since 1986.

Table 7.1. Historical commercial value of black drum landings in the Gulf of Mexico, by state, 1970-1991.

YEAR	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	TOTAL
1970	$ 3,956	$ 1,316	$ 2,976	$ 32,644	$ 83,854	$ 124,746
1971	5,187	1,762	1,235	35,775	116,800	160,759
1972	8,283	3,246	7,463	38,467	135,384	192,843
1973	7,873	4,652	1,039	44,887	154,350	212,801
1974	6,377	3,239	860	41,630	221,396	273,502
Average 1970-1974	**6,335**	**2,843**	**2,715**	**38,681**	**142,357**	**192,930**
1975	3,621	1,114	1,664	29,048	207,772	243,219
1976	2,689	1,247	3,240	68,711	508,810	584,697
1977	2,675	1,331	3,496	81,798	399,800	489,100
1978	3,978	1,362	54,284	116,354	607,543	783,521
1979	23,462	2,693	245,119	98,661	602,307	972,242
Average 1975-1979	**7,285**	**1,549**	**61,561**	**78,914**	**465,246**	**614,556**
1980	47,432	5,522	365,066	92,910	539,772	1,050,702
1981	83,688	12,428	218,367	612,204	378,089	1,304,776
1982	9,064	11,092	158,549	572,882	782,455	1,534,042
1983	47,072	12,330	203,766	703,453	971,034	1,937,655
1984	63,073	7,264	388,473	1,042,759	449,164	1,950,733
Average 1980-1984	**50,066**	**9,727**	**266,844**	**604,842**	**624,103**	**1,555,582**
1985	54,880	5,123	503,225	1,018,687	427,155	2,009,070
1986	125,367	50,204	252,730	1,836,930	411,000	2,676,231
1987	134,539	83,474	212,016	2,670,319	597,639	3,697,987
1988	43,204	25,222	108,194	2,347,834	565,609	3,090,063
1989	66,142	14,481	35,682	1,831,962	574,426	2,522,693
Average 1985-1989	**84,826**	**35,701**	**222,369**	**1,941,146**	**515,166**	**2,799,209**
1990	17,360	17,384	69,380	4,115,212	551,327	1,770,663
1991	18,289	4,376	11,507	1,089,004	351,683	1,474,859

Source: Compiled from data contained in Fisheries of the United States (various issues) and unpublished National Marine Fisheries Service data.

Table 7.2. Historical black drum dockside price in the Gulf of Mexico, by state, 1970-1989.

YEAR	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	TOTAL
1970	$0.08	$0.05	$0.06	$0.08	$0.11	$0.09
1971	0.07	0.06	0.06	0.07	0.10	0.09
1972	0.09	0.07	0.32	0.07	0.12	0.10
1973	0.09	0.06	0.08	0.08	0.13	0.11
1974	0.11	0.06	0.08	0.09	0.16	0.14
Average 1970-1974	**0.09**	**0.06**	**0.12**	**0.08**	**0.13**	**0.11**
1975	0.10	0.06	0.08	0.11	0.18	0.16
1976	0.10	0.07	0.07	0.12	0.24	0.21
1977	0.13	0.05	0.08	0.14	0.28	0.23
1978	0.12	0.08	0.14	0.20	0.34	0.28
1979	0.11	0.09	0.13	0.18	0.39	0.23
Average 1975-1979	**0.11**	**0.07**	**0.10**	**0.15**	**0.29**	**0.22**
1980	0.15	0.12	0.09	0.20	0.51	0.18
1981	0.11	0.14	0.10	0.21	0.57	0.20
1982	0.16	0.14	0.13	0.34	0.63	0.36
1983	0.12	0.13	0.14	0.38	0.65	0.37
1984	0.14	0.12	0.15	0.53	0.50	0.33
Average 1980-1984	**0.14**	**0.13**	**0.12**	**0.33**	**0.57**	**0.29**
1985	0.15	0.15	0.20	0.30	0.66	0.29
1986	0.22	0.20	0.26	0.35	0.70	0.35
1987	0.31	0.23	0.22	0.33	0.70	0.35
1988	0.29	0.21	0.15	0.27	0.77	0.30
1989	0.32	0.26	0.30	0.42	0.82	0.46
Average 1985-1989	**0.26**	**0.21**	**0.23**	**0.33**	**0.73**	**0.35**

Source: Compiled from data contained in Fisheries of the United States (various issues) and unpublished National Marine Fisheries Service data.

Table 7.3. Historical deflated value of black drum landings in the Gulf of Mexico, by state, 1970-1989 (1980 as the base year).

YEAR	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	TOTAL
1970	$ 8,405	$ 2,796	$ 6,323	$ 69,355	$178,156	$265,035
1971	10,548	3,583	2,512	72,753	237,529	326,926
1972	16,345	6,405	14,727	75,907	267,152	380,536
1973	14,624	8,641	1,930	83,379	286,712	395,287
1974	10,655	5,412	1,437	69,558	369,920	456,982
Average 1970-1974	**12,115**	**5,367**	**5,386**	**74,190**	**267,894**	**364,953**
1975	5,548	1,707	2,550	44,509	318,360	372,674
1976	3,887	1,803	4,684	99,332	735,562	845,268
1977	3,638	1,810	4,754	111,239	543,695	665,136
1978	5,029	1,722	68,629	147,102	768,091	990,573
1979	26,670	3,061	278,640	112,153	684,674	1,105,198
Average 1975-1979	**8,954**	**2,021**	**71,851**	**102,867**	**610,076**	**795,770**
1980	47,432	5,522	365,066	92,910	539,772	1,050,702
1981	75,924	11,275	198,109	555,410	343,014	1,183,733
1982	7,748	9,481	135,521	489,674	668,808	1,311,231
1983	38,982	10,211	168,748	582,561	804,156	1,604,658
1984	50,052	5,764	308,275	827,488	356,437	1,548,016
Average 1980-1984	**44,028**	**8,451**	**235,144**	**509,609**	**542,437**	**1,339,668**
1985	42,045	3,925	385,535	780,446	327,256	1,539,207
1986	94,309	37,767	190,119	1,381,853	309,180	2,013,228
1987	97,673	60,601	153,920	1,938,605	433,875	2,684,674
1988	30,116	17,581	75,418	1,636,593	394,266	2,153,975
1989	43,984	9,630	23,729	1,218,255	381,993	1,677,591
Average 1985-1989	**61,625**	**25,901**	**165,744**	**1,391,150**	**369,314**	**2,013,735**

Source: Compiled from data contained in Fisheries of the United States (various issues) and unpublished National Marine Fisheries Service data.

Table 7.4. Historical black drum deflated dockside price in the Gulf of Mexico, by state, 1970-1989 (1980 as the base year).

YEAR	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS	TOTAL
1970	$0.17	$0.12	$0.12	$0.16	$0.23	$0.20
1971	0.15	0.11	0.12	0.14	0.21	0.18
1972	0.17	0.15	0.64	0.14	0.23	0.20
1973	0.17	0.11	0.14	0.15	0.24	0.21
1974	0.18	0.10	0.14	0.16	0.27	0.24
Average 1970-1974	**0.17**	**0.12**	**0.23**	**0.15**	**0.24**	**0.21**
1975	0.16	0.09	0.13	0.16	0.27	0.25
1976	0.14	0.09	0.10	0.17	0.35	0.31
1977	0.18	0.07	0.11	0.19	0.37	0.31
1978	0.15	0.10	0.17	0.25	0.43	0.35
1979	0.12	0.10	0.14	0.25	0.45	0.26
Average 1975-1979	**0.15**	**0.09**	**0.13**	**0.20**	**0.37**	**0.30**
1980	0.15	0.12	0.09	0.20	0.51	0.18
1981	0.10	0.13	0.09	0.19	0.52	0.18
1982	0.14	0.12	0.11	0.29	0.54	0.31
1983	0.10	0.11	0.12	0.31	0.54	0.30
1984	0.11	0.10	0.12	0.42	0.40	0.26
Average 1980-1984	**0.12**	**0.12**	**0.11**	**0.28**	**0.50**	**0.25**
1985	0.11	0.12	0.15	0.23	0.51	0.22
1986	0.16	0.15	0.20	0.26	0.53	0.26
1987	0.22	0.16	0.16	0.24	0.51	0.25
1988	0.20	0.14	0.11	0.19	0.53	0.21
1989	0.22	0.17	0.20	0.28	0.54	0.31
Average 1985-1989	**0.18**	**0.15**	**0.16**	**0.24**	**0.52**	**0.25**

Source: Compiled from data contained in Fisheries of the United States (various issues) and unpublished National Marine Fisheries Service data.

7.1.3 Mississippi

The deflated value of Mississippi's black drum fishery expanded rapidly throughout the 1970s and into the 1980s, before declining sharply since 1985. The decline reflects a significant reduction in poundage harvested. As was the case in Florida and Alabama, the deflated price of black drum landed in Mississippi was high during the mid to late 1980s relative to the long-run, historical price.

7.1.4 Louisiana

The deflated value of Louisiana's black drum fishery expanded more than 15 fold during 1970-1989. When evaluated on a five-year basis, most of this increase occurred during the 1980s in association with increased poundage. Since the early 1980s, the per-pound price of Louisiana black drum has typically exceeded that received in any of the other Gulf States, excluding Texas. The relatively high price received for Louisiana-landed black drum may reflect better handling and higher quality fish from gill net harvests.

7.1.5 Texas

The deflated value of Texas produced black drum expanded from an average of $142 thousand annually during 1970-1974 to $624 thousand annually during 1980-1984, before falling during the following five-year period. Texas generally accounted for 60% to 80% of the black drum value in the gulf during the 1970s, but the state's share fell significantly during the 1980s due to both a decline in production and an increase in the production among other Gulf States.

The dockside price of black drum harvested in Texas has consistently exceeded that received in the other Gulf States by a significant margin (Table 7.4). This price difference likely reflects the almost exclusive harvest of black drum by trotlines that yield the highest quality fish.

7.2 Processing and Wholesaling

Black drum are currently sold in a variety of forms depending upon which gulf state they are landed and the point of purchase (Table 7.5). Dockside, from high capacity vessels, large (5-10 lb) and "bull" drum are usually sold whole, by the pound; although "bull" drum are often sold by individual head of fish in Louisiana. Black drum greater than 10 pounds are more often sold drawn than round from smaller vessels. At the wholesale and retail level, most black drum greater than 10 pounds are sold collared. In states with laws that require the fish to be docked with head and tail attached, fish are usually gutted and gilled.

Fish houses head and gut small and medium drum for resale to fish markets and restaurants. Medium to large drum are further processed into steaks and fillets for restaurants and food service outlets. Bull drum are collared and subsequently filleted by secondary processors who retail them largely to institutional markets as breaded fish products or fish steaks.

The quality of "bull" drum is not as good as that of the smaller fish because the flesh of larger fish often contains Poecilancistrium spp. larvae. Their presence effects the black drum's marketability. When observed, these larvae can be removed by suction using a specially designed light table; however, this procedure increases processing efforts and costs.

Table 7.5. Comparison of product form by size, region and market level.

Product Form	Process Description	Size	Region	Marketing Level	Notes
Round (whole)	Entire fish, uncut	Bull drum, occasionally other sizes when bycatch	Gulfwide	Dockside	
Drawn	Entrails removed, gilled	1-12 lbs	Gulfwide	Dockside and retail	
Dressed	Deheaded, gutted, gilled, skin and/or scales removed	1-5 lbs	Gulfwide	Retail	
Filleted	Flesh of fish is removed from vertebrae in two halves, usually skinned	All sizes	Gulfwide	Retail	
		Bull drum	LA, MS, TX	Wholesale	Bull drum fillets are usually cut to smaller portions
Collared	Head removed behind side fins, entrails removed	Bull drum	Gulfwide	Wholesale and retail	
		>10 lbs	Texas		

Attempts have been made, with varying degrees of success, to use black drum and their scrap parts for other purposes such as bait, a leather substitute and surimi. Although black drum produce a good grade of surimi, the drum's use is not considered economically feasible partially due to high production costs and a relatively low product yield (Wilson and Wagner 1985).

7.3 Markets and Product Distribution

The majority of the markets for 2 to 15 pound black drum are located in the Gulf States, while the markets for larger drum products are located largely in the midwestern and northeastern United States and Mexico. The most important markets for black drum are the restaurant and food service outlets. The largest demand is currently for medium and large (up to fifteen pounds) black drum for use as fillets and steaks. Since larger drum have a coarser texture, common methods of preparation are grilling and broiling. The second largest outlet is retailers who primarily sell drum five pounds or less. The majority of these fish are sold drawn, although it is becoming more common for retailers to handle fresh fillets (K. Turner, personal communication).

7.4 Organizations

7.4.1 National

National Coalition for Marine Conservation
Ken Hinman
5105 Paulsen Street, Suite 243
Savannah, GA 31403

National Fisheries Institute
Lee J. Weddig
1525 Wilson Boulevard, Suite 500
Arlington, VA 22209

Sport Fishing Institute
Gilbert C. Radonski
1010 Massachusetts Avenue, NW
Suite 100
Washington, DC 20001

7.4.2 Regional

Southeastern Fisheries Association
Robert Jones
312 East Georgia Street
Tallahassee, FL 32301

Gulf and South Atlantic Fishery Development Foundation
Judy L. Jamison
Lincoln Center, Suite 997
5401 West Kennedy Boulevard
Tampa, FL 33609

Gulf Coast Conservation Association (GCCA)
Walter Fondren, Chairman
4801 Woodway, Suite 220W
Houston, TX 77056

7.4.3 Local (State)

The following organizations are concerned with finfish-related legislation and regulations, and they are consequently interested in their affects on black drum.

7.4.3.1 Florida

Florida Conservation Association
Dave Lear
905 East Park Avenue
Tallahassee, FL 32301-2646

Florida Department of Agriculture and
Consumer Services
Bureau of Seafood and Aquaculture
Charles Thomas
2051 East Dirac
Tallahassee, FL 32310

Florida League of Anglers
M.T. Stoppelbein
534 North Yachtsman
Sanibel, FL 33957

Organized Fishermen of Florida
Jerry Sansom
P.O. Box 740
Melbourne, FL 32902

7.4.3.2 Alabama

Alabama Oystermen's Association
Emanuel Peters
4181 Heron Bay Loop Road
Coden, AL 36523

Saltwater Sportsman's Association
P.O. Box 190251
Mobile, AL 36619

Save Our Shells Association
Roland Nelson
14730 Niolon Lane
Coden, AL 36523

Southeast Alabama Seafood Association
Mr. Lawrence Johnson
Route 1, Box 648
Coden, AL 36523

7.4.3.3 Mississippi

Gulf Coast Seafood Producers and Consumers Association
Tommy Bordage
11 Chantilly Terrace
Bay St. Louis, MS 39520

Mississippi Charterboat Association
Jim Twiggs
3209 Magnolia Lane
Ocean Springs, MS 39564

Mississippi Gulf Coast Fishermen's Association
Eley Ross
176 Rosetti Street
Biloxi, MS 39530

Mississippi Gulf Fishing Banks
Paul Kensler
P.O. Box 223
Biloxi, MS 39533

Mississippi Shellfish Association
Earl Fayard
376 Bayview Avenue
Biloxi, MS 39530

Pass Christian Commercial Fishermen's Association
P.O. Box 324
Pass Christian, MS 39571-0324

Save America's Seafood Industry
Jean Williams
P.O. Box 2275
Pascagoula, MS 39569-2275

United Fisheries Cooperative
Earl Fayard
400 Front Beach Drive
Ocean Springs, MS 39564

7.4.3.4 Louisiana

Louisiana Seafood Promotion and Marketing Board
Karl Turner, Executive Director
P.O. Box 70648
New Orleans, LA 70172

Concerned Finfishermen of Louisiana & Louisiana Fishermen for Fair Laws
Mr. Henry Truelove, President
P.O. Box 292
Charenton, LA 70523

Organization of Louisiana Fishermen
Mr. L.J. Brunet, President
P.O. Box 220
Galliano, LA 70354

Louisiana Coastal Fishermen's Association
Mr. Terry Pizani, President
P.O. Box 420
Grand Isle, LA 70354

Coastal Concerned Association
Mr. Daniel Shay, President
Route 2, Box 64-A
Creole, LA 70632

Concerned Citizens and Fishermen's Association
Mr. Tyrone Edwards, President
P.O. Box 63
Davant, LA 70046

Louisiana Seafood Processors Council
Mike Voisin, President
P.O. Box 3916
Houma, LA 70361-3916

Louisiana Oyster Dealers/Growers Association
William A. "Buster" Kass IV, President
P.O. Box 826
Grand Isle, LA 70358

Southwest Pass Oyster Dealers/Growers Association
Daniel Edgar, President
HC 71, Box 394
Franklin, LA 70538

7.4.3.5 Texas

Professional Involvement of Seafood Concerned Enterprises (PISCES)
C.L. Stanley, President
Attention: David Steed
P.O. Box 9802 #556
Austin, TX 78766

Women in the Seafood Industry (WISI)
Jonell Wright, President
c/o Anchor Seafood
Rockport, TX 78382

C.A.R.E.
Margaret Garrett
P.O. Box 1030
Portland, TX 78374

Tournament Directors Foundation of Texas (TDF of TX)
Attention: Pam Basco
P.O. Box 75231
Houston, TX 77034

Finfish Producers of Texas
Carroll and Ruth West
P.O. Box 60-B
Riviera, TX 78379

8.0 SOCIAL AND CULTURAL FRAMEWORK OF DOMESTIC FISHERMEN AND THEIR COMMUNITIES

The black drum is part of a multispecies finfish complex of near-shore fishes in the Gulf of Mexico that have commercial and recreational value. With the exception of Texas, the black drum fishery is more or less a recent outgrowth of the commercial red drum fishery. The popularity of the fish and the escalation of the fishery from 1979 to approximately 1987 resulted in a cultural fad for blackened fish. This was part of a trend of increasing demand for fish products for health reasons and an outcome of a greater availability of fish products from domestic and international markets.

The term "fishery" when used throughout this section refers to the interaction between human users and target-fish populations. Thus, a fishery is composed of users that harvest a resource for commercial, subsistence and sport purposes. Little information is available in the social and cultural framework of the black drum fishery.

Commercial fishermen harvesting natural resources in the gulf represent members of natural resource communities (NRCs) (Berrigan et al. 1991). Residents of NRCs are economically and culturally dependent on having access to sustainable supplies of natural resources. Their traditions of resource sustainability provide for the maintenance of community viability. These traditions include social networks maintained by occupational roles, and life satisfaction gained from the profession of fishing and related activities (i.e., fish marketing and processing). Transgenerational transmission of fishery knowledge begins at an early age, and the length of the learning experience can impact ones success in the fishery (Acheson 1988, Firestone 1978).

Fish processing and fishing are family oriented, with family members often being integrally linked to occupational and work activities (Dyer and Moberg 1992, Stiles 1972). For example, fishermen's wives serve in support roles of communication and supply when their husbands are at sea and have also become more active in political actions to support commercial fishing operations (Thomas 1990).

Bowman et al. (1977) characterized the commercial finfish fishermen using nets in coastal Louisiana. The fishermen averaged 47.6 years of age and had lived in Louisiana an average of 44.0 years. A small number of participants in the fishery had recently moved to Louisiana from Florida. In 1974, Florida commercial fishermen averaged 48 years of age with an average of 16.5 years of fishing experience. The majority (52%) were between 41 and 60 years of age with only 11% less than 31 years of age. Years of formal schooling declined with increased age (Prochaska and Cato 1977); however, older participants in finfish fisheries are considered the ones possessing the greatest amount of folk knowledge and skill at catching fish. They may be typical of the finfish commercial fishery in the gulf (i.e., an aging population, little recruitment into the industry and limited opportunities for movement into other occupations).

A survey was conducted of fish processors and wholesalers of black drum. This survey was administered as a mailout with key respondents being further questioned by telephone and personal interview. Nine processors and 70 wholesalers throughout the five Gulf States were queried and 20 responses were received. A total of ten of those surveyed were no longer in business at the indicated addresses, and others may not have responded because they did not market black drum (e.g.,

no responses were received from Florida which does not have a viable market for the species).

Besides lack of human recruitment into the fisheries, other problems indicated by key respondents included: poor prices, lack of markets outside their regions, insufficient product, too few fishermen, little product demand and poor condition of the product. Other major problems indicated included: pollution of fish and fishing grounds, family pressures, excessive work, absence from home and high operating costs. These perceptions are based on domestic finfish operations in the gulf and do not take into account the wholesale or retail marketing of imported finfish products.

