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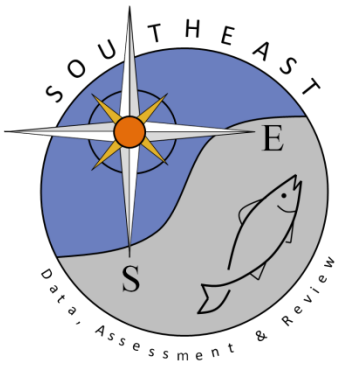

A Review of the Biology and Fishery for Gray Triggerfish, *Balistes capriscus*, in the Gulf of Mexico

by

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Introduction

The gray triggerfish, *Balistes capriscus*, is an important component of the Gulf of Mexico reef fish fishery, particularly for the recreational sector, and ranks eighth in total reef fish landings during the period 1986 through 1991 (Goodyear and Thompson, 1993). In the Gulf of Mexico, gray triggerfish are principally caught by recreational fishers using handlines, while commercial fishers harvest this species with various gears including handlines, longlines, traps, and trawls. Based on National Maine Fisheries Service (NMFS) data, the 1986 through 1996 gray triggerfish ex-vessel commercial value from the Gulf of Mexico ranged from $51.5 thousand in 1986 to a record in $545.7 thousand in 1993 and averaged $282.7 thousand during this time period. Until recently, gray triggerfish were not prized by most fishers. An increased targeting of this species by both recreational and commercial fishers with a resultant increase in total gray triggerfish landings has occurred over this period. This increase may be due to reduction in other reef fish stocks and more restrictive regulations on other reef fish species.

Gray triggerfish in the Gulf of Mexico EEZ are managed under the 1981 Fishery Management Plan (FMP) for Reef Fish Resources and subsequent amendments. In addition to the management measures applicable for this FMP, gray triggerfish taken by recreational fishers from state territorial waters in Florida are subject to a 12 inch total length minimum size limit. Effective management of this species is hindered by a lack of complete life history information. The potential effects of overfishing gray triggerfish populations are assumed to be similar to the effects of overfishing on other reef fish species because of similar mortality rates (Johnson and Saloman, 1984).

Due to concern caused by recent increased landings of this resource, an evaluation of data on size and catch limits for gray triggerfish in the Gulf of Mexico was prepared by Goodyear and Thompson (1993). They estimated that from 1986 to 1991 total landings increased to approximately 3 million pounds and average annual landings were about 2 million pounds . The objectives of this report are to: (1) examine trends in the commercial and recreational harvests, and (2) summarize biological, life history, and population parameters presented in the literature.

Data Sources and Methods

Gray triggerfish landings statistics in the Gulf of Mexico since 1986 were available for both the recreational and commercial sectors. Recreational harvest estimates were obtained from: (1) National Marine Recreational Fishery Statistics Survey (MRFSS), (2) Southeast Fisheries Science Center (SEFSC) Beaufort Laboratory Headboat Survey, and (3) Texas Parks and Wildlife Department

Recreational Creel Survey. Estimates of recreational catches from the MRFSS represent the most current revisions available in the database at this time. Commercial landings estimates were provided from the SEFSC General Canvass Program as presented in the Accumulated Landings Data Files of the Southeast Fisheries Information Network.

An extensive literature search for information pertaining to the gray triggerfish, *Balistes capriscus* = *Balistes carolinesis*, was performed. This search included, but was not limited to: (1) computerized bibliographic and information services such as FishBase96, Aquatic Sciences and Fisheries Abstracts, Current Contents, and Carl Uncovered; (2) library resources at the SEFSC Miami facility and the Rosensteil School of Marine and Atmospheric Sciences; and (3) efforts to glean information provided in the "gray literature".

Results and Discussion

Fishery

The fishery for gray triggerfish is described in the FMP for reef fish resources in the Gulf of Mexico (GMFMC, 1981). The Gulf of Mexico reef fish fishery is a multi-species fishery in which catches and landings for individual trips consist of several to many species. Historically the reef fish fishery began in 1865, targeting red snapper. Participants in this fishery primarily target groupers and snappers, and occasionally amberjack. The current fishery provides both commercial and recreational fishing opportunities in the Gulf of Mexico. Commercial fishers use longlines and power reels or handlines to harvest reef fish for sale as food. Recreational fishers include persons fishing, primarily with handlines, from privately owned craft, charter and headboat vessels, and shore or pier. A large number of species associated with reefs not managed or targeted are taken incidentally by some gear and frequently discarded.