Given the pessimism prevalent in the industry, lack of recruitment to the fishing and processing population and the aging of this population, the description of the industry as "dying, not quite dead" by one processor seems an accurate impression. On the other hand, young fishermen note the need for compromise, flexibility and political action in order to remain active in the fishery (Biro 1992).

Another serious problem that has been noted by the commercial segment is conflict with the recreational sector. Commercial finfish fishermen view the recreational segment as being responsible for the loss of the commercial red drum fishery and other reductions in their ability to fish. Conflict has escalated as special interest groups, such as Gulf Coast Conservation Association (GCCA) have lobbied regulators to enact what are perceived as unjustified regulations. This conflict and reduced quotas have made it difficult to maintain finfish utilization as an occupational role, and created opportunistic resource exploitation. As noted by one processor from Texas:

> "Political influence from special interest groups makes for fewer fishermen by influencing Texas Parks and Wildlife to impose restrictions. The few fishermen left are so inefficient that product is very expensive and priced only for gourmet classic restaurants."

Black drum fishermen represent mixed-species fishermen. They exploit a variety of fish species and stocks in addition to black drum. In some cases, black drum may be an incidental catch to other target species.

When increased markets were established for black drum in the late 1970s, purse seine fishermen immediately seized the fishing opportunity. Some of these fishermen had been displaced as the result of regulations on other species. Although at this time black drum prices were still very low compared to other commercially-caught food species, a small market developed for blocks of unspecific species of fish primarily in Nigeria (D. Horn, personal communication). Since drum could easily be caught in large numbers by purse seines, a small profit was realized. In the early to mid 1980s, purse seiners that were catching red drum also entered the fishery as more regulations precluded their harvests, and as the result of increased demand for black drum during the "blackened" fish fad.

Fishermen have the capacity to adapt to changes in fishing opportunities and regulatory changes (Dyer and Moberg 1992). Switching among fisheries can occur on a seasonal basis in the gulf (Picou et al. 1992). For example, in Bayou La Batre, Alabama, inshore fishermen utilize finfish, oysters, crabs and shrimp in a seasonal cycle. With an increase in the management of specific fisheries, it becomes more difficult to switch from one fishery to another because of increasing costs for

permits, gear, etc., and an increase in the number and complexity of regulations on particular fishery populations.

The highly efficient purse seine fishery for black drum gradually has given way to the gill net fishery in the Gulf of Mexico because of the increasing regulatory burden imposed on the seine fishery and because gill nets are more cost-effective to operate. Although markets expanded, prices remained low, and profits demanded the lowest cost production strategies. In the late 1980s, as the "blackened" fish fad subsided, markets deteriorated and catches consequently declined as finfish fishermen began to exit the fishery. Because of additional regulations on other species, fewer opportunities were available for fishermen to utilize other finfish populations. Comments from key respondents in the survey may reflect this decrease in commercial utilization opportunities.

Unlike the "pulse" fishery for black drum in the north-central gulf that occurred from 1979-1987, fishermen in Texas have a long tradition of fishing for black drum. Trotlines have been the primary gear used, even before nets were banned in 1986.

In Texas, there are basically two fishing communities: (1) the Laguna Madre and (2) the Galveston Bay. Fishermen who target black drum in the Laguna Madre are approximately 50% white and 50% hispanic from Baffin Bay to Corpus Christi. In the Upper Laguna Madre, whites predominate the population, and fishing families exist with transgenerational knowledge being passed from generation to generation. These families are spread out and fish from a number of ports in the area.

In the Lower Laguna Madre, hispanics make up approximately 90% of the drum fishing population. They also have a history of transgenerational fishing in families, and all work from the Port Isabell area. In the spring, a few Vietnamese fishermen migrate from the Galveston Bay area to fish in the Lower Laguna Madre.

Fishing is mostly seasonal in the Laguna Madre during the fall and winter (some spring fishing in the Lower Laguna Madre), and fishermen work at other occupations, primarily shrimp fishing, during the summer. A small group of fishermen in the Nueces Bay area at the northern end of Corpus Christi Bay fish for black drum year-round.

In Galveston Bay, whites and Vietnamese are the predominant ethnic groups in the black drum fishery. Here, whites have transgenerational, family-oriented ties to the fishery; whereas the Vietnamese are recent immigrants. They fish primarily trotlines but occasionally use trawls in the fall and winter. They are in essence finfish fishermen because they target other species (i.e., flounder and sheepshead) in addition to drum. Fall is the peak season for drum fishing, but many fish year-round. These year-round fishermen and those previous described from Nueces Bay have successfully lobbied to prevent efforts to shorten the fishing season.

9.0 MANAGEMENT CONSIDERATIONS

9.1 Definition of the Fishery

The fishery includes only one species in the United States Gulf of Mexico.

Common Name: Black Drum
Accepted Scientific Name: Pogonias cromis

9.2 Management Unit

The management unit is the total population of black drum, Pogonias cromis, occurring in the United States Gulf of Mexico.

9.3 Stock Assessment

The development of a stock assessment for black drum in the U.S. Gulf of Mexico was limited by the paucity of available catch/effort data, age frequency and overall knowledge of the life history of the species and the history of the fishery. In order to conduct an assessment, the following available data were used: length and age frequency, growth models, and estimates of natural, fishing and total mortality. The primary analysis employed was virtual population analysis (VPA). Results of the analysis included an estimate of spawning stock biomass (SSB) and spawning stock biomass per recruit (SSB/R). Recruitment estimates from monitoring data were also used to develop conclusions regarding the status of the stocks.

9.3.1 Length and Age Frequencies

Data from aged fish, used and described by Beckman et al. (1988), and additional unpublished data through 1990 were available for this analysis. The aged data showed periodic strong cohorts. Length frequencies from S. Russell (unpublished draft) were also available. Both data bases represented samples from a variety of sampling gears.

Length frequency data from the Texas recreational fishery showed that the recreational fishery targets smaller fishes under 60 cm. This database included both inshore and offshore (outside of embayments) catches and showed that as the catches of fish greater than 40 cm declined inshore, catches of those sizes increased in relative abundance outside the bay systems. Offshore catches peaked at sizes that are not commonly observed inshore.

From these length frequencies, it has been determined that young black drum approximately 20 cm (age 0-1) first appear in the inshore recreational fishery and experimental gill nets. One-year-old fish become fully recruited to the recreational fishery by the time they are two years of age (approximately 43 cm). By age 2, fish are unavailable to the near-shore, experimental gill nets, possibly due to gill net selection, but they begin to recruit to commercial gill nets at 40 to 50 cm. By the second and third year, they become decreasingly available to the recreational and inshore gill net fisheries, apparently gradually moving offshore.

At approximately age 4 (61 cm) fish were no longer available to the inshore gill net or recreational fisheries, but they were not immediately available to the offshore fisheries except for the offshore recreational fishery in Texas. Length frequency data for commercial catches showed that full recruitment of fish over 61 cm to haul seines, run-around gill nets, purse seines and gill nets catching larger fish,

increased gradually to about 75 cm (approximately 14 years of age) at which time they appeared to be fully recruited to these offshore gear. Age frequency data confirmed that catches peak at about 12 to 15 years of age for these same gears (Beckman et al. 1988).

The reasons why the intermediate ages, approximately 4-7, and corresponding sizes do not appear in offshore catches is unknown. Since many of the gear used to catch fish rely on their schooling behavior, it is possible that the degree, duration or frequency of schooling behavior may vary with age, and thus influence the availability of various age classes in the fishery. This hypothesis would be consistent with the occurrence of 4 and 5 year old fish almost exclusively in the offshore recreational fishery because this gear would not be as likely to target schooling black drum as offshore commercial gears.

Although the apparent absence of these age classes is of justifiable concern, the phenomenon is present in length frequency data dating back to 1976 (J. Shepard, personal communication), and is observable for virtually every gear and year for which data is available. A similar phenomenon has also been observed for red drum. Since the phenomenon occurs in virtually every year examined, and predates the 1979-1987 escalating period, it is assumed to be a natural state and not the result of a segment of the population having been depleted.

9.3.2 Growth Models

The von Bertalanffy and the Gompertz versions of a sloped asymptote model were used to evaluate the increasing size of black drum with age. As shown in Appendix Table 1, growth is rather rapid to approximately 60 cm (age 4) and then begins to slow. Growth continues throughout the life of the fish but at a much slower rate (approximately 20 cm/year [age 0-2] versus 1 cm/year after age 5).

9.3.3 Mortality Estimates

Mortality estimates were developed using two basic approaches. The first provided estimates of total mortality (Z) from the descending section of various age frequency databases. The second was a less direct approach to estimate natural mortality (M) from growth model parameters using the method of Alverson and Carney (1975). Fishing mortality (F) was calculated for various age groups using virtual population analysis (VPA).

9.3.3.1 Total Mortality Estimates

Estimates of total mortality were made using length frequency information (S. Russell, unpublished draft), and age frequency data (Beckman et al. 1988) for various gear. Three estimation procedures were applied to each database: (1) Beverton and Holt (1956) method; (2) Ssentongo and Larkin (1973) method; and (3) Slope method. Assumptions used in these estimations were the same as those of Pauly (1984). The results of these calculations are summarized in Table 9.1. (See Appendix 1 for further information regarding calculations.)

The results varied considerably between methods and between gears (Table 9.1). Based on these estimates, it is assumed that the Z value for fish over age 12 is 0.25. This is primarily based on gill net data from S. Russell (unpublished draft). Her information was used because it was the largest consistent sample available, and it was consistent between the various methods. Also, gill nets,

Table 9.1. Total mortality (Z) estimates from three methods applied to fish over 12 years of age for various gear from two data sources.

Gear	n	Beverton-Holt	Ssentongo	Slope	SE(slope)
Russell Commercial Samples					
Haul seine	702	0.085	0.109	0.271	0.0388
Purse seine	198	0.129	0.153	0.188	0.0265
Anchor gill net	3894	0.227	0.253	0.249	0.00879
Trawl	40	0.220	0.240	0.08	0.077
Run around gill	153	0.195	0.219	0.22	0.02
Beckman Aged Samples					
Haul seine	262	0.092	0.116	0.176	0.021
Purse seine	554	0.145	0.170	0.530	0.120
Gill net	356	0.154	0.179	0.292	0.062
Trawl	100	0.265	0.288	0.311	0.034

though deployed by various means, were probably the least selective gear. Data on other gears, particularly purse seines, were not used because these nets are set on schooling fishes and not all ages or sizes may school to an equal extent. Trawl samples were less selective for schooling fishes, and though sample sizes for trawls were much smaller, results for this gear were generally consistent with the results of gill nets. A final consideration was that other gears generally yielded lower mortality values; consequently, the 0.25 value is more conservative.

9.3.3.2 Natural Mortality Estimates

The approach used for estimating natural mortality (M) was basically the same approach given by Alverson and Carney (1975). This approach was based on the von Bertalanffy growth model, and was used in conjunction with an estimate of the maximum age. Table 9.2 shows the natural mortality values for 4 ages from 45 to 60, that cover the upper range given by Murphy and Taylor (1989), 50-60 years of age, and have a lower boundary similar to that of Beckman et al. (1988), 43 years of age.

Table 9.2. Estimates of the natural mortality (M) from the technique of Alverson and Carney (1975). (Values in the table are the growth value [k] from the von Bertalanffy growth model and the natural mortality estimate assuming various potential maximum age values.)

Source	k	Maximum Age 45	50	55	60
Doerzbacher et al. (1988)	0.219	0.0611	0.0454	0.034	0.025
Beckman et al. (1988)	0.0540	0.1938	0.1680	0.1471	0.1298
Murphy and Taylor (1989)	0.2783	0.0381	0.0265	0.0185	0.0130

These estimates were determined for three different fits of the von Bertalanffy model. Based on these calculations, the value of "M" was estimated at 0.15 using a maximum age of 55 years and the "k" value from Beckman et al. (1988). Murphy and Taylor (1989) observed the highest growth rates, and the oldest and largest specimens, but these fish were not collected in the Gulf of Mexico and may not be representative of the populations in the gulf. Much lower values for "k" were reported from tagging studies by Doerzbacher et al. (1988) and Murphy and Taylor (1989); however, data from Beckman et al. (1988) were used because of the study's sample size and validated aging techniques. Additionally, the "M" value chosen is the most conservative.

9.3.3.3 Terminal Fishing Mortality Estimate

Previous estimates of "Z" (0.25) and "M" (0.15) can be used to develop a terminal estimate of fishing mortality (F) for the oldest ages of black drum; however, the best estimates are derived from the VPA. These estimates of "F" for various age groups are discussed in Section 9.3.5.1.

9.3.4 Virtual Population Analysis (VPA)

The primary analysis used to develop the black drum stock assessment was (VPA). The particular version used for the calculations was given by Jones (1984). The data required for VPA analysis included the total recreational and commercial catches categorized by numbers in each age class. Total catches were available for gulf coast commercial (in pounds) and recreational (in numbers) fisheries from the NMFS, and these data were broken down into numbers per age class.

Length frequency data in 1 cm intervals for commercial catches were available from S. Russell (unpublished draft). TPWD (unpublished data) were the most extensive recreational length frequencies. Although Jones (1984) had developed a cohort analysis for doing VPA from length frequencies, age structure was available from Beckman et al. (1988). Length frequencies from S. Russell (unpublished draft) and TPWD (unpublished data) were converted to age for black drum under 60 cm (approximately age 4). The remaining commercial catch numbers were proportioned in accordance with the age distribution observed by Beckman et al. (1988).

The conversion of commercial samples to the expanded commercial catch involved several steps, since the sample numbers had to be converted to biomass, expanded to match the NMFS biomass, and then converted back to numbers for the VPA analysis. Once the recreational and commercial catches were aged and expanded to reflect NMFS catch statistics, VPA was undertaken.

9.3.5 Results of VPA Analysis

The two most important results of the VPA to an analysis of the black drum stocks are: (1) estimates of fishing mortality (F) for various age groups; and (2) calculations of spawning stock biomass (SSB) and spawning stock biomass per recruit (SSB/R).

9.3.5.1 Estimates of Fishing Mortality (F) by Age Groups

The F values were near 0.0 for age zero and increased quickly to 0.286 and 0.392 for ages one and two, respectively. The figures reflected the influence of the recreational fishery and the commercial gill net fisheries. The F values then declined to 0.131 (age three) and reached a minimum at age 4 through 7 (F=0.02 to

0.03). The F values gradually increased from age 8 (F=0.058) to age 14 where F values reached 0.201, and then started to level off. Most F values from age 14 to 20 ranged from approximately 0.2 to 0.3.

The F values continued to increase slightly to age 22 (0.420), and unusually high F values of 0.524, 0.503 and 0.565 were seen in 23 to 25-year-olds, respectively. Jones (1984) pointed out that the F estimates of the oldest fish are the poorest estimates, and that the estimates will converge on the real value as the estimates proceed from the oldest to the youngest fish. As a result, these older age groups may be poorly estimated. The very low F values for ages 4-7 are also puzzling. As previously discussed, for unknown reasons, these fish are seldom caught by either commercial or recreational gear.

Given Jones (1984) caution on estimates of the oldest ages, the best estimate of annual fishing mortality is determined to be an average of the 14 to 22-year-old fish. These are provided separately from the 23 to 25-year-old fish in Table 9.3.

Table 9.3. Mean fishing mortality (F) values for selected age ranges from VPA on years where horizontal estimates are available.

Age Group	Mean F Value By Year 1986	1987	1988	1989
Age 1-3	0.209	0.226	0.395	0.248
Age 4-7	0.039	0.028	0.029	0.008
Age 8-13	0.100	0.121	0.094	0.040
Age 14-22	0.285	0.343	0.351	0.168
Age 23-25	0.412	0.347	0.788	0.576

9.3.5.2 Spawning Stock Biomass (SSB) and Spawning Stock Biomass per Recruit (SSB/R)

The SSB at each age was calculated as the number in each age class, times the fraction that is mature, times the weight (calculated at the age median [age + 0.5]) of an individual. This total value can then be scaled by the original number of recruits as SSB/R (Gabriel et al. 1989).

Although actual maturation tables were not available, approximate age at maturity was determined to be 5 years. Consequently, it was assumed that no fish age 0 to 3 spawn, 33% of 4-year-olds spawn, 66% of 5-year-olds spawn, and 100% of fish over 5 years of age spawn. These assumptions were consistent with observations in the literature (Fitzhugh et al. 1987, Parker et al. 1988).

The annual SSB was the biomass of a stock for a given year under conditions of both fishing and natural mortality. To estimate annual SSB one must first

calculate SSB with only natural mortality. This was accomplished with the following three assumptions; however, it should be noted that these assumptions are probably not factual: (1) natural mortality was the same for all year classes over all years (M=.1471); and (2) since SSB serves as a proxy for egg biomass, it is assumed that "the ratio of eggs produced to grams of body weight is...constant over spawner size and age, and egg viability is also assumed to be independent of spawner age" (Gabriel et al. 1984). The VPA was used to estimate recruitment for the zero-year class. The SSB with only natural mortality was then calculated for each subsequent year class. The ratio of SSB with fishing and natural mortality to the SSB with only natural mortality is the percent of maximum spawning stock biomass that could be expected (had there been no fisheries) to be available to spawn that year. Table 9.4 shows the results of the SSB and SSB/R calculations for each year, 1986-1990. The pattern of recruitment used in these calculations closely matched actual monitoring data discussed in Section 9.3.6.

Table 9.4. Results of the SSB/R analysis.

	1986	1987	1988	1989	1990
Zero class (millions)	4.051	3.119	3.461	4.073	4.072
Total SSB (millions/Kg)	35.411	29.142	24.237	22.186	21.726
With fishing: SSB/R (Kg)	8.740	9.344	7.004	5.447	5.336
Without fishing: SSB/R (kg)	18.754	18.754	18.754	18.754	18.754
Percent of maximum	46.605	49.823	37.344	29.045	28.452

9.3.6 Recruitment

Recruitment was measured using monitoring data from Louisiana and Texas. Louisiana data included 23 years of trawl samples while Texas had from 13 to 16 years of trawl, seine and gill net samples. Only stations with 15 or more black drum captures were used. Results of recruitment analysis showed no statistical significance in increasing or decreasing trends.

9.3.7 Conclusions of the Stock Assessment

The SSB/R estimates indicate that as a result of the peak fishing years (1986 through 1988), the stock size fell from high values of nearly 50% to values slightly under 30% by 1990. Although the decline was substantial, significant reductions in landings have occurred since 1988, primarily as the result of reduced fishing pressure, and it is likely that stock levels have remained near the 30% level. If fishing effort increases, this value should be monitored in subsequent years as data become available.

Although fishery independent gill net samples from Texas showed possible decreases in fish over 30 inches TL length from 1980-1988, no substantial trend was noted. The only other evidence in the data of potential growth overfishing was the apparent decline in catches of large drum from the gill net samples in Louisiana. On analysis, this observation was apparently due to the exclusion of the Lake Pontchartrain bull drum fishery from the samples since 1988, and not a result of actual fishing pressure. It is, however, quite possible that if the higher 1986 to 1988 levels of catch had continued, growth overfishing would have been evident by 1990 or 1991. Apparently, management efforts since 1988 have averted this possibility. Without some measure of catch per effort or other relative measure of fish density, any evidence of growth overfishing would be difficult to detect, and it is not presently evident.

Monitoring programs in Louisiana and Texas reveal no decreasing trends in recruitment, and there is no evidence of recruitment overfishing. These programs have a sufficiently long time series to jointly determine if even a single year is extraordinarily low. Data from these programs should be closely monitored for indications of any change in recruitment levels in subsequent years.

9.4 Problems in the Fishery

Identification of problems within the black drum fishery of the gulf is in many ways subjective especially with regard to the impact of fishing. The commercial fishery in most states has a very short history. It grew rapidly from approximately 1979 to 1988, and few data are available to actually access the impact of this growth. The magnitude of the increase in catch over such a short time caused concern that initiated this FMP; however, as previously discussed, declining catches in 1989 through 1991 do not appear to be the result of fishing pressure and probably reflect a reduction in fishing effort.

Other problems involving habitat loss, enforceability of regulations and cooperative management are not subjective. One of the major problems is the paucity of data on the species and the fishery.

9.4.1 Increased Harvest of Spawning Stock

Commercial catches of black drum, particularly large adults, increased rapidly and extensively in the north central gulf from approximately 1979 to 1988 (Table 6.1). Although the rapidity and magnitude of these increases in catch were a concern, analyses in this plan have not substantiated it.