In recent years, the well known species (e.g., red snapper and grouper) targeted by recreational fishers have been less available and effort has shifted to what used to be called under-utilized species, of which the gray triggerfish is a member. Charter and headboat captains in the Panhandle of Florida now consider the "trigger snapper" to be a desirable catch, and it is possible to see large numbers mounted on the fish racks after fishing trips. In the past it has been known to be impossible to get a bait to the bottom for snapper and grouper because the triggerfish meet the bait in the water column.

Total Gulf of Mexico gray triggerfish landings by weight were estimated for

both the recreational and commercial sectors for 1986 through 1996 (Table 1, Figure 1). Total landings were dominated by the recreational sector which averaged 82.9% of total landings estimated during this time period. Total landings increased from 1.54 million pounds in 1986 to a peak harvest of 2.85 million pounds in 1990. Since 1990, estimated total gray triggerfish landings from the Gulf of Mexico have steadily declined to .88 million pounds during 1996. The proportion of total estimated gray triggerfish landings by state during the 1986-1996 period was: Florida 67.2%, Alabama 18.7%, Louisiana 8.2%, Texas 5.1%, and Mississippi 0.8%.

The recreational gray triggerfish harvest by fishing mode from the Gulf of Mexico in numbers and weight was estimated for 1986-1996 (Table 2). Estimated recreational gray triggerfish landings reached a peak of 2.39 million pounds in 1990 and have since declined to 0.63 million pounds in 1996 (Figure 2). For the period 1986-1996 landings from the charter boat mode have dominated the recreational sector averaging 59.1% by number and 63.4% by weight of total recreational landings.

Annual gray triggerfish landings by weight from the Gulf of Mexico for the period 1986-1996 were estimated for the commercial sector (Table 3, Figure 3). The majority of commercial landings were reported from Florida with 71.2 % of total commercial landings during this time period. Proportional representation for the other Gulf states was: Louisiana 21.5%, Texas 2.6%, Alabama 2.4%, and Mississippi 2.3%. Within the Gulf, commercial gray triggerfish landings were stratified by statistical grid (Table 4, Figure 4). Four statistical grids accounted for more than 50% of total estimated commercial landings for 1986-1996. These statistical grids and proportional representation were: Grid 10 - 19.%, Grid 11 - 12.7%, Grid 6 - 10.6%, and Grid 14- 9.5%.

Biological and Population Information

Distribution

The gray triggerfish, *Balistes capriscus* (Gmelin, 1788), is a member of the Family Balistidae and is widely found in tropical and temperate waters throughout the Atlantic (Moore, 1967; Tyler, 1978). In the Eastern Atlantic it is found from the British Isles to Mocamedes, Angola, including Madeira, Canary, Cape Verde Is., Ascension and St. Helena north to the Mediterranean, Adriatic, and Black Seas (Harmelin-Vivien and Quero, 1990). In the Western Atlantic it ranges from Nova Scotia through the Gulf of Mexico to Argentina and also found in Bermuda (Robins and Ray, 1986).

Gray triggerfish are important members of reef fish assemblages and are commonly associated with coral reefs, wrecks, outcroppings, artificial structures, and hard bottom areas (Bohlke and Chapman, 1993; Aiken, 1983; Manooch, 1984). A diurnally active species (Vose and Nelson, 1994), it is usually solitary except for spawning but does form large schools (Caveriviere, 1982). It occurs from shallow water down to about 50-100 meter depth (Froese and Pauly, 1996). In the Gulf of Mexico the gray triggerfish inhabits areas between 12 and 42 m in depth (Smith, 1976), except for the first year of life when it is planktonic and associated with sargassum or other drifting debris (Dooley, 1972; Johnson and Saloman, 1984). They are known to refuge in reef cavities when disturbed (Frazer and Lindberg, 1994). Triggerfishes commonly associate with artificial reef structures and are a successful early colonizer of artificial reefs (Frazer et al, 1991; Vose and Nelson, 1994). Even though the literature describes them to be solitary individuals, large numbers are known to congregate over offshore reefs, wrecks, and artificial reefs. Caveriviere (1982) describes how the subsurface concentrations extend as far as the continental shelf, with day-night variations of abundance observed, individuals on the bottom during the day move towards the surface at night. Seasonal abundance variations occur off Senegal in upwelling areas, where they may disappear during the cold season (Caveriviere, 1982).

Reproduction and early life history

Early life history of gray triggerfish has been reviewed from the mid Atlantic Bight (Martin and Drewry, 1978), off Senegal (Caveriviere et al., 1981; Caveriviere, 1982), and off Brazil (Matsuura and Katsuragawa, 1981). Dooley (1972) estimated the spawning season from July-October in the Gulf of Mexico based on sizes of fish captured. Gray triggerfish spawn in the northern Gulf of Mexico during the late spring (March) and early summer (August), with a peak in June (Wilson et al, 1995). Caveriviere et al. (1981) reported gray triggerfish spawned off Senegal from the late Spring to early Fall based on sexual maturity and gonadal index stage 4-5 in July and August. Ofori-Danson (1990) defined the breeding season as October to December, the warmer months off Ghana. Garnaud (1960) observed the spawning of gray triggerfish in captivity and showed a figure of a yolk-sac larvae. Matsuura and Katsuragawa (1981) described the larvae and juveniles. Since intromittent organs are absent it is assumed that fertilization is external (Aiken, 1983). Egg incubation period has been reported as 2 days (Lythgoe and Lythgoe, 1975; Caveriviere, 1982). Some distinct pairing of gray triggerfish have been observed, usually offshore in shallow seas (Breder and Rosen, 1966). Loebel and Johannes (1980) reported spawning aggregations of *Balistes undulatus.*

Most studies indicate gray triggerfish reach sexual maturity at 2 years, but may mature at 1 year (Wilson et al, 1995; Ofori-Danson, 1981), 1.5 years (Ofori-Danson, 1990), to up to 3 years (Manooch, 1984). Estimated length at time of first spawning has been reported to be 14-15 cm FL (Ofori-Danson, 1981), 13.3-15.7 cm FL and 50.0 - 70.5 grams (Ofori-Danson, 1990), 13-14 cm from Senegal and Guinean waters (Gerlotto et al., 1979), and 17-21 cm (Ofori-Danson, 1989). Manooch (1984) reports 30 cm as length at first spawning. No evidence of sex change was found by Wilson et al., (1995).

Balistid eggs may be pelagic and non-adhesive or demersal and adhesive. Some parental care may take place if the eggs are demersal and adhesive (Breder and Rosen, 1966; Fricke, 1980). Lythgoe and Lythgoe (1975) reported *B. carolinensis* (= *B. capriscus*) excavating a shallow nest in sand, depositing of an egg mass in it, and the adults guarded the embryos which hatched in two days. Caveriviere (1982) reported gray triggerfish off Senegal as being nest builders, the eggs hatching in 50-55 hours, the larvae being planktonic. Two species in the Pacific are nest builders and Aiken (1983) describes two Pacific species which attaches to corals. Fricke (1980) describes courtship, mating, and parental care in two species from the Red Sea. Gray triggerfish may be multiple batch spawners (Wilson et al, 1995), but it is not known whether they are pelagic spawners or nest builders (Aiken, 1983; Wilson et al, 1995). Richards and Lindeman (1987) in a review of reef fish recruitment dynamics list the triggerfishes as either pelagic or demersal spawners but having pelagic larvae that have no standard term of planktonic life.

Nesting, eggs and larvae for the Balistids are discussed by Lobel and Johannes (1980), Bertolini et al (1956), and Fricke (1980). Not much is known about fecundity except 73 eggs/gram for *Balistes vetula* and 217 eggs/ gram for *Cantherhines sufflamen* are estimated (Aiken, 1983). Gray triggerfish fecundity has been estimated as 49 thousand for a 30 cm fish, 66 thousand for a 41 cm fish, and more than 90,000 for a 56 cm fish (Manooch, 1984). Ofori-Danson (1990) for triggerfish off Ghana described a linear regression log F (fecundity) = 1.176 + 1.642 log FL. Caveriviere et al. (1981) reported a linear relation for gray triggerfish off Senegal between the gonad weight on fish weight as : Y(pounds of gonads) = 0.55 + (6.36×10^{-2})X(pounds of fish); r = 0.82. They also provide a relation for fecundity on gonad weight as Y(pounds of gonads) = 8.2 + (9.2×10^{-5})X(number of eggs); r=0.85 and fecundity on fish weight as Y(number of eggs) = -83000 + 690X (pounds of fish).