The overall commercial harvest of black drum began to rapidly increase around 1979 (Table 6.1). Initially, this increase targeted many size classes as fishermen and processors attempted to meet increasing demands for black drum. From 1985-1988, principally in Louisiana, harvest figures increased further partly because black drum were being substituted for red drum and because of shifts in fishing operations. A substantial portion of this increase resulted from catches of large, schooling adults. If harvest levels return to those of the mid to late 1980s and remain at such levels for an extended period, the spawning stock may be reduced to unacceptable levels.

9.4.2 Increased Harvest of Juveniles in Nearshore Waters

Juveniles and young adults also experienced increasing fishing pressure during most of the 1980s. This fact caused concern that a potential problem of recruit and/or growth overfishing was occurring. If so, concern for the overall well-being of the black drum stocks would be magnified when the increased harvest of adults, outlined in Section 9.4.1 is considered.

9.4.3 Limited Database for Management

The life history of black drum in the gulf is, in general, adequately described; however, data regarding population dynamics, necessary for management are seriously lacking. Catch per unit of effort data for both the commercial and recreational fisheries are lacking, and total effort data are virtually nonexistent. Also, other needed information on natural and fishing mortality, recruitment, fecundity, etc. are insufficient for accurate stock assessments and analysis of fishing impacts.

9.4.4 Habitat Reduction and Degradation

Marine fishery habitat has changed all across the northern Gulf of Mexico. Louisiana loses approximately 35 square miles of coastline per year. Thousands of acres of vegetated wetlands have been lost to natural and man-made influences. The most extensive changes have resulted from human activities in the coastal area. Filling, dredging, construction of levees and channelization are examples of man-induced modifications.

Natural changes have resulted from hurricanes, diversion of rivers, fluctuations in sea level and other phenomena. Changes resulting from natural fluctuations have usually occurred less frequently and over a longer period of time than man-induced changes.

How these changes have affected black drum populations is unknown. Most likely, overall populations have been reduced as a result of habitat alterations of which the most serious to larval and juvenile black drum has been loss of vegetated wetlands. These low salinity areas provide food and shelter during the highly sensitive early life stages.

Habitat changes have also resulted in the creation of greater amounts of shallow waterbottoms. These areas are primary habitat for black drum during juvenile and early adult stages. With increasing shallow-waterbottom habitat, survival at this stage would be expected to increase; however, the actual effect is unknown. Also, it is not known whether survival at early or later stages is most important to later recruitment to spawning, adult populations.

9.4.5 Inconsistent Interstate Management

States have adopted varying regulations to manage black drum including, but not limited to, bag limits, size limits and quotas for the commercial and recreational fisheries. These measures have been approved for a variety of reasons including area specific differences in black drum population structures and habitats, fishing pressure by sport and commercial fishermen, modes of fishing and socio-economic factors. Many of these measures were approved with little consideration of impacts

to interstate management or enforcement. This problem is compounded because most states lack statutory authority to enter into reciprocal management agreements with other states.

10.0 MANAGEMENT MEASURES

10.1 Fishing Year

States could establish a fishing year to assist in quota management, data collection or other purposes.

10.2 Catch Limitations

Catch limitations may be established by a quota or by setting daily bag and possession limits. Quota systems are only effective when reporting systems accurately audit the amount caught. Bag and possession limit systems attempt to extend fishing over an entire fishing year and to provide more equitable fishing opportunities for more fishermen.

10.2.1 Commercial Limitations

10.2.1.1 Allowable Biological Catch (ABC) and Total Allowable Catch (TAC)

The GSMFC, S-FFMC could direct the TCC or a subcommittee thereof to periodically provide a stock assessment for black drum in the U.S. gulf. This assessment could include ranges of ABC for the entire region as well as other relevant concerns of the fishery. The S-FFMC could then recommend a commercial quota or TAC recommendation for the five Gulf States either individually or collectively. The quota or TAC could be implemented singularly as one established harvest level for the fishing year, or by trip limits or subquotas such as individual transferable quotas (ITQs). Combinations of these systems are also possible.

10.2.1.2 Size Restrictions

States could establish minimum and maximum size limits for black drum with consideration of no tolerance for undersized or oversized fish. Such size restrictions should consider biological needs for stock recruitment as well as the social and economic needs of the users. Uniform size criteria would increase enforceability of such regulations especially with regard to interstate transport of catch.

10.2.2 Recreational Limitations

10.2.2.1 Bag and Possession Limits

States could establish uniform bag and/or possession limits for black drum. These limits could be developed by the S-FFMC when it reviews stock assessment data as directed in Section 10.2.1.1. Such bag limits should consider the biological needs of the fishery as well as social and economic factors. Daily bag and possession limits are effective means of distributing catch among a large group of fishermen over a longer period of time. They are most effective when effort is greater than that needed to catch the available supply in a given time period.

10.2.2.2 Size Restrictions

States could establish minimum and maximum size restrictions on black drum for recreational fishermen consistent with commercial limitations with no provisions for tolerance.

10.3 Gear Restrictions

Most states currently have regulations regarding gear used to catch black drum. States could review existing regulations considering current and future stock assessments to determine the adequacy of restrictions to meet management goals. States could also develop more uniform gear-use regulations in the process.

Gear restrictions are perhaps the most effective and widely used methods to control harvests of finfish including black drum; however, they generally reduce harvesting efficiency. They range from total prohibition of some gear to limits of nets' mesh size, length and other parameters. Gear use may also be restricted spatially and seasonally. Restricting gear usage can effectively regulate the size and amount of fish harvested.

10.4 Area and Seasonal Closures

Prohibiting harvest of black drum from certain areas and during certain seasons could help regulate harvests. Area closures could be used to protect schools where they are known to congregate annually. Also, closures of nursery areas where juveniles are abundant could help increase recruitment to adult populations.

Seasonal closures might also be used to protect adults during peak spawning periods or to preclude harvest once quotas or TACs are reached.

10.5 Limited Access Considerations

States could evaluate the need for limiting access to the black drum fishery in the gulf. States could also review the various forms of limited access and the procedures for their implementation should a need be determined. With the exception of Texas, the commercial black drum fishery in the gulf is relatively new, and the number of participants are relatively few. Consequently, a limited access program might be implemented with the least impact to users and traditional fishing patterns.

10.6 Habitat Management Program

States could pursue development of a habitat management program and include habitat that is critical for black drum. This program might include multi-agency involvement at the state and federal level. Many habitat protection efforts are ongoing; however, a more focused and coordinated effort directed at marine fisheries habitat could provide increased protection and production in a shorter period of time.

10.6.1 Marine Debris Projects

States could increase their involvement with marine debris programs, especially those directed at educating the general public about the effects of debris on fishery resources. A collective and coordinated effort by all five Gulf States could help increase solidarity and credibility of the projects. Programs might also address efforts to ameliorate or eliminate ghost fishing by lost and abandoned traps, nets and other gear.

10.6.2 Destruction of Habitat and Water Pollution

States could increase their efforts to contest activities that have potential to degrade or destroy marine fisheries habitat. Black drum spend most of their lives in nearshore, estuarine areas that have been negatively impacted by both natural and man-induced changes. States could develop more specific programs to review coastal development proposals including but not limited to dredging, filling, channelization, construction of levees and other construction. Appropriate action could then be taken to support projects that enhance critical habitat and fight implementation of those that would further degrade estuarine habitat.

10.7 Data Reporting Requirements

10.7.1 Catch Reporting

States could increase their efforts to collect data on the catch of black drum. The Cooperative Statistics Program and the Marine Recreational Fisheries Statistics Survey (MRFSS) have been the primary programs utilized by states to gather data on the harvest of black drum. States could work in conjunction with these programs to expand data collection efforts and establish uniform collection programs to more specifically identify black drum as a target species. States could review existing requirements for reporting of data by harvesters, dealers, processors and others. Where such reporting is determined to be inadequate, modifications to laws, regulations and policies could be sought to improve the quantity and quality of data received. Simplification of reporting forms, as well as reducing the number and frequency of reports could enhance the quality and accuracy of data leading to better management.

10.7.2 Effort Reporting

States could increase efforts to gather information on the effort expended by both commercial and recreational fishermen toward the catching of black drum. Commercial fishermen targeting black drum could be more specifically identified in order to monitor their catches. This could be accomplished by special black drum permits or by increased monitoring of individual catches through an expanded statistics collection program that would include more individual trip information. Recreational effort could also be more accurately determined through recreational licensing in some states and by expanded creel surveys. States could review existing programs and procedures for collecting recreational effort data and implement changes where needed.

10.8 Cooperative Management Program

Cooperative management or co-management of marine resources is an effective way to increase the reliability of data, decrease enforcement costs, increase sustainability of the fishery and improve the relationship between users and regulators (Pinkerton 1989, Troadec 1989). Cooperative management requires the incorporation of social and economic data in a proactive format, and gives more responsibility to user groups to maintain the viability of fishery stocks.

Implementation of co-management involves changing the attitudes and approaches of users and regulators. Implementation of co-management is easiest when instituted as pilot projects with select populations of users. Since the black drum fishery encompasses a relatively small select user group, it could be ideal as

an experimental opportunity for co-management. Social conditions for co-management have been detailed (see Section 14.3.6, Berrigan et al. 1991).

10.9 Measures to Support Management

States could review the current level of management effort in conjunction with the level of support being received for management of black drum to determine if support is adequate to meet the needs of resource management. If support is determined to be inadequate, states could pursue increased license fees, inspection fees or other support from users. Additionally, states could seek additional support from state and federal funding sources while reviewing management needs and priorities of other species and fisheries.

11.0 MANAGEMENT RECOMMENDATIONS

Although the stock assessment reveals declines in the spawning stock biomass per recruit ratio during the period 1986-1990, there is at present no clear evidence of growth or recruitment overfishing. Due to inadequacies of data used in the stock assessment as previously described, caution should be used when applying conclusions from the assessment to make management recommendations on a gulf-wide basis.

SSB/R estimates from the stock assessment declined to between 20%-30% in 1990 following peak fishing years (1986-1988); however, no evidence of overfishing was observed. Consequently, this level should be acceptable to maintain healthy stocks. States should review existing regulations and assess their ability to maintain an acceptable conservation standard that is equivalent at minimum to a 20% SSB/R ratio.

Localized differences in fishing effort by recreational and commercial fishermen may affect harvests in given areas. Based on these observations, states should consider modifications to regulations including but not limited to size limits, bag limits and quotas to effectively manage the fishery for the greatest benefit to the users. The following additional management recommendations are made:

11.1 Fishing Year

No particular fishing year is identified for black drum in the U.S. Gulf of Mexico; however, it is recommended that the individual states establish a fishing year when necessary to assist in quota management, data collection or other purposes. States should work cooperatively to implement consistent fishing years where possible.

11.2 Catch Limitations

It is recommended that the S-FFMC continue to monitor stocks and direct stock assessment revisions when appropriate to address any future problems or potential problems from fishing effort.

11.2.1 Commercial Limitations

11.2.1.1 Allowable Biological Catch and Total Allowable Catch

Based on the current gulf-wide knowledge of black drum stocks, neither an allowable biological catch (ABC) nor a total allowable catch (TAC) is recommended at this time for the black drum fishery of the U.S. Gulf of Mexico.

11.2.1.2 Size Restrictions

Presently three states have implemented commercial size limits for drum: (Louisiana-16" TL minimum, 27" TL maximum [special permit is required to take drum over 27"]; Florida-14" TL minimum, 24" TL maximum; and Texas-14" TL minimum, 30" TL maximum). These restrictions reflect a biologically conservative management philosophy while considering that black drum under 14" TL are less desirable in the commercial fishery. The presence of a size limit may also increase yield per recruit. Based on these considerations, it is recommended that states consider adoption of minimum size restrictions for the commercial black drum fishery of the U.S. Gulf of Mexico. States should work cooperatively to implement consistent commercial size restrictions where possible.

11.2.1.3 Commercial Quotas

Individual states should assess black drum populations to determine if quotas are needed.

11.2.2 Recreational Limitations

11.2.2.1 Bag and Possession Limits

States should assess the present level of fishing pressure on black drum stocks to determine if bag or possession limits are needed. The S-FFMC should monitor this fishery, and if future stock assessments indicate the need for restricted harvests, the recreational fishery should be appropriately restricted by a per-person possession limit while on the water or at any point of landing or dockage.

11.2.2.2 Size Restrictions

Presently three states have implemented minimum and maximum recreational size limits for black drum (Louisiana - 16" TL minimum, 27" TL maximum; Florida - 14"TL minimum, 24"TL maximum; and Texas - 14"TL minimum, 30" TL maximum. Louisiana and Florida allow fishermen to take one fish per person per day over the maximum size, but Texas does not. States should assess the present level of fishing pressure on black drum stocks to determine if size restrictions are needed and appropriate. States should work cooperatively to implement consistent recreational size restrictions where possible. Because there is currently a very low interest in black drum by recreational fishermen in the gulf, no gulf-wide size limits are recommended.

11.2.3 Sale and Landing

It is recommended that only licensed commercial fishermen be allowed to sell black drum. It is further recommended that both commercially and recreationally caught black drum be maintained with heads, tails and flesh naturally attached during all fishing activities up to and including the point of landing. These provisions are recommended to enhance enforcement of size and bag restrictions and for species identification.

11.3 Gear Regulations

It is recommended that no prohibitions be placed on the specific types of gear currently being used to harvest black drum. States should, however, evaluate the impacts including, but not limited to, bycatch of other species that are under more restrictive management programs by various gear and enact appropriate regulations to prevent unacceptable mortalities.

The use of certain gear may also conflict with other water-related and near-shore activities. The use of piers, bridges, bulkheads, jetties, beaches, channels and other structures may be restricted by the placement of certain gears in or around these areas. Individual states should use their authority to regulate the type and placement of gear based on public safety and public interest in such areas.

11.4 Area and Seasonal Closures

Based on the stock assessment, it is recommended that no area or seasonal closures be implemented for the specific purpose of regulating the harvest of black drum. Area and seasonal closures have been implemented to restrict the uses of certain nonspecific gear, to prevent water-related user conflicts and to conserve other fishery stocks in need of such measures. These restrictions have also affected the harvest of black drum. If future stock assessments or additional life history information indicate the need to close certain areas or seasons (e.g., for spawning), states should take appropriate action to implement conservation measures.

11.5 Monitoring

States should continue efforts to monitor black drum populations and increase or modify programs to meet additional data needs.

11.6 Management Programs

States should review management programs to determine if they are accomplishing specific objectives or addressing identified problems. They should also attempt to utilize management measures that address such needs with the least adverse impacts to users.

12.0 RESEARCH AND DATA NEEDS

Research and data needs of the black drum fishery encompass a wide range of biological, social, economic and environmental studies. Because black drum are relatively unimportant to commercial and recreational fishermen, little effort has been expended to understand its life history and habitat requirements. Additional research and data collection programs are needed, and the following is a partial list of some of the more important needs.

12.1 Biological

1. Collect additional age frequency data to better understand the age structure of stocks and possibly identify previously "lost" groups such as the 4-7-year-old fish mentioned in Section 10.3.

2. Enhance estimates of natural mortality and predation especially on early life stages.

3. Assess depredation potential of black drum on natural and man-made oyster reefs.

4. Expand mark/recapture studies.

5. Increase intercept studies to determine the nature and size of catches as well as effort.

6. Utilize aerial surveys to help monitor black drum populations.

12.2 Environmental

1. Determine optimum environmental requirements especially on early life stages.

2. Assess the effects of flooding and periods of high salinity on reproduction and survival.

3. Determine how the loss of vegetated wetlands and the increase in shallow waterbottom habitat have affected black drum populations.

12.3 Industrial/Technological

1. Identify existing processing and marketing activities for black drum and evaluate alternative methods.

12.4 Economic and Social

1. Determine economic and social impacts of various management options.

12.5 Resource Management

1. Reevaluate existing management programs to determine their effectiveness in meeting management goals and objectives and solving problems.

13.0 REVIEW AND MONITORING OF THE PLAN

13.1 Review

The State-Federal Fisheries Management Committee (S-FFMC) of the Gulf States Marine Fisheries Commission (GSMFC) will review, as needed, the status of the stock, condition of the fishery and habitat, the effectiveness of management regulations and research efforts. Results of this review will be presented to the GSMFC for approval and recommendation to the management authorities in the Gulf States.

13.2 Monitoring

The GSMFC, NMFS, states and universities should document their efforts at plan implementation and review these with the S-FFMC.

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15.0 APPENDIX

Assessment of the status of black drum stock on the Gulf Coast

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Executive Summary

The black drum is a complex species from a management perspective. At about age one they recruit to the sport fishery, and to some commercial fisheries shortly thereafter. After age two the catches by sport and commercial fishermen decline rapidly to age four, and few fish age five or six are caught. The species then gradually recruits to other commercial fisheries through age 10 or 12, and then gradually diminishes in the catches over age 30.

As black drum recruit to various fisheries, they appeal to different markets. As 1 to 2 pound "puppy drum" the fish are sold fresh with limited popularity. As 3 to 10 pound medium sized fish, they are sold fresh, and as over 10 pound "bull drum" they are sold mostly as fillets. Commercial fisheries use a wide variety of gears, and these are implemented in a number of different ways to target the various sizes.

The complexity of the species' life history, the various fishery components, and the varying marketability of the different sizes makes the species somewhat difficult to study. There are also some uncertainties in the life history, particularly, why so few fish of the ages 4 to 7 are caught.

Fishing pressure on black drum stocks in the late 1980's exceeded historic levels, and became a cause for concern. However, estimates of fishing mortality (F) indicate that mortality has fallen from the 1987 and 1988 peak years to 1989 levels which are similar to those of 1986. Commercial catch fell in 1989 to levels similar to those of the early 1980's, and recreational catch fell to unprecedented low levels in 1989 and 1990. One probable explanation for the decreasing catches is reduced fishing pressure by both recreational and commercial fishermen as a result of management efforts implemented by state agencies.

The best evidence available at present indicates that the natural mortality (M) of the species is about 0.15. Other estimates of M are lower than this value, and seem biologically reasonable in view of the longevity of the species.

One important indication that the black drum stocks have not been excessively fished is the continued recruitment levels observed by various monitoring programs. Recruitment levels in 1989 and 1990 appear to be well within the average range of values observed over the last 10 to 25 years.

A major limitation to utilizing the existing databases is that the black drum cannot be viewed as a single fishery; it must be viewed as at least two fisheries, an inshore fishery for fish under 10 pounds, and an offshore fishery for bull drum over 10 pounds. Future data collection, particularly of gill net catches, must distinguish between effort directed at smaller drum (under 10 pounds) and that directed at the larger bull drum.

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Introduction

Traditionally, the black drum has not been one of the more popular fishes sought by commercial or recreational fishermen along the Gulf coast. It is not usually specified as a targeted species by recreational fishermen, but considerable numbers are taken and kept by anglers targeting other fishes. Gulf-wide recreational catches have been generally stable since 1981 (Fig. 1) at around 1 million fish, but declined in 1989 and 1990 to half that level.

Gulf-wide commercial catches of black drum were generally under 2 million pounds until the late 1970's when catches increased dramatically (Fig. 2). The first increases to about 6 million pounds resulted from developing purse seine and trawl fisheries in north-central Gulf waters during the late 70's. An additional increase in the mid 1980s resulted from black drum's acceptance as a cheaper substitute for "blackened redfish" (Russell 1989). When redfish stocks were limited by quotas and eventually closed, total landings of black drum rose to over 10 million pounds in 1987 and 1988. Later demand declined and catches of black drum fell to under 6 million pounds in 1989, and subsequently maintained this lower level.

Our objective was to prepare an assessment of the present state of the stock of black drum on the Gulf coast. The available data for this task consist primarily of catch records and length frequencies for various gears. As a result, our estimates of mortalities are based primarily on disappearance rates of age frequencies that were estimated from size-frequency data using known growth equations. Although there are several published articles on various aspects of the population dynamics of the species, the black drum stock in the Gulf has not been assessed. We also discuss a number of questionable and debatable aspects of the species life history, behavior, and population dynamics.

The fishery

The black drum is a relatively long lived species, which apparently goes through a series of movements and behavioral changes that result in not all ages being equally available to the fishery; therefore, we initiate our assessment of the fishery with a discussion of gear selection and an examination of the available length frequency data. We attempt to develop an understanding of the availability of the species over its life span, and use the available information to develop a working hypothesis of the species' behavior and population dynamics.

The commercial fishery does not consist of a single category of gear targeting a single size group of fish. Commercial dealers recognize at least three distinct categories of black drum, and pay different prices on each (Russell 1989). Not only do the types of gears used to target these size classes differ, but a single gear may be applied in different ways to target different sizes of black drum. For example, one of the most effective gears for black drum is the gill net. Gill nets, generally anchored, are used in inshore waters primarily to catch the smaller and intermediate size black drum, up to about 10 pounds. This size is the most desirable for commercial purposes, and brings the highest price.