The descriptive biology of larvae and juveniles of gray triggerfish was reviewed from Brazil by Matsuura and Katsagawa (1981). Longley and Hildebrand (1942) describe gray triggerfish up to 10 cm common in *Sargassum spp*. and about

bits of flotsam and some were described as hiding inside bits of bamboo. Nugent (1970) found juveniles in mangrove estuaries . Aiken's (1983) study in Jamaica found them among mangroves and in sargassum and suggests the larvae are transported by oceanic currents. At approximately 16-17 cm SL, it appears that gray triggerfish colonize hard bottom habitat (Vose and Nelson, 1994).

Movements and Migration

Aiken (1983), based upon the results of several tropical Atlantic tagging studies, reported no indications of migration for triggerfishes. However, he did indicate that a similar species, the queen triggerfish *Balistes vetula*, appears to move to deeper water as they grow older based upon size composition of fish captured by depth. Most literature indicates that gray triggerfish settle out of a planktonic larval stage on artificial reefs and natural substrates, and move to offshore reefs as they grow.

Gulf of Mexico tagging studies {Beaumariage, 1969; Johnson and Saloman, 1984; R. L. Shipp, pers. comm.) suggest that gray triggerfish have very high site fidelity. The NMFS tagging database only has records of six releases and one recapture with incomplete release data (D. Rosenthal, NMFS, SEFSC, pers. comm.). Beaumariage (1964) found that 38 of 103 fish (36.9%) remained in the approximate area of release in the northern Gulf of Mexico. In an ongoing northern Gulf of Mexico tagging study, 18 of the 25 (72%) recaptured gray triggerfish (153 releases) demonstrated high site fidelity (R.L. Shipp, pers. comm.) .

Diseases

Hepatomegaly (enlargement of the liver) occurs in gray triggerfish collected near platforms, which act as artificial reefs (Grizzle, 1986). Aiken (1983) describes known diseases found in Balistids.

Predation and Mortality

One of the major sources of natural mortality of balistids would be predation on the pelagic stages (Dragovich 1969, 1970) and by groupers or sharks upon demersal fish (Aiken, 1983). Aiken (1983) noted that tunas feed on post-larval and juvenile triggerfish, and reports other authors identifying blue marlin, dolphinfish, sailfish, and sharks also preying upon juvenile Balistidae. Caveriviere et al. (1981) reported greater amberjack, sharks, and grouper are important predators. Extreme

cases of infestation by cestode parasites would also cause death (Aiken, 1983).

Food and feeding

Triggerfishes feed diurnally (Randall, 1968), are mainly bottom feeders (Aiken, 1983), and are particularly adapted to prey upon hard shelled invertebrates which are consumed by few other reef dwelling fishes (Frazer et al, 1991). Vose and Nelson (1994) describe feeding of the gray triggerfish. They are adapted for feeding on well armored prey but are not specialized feeders. The species are opportunistic feeders whose morphology provide the ability to feed on both unarmored and armored prey. Attached fauna are the main food on both artificial and natural substrate and reef-produced prey items are the most important. Greater amount of bivalves from natural reefs and more barnacles on artificial reefs are consumed. They have been reported to feed on a variety of sand dwelling invertebrates, including decapod crustaceans, echinoderms, scyllarid (slipper) lobsters, clams, and sand dollars, many of which were planktonic (Randall, 1967; Aiken, 1983; Sedberry, 1984; Tortonese, 1986; Nelson et al, 1986; Nelson, 1988; Vose, 1990; Frazer et al, 1991; Robert and Parra, 1991; Barshaw and Spanier, 1994; Frazer and Lindberg, 1994; Kurz, 1995). Dooley (1972) found juveniles relied heavily on the sargassum complex for food and that algae, hydroids, barnacles and polychaetes were important in the diet of small gray triggerfish.