Gill nets can also be used to surround and capture schools of larger "bull drum" (over 10 pounds). These larger drum are not generally available inshore except seasonally in particular areas, such as Lake Pontchartrain (H. Pierce and J. Black, pers com). This application of gill nets is best viewed as a separate fishery, operating on a different sized class of fish than most other gill net applications. In the past this capture method was enhanced by the use of spotter aircraft, but this practice is no longer legal in Louisiana.

Other major capture methods include purse seines, trawls, trotlines and haul seines. Methods applied primarily offshore, such as purse seines, almost exclusively target the larger bull drum (over 10 pounds). Many gears, like the gill nets, can be used to target smaller or larger black drum, depending on where and how they are fished. When these gears are sampled, they are categorized by general type, and no distinction is made for the particular application and size of drum targeted. As a result, the length frequencies for many gears show a clear dichotomy, with a mix of sizes in the under and over 10 pound sized group.

Length and age frequency data

One of the more unique databases available is a series of aged fish taken by D. Beckman and C. Wilson of LSU (Figs 3a and 3b). Figure 3b shows four years of purse seine (1987-1990) and two years of trawl data (1987 and 1988). Unlike length frequency data, this aged data shows the periodic strong cohorts that appear to

dominate the samples. The 1987 purse seine data clearly shows strong cohorts at ages 8, 13 and 17 that can be readily followed through the subsequent three years of length frequencies (Figure 3a & 3b). There are fewer sampled fish available for trawls, but some of the same strong cohorts are visible. Figure 3a shows age frequencies for haul seines and gill nets. The periodic strong cohorts are also clearly in evidence for these gears as well.

Contrasting figures 3a and 3b, it is apparent that for trawls and purse seines, fishes under 4 years of age are not common; however, for gill nets and haul seines fish of age 1 to 3 are not uncommon. Dr. Beckman indicated, during meetings of a stock assessment subcommittee examining black drum, that catches of individual nets were frequently dominated by a relatively narrow range of ages, particularly for catches of young fish. Noncommercial fishing from 1986 to 1990 by Louisiana Wildlife and Fisheries, using trammel nets and experimental gill nets in near shore waters, also clearly demonstrates the ability of these gears to select for smaller sizes (Fig 4).

One of the largest databases, that also shows a clear dichotomy between the larger and smaller sizes of black drum, is made available by Sandy Russell of LSU (Figs 5a & 5b). This database consists of length frequencies of commercial catches in Louisiana. Gill net data is available from 1985 through 1991, and data for "run around" gill nets (fished by circling schools of fish) is available for 1989 (Fig 5a). Most years of data show a relatively low abundance at approximately 60 cm, a size approximately equivalent to 4 years of age.

Since about 1988 smaller sizes have come to dominate the gill net catches (Fig 5a). This is probably due in part to the targeting of smaller sizes as a replacement for redfish, and also to reduced catches of bull drum in gill nets as a result of management efforts, particularly the prohibition of spotter aircraft since 1990. Another factor is that sampling efforts have shifted west of the Mississippi River delta as the fishery there intensified, and the bull drum fishery in Lake Pontchartrain is no longer included in the samples. In 1991 the bull drum did not remain in Lake Pontchartrain after unusually heavy spring rains resulted in generally lower salinities in the lake area (H. Pierce and J. Black, pers. com).

From the same data source, figure 5b shows haul seine data from 1986 through 1990, purse seine data for 1986 and 1988 and trawl data for 1989 and 1990. The purse seine obviously targets larger sizes, while the trawls and haul seines are more likely to show a dichotomy similar to the gill nets.

Another unique length frequency database is available for the Texas recreational fishery. This database clearly shows (Fig. 6 for the inshore fishery only) the inshore

recreational fishery to be directed primarily at the smaller sizes, and also shows diminishing catches to approximately 60 cm. This database is available for inshore and offshore (outside of embayments) catches, and is graphed in Figure 7. This figure shows that as the catches of fish greater than 40 cm decline inshore, catches of those sizes increase in relative abundance outside the bay systems, with catches peaking at sizes that are not commonly observed inshore.

From these length frequencies, as well as discussions with other investigators, we have formulated a concept of black drum dynamics, that we present here as a working hypothesis. The youngest black drum, just under one year of age at 20 cm (see Appendix Table 1 for age to size and weight conversion tables) first show up inshore and are captured in the recreational fishery and in experimental gill nets. One-year-old fish gradually become fully recruited to the recreational fishery by the time they are two years of age (approximately 43 cm), and then to commercial gill nets at age two (40 to 50 cm). By age two the fish are unavailable to the near shore experimental gill nets, possibly due to gill net selection. As the fish grow into their second and third year, they become decreasingly available to the recreational and inshore gill-net fishery, apparently gradually moving offshore.

By age 4 (61 cm) the fish are no longer available to the inshore gill-net or recreational fishery. However, the sizes of fish that diminish in abundance in the inshore fishery do not become immediately available to other gears, except for the recreational fishery outside embayments (Figure 7). Osburn and Matlock (1984) also conclude that large drum [over 4 years of age] appear principally in Gulf waters outside of embayments.

The length frequency data for commercial catch (Figs 5a & 5b) show that full recruitment of fish over 61 cm to haul seines, run-around gill nets, purse seines and gill nets catching larger fish, increased gradually to about 75 cm (approximately 14 years of age) at which time they appear to be fully recruited to the gear. The aged database (Figs 3a & 3b) confirms that catches peak at about 12 to 15 years of age for these same gears.

We do not know the mechanism that prevents the intermediate ages and sizes from appearing in the catches. Since many of the gears applied to larger fish rely on schooling fish, we suspect that the degree, duration or frequency of schooling behavior may vary with age, and thus influence the availability of various age classes in the fishery. This hypothesis would be consistent with the occurrence of 4 and 5 year old fish almost exclusively in the offshore recreational fishery, as this gear would not be as likely to target schooling black drum as offshore commercial gears.

The apparent missing fish, at 4 years of age, have caused some justifiable concern among investigators; however, the phenomenon is present in length frequency data dating back at least to 1976 (J. Shepard, pers com), and is observable for virtually every gear and year for which data is available. A similar phenomenon has also been observed for red drum, and has been attributed to stock depletion. However, since the phenomenon occurs in virtually every year examined, and predates years where overfishing is a concern, we will assume that it is a natural state and not the result of a segment of the population having been depleted.

Methods

Length and Weight conversions

In a number of cases it has been necessary to convert data from fork length to total length. The difference between the two lengths are minor for black drum, less than 3 percent. However, conversions were used to retain as much accuracy as possible in estimates. There were two equations available for conversion, a linear equation from Murphy and Taylor (1989), and a log-log model derived from Beckman (1988). These equations are;

linear	$TL = -3.8 + 1.03\ FL$
logarithmic	$TL = 0.03743*FL^{1.0265}$

We have used the linear equation for most of our conversions.

It was also necessary to convert data in length categories from number of fish to total biomass. The equation used was fitted to 3107 fish sampled by D. Beckman and C. Wilson. The formula used, (converting fork length in mm to weight in grams), was

$$Wt = 0.00001274*FL^{3.03637}$$

Growth

Growth models were available from various sources and were used in a number of calculations (Table 1). The sloped-asymptote model (Geaghan, Beckman and Wilson, in prep) was devised particularly to fit black and red drum. It was fitted to 2660 aged black drum observations taken by Dan Beckman, and fit significantly better than any other model examined (Figure 8). Two versions of a sloped asymptote model were fit

Table 1. Growth models for Black drum.

Source	k	t_0	L_∞
Doerzbacher et al (1988)	0.219		798
Beckman et al (1988)			
immature	0.0884	-1.140	1745
mature	0.0110	-36.68	1745
all ages	0.0540	-12.6	988.8
Sloped asymptote (SA) model	0.6226	0.1229	610+9.959*Age
SA model on Florida data	0.23	-1.617	888+5.50*Age
Murphy and Taylor (1989)	0.124±.003	-1.29±.08	1172±9

to the data. These were the von Bertalanffy

$$L_t = (b_0 + b_1)\,(1 - e^{-k(t - t_0)})$$

and the Gompertz

$$L_t = L_0 e^{(b_0 + b_1)e^{-kt}}$$

The Gompertz model fit significantly better than the von Bertalanffy, and has been employed in this study. A table of ages by 1 cm size classes, calculated by iteratively solving the Gompertz equation for each size, is given in Appendix Table 1.

We should note that a study in Florida (Murphy and Taylor, 1989) does not show as strong an indication of sustained growth as the Louisiana black drum (Figure 8), and is adequately fit by a traditional von Bertalanffy model. Most of the data we had to age from lengths was, however, from the Louisiana-Texas area, and we have used a Gompertz model with a sloped asymptote fit to Dan Beckman's data for this aging.

Estimates of mortality

We have examined a number of techniques to obtain mortality estimates, and two basic approaches have been used. The first provides estimates of total mortality (Z) from the descending section of various age frequency databases. The second is a less direct approach to estimate natural mortality (M) from growth model parameters using the method of Alverson and Carney (1975).

Estimates of total mortality were made using length frequency (S. Russell database), and age frequency data (D. Beckman database). Three estimation procedures were applied to each database.

1) Total mortality : Beverton and Holt method
In their calculation of total mortality (Z), Beverton and Holt (1956, equation 4) use the asymptotic length at age (L_∞), mean length for fish fully recruited to a gear (L_m), initial length at which the fish is fully recruited to the gear (L_o) and the von Bertalanffy growth coefficient (K). Their equation is given as:

$$Z = K(L_\infty - L_m)/(L_m - L_o)$$

and the results of applications to the black drum are given in Table 2. Although the sloped asymptote model, discussed under growth models above, provides a superior fit and was used where possible, the von Bertalanffy parameter estimates for this analysis were fit to the traditional von Bertalanffy model.

Table 2. Total mortality (Z) estimates from three methods applied fish over 12 years of age for various gears from two data sources.

Russell commercial samples

Gear	n	Beverton-Holt	Ssentongo	Slope	SE(slope)
Haul Seine	702	0.085	0.109	0.271	0.0388
Purse Seine	198	0.129	0.153	0.188	0.0265
Anchor Gill net	3894	0.227	0.253	**0.249**	**0.00879**
Trawl	40	0.220	0.240	0.08	0.077
Run around gill	153	0.195	0.219	0.22	0.02

Beckman aged samples

Gear	n	Beverton-Holt	Ssentongo	Slope	SE(slope)
Haul Seine	262	0.092	0.116	0.176	0.021
Purse Seine	554	0.145	0.170	0.530	0.120
Gill net	356	0.154	0.179	0.292	0.062
Trawl	100	0.265	0.288	0.311	0.034

2) Total mortality : Ssentongo and Larkin method
Ssentongo and Larkin (1973, equation 20) can be rewritten as:

$$Z = [(n*K)/(n+1)]*\ln[(L_\infty - Lo)/(L_\infty - L_m)]$$

where n is the number of fish sampled that have been fully recruited to the fishery, and the other variables have the same definition as above. The results of their method to the black drum are also given in Table 2.

3) Total mortality : Slope method
This method provides an estimate of the instantaneous total disappearance or mortality rate (Z) as the slope of the log abundances of the age groups for those fish that are fully recruited to the gear. This method has the advantage that a standard error for the slope (which is the instantaneous total mortality estimate) can be estimated.

Using age data, or fish aged by applying the sloped asymptote model as a conversion from lengths, this method follows from the relationship:

$$N_t = N_o \exp(-Zt)$$

taking logs:

$$\text{Log}(N_t) = \text{Log}(N_o) - Zt$$

These approaches to estimating total mortality require some assumptions, summarized by Pauly (1983). He states that the assumptions are: "(1) Z is the same in all groups used in the plot; (2) all age groups used in the plot were recruited with the same abundance (or the recruitment fluctuations have been small and of random character); (3) all age groups used in the plot are equally vulnerable to the gear used for sampling; and (4) the sample used is large enough and covers enough age groups to effectively represent the average population structure over the period of time considered."

The results of the mortality calculation methods summarized in Table 2 varied considerably between methods and between gears. Based on these estimates, we assume that the Z value for fish over age 12 is 0.25. We settled on this value primarily by studying the gill net values from Sandy Russell's data set. First, this information was used because it was the largest consistent sample available, and it was consistent between the various methods. Second, it seems likely that the gill nets, though deployed by various means, would be the least selective gear. Other gears, particularly the purse seines, were not used because these nets are set on schooling fishes and not all ages or sizes may school to an equal extent. Trawl samples would be less selective for schooling fishes, and though sample sizes for trawls are much smaller, results for this gear were generally consistent with the results of gill nets. A final consideration is that the other gears generally gave results that were lower than the gill nets, so our choice of the higher F values calculated from the gill-net samples provides a more conservative approach.

Natural mortality estimates

The approach used for estimating M is based on an approach given by Alverson and Carney (1975). This approach is based on the von Bertalanffy growth model, and is used in conjunction with an estimate of the maximum age. Murphy and Taylor (1989) give the maximum age of black drum as 50 to 60 years of age. The oldest fish found by Beckman (1988) was 43 years of age, but the Louisiana stocks have been more heavily fished than other areas, and as a result the oldest fish are likely to be absent. We calculated the natural mortality for 4 ages from 45 to 60, which covers the range given by Murphy and Taylor, and has a lower bound similar to Beckman et al's (1988) oldest fish.

Table 3. Estimates of the natural mortality (M) from the technique of Alverson & Carney. Values in the table are the growth value (k) from the von Bertalanffy growth model and the natural mortality estimate assuming various potential maximum age values.

		Maximum age			
Source	k	45	50	55	60
Doerzbacher et al	0.219	0.0611	0.0454	0.034	0.025
Beckman et al	0.0540	0.1938	0.1680	**0.1471**	0.1298
Murphy and Taylor	0.2783	0.0381	0.0265	0.0185	0.0130

These estimates were determined for three different fits of the von Bertalanffy model. Murphy and Taylor (1989) observed the highest growth rates, and the oldest and largest specimens, but these fish were not collected in the Gulf of Mexico and may not be representative of the populations in the Gulf. We chose a maximum age of 55, and decided on the k value from the Beckman et al (1988) because of the study's sample size and the validated aging techniques used. Much lower values for k were reported by Doerzbacher et al's (1988) tagging study and Murphy and Taylor's (1989) study suggesting that M may actually be lower than the value we use.

The estimated Z value for older fish was 0.25, and the estimated M value was 0.15. This translates to an F value of 0.10, and this value was used in subsequent analyses as the terminal F value, the fishing mortality for the oldest ages.

Stock Assessment approach

The analysis presented in this report is primarily Virtual Population Analysis (VPA). The particular version used for the calculations was given by Jones (1984). With the data available, this seemed to be the most appropriate approach. VPA was done both "vertically" and "horizontally". The vertical analysis was done within a single year, with both cohort reductions and population magnitude being calculated from the

previous age group with an assumption of a stable age structure. This assumption did not fit well for the black drum because of the great cohort variation and shifting fishing practices in recent years.

The horizontal cohort analysis was done, where possible, with the calculations based on a true cohort, back calculating to a previous year. Since 1990 was the most recent year of available data, cohort reductions were back calculated for 1989, 1988, 1987 and 1986. Theoretically, calculations were expected to improve as we moved further back in time and as we obtained more years of data. Since 5 years of data were available, and 26 cohorts were included in the calculations, a vertical cohort analysis for 1990 was included as part of the horizontal analysis to obtain the population magnitude for calculations of fishing mortalities. Age structure was available for 1990, but the total catch was not, so the total catch was assumed to be equal to the 1989 level.

Virtual Population Analysis (VPA) calculations

In order to do VPA we required that the total recreational and commercial catches be known, and that they be categorized by numbers in each age class. Total catches were available for Gulf coast commercial (in pounds) and recreational (in numbers) fisheries from the National Marine Fisheries Service (NMFS). Most of our efforts were directed at breaking these values down into numbers per age class.

The calculations were done in the following sequence. S. Russell's length frequencies (Fig 5a and 5b) in 1 cm intervals were judged to be the most complete commercial length frequencies available, and data from Texas (Fig 6) were the most extensive recreational length frequencies. Although Jones (1984) had developed a Cohort Analysis for doing VPA from length frequencies, age structure was available from Dr. D. Beckman's work. We therefore chose the following approach based on ages:

> The yearly Texas recreational length frequencies were "aged" from the length frequencies (using Appendix Table I conversions). This led to some inaccuracies, and smoothed the highly variable cohort strength obvious in Dan Beckman's aged data; however, we felt that small sizes (under age 4) could be aged quite well from lengths, while the smoothing effect of aging fish over age 4 from lengths would be excessive. We did, as mentioned, age the recreational fishery from lengths, so some smoothing is present; the recreational fishery consisted primarily of smaller fish and was responsible for a smaller fraction of the total landings than the commercial fishery, so the effect of smoothing was less.

Sandy Russell's database was expanded so that yearly numbers represented the Gulfwide commercial catch. The lengths were "aged" for the first 3 years only. The remaining commercial catch numbers were proportioned in accordance with the age distribution observed in Dan Beckman's aged data. This retains some of the cohort variability actually present in the data.

We felt that the aged data best represented the cohort strength present in the commercial catch; however, the objective of collecting the aged database was not to obtain a representative sample of the fishery, but rather to obtain a wide range of lengths. As a result, the gears targeting smaller fish (under 3 years of age) appeared to be under-represented. For this reason, the first three age classes were aged from lengths.

The conversion of commercial samples to the expanded commercial catch involved several steps, since the sample numbers had to be converted to biomass, expanded to match the NMFS biomass, and then converted back to numbers for the VPA analysis.

Once the recreational and commercial catches were aged and expanded to reflect NMFS catch statistics (Appendix Table II), VPA was undertaken. Both vertical (Appendix Tables IIIa-IIIe, assuming constant age structure) and horizontal (Appendix Table IV) Virtual Population Analyses were done. For all VPA analyses, fish equal to or over 26 years of age were pooled into a single group.

The vertical analysis for each year, 1986 to 1990, were not of particular interest, except for comparison to some previous studies. The details of the horizontal analysis is presented for only 1986-1989. The 1990 results are used to provide the population magnitudes, but not the actual cohort reductions.

Spawning stock biomass (SSB)

The spawning stock biomass (SSB) at each age is calculated as the number in each age class times the fraction that is mature times the weight (calculated at the age median; age+0.5) of an individual. This total value can then be scaled by the original number of recruits as SSB/R (Gabriel et.al. 1989).

Our analysis was based on the estimated "mean number in the sea" for each age class using the estimates from the horizontal cohort analysis, and converted to weight with the formula previously given. Although actual maturation tables were not available, approximate size at maturity is 5 years of age, so we assumed that no fish age 0 to 3 spawn, 33% of 4 year-olds spawn, 66% of 5 year olds spawn, and 100% of fish over

5 are mature spawners. These assumptions are consistent with observations in the literature (Fitzhugh, et. al. 1987, and Parker et. al. 1988).

The annual SSB from the cohort analysis represents the biomass of a stock for a given year under conditions of both fishing and natural mortality. To estimate the SSB without fishing mortality, we used the "numbers attaining each age" from the VPA that estimates recruitment for the zero-year class. We then calculated the number that would be expected due to only natural mortality for each subsequent year class midpoint using the equation,

$$N_t = N_o * \exp[-M*(age+0.5)]$$

The ratio of the SSB with fishing and natural mortality to the SSB with only natural mortality is the percent of maximum spawning stock biomass that we could expect (had there been no fisheries) to be available to spawn that year. The assumptions made for this study include (1) the natural mortality is the same for all year-classes over all years (M=.1471), and (2) since SSB serves as a proxy for egg biomass, we assume that "the ratio of eggs produced to grams of body weight is ... constant over spawner size and age, and egg viability is also assumed to be independent of spawner age" (Gabriel 1984).

Table 4. Results of the SSB/R analysis.

	1986	1987	1988	1989	1990
Zero class (millions)	4.051	3.119	3.461	4.073	4.072
Total SSB (millions Kg)	35.411	29.142	24.237	22.186	21.726
With fishing: SSB/R (Kg)	8.740	9.344	7.004	5.447	5.336
Without fishing: SSB/R (Kg)	18.754	18.754	18.754	18.754	18.754
Percent of maximum	46.605	49.823	37.344	29.045	28.452

In calculating the SSB/R another usual assumption is that the recruitment does not vary substantially from year to year (i.e. there is no great variation in year-class sizes). While this assumption would be particularly difficult to meet for black drum, use of the estimated recruitment from VPA for each year should improve estimates. The magnitude of the recruitment is based primarily on a vertical VPA from 1990, with a horizontal segment for the last few years. Although this approach undoubtedly reduces the cohort variation, it is encouraging to see that the pattern of recruitment from 1986 to 1990, given in Table 4, matches the pattern observed for the Louisiana shrimp monitoring trawl index (Figure 9). Both sets of values show high recruitment in 1986, followed by a large decline in 1987 and a subsequent gradual increase.

Recruitment indices

A number of monitoring programs are available which provide a record of juvenile stock levels over time. In particular, Louisiana Department of Wildlife and Fisheries' shrimp monitoring in their area 7 (Calcasieu in western Louisiana) frequently captures young of the year black drum, as does the Texas Parks and Wildlife Department's monitoring program. In our examination of these data, we included all stations with more than 15 black drum captures. The capture of young-of-year black drum in most of these programs started in July (March for Texas bag seines), and continued through the end of the year. We defined a season as a 12 month period starting in July (March for bag seines). There were sizable month and station differences in rates of capture, in addition to the seasonal year-class strength that we wished to measure. We fitted an Analysis of Variance main effects model (month, station, season) to the logarithm of (catch + 1) at each station. This procedure provided a geometric mean measure of the year class strength for each monitoring program. These values were standardized to an arbitrarily chosen month and station, so the magnitude of the values was not to be interpreted as a measure of real abundance. Within a gear, however, the relative catch rates were expected to reflect the annual differences in cohort strength. For graphical purposes low values for bag seine and Texas trawl catches were multiplied by a constant.

The graphic representation of the cohort strength is given in figure 9. Simple linear regressions were fitted to the geometric means of each monitoring program to test for an indication of trends in the data. The slopes to these lines are given in Table 5.

Table 5. Slopes of the geometric mean catch from various monitoring programs.

Data base	n	Slope Estimate	Standard Error	T for H0: $\beta_1=0$	Prob > |t|
Louisiana Trawls	23	-0.004415	0.00749970	-0.589	0.5624
Texas gill nets	16	0.010286	0.01163735	0.884	0.3917
Texas trawls	13	0.004773	0.00776755	0.614	0.5504
Texas bag seines	14	0.001081	0.00568543	0.190	0.8522

All tests of the hypothesis of "no increasing or decreasing trend on the data" ($H_0:\beta_1=0$) were well above the usual 0.05 cut of point for an indication of significance, as evidenced by the Prob > |t| (Table 5). This can be interpreted as an indication that for all monitoring programs available to provide an index of recruitment, the recruitment shows no long term trends over time. There was, as previously mentioned, considerable year to year variation.

Results

Estimates of fishing mortality : F values

There is a clear pattern of F values throughout the life history of the species. The mean of all available "horizontal" cohort calculations (1986-1989) is given in Appendix Table IV. The F values are near 0.0 for age zero, and increase quickly to 0.286 and 0.392 for ages one and two. This reflects the recreational fishery and commercial gill nets. The F values then decline to 0.131 (age three) and reach a minimum at age 4 through 7 (F=0.02 to 0.03). F values start a gradual increase from age 8 (F=0.058) to age 14 where F values reach 0.201, and then start to level off. Most F values from age 14 to 20 range from the low 0.2's to mid 0.3's, which is probably the fully recruited level.

There is still some increase in F values to age 22 (0.420), and the last three ages (23-25) have unusually high F values of 0.524, 0.503 and 0.565, respectively. These are very high values that are inconsistent with other ages from 12 through 22. There are a number of possible explanations for the unusual values at older ages. Jones (1984) points out that the F estimates for the oldest fish are the poorest estimates, and that the estimates will converge on the real value as the estimates proceed from the oldest to the youngest fish. As a result, these older age groups may be just poorly estimated. It is also possible that there is another "disappearance" of fish at the older ages. If these older fish do not school as frequently or as long as younger fish, they would be less susceptible to many of the commercial gears. Regardless of the reason, it seems unlikely, from our present knowledge of the gears and the species behavior, that there is any selection for the older fishes that would not effect the 14 through 25 year olds equally. As a result, all of these age classes should be experiencing the same fishing mortality (F) unless there is some behavioral mechanism.

Given Jones' caution on estimations of the oldest ages, we feel our best estimate of the annual mortality is provided by an average of the 14 to 22 year old fish. These are provided separately from the 23 to 25 year old fish in Table 6.

The pattern of F values for the 14 to 22 year-old fish was consistent with the observations made from the total catches (Figure 2). The values increased from 1986 through 1988, and dropped in 1989. The values of about 0.10 obtained from the descending arm predicted age (from length) and observed age frequencies indicated a pattern established in the 1970's, 12 to 20 years prior to the data collection used in calculating F. It was apparent that from 1986 through 1989 the instantaneous rate of fishing mortality was triple these historic levels. Management efforts since 1988 should have insured that mortality in 1990 and 1991 was at or below the lower 1989 value, and more in keeping with historic levels of mortality.

Table 6. Mean fishing mortality (F) values for selected age ranges from VPA on years where horizontal estimates are available.

Age group	Mean F value by year			
	1986	1987	1988	1989
Age 1-3	0.209	0.226	0.395	0.248
Age 4-7	0.039	0.028	0.029	0.008
Age 8-13	0.100	0.121	0.094	0.040
Age 14-22	0.285	0.343	0.351	0.168
Age 23-25	0.412	0.347	0.788	0.576

The only evidence in the data of potential growth overfishing was the apparent decline of large drum from the gill net samples, and this was apparently due to the exclusion of the Lake Pontchartrain bull drum fishery from the samples since 1988. It is quite possible that if the higher 1986 to 1988 levels of catch had been continued, growth overfishing would have been evident by 1990 or 1991. However, without some measure of catch per effort, or other relative measure of fish density, any evidence of growth overfishing would be difficult to detect.

The pattern of fishing mortality in the 1 to 3 year-old fish also followed a pattern similar to the pattern of observed catches. It is possible that the changing proportions of large to small fish affected the calculation of these fishing mortality values. Since bull drum were not sampled as much as in the past, the expansion of the commercial samples was more heavily weighted to the small fish, and this may have resulted in unrealistically high catch values. For ages 1 to 3 this increased expansion is averaged across only three age classes, and may have artificially increased these values for 1988 and 1989.

Spawning stock biomass estimates indicate that during the peak fishing years of 1986 through 1988 the stock fell from high values of nearly 50% to values slightly under 30%. Although the decline was substantial, the reduction in landings since 1988 may not have reduced levels below the 30% level. This value should be monitored closely as additional years of data become available.

Recruitment

The various monitoring programs shown in Figure 9 reveal no decreasing trends in recruitment. The time series clearly shows very large annual variation, particularly evident for the 23 years of trawl data from the Louisiana Department of Wildlife and Fisheries, and 16 years of gill net data from the Texas Parks and Wildlife Department. These data lead to the conclusion that there is no evidence of recruitment overfishing.

Since there are a number of monitoring programs now in existence, it is suggested that data from these programs be closely monitored for indications of any change in recruitment levels. In addition to the Texas monitoring program and the Louisiana shrimp monitoring program, there is also a Louisiana finfish monitoring program. We did not include this latter program in our analysis of recruitment since only 5 years of data are available to date. All of these sampling programs could, however, be used as measures of recruitment strength.

Since the black drum cohorts are so highly variable, a one year drop should not be alarming. All programs have a sufficiently long time series to determine if even a single year is extraordinarily low. If confirmed by several different monitoring programs a management response could be triggered. Several years of very low values evidenced by several monitoring programs should certainly result in management action.

Limitations of the analysis

1) A true estimate of the natural mortality, M, is not available. The analysis of Alverson and Carney (1975), used for this calculation, depends on the fit of a von Bertalanffy growth curve, which does not well describe this the black drum. The von Bertalanffy growth curve fits an asymptote, while the black drum appears to have indeterminate growth (Figure 8). As a result, the Alverson and Carney Method probably provides a poor approximation of M for this species.

Although it is a poor approximation, we chose a value that was one of the largest estimates of M observed among our calculations. This choice is somewhat arbitrary, but it was based on our faith in the large sample size and validated aging techniques used by Beckman et. al. (1988) in establishing their model. Still, one must consider the possibility that this long lived species has a natural mortality considerably less than the 0.15 that we have used in our analysis. For example, if M were actually 0.05, the historic levels of fishing mortality would have been about 0.20, and the values resulting from our horizontal VPA would be about 25% to 50% larger for fish age 14 to 22 than those calculated. These are higher in magnitude, but represent a smaller proportional increase in the historic values.

2) The black drum really cannot be viewed as a single fishery. It must be viewed as at least two fisheries, an inshore fishery for fish under 10 pounds, and an offshore fishery for bull drum over 10 pounds. There are also a few selected areas where bull drum are captured inshore.

The data taken by all sampling agencies only recognizes the different "fisheries" as gill net, trawl, etc, and catch data is provided in these categories. For VPA it is necessary to know the breakdown of size classes in each gear. Since gill nets, in particular, can target either small or large drum, it is necessary to determine how many fish are captured in each size category.

3) One of the greatest limitations of VPA, after the fact that the time series only contains 5 years of data, is that the data are not subdivided by size category. Each gear, gill net, trawl and haul seine, target both large and small fish in some unknown proportion. To the extent that the sampling is random, there is no problem; however, different types of fisheries (purse seines, trawls and gill nets) are almost never sampled at random in equal proportions to their landings. As a result, the past failure to recognize that many gears fishing both large and small drum really constitute different gears results in a potentially disproportionate split between size groups from year to year, with consequent problems with VPA.

Conclusions

Fishing pressure on black drum stocks in the late 1980's exceeded historic levels, and became a cause for concern. The present evidence indicates that fishing pressure by both recreational and commercial fishermen has declined, probably as a result of management efforts undertaken by various state agencies. The estimates of fishing mortality indicate that mortality has fallen from the 1987 and 1988 peak years to levels in 1989 which are similar to those of 1986. Commercial catch fell in 1989 to levels similar to those of the early 1980's, and recreational catch fell to unprecedented low levels in 1989 and 1990.

The best available evidence indicates that the natural mortality (M) of the species is about 0.15. Other estimates are lower than this value, and are reasonable in view of the longevity of the species.

One important indication that the black drum stocks have not been excessively fished is the continued recruitment levels observed by various monitoring programs. Recruitment levels in 1989 and 1990 appear to be well within the average range of values observed over the last 10 to 25 years.

A major limitation to utilizing the existing databases is that the black drum cannot be viewed as a single fishery; it must be viewed as at least two fisheries, an inshore fishery for fish under 10 pounds, and an offshore fishery for bull drum over 10 pounds. Future data collection, particularly of gill net catches, must distinguish between effort directed at smaller drum (under 10 pounds) and that directed at the larger bull drum.

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Appendix Table 1. Conversion table for fork lengths to age using the sloped asymptote versions of the Gompertz and for fork lengths to weight.

Size (cm)	inches	Gompertz Age	Weight (Kg)	Size (cm)	inches	Gompertz Age	Weight (Kg)
10	3.94	0.38983	0.01506	61	24.02	3.87525	3.65149
11	4.33	0.44692	0.02012	62	24.41	4.09554	3.83630
12	4.72	0.50179	0.02620	63	24.80	4.35483	4.02728
13	5.12	0.55483	0.03341	64	25.20	4.66741	4.22453
14	5.51	0.60635	0.04184	65	25.59	5.05456	4.42816
15	5.91	0.65661	0.05159	66	25.98	5.54687	4.63828
16	6.30	0.70582	0.06276	67	26.38	6.18154	4.85497
17	6.69	0.75416	0.07545	68	26.77	6.98322	5.07836
18	7.09	0.80179	0.08975	69	27.17	7.93222	5.30853
19	7.48	0.84884	0.10576	70	27.56	8.96925	5.54560
20	7.87	0.89543	0.12358	71	27.95	10.04008	5.78966
21	8.27	0.94166	0.14332	72	28.35	11.11544	6.04083
22	8.66	0.98765	0.16506	73	28.74	12.18325	6.29920
23	9.06	1.03347	0.18891	74	29.13	13.23922	6.56489
24	9.45	1.07922	0.21497	75	29.53	14.28199	6.83798
25	9.84	1.12498	0.24334	76	29.92	15.31132	7.11859
26	10.24	1.17081	0.27411	77	30.31	16.32733	7.40682
27	10.63	1.21680	0.30740	78	30.71	17.33028	7.70278
28	11.02	1.26302	0.34328	79	31.10	18.32047	8.00656
29	11.42	1.30954	0.38188	80	31.50	19.29821	8.31828
30	11.81	1.35644	0.42329	81	31.89	20.26381	8.63803
31	12.20	1.40378	0.46760	82	32.28	21.21757	8.96593
32	12.60	1.45165	0.51492	83	32.68	22.15976	9.30206
33	12.99	1.50012	0.56535	84	33.07	23.09067	9.64655
34	13.39	1.54927	0.61899	85	33.46	24.01057	9.99949
35	13.78	1.59918	0.67594	86	33.86	24.91970	10.36099
36	14.17	1.64996	0.73630	87	34.25	25.81832	10.73115
37	14.57	1.70168	0.80018	88	34.65	26.70668	11.11008
38	14.96	1.75445	0.86767	89	35.04	27.58499	11.49788
39	15.35	1.80839	0.93888	90	35.43	28.45349	11.89465
40	15.75	1.86361	1.01390	91	35.83	29.31240	12.30050
41	16.14	1.92025	1.09284	92	36.22	30.16191	12.71554
42	16.54	1.97845	1.17580	93	36.61	31.00225	13.13987
43	16.93	2.03837	1.26288	94	37.01	31.83359	13.57359
44	17.32	2.10019	1.35418	95	37.40	32.65614	14.01680
45	17.72	2.16411	1.44981	96	37.80	33.47008	14.46963
46	18.11	2.23036	1.54987	97	38.19	34.27558	14.93215
47	18.50	2.29919	1.65446	98	38.58	35.07281	15.40450
48	18.90	2.37091	1.76367	99	38.98	35.86196	15.88676
49	19.29	2.44586	1.87762	100	39.37	36.64317	16.37904
50	19.69	2.52443	1.99641	101	39.76	37.41661	16.88145
51	20.08	2.60710	2.12013	102	40.16	38.18243	17.39409
52	20.47	2.69441	2.24889	103	40.55	38.94078	17.91707
53	20.87	2.78703	2.38280	104	40.94	39.69180	18.45049
54	21.26	2.88577	2.52195	105	41.34	40.43564	18.99446
55	21.65	2.99161	2.66645	106	41.73	41.17242	19.54909
56	22.05	3.10578	2.81639	107	42.13	41.90228	20.11447
57	22.44	3.22982	2.97190	108	42.52	42.62536	20.69071
58	22.83	3.36571	3.13305	109	42.91	43.34177	21.27792
59	23.23	3.51605	3.29997	110	43.31	44.05164	21.87621
60	23.62	3.68431	3.47275	111	43.70	44.75508	22.48567

Appendix Table II. Estimated annual total Gulf Coast catch in numbers for the commercial and recreational by age and year.

	Commercial catch number					Recreational catch				
Age	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
0	616	0	0	4509	2890	31609	19992	10697	663	1183
1	12484	80200	175360	218879	751656	683501	611354	588957	255607	218624
2	78278	169042	840972	316571	749409	185328	216595	218698	148336	209264
3	22323	28188	79349	120111	37961	31456	83776	52974	38704	30574
4	0	6834	4495	1577	5200	12820	20306	18846	7530	17663
5	23965	14165	2205	1782	1300	2315	7160	11425	3197	2455
6	11987	4660	8439	0	1300	1685	5344	8207	2170	1341
7	37957	8164	8096	1166	0	3622	129	2954	903	102
8	19976	47653	14385	5728	0	6224	1981	3522	818	1476
9	17972	18328	50269	3730	6500	4741	4780	2683	418	506
10	13982	9815	15519	26316	3900	2905	3514	3288	385	931
11	11987	40612	14177	7396	5200	9785	3684	1921	760	975
12	79903	23485	7219	8562	2600	13282	2959	2453	481	582
13	15977	60651	28860	5064	6500	11628	4259	4657	98	879
14	33958	23045	56076	13421	3900	8756	5450	7917	300	646
15	23965	16270	8964	27827	1300	19005	5122	8402	130	511
16	23965	10165	32658	950	7800	25325	4226	6993	578	168
17	29959	120642	9515	12167	0	19579	3293	5237	575	0
18	1995	48324	49360	4573	1300	16575	5060	5970	738	0
19	13982	27776	14618	27053	1300	15607	6093	5312	576	0
20	21970	28873	6549	6920	10400	20329	5412	6233	450	0
21	19976	41112	14416	2571	1300	26446	6027	6058	98	866
22	11987	4382	29781	6697	0	17633	8996	5924	0	177
23	13982	5770	6903	15422	1300	19120	5727	4179	0	0
24	15977	8383	5163	8471	7800	20750	1656	5058	431	0
25	5994	10326	4607	4448	1300	11371	6676	5322	0	0
>26	5994	278	5512	411	2600	103142	28140	25573	862	0

Appendix Table IIIa. Vertical cohort analysis for 1986. Numbers caught include both commercial and recreational catch. Calculations were done using a value of natural mortality of M=0.1471 for all ages.

Age	Numbers caught	Attaining each age	St [EXP(-Zt)]	Zt	Ft	Mean number in the sea	M	Cumulative F
0	32226	23842505	0.86195	0.1486	0.0015	22156067	0.147	0.00
1	695984	20551092	0.83174	0.1842	0.0371	18769103	0.147	0.04
2	263605	17093228	0.84888	0.1638	0.0167	15766408	0.147	0.06
3	53779	14510092	0.85976	0.1511	0.0040	13467063	0.147	0.06
4	12820	12475257	0.86225	0.1482	0.0011	11594826	0.147	0.06
5	26280	10756827	0.86094	0.1497	0.0026	9990234	0.147	0.06
6	13672	9260958	0.86184	0.1487	0.0016	8605344	0.147	0.06
7	41579	7981427	0.85837	0.1527	0.0056	7401832	0.147	0.07
8	26199	6850999	0.85965	0.1512	0.0041	6358134	0.147	0.07
9	22713	5889493	0.85962	0.1513	0.0042	5465706	0.147	0.08
10	16887	5062753	0.86011	0.1507	0.0036	4699745	0.147	0.08
11	21772	4354518	0.85856	0.1525	0.0054	4038747	0.147	0.09
12	93185	3738625	0.84005	0.1743	0.0272	3430947	0.147	0.11
13	27605	3140632	0.85504	0.1566	0.0095	2907063	0.147	0.12
14	42713	2685371	0.84843	0.1644	0.0173	2476287	0.147	0.14
15	42970	2278348	0.84568	0.1676	0.0205	2097648	0.147	0.16
16	49290	1926764	0.83944	0.1750	0.0279	1767574	0.147	0.19
17	49538	1617402	0.83475	0.1806	0.0335	1479745	0.147	0.22
18	18570	1350129	0.85043	0.1620	0.0149	1246433	0.147	0.24
19	29589	1148188	0.83927	0.1752	0.0281	1053218	0.147	0.27
20	42300	963635	0.82242	0.1955	0.0484	875290	0.147	0.31
21	46422	792517	0.80879	0.2122	0.0651	714068	0.147	0.38
22	29620	640976	0.82027	0.1981	0.0510	581475	0.147	0.43
23	33102	525776	0.80471	0.2173	0.0702	472580	0.147	0.50
24	36727	423099	0.78256	0.2452	0.0981	375222	0.147	0.60
25	17365	331100	0.81448	0.2052	0.0581	299338	0.147	0.66
26+	109136	269675		0.2471	0.100	1091359	0.147	
Sum	1895648							

Appendix Table IIIb. Vertical cohort analysis for 1987. Numbers caught include both commercial and recreational catch. Calculations were done using a value of natural mortality of M=0.1471 for all ages.

Age	Numbers caught	Attaining each age	St [EXP(-Zt)]	Zt	Ft	Mean number in the sea	M	Cumulative F
0	19992	13489345	0.86183	0.1487	0.0016	12534352	0.147	0.00
1	691554	11625532	0.80794	0.2133	0.0662	10469480	0.147	0.07
2	385637	9392732	0.82506	0.1923	0.0452	8544845	0.147	0.11
3	111964	7749587	0.84978	0.1628	0.0157	7151750	0.147	0.13
4	27141	6585479	0.85938	0.1515	0.0044	6110758	0.147	0.13
5	21325	5659419	0.85971	0.1512	0.0041	5252432	0.147	0.14
6	10004	4865441	0.86130	0.1493	0.0022	4519622	0.147	0.14
7	8292	4190591	0.86137	0.1492	0.0021	3892897	0.147	0.14
8	49634	3609646	0.85043	0.1620	0.0149	3332417	0.147	0.16
9	23108	3069760	0.85621	0.1552	0.0081	2843358	0.147	0.16
10	13329	2628371	0.85850	0.1526	0.0055	2437681	0.147	0.17
11	44296	2256446	0.84497	0.1685	0.0214	2076628	0.147	0.19
12	26444	1906627	0.85032	0.1621	0.0150	1760082	0.147	0.21
13	64910	1621246	0.82601	0.1911	0.0440	1475715	0.147	0.25
14	28495	1339165	0.84344	0.1703	0.0232	1231360	0.147	0.27
15	21392	1129503	0.84561	0.1677	0.0206	1039876	0.147	0.29
16	14390	955121	0.84921	0.1634	0.0163	881148	0.147	0.31
17	123935	811097	0.72124	0.3268	0.1797	691902	0.147	0.49
18	53384	584998	0.77842	0.2505	0.1034	517485	0.147	0.59
19	33869	455376	0.79411	0.2305	0.0834	406697	0.147	0.68
20	34285	361617	0.77512	0.2547	0.1076	319233	0.147	0.78
21	47139	280297	0.70696	0.3468	0.1997	236859	0.147	0.98
22	13378	198158	0.80048	0.2225	0.0754	177658	0.147	1.06
23	11497	158622	0.79587	0.2283	0.0812	141816	0.147	1.14
24	10039	126242	0.78932	0.2366	0.0895	112420	0.147	1.23
25	17002	99646	0.70468	0.3500	0.2029	84076	0.147	1.43
26+	28417	70219		0.2471	0.100	284171	0.147	
Sum	1934852							

Appendix Table IIIc. Vertical cohort analysis for 1988. Numbers caught include both commercial and recreational catch. Calculations were done using a value of natural mortality of M=0.1471 for all ages.

Age	Numbers caught	Attaining each age	St [EXP(-Zt)]	Zt	Ft	Mean number in the sea	M	Cumulative F
0	10697	12561827	0.86242	0.1480	0.0009	11676366	0.147	0.00
1	764317	10833526	0.79766	0.2261	0.0790	9696233	0.147	0.08
2	1059669	8641464	0.74928	0.2886	0.1415	7506113	0.147	0.22
3	132323	6474850	0.84422	0.1693	0.0222	5956298	0.147	0.24
4	23340	5466200	0.85924	0.1517	0.0046	5071766	0.147	0.25
5	13630	4696780	0.86051	0.1502	0.0031	4361008	0.147	0.25
6	16646	4041633	0.85938	0.1515	0.0044	3750293	0.147	0.26
7	11050	3473302	0.86025	0.1505	0.0034	3224522	0.147	0.26
8	17906	2987915	0.85764	0.1536	0.0065	2769793	0.147	0.27
9	52952	2562554	0.84401	0.1696	0.0225	2357040	0.147	0.29
10	18807	2162819	0.85513	0.1565	0.0094	2002069	0.147	0.30
11	16098	1849489	0.85512	0.1565	0.0094	1712019	0.147	0.31
12	9672	1581537	0.85753	0.1537	0.0066	1465988	0.147	0.31
13	33516	1356209	0.84025	0.1741	0.0270	1244738	0.147	0.34
14	63993	1139550	0.81103	0.2094	0.0623	1028125	0.147	0.40
15	17366	924212	0.84575	0.1675	0.0204	850943	0.147	0.42
16	39651	781653	0.81608	0.2032	0.0561	707338	0.147	0.48
17	14751	637889	0.84172	0.1723	0.0252	585958	0.147	0.50
18	55330	536925	0.76747	0.2647	0.1176	471748	0.147	0.62
19	19930	412072	0.81827	0.2006	0.0535	373378	0.147	0.68
20	12782	337186	0.82799	0.1888	0.0417	307274	0.147	0.72
21	20475	279186	0.79507	0.2293	0.0822	249487	0.147	0.80
22	35705	221973	0.71376	0.3372	0.1901	188422	0.147	0.99
23	11082	158436	0.79822	0.2254	0.0783	141851	0.147	1.07
24	10220	126467	0.78812	0.2381	0.0910	112538	0.147	1.16
25	9930	99671	0.77064	0.2605	0.1134	87745	0.147	1.27
26+	31085	76811		0.2471	0.100	310850	0.147	
Sum	2522927							

Appendix Table IIId. Vertical cohort analysis for 1989. Numbers caught include both commercial and recreational catch. Calculations were done using a value of natural mortality of M=0.1471 for all ages.

Age	Numbers caught	Attaining each age	St [EXP(-Zt)]	Zt	Ft	Mean number in the sea	M	Cumulative F
0	5172	4566022	0.86216	0.1483	0.0012	4243544	0.147	0.00
1	474487	3936620	0.75122	0.2861	0.1390	3423636	0.147	0.14
2	464907	2957280	0.71715	0.3325	0.1854	2515910	0.147	0.33
3	158815	2120806	0.79363	0.2311	0.0840	1893552	0.147	0.41
4	9107	1683143	0.85818	0.1529	0.0058	1560750	0.147	0.42
5	4979	1444440	0.86001	0.1508	0.0037	1340793	0.147	0.42
6	2170	1242226	0.86158	0.1490	0.0019	1154121	0.147	0.42
7	2069	1070283	0.86141	0.1492	0.0021	994275	0.147	0.42
8	6546	921954	0.85661	0.1548	0.0077	854151	0.147	0.43
9	4148	789757	0.85833	0.1528	0.0057	732390	0.147	0.44
10	26701	677870	0.82661	0.1904	0.0433	617239	0.147	0.48
11	8156	560335	0.84968	0.1629	0.0158	517079	0.147	0.50
12	9043	476108	0.84556	0.1678	0.0207	438315	0.147	0.52
13	5162	402578	0.85129	0.1610	0.0139	371842	0.147	0.53
14	13722	342713	0.82601	0.1912	0.0441	311949	0.147	0.57
15	27958	283084	0.77145	0.2595	0.1124	249337	0.147	0.69
16	1528	218385	0.85671	0.1547	0.0076	202335	0.147	0.69
17	12742	187092	0.79993	0.2232	0.0761	167680	0.147	0.77
18	5311	149661	0.83024	0.1860	0.0389	136564	0.147	0.81
19	27628	124254	0.65662	0.4207	0.2736	101429	0.147	1.08
20	7370	81588	0.77928	0.2494	0.1023	72210	0.147	1.19
21	2669	63579	0.82420	0.1933	0.0462	57811	0.147	1.23
22	6697	52402	0.74447	0.2951	0.1480	45378	0.147	1.38
23	15422	39012	0.49592	0.7013	0.5542	28039	0.147	1.93
24	8902	19347	0.43572	0.8307	0.6836	13141	0.147	2.62
25	4448	8430	0.37298	0.9862	0.8391	5359	0.147	3.46
26+	1272	3144		0.2471	0.100	12724	0.147	
Sum	1317130							

Appendix Table IIIe. Vertical cohort analysis for 1990. Numbers caught include both commercial and recreational catch. Calculations were done using a value of natural mortality of M=0.1471 for all ages.

Age	Numbers caught	Attaining each age	St [EXP(-Zt)]	Zt	Ft	Mean number in the sea	M	Cumulative F
0	4073	4071690	0.86228	0.1482	0.0011	3784388	0.147	0.00
1	970280	3510929	0.60644	0.5001	0.3530	2762706	0.147	0.35
2	958673	2129184	0.44488	0.8099	0.6628	1459291	0.147	1.02
3	68535	947234	0.79599	0.2282	0.0811	846938	0.147	1.10
4	22863	753985	0.83503	0.1803	0.0332	689927	0.147	1.13
5	3755	629604	0.85767	0.1535	0.0064	583651	0.147	1.14
6	2641	539990	0.85866	0.1524	0.0053	500861	0.147	1.14
7	102	463670	0.86300	0.1473	0.0002	431130	0.147	1.14
8	1476	400149	0.85978	0.1511	0.0040	371388	0.147	1.15
9	7006	344040	0.84429	0.1693	0.0222	316499	0.147	1.17
10	4831	290468	0.84776	0.1652	0.0181	267749	0.147	1.19
11	6175	246246	0.83991	0.1745	0.0274	225962	0.147	1.21
12	3182	206824	0.84891	0.1638	0.0167	190774	0.147	1.23
13	7379	175576	0.82416	0.1934	0.0463	159642	0.147	1.28
14	4545	144703	0.83402	0.1815	0.0344	132331	0.147	1.31
15	1811	120686	0.84927	0.1634	0.0163	111342	0.147	1.33
16	7968	102494	0.79098	0.2345	0.0874	91364	0.147	1.42
17	0	81071	0.86321	0.1471	0.0000	75390	0.147	1.42
18	1300	69981	0.84595	0.1673	0.0202	64440	0.147	1.44
19	1300	59200	0.84281	0.1710	0.0239	54415	0.147	1.46
20	10400	49894	0.66955	0.4012	0.2541	41101	0.147	1.71
21	2166	33407	0.80298	0.2194	0.0723	29996	0.147	1.79
22	177	26825	0.85709	0.1542	0.0071	24859	0.147	1.79
23	1300	22991	0.81067	0.2099	0.0628	20739	0.147	1.86
24	7800	18638	0.47439	0.7457	0.5986	13137	0.147	2.45
25	1300	8842	0.72661	0.3194	0.1723	7569	0.147	2.63
26+	2600	6425		0.2471	0.100	26000	0.147	
Sum	2103638							

Appendix Table IV. Horizontal cohort analysis for 1986-1989. Numbers caught include both commercial and recreational catch. Calculations were done using a value of natural mortality of M=0.1471 for all ages and a value of 0.1 for fishing mortality (F) at ages over 26.

	Numbers Caught					Numbers attaining each age					Zt					Ft					Average F
Age	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990	86-89
0	32226	19992	10697	5172	4073	4051412	3118775	3460620	4072872	4071690	0.16	0.15	0.15	0.15	0.15	0.009	0.007	0.003	0.001	0.001	0.0051
1	695984	691554	764317	474487	970280	2570309	3467269	2673576	2977295	3510929	0.49	0.39	0.51	0.34	0.50	0.345	0.242	0.368	0.188	0.353	0.2855
2	263605	385637	1059669	464907	958673	1437956	1572078	2350457	1597732	2129184	0.37	0.45	0.81	0.52	0.81	0.220	0.307	0.664	0.376	0.663	0.3915
3	53779	111964	132323	158815	68535	950164	996341	998739	1044405	947234	0.21	0.28	0.30	0.33	0.23	0.063	0.129	0.154	0.179	0.081	0.1311
4	12820	27141	23340	9107	22863	788605	770223	756025	739179	753985	0.16	0.19	0.18	0.16	0.18	0.018	0.039	0.034	0.013	0.033	0.0259
5	26280	21325	13630	4979	3755	687326	668819	639646	630921	629604	0.19	0.18	0.17	0.16	0.15	0.042	0.035	0.023	0.009	0.006	0.0272
6	13672	10004	16646	2170	2641	581025	568888	557517	539484	539990	0.17	0.17	0.18	0.15	0.15	0.026	0.019	0.033	0.004	0.005	0.0204
7	41579	8292	11050	2069	102	671324	488843	481774	465787	463670	0.22	0.17	0.17	0.15	0.15	0.069	0.018	0.025	0.005	0.000	0.0293
8	26199	49634	17906	6546	1476	470339	540862	414269	405605	400149	0.21	0.25	0.19	0.16	0.15	0.062	0.104	0.048	0.018	0.004	0.0577
9	22713	23108	52952	4148	7006	395683	381659	420762	340963	344040	0.21	0.21	0.29	0.16	0.17	0.064	0.067	0.146	0.013	0.022	0.0725
10	16887	13329	18807	26701	4831	356641	320454	307981	314008	290468	0.20	0.19	0.22	0.24	0.17	0.052	0.046	0.068	0.096	0.018	0.0655
11	21772	44296	16098	8156	6175	345149	292166	264234	248378	246246	0.22	0.33	0.21	0.18	0.17	0.070	0.178	0.068	0.036	0.027	0.0881
12	93185	26444	9672	9043	3182	505056	277707	211045	213133	206824	0.37	0.26	0.20	0.19	0.16	0.221	0.108	0.051	0.047	0.017	0.1067
13	27605	64910	33516	5162	7379	238900	349392	215150	173190	175576	0.28	0.37	0.33	0.18	0.19	0.133	0.223	0.184	0.033	0.046	0.1430
14	42713	28495	63993	13722	4545	277287	180573	241290	154579	144703	0.33	0.33	0.48	0.25	0.18	0.181	0.186	0.336	0.100	0.034	0.2010
15	42970	21392	17366	27958	1811	201014	199672	129398	148828	120686	0.41	0.27	0.30	0.37	0.16	0.261	0.123	0.156	0.226	0.016	0.1915
16	49290	14390	39651	1528	7968	423607	133594	152484	95563	102494	0.28	0.27	0.48	0.16	0.23	0.134	0.123	0.328	0.017	0.087	0.1507
17	49538	123935	14751	12742	0	221174	319866	101949	94786	81071	0.42	0.69	0.32	0.30	0.15	0.276	0.540	0.169	0.156	0.000	0.2853
18	18570	53384	55330	5311	1300	133462	144894	160963	74298	69981	0.31	0.65	0.61	0.23	0.17	0.162	0.505	0.462	0.080	0.020	0.3023
19	29589	33869	19930	27628	1300	156788	97952	75475	87538	59200	0.37	0.61	0.48	0.56	0.17	0.227	0.465	0.334	0.415	0.024	0.3605
20	42300	34285	12782	7370	10400	215257	107850	53086	46633	49894	0.38	0.57	0.45	0.33	0.40	0.238	0.419	0.300	0.186	0.254	0.2857
21	46422	47139	20475	2669	2166	113475	146511	61243	33948	33407	0.73	0.57	0.59	0.24	0.22	0.580	0.425	0.446	0.088	0.072	0.3850
22	29620	13378	35705	6697	177	79994	54823	82674	33843	26825	0.66	0.45	0.77	0.39	0.15	0.508	0.305	0.625	0.240	0.007	0.4195
23	33102	11497	11082	15422	1300	67378	41532	34894	38191	22991	0.90	0.50	0.57	0.72	0.21	0.752	0.354	0.418	0.570	0.063	0.5237
24	36727	10039	10220	8902	7800	163814	27407	25169	19824	18638	0.42	0.65	0.72	0.81	0.75	0.276	0.501	0.575	0.660	0.599	0.5031
25	17365	17002	9930	4448	1300	100036	107283	14330	12230	8842	0.35	0.33	1.52	0.64	0.32	0.207	0.187	1.370	0.497	0.172	0.5651
26+	109136	28417	31085	1272	2600	269675	70219	76811	3144	6425						0.1	0.1	0.1	0.1	0.1	
Sum	1895648	1934852	2522927	1317130	2103638																

Mean Annual F	1986	1987	1988	1989	1990
Age 1-3	0.209	0.226	0.395	0.248	0.366
Age 4-7	0.039	0.028	0.029	0.008	0.011
Age 8-13	0.100	0.121	0.094	0.040	0.022
Age 14-22	0.285	0.343	0.351	0.168	0.057
Age 23-25	0.412	0.347	0.788	0.576	0.278

Appendix Table IV (continued). Horizontal cohort analysis for 1986-1989. Estimated mean number in the sea from VPA and calculated without fishing with total estimated biomass in each group and the spawning stock biomass estimates.

	Estimated	Percent	Mean number in the sea (millions)					Estimated Numbers without fishing (millions)				
Age	Weight	Spawners	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
0		0	3.752	2.890	3.213	3.785	3.784	4.051	3.119	3.461	4.073	4.072
1	0.565	0	2.030	2.873	2.090	2.530	2.763	3.249	2.501	2.775	3.266	3.265
2	1.960	0	1.204	1.264	1.610	1.244	1.459	2.805	2.159	2.396	2.820	2.819
3	3.283	0	0.857	0.871	0.862	0.891	0.847	2.421	1.864	2.068	2.434	2.433
4	4.123	33	0.727	0.703	0.692	0.683	0.690	2.090	1.609	1.785	2.101	2.100
5	4.620	66	0.626	0.611	0.588	0.584	0.584	1.804	1.389	1.541	1.814	1.813
6	4.948	100	0.534	0.524	0.510	0.501	0.501	1.557	1.199	1.330	1.565	1.565
7	5.206	100	0.604	0.451	0.443	0.432	0.431	1.344	1.035	1.148	1.351	1.351
8	5.438	100	0.424	0.478	0.376	0.374	0.371	1.160	0.893	0.991	1.166	1.166
9	5.665	100	0.357	0.344	0.365	0.315	0.316	1.002	0.771	0.856	1.007	1.007
10	5.895	100	0.323	0.291	0.277	0.279	0.268	0.865	0.666	0.739	0.869	0.869
11	6.132	100	0.310	0.249	0.238	0.227	0.226	0.746	0.575	0.637	0.750	0.750
12	6.377	100	0.422	0.245	0.191	0.194	0.191	0.644	0.496	0.550	0.648	0.647
13	6.631	100	0.208	0.292	0.183	0.159	0.160	0.556	0.428	0.475	0.559	0.559
14	6.895	100	0.236	0.154	0.191	0.137	0.132	0.480	0.370	0.410	0.483	0.482
15	7.170	100	0.165	0.175	0.112	0.124	0.111	0.414	0.319	0.354	0.417	0.416
16	7.455	100	0.369	0.117	0.121	0.088	0.091	0.358	0.275	0.306	0.360	0.359
17	7.752	100	0.180	0.231	0.087	0.082	0.075	0.309	0.238	0.264	0.310	0.310
18	8.061	100	0.115	0.106	0.121	0.066	0.064	0.267	0.205	0.228	0.268	0.268
19	8.382	100	0.131	0.073	0.060	0.067	0.054	0.230	0.177	0.197	0.231	0.231
20	8.716	100	0.179	0.082	0.043	0.040	0.041	0.199	0.153	0.170	0.200	0.200
21	9.063	100	0.081	0.112	0.046	0.030	0.030	0.171	0.132	0.146	0.172	0.172
22	9.423	100	0.059	0.044	0.058	0.028	0.025	0.148	0.114	0.126	0.149	0.149
23	9.799	100	0.044	0.033	0.027	0.027	0.021	0.128	0.098	0.109	0.128	0.128
24	10.189	100	0.134	0.020	0.018	0.014	0.013	0.110	0.085	0.094	0.111	0.111
25	10.595	100	0.084	0.091	0.007	0.009	0.008	0.095	0.073	0.081	0.096	0.096

Total biomass estimates in millions of Kg.

	With Fishing					Without fishing				
Sum (millions of Kg)	35.411	29.142	24.237	22.186	21.726	75.981	58.490	64.901	76.384	76.362
SSB/Recruit	8.740	9.344	7.004	5.447	5.336	18.754	18.754	18.754	18.754	18.754
Percent of maximum	46.605	49.823	37.344	29.045	28.452					

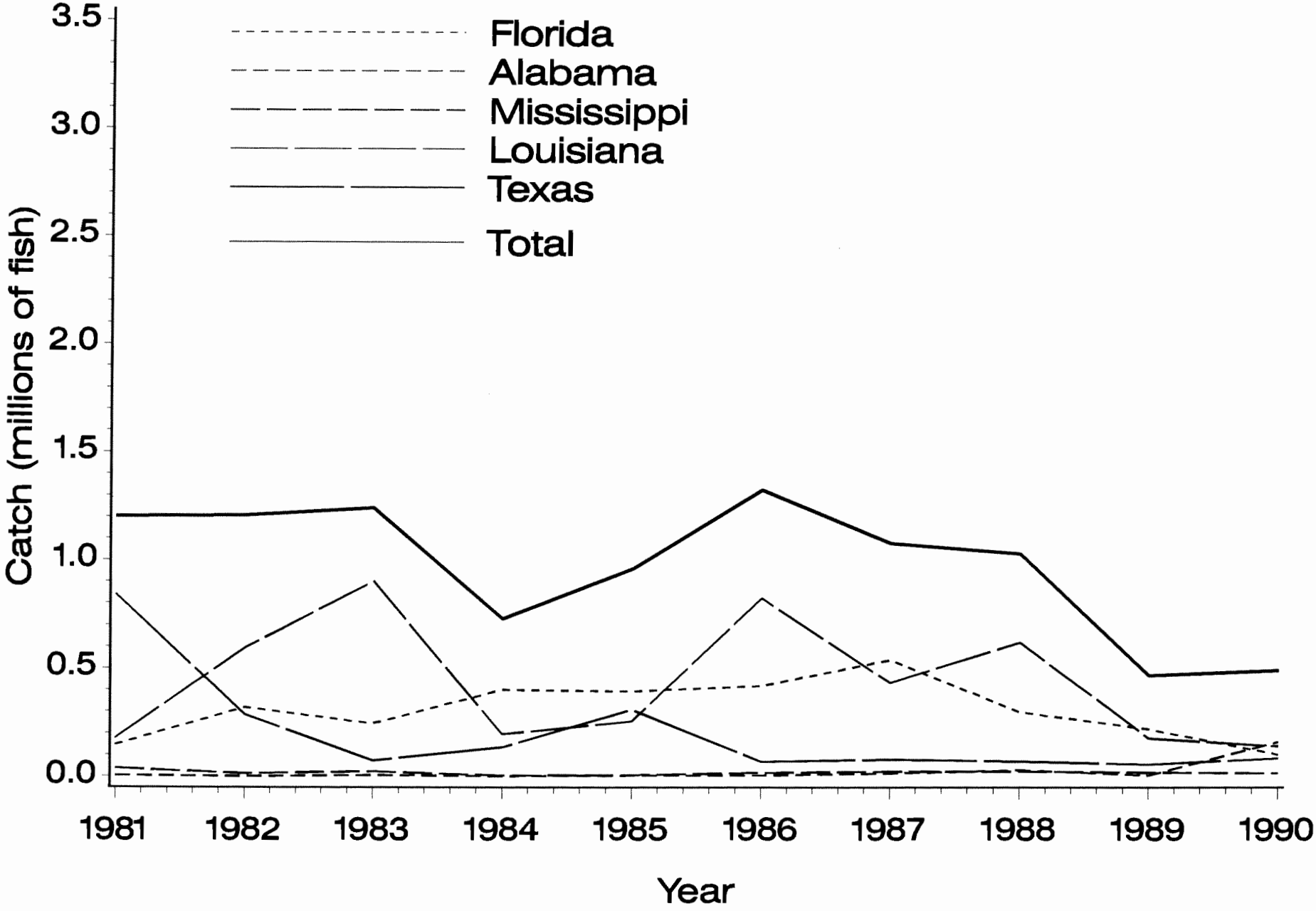

Figure 1. Gulf Coast recreational catch of Black drum by state.

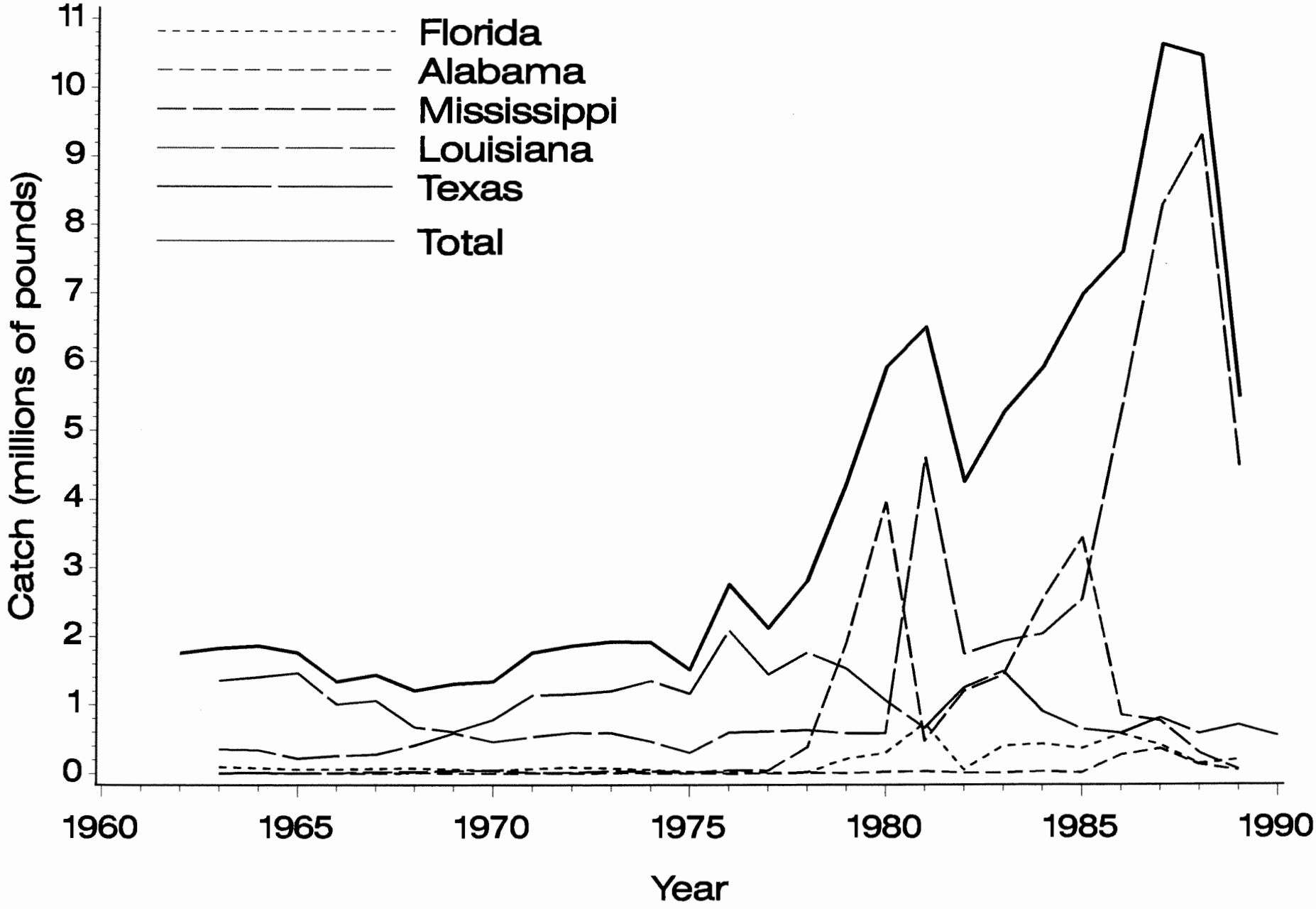

Figure 2. Gulf Coast commercial catch of Black drum by state.

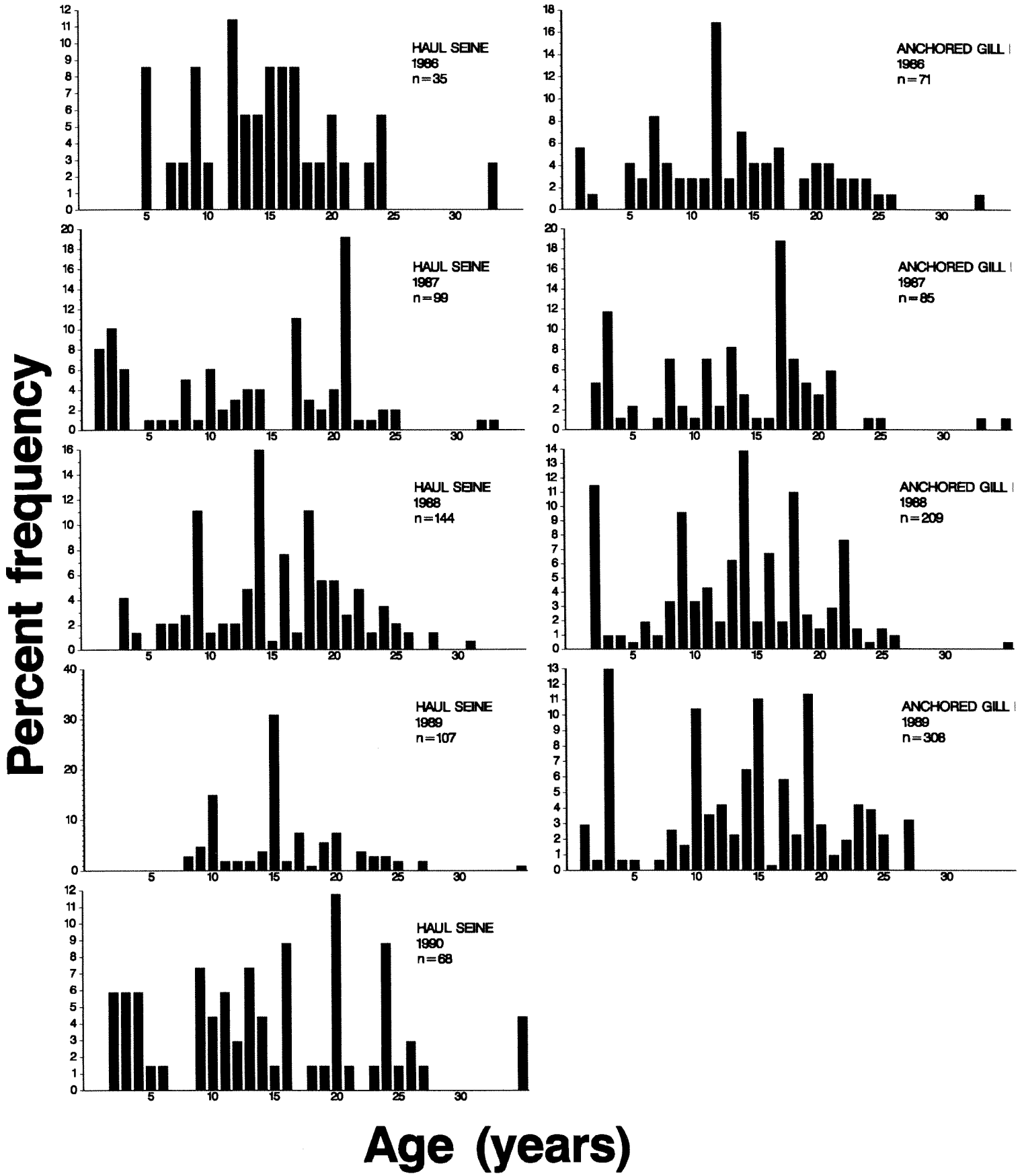

Figure 3a. Aged Black drum from Louisiana commercial catchs.

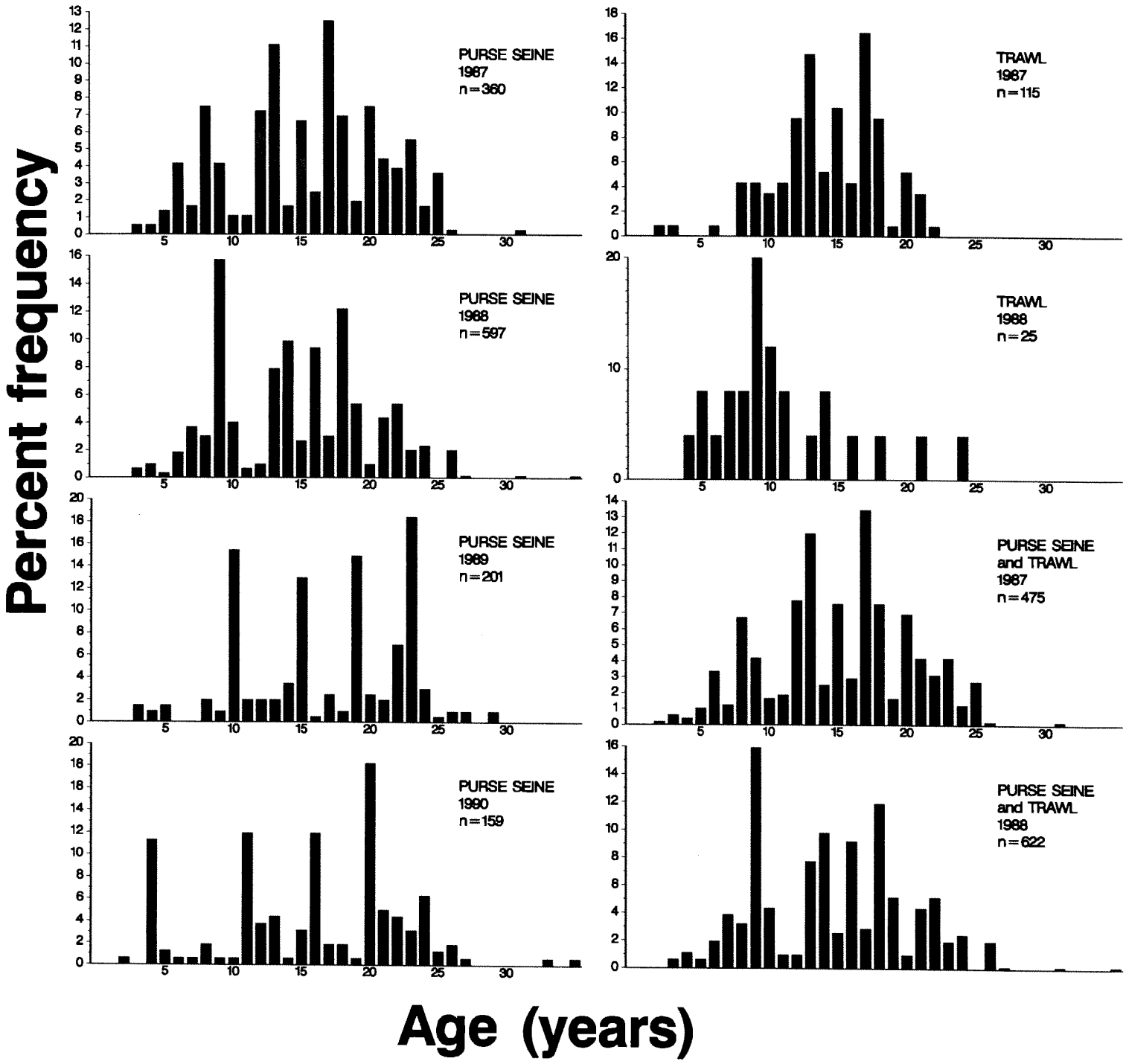

Figure 3b. Aged Black drum from Louisiana commercial catches.

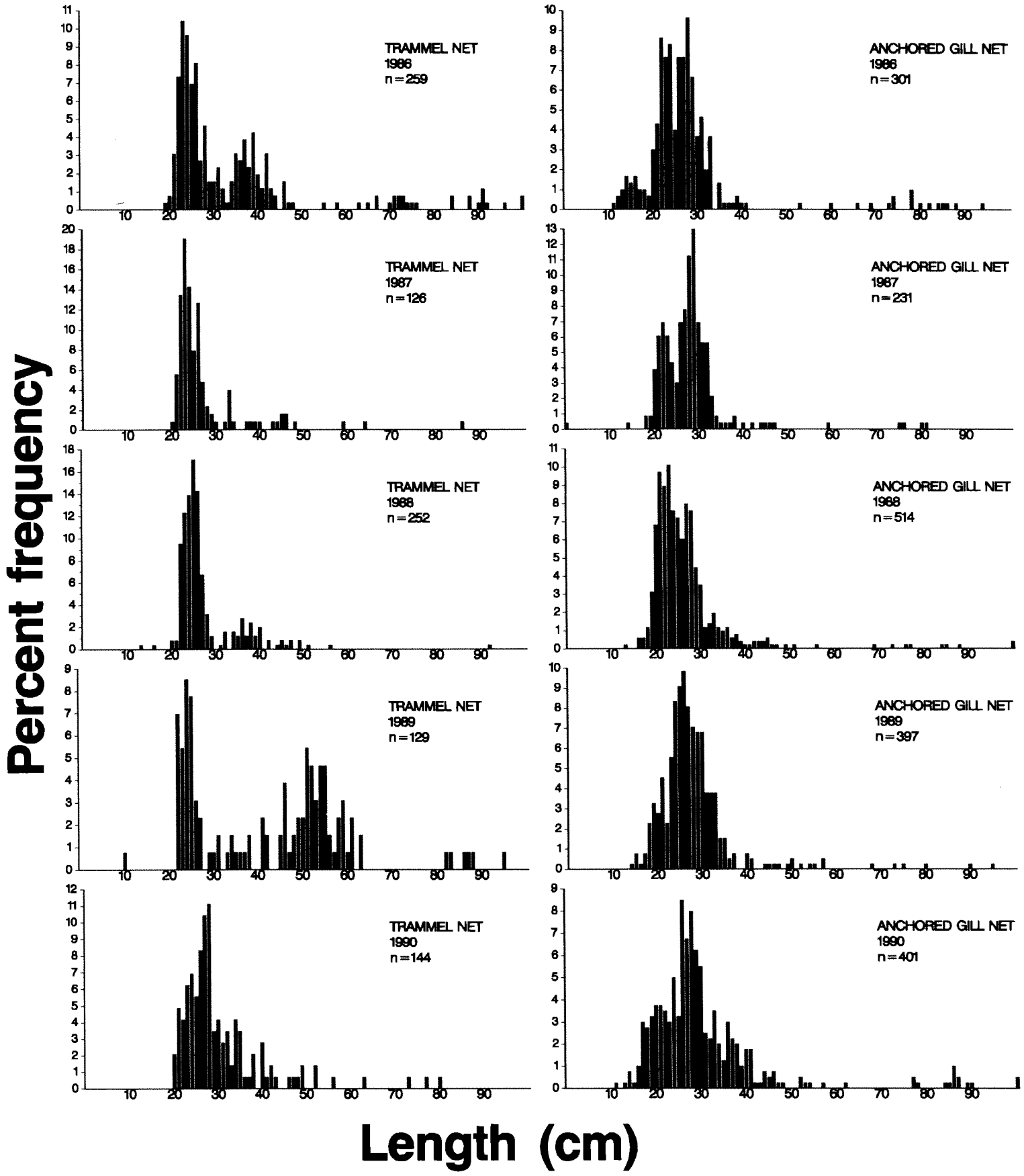

Figure 4. Black drum lengths from La. Wildlife and Fisheries finfish monitoring.

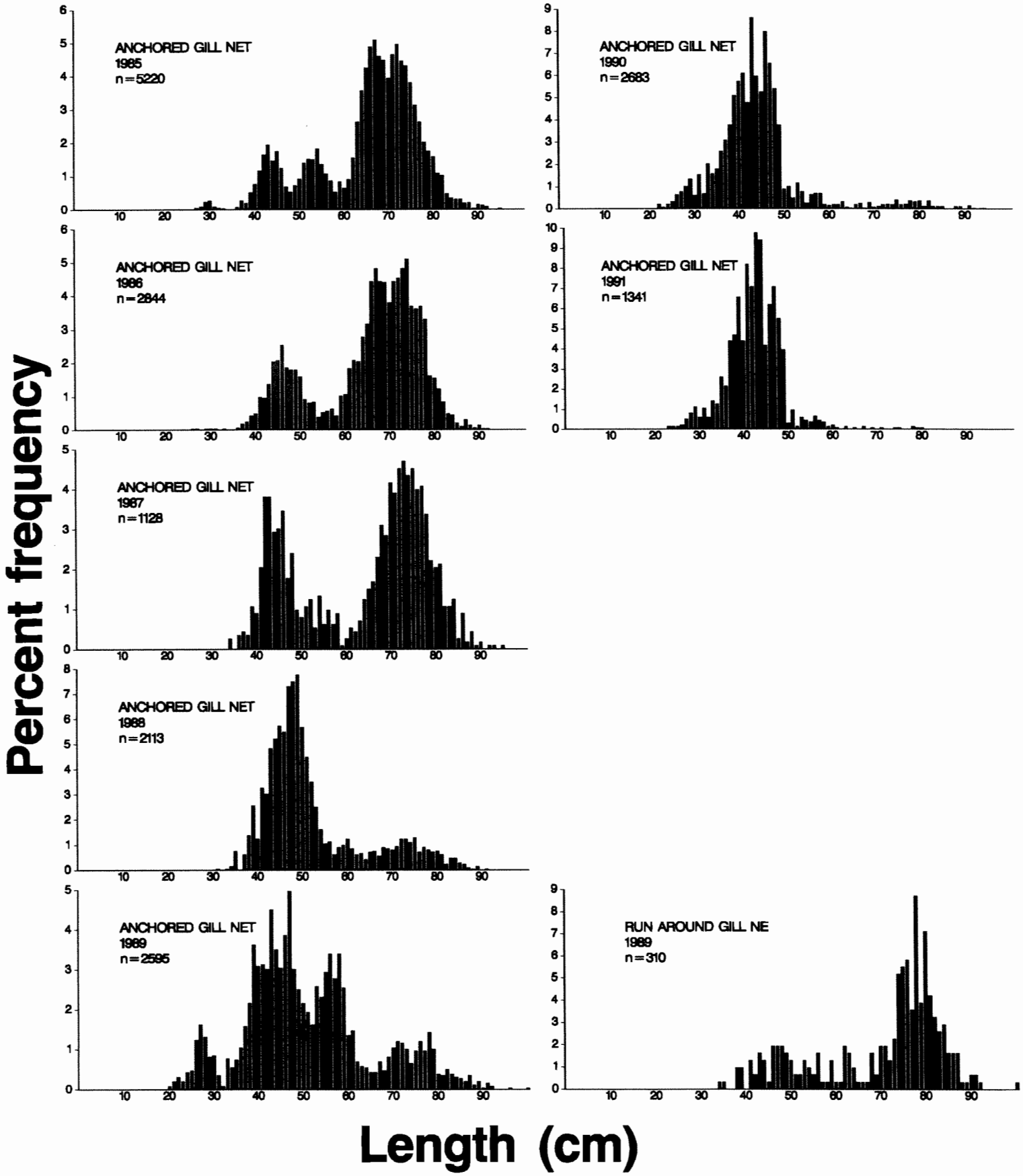

Figure 5a. Black drum lengths from Louisiana commercial catch.

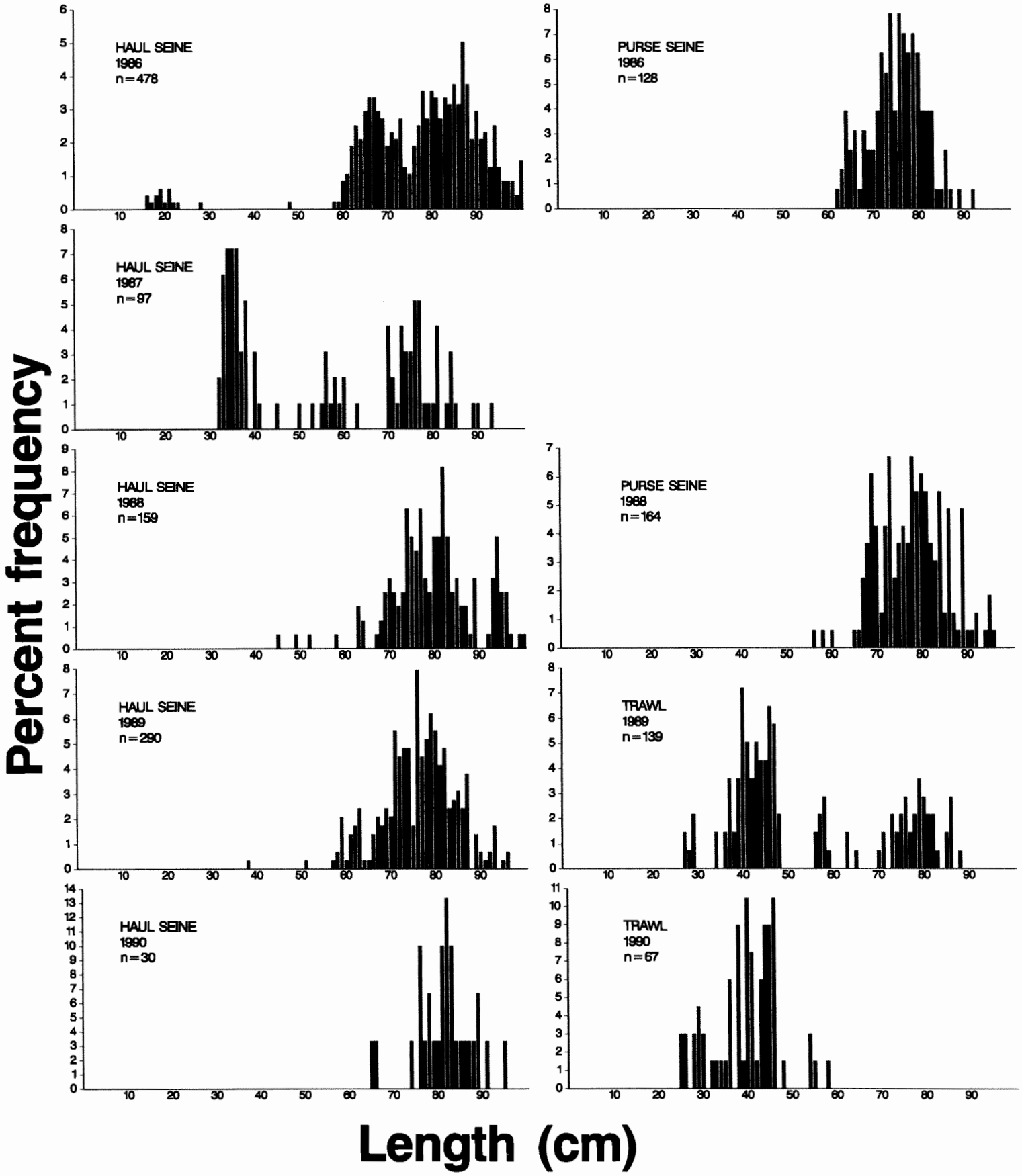

Figure 5b. Black drum lengths from Louisiana commercial catch.

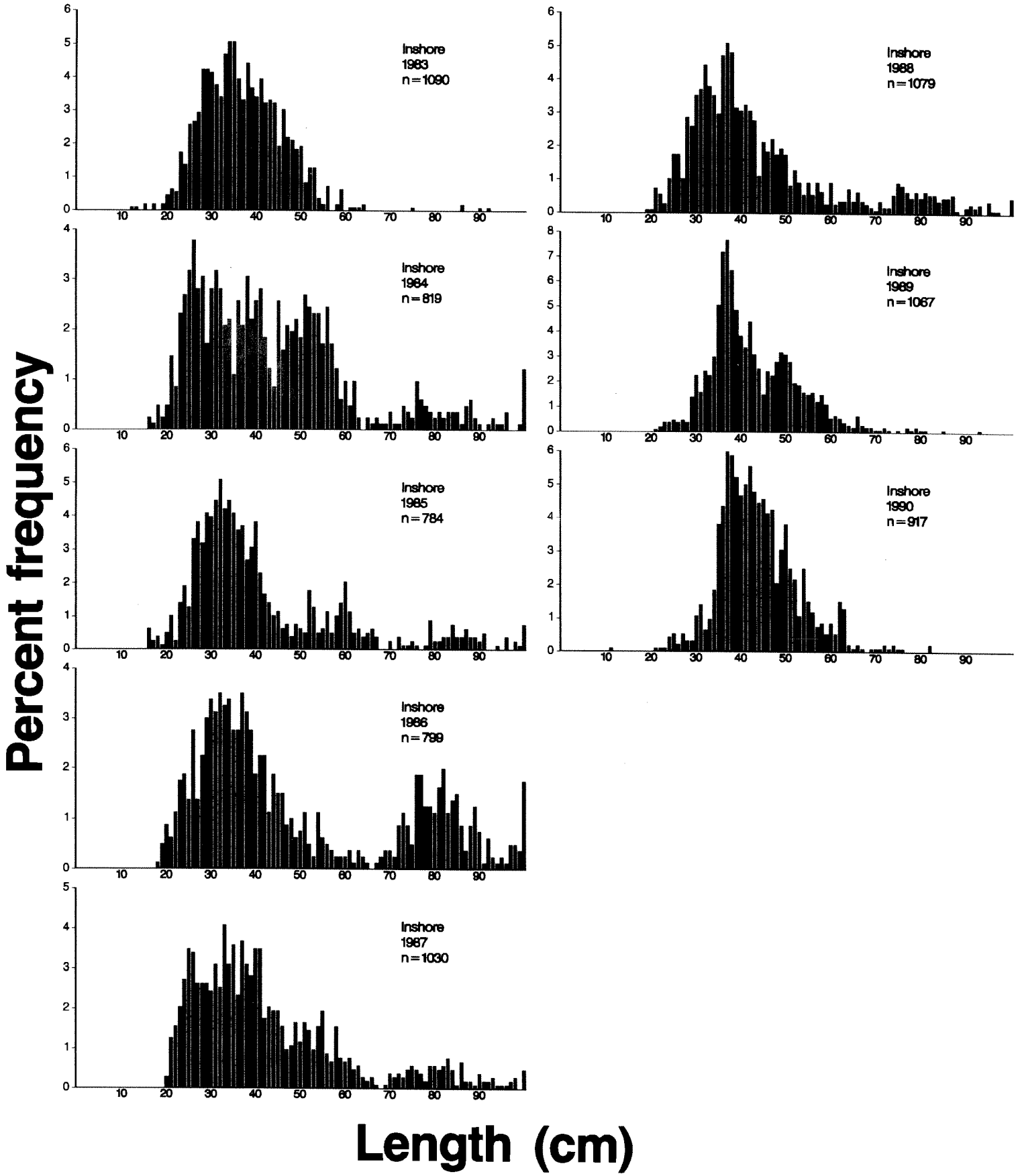

Figure 6. Black drum lengths from Texas inshore recreational catch.

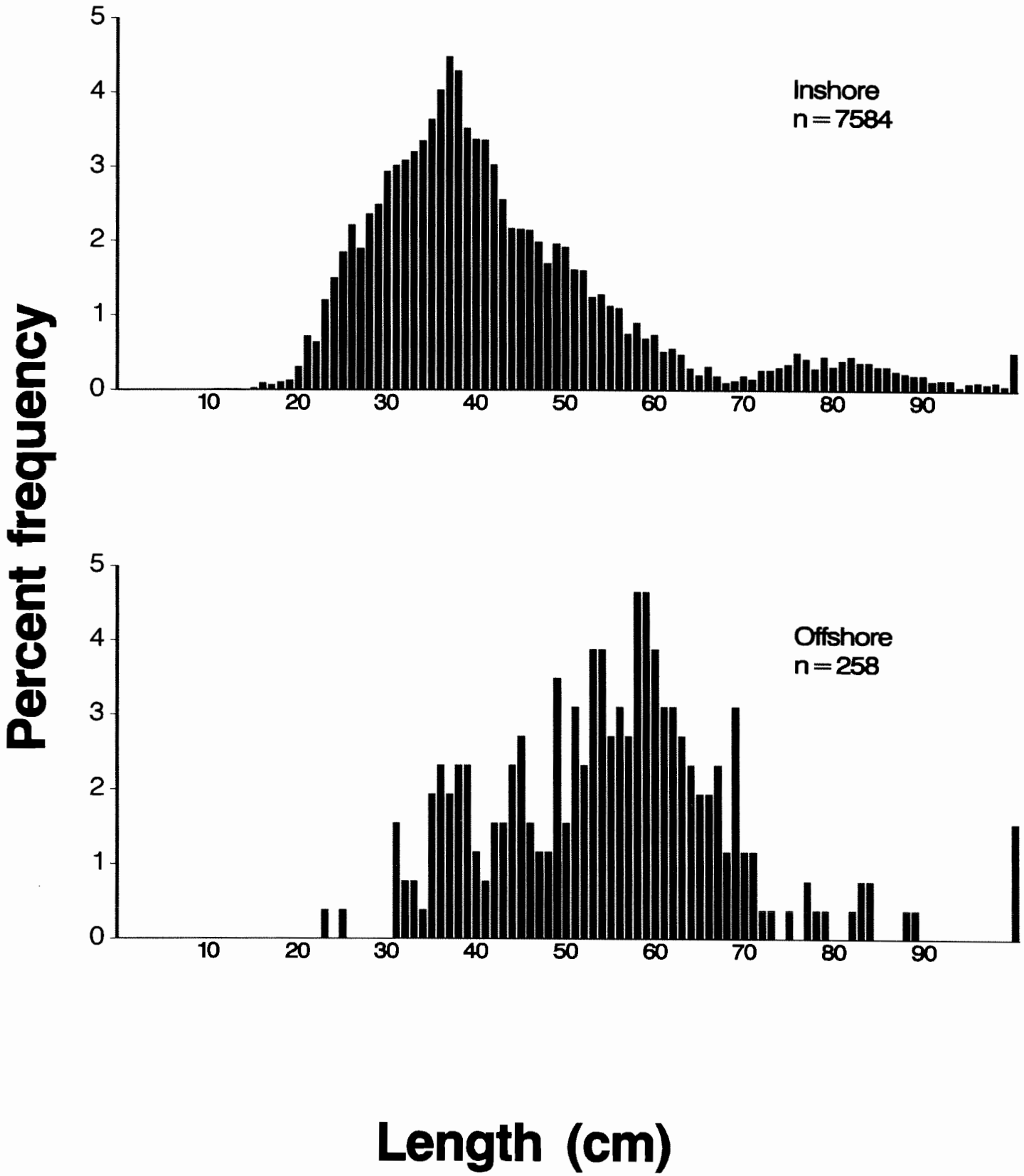

Figure 7. Black drum lengths from Texas recreational catch.

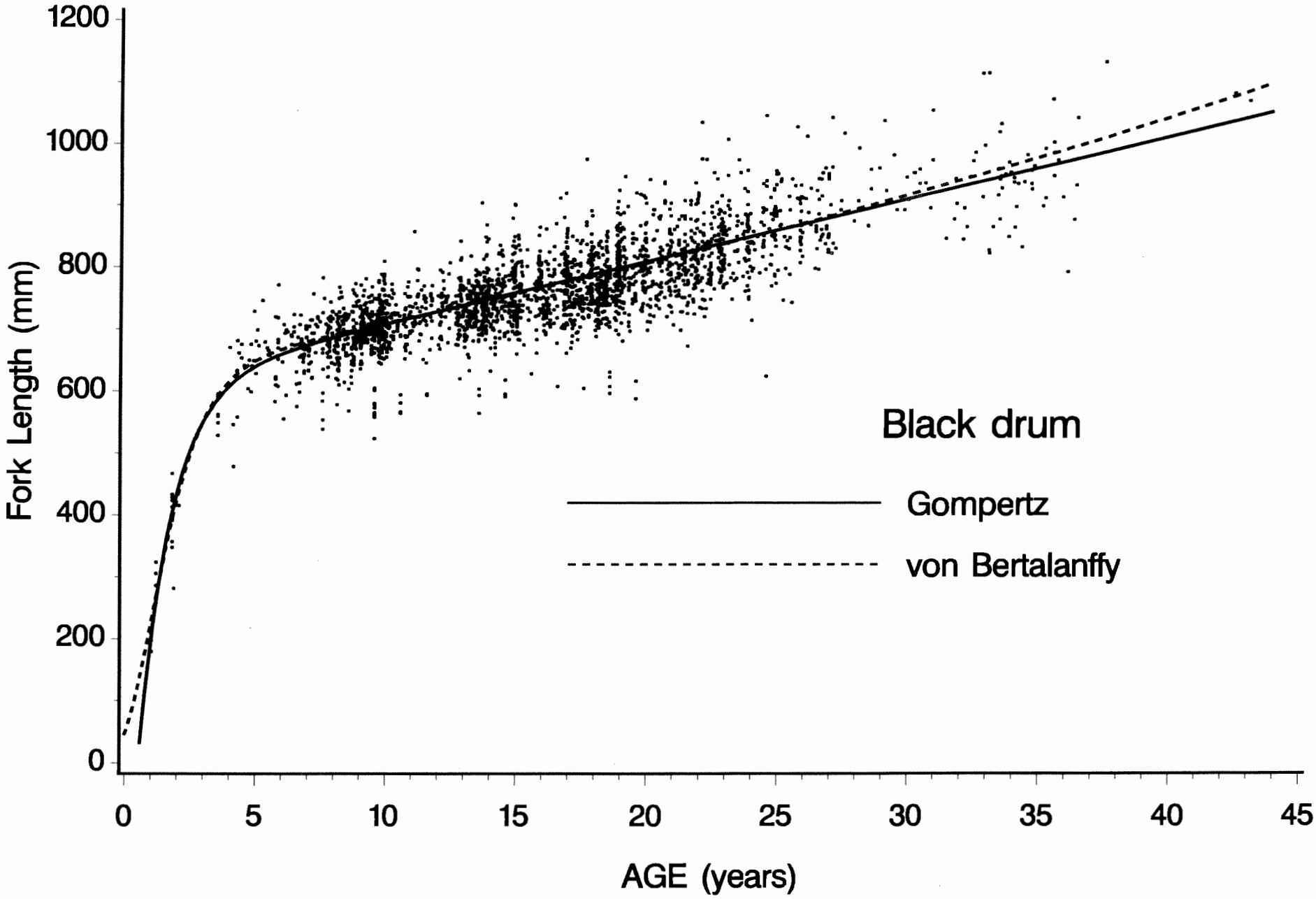

Figure 8. Black drum growth fitted to two sloped asymptote versions of growth models.

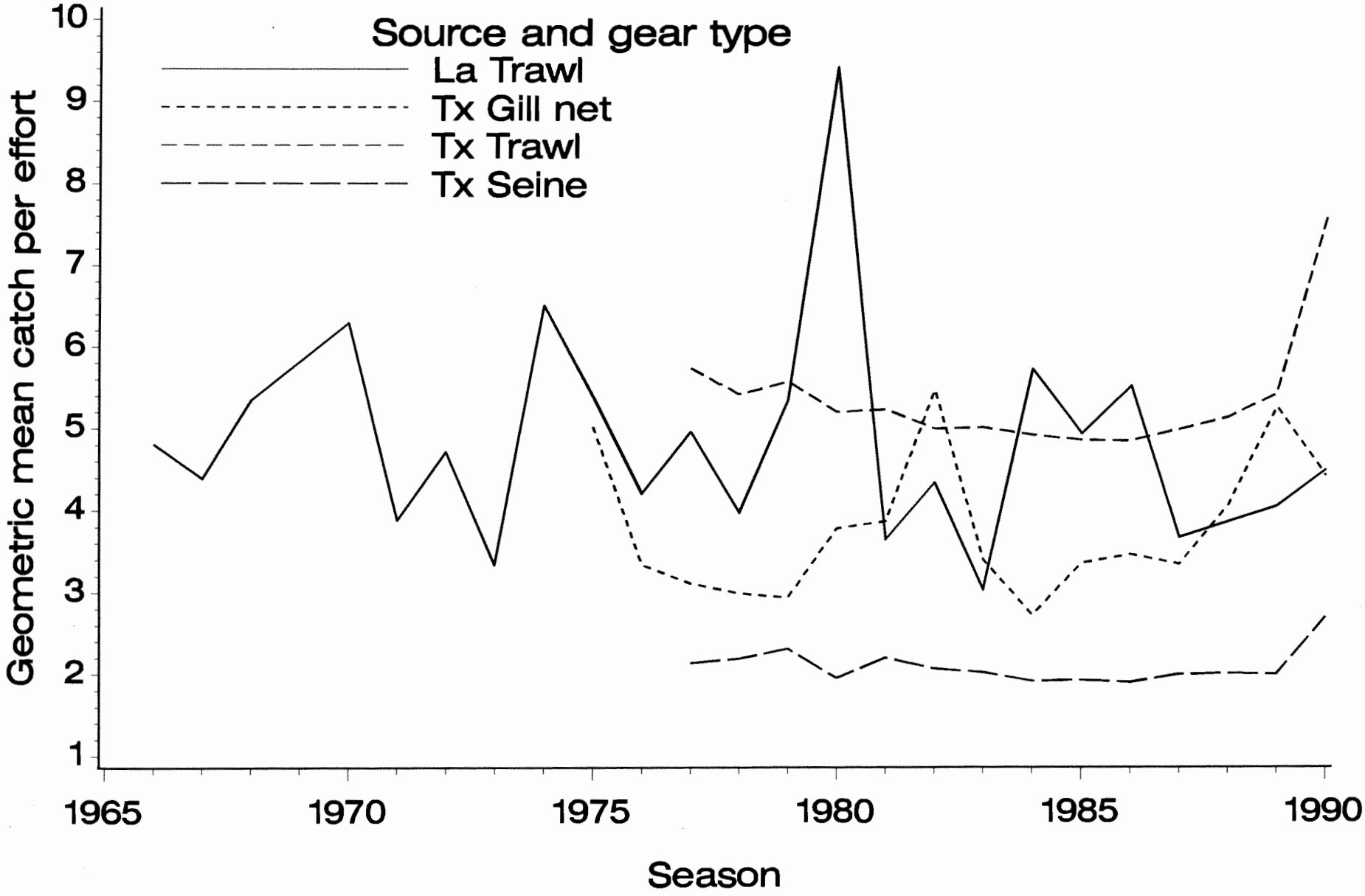

Figure 9. Black drum year class strength from La. Wildlife and Fisheries shrimp monitoring trawl data and from Texas Parks and Wildlife monitoring program.