McClanahan (1990,1994,1995) indicated a relationship between the number of gastropods and sea urchins, and triggerfish (*Balistes undulatus*) in Kenyan waters where triggerfish are the main predator on sea urchins. He examined the ecology of overfishing and the upswings of prey and predator densities. Sand dollars and gray triggerfish have been extensively studied (Frazer et al, 1991; Frazer and Linberg, 1994; Vose and Nelson, 1994; Kurz, 1995). The abundance of dead sand dollars decreased as distance from the artificial reef increased reef, and prey densities increase with distance from reef units.

Morphometrics

The possibility of intraspecific differentiation exists within populations of gray triggerfish as noted by Sazonov and Galationova (1984) in the Central-eastern Atlantic.

The following relationships were available from the literature:

Total Weight on Gutted Weight		
TW = GW x 1.0669	Coull et al., 1989	N = 3

Fork Length on Total Length

FL(mm) = 29.704 +0.774TL(mm)	Johnson and Saloman, 1984	N=100
FL(in) = 0.621 + 0.824 TL(in)	Goodyear and Thompson, 1993	N=243

Fork Length on Standard Length

FL(mm) = 22.823 +1.171SL(mm)	Johnson and Saloman, 1984	N=100

Total Length on Standard Length

TL (mm) = 9.666 +1.446 SL(mm)	Johnson and Saloman, 1984	N=100

Total Length on Fork Length

TL(in) = 1.214FL(in) - .754	Goodyear and Thompson, 1993	N=243

Weight on Fork Length - Unsexed

$Wt(g) = 4.13x10^{-5}FL(mm)^{2.87}$	Caveriviere et al., 1981	N=1584
$Wt(lbs) = 8.975x10^{-4}FL(in)^{2.96}$	Goodyear and Thompson, 1993	N=9138
$Wt(kg) = 4.168x10^{-5}$ $FL(cm)^{2.9057}$	Wilson et al., 1995	N=318
$Wt(g) = 2.911x10^{-5}FL(mm)^{2.9352}$	Bohnsack and Harper, 1988	N=233
$Wt(g) = 2.146x10\text{-}5FL(mm)^{2.992}$	Johnson and Saloman, 1984	N=175

Weight on Fork Length - Males

$Wt(g)=6.7105x10\text{-}6FL(mm)^{3.187}$	Johnson and Saloman, 1984	N=169

Weight on Fork Length - Females

$Wt(g) = 1.393x10\text{-}5FL(mm)^{3.065}$	Johnson and Saloman, 1984	N=169

Available length frequency distributions from 1979 are presented in Saloman and Fable (1981); and Goodyear and Thompson (1993). Bohkle and Chapman (1993) and Randall (1968) both reported maximum length was 30.5 cm (12 inches) as reported by Aiken (1983). The species is considered a gamefish with a world record all tackle weight of 6.165 kg (13.563 pounds) caught in 1989 off South Carolina (IGFA, 1997).

Age and Growth

Limited information exists about age and growth of the gray triggerfish, but they indicate that males live longer and females attain larger sizes . Johnson and Saloman (1984) reported that female ranged up to 12 years and 13 years for males in the northeastern Gulf of Mexico. The von Bertalanffy growth equations were as follows: males $l_t=491.9\ (1-e^{-3.82(t-0.227)})$; females $l_t=437.5(1-e^{-0.383(t-0.150)})$, where l = fork

length in millimeters and t = age in years. These calculations were based upon weighted means for a sample of 742 male and 625 female fish. Wilson et al, (1995) aged their fish up to 11 years and found length at age to be similar to those reported by Johnson and Salomon (1984). Based on these two studies from the Gulf of Mexico, gray triggerfish are slow growers and moderately long lived, achieving ages of 11-13 years.

Average back-calculated lengths-at-age calculated as weighted means were presented in Johnson and Saloman (1984) as 11.3 cm, 23.7 cm, 30.6 cm, 35.4 cm, and 39.3 cm for age I, II, III, IV, and V respectively. Anonymous (1980) gave estimated values of 14.8 cm, and 20.3 cm for age I and II for fish off southwest Africa. Caveriviere et al. (1981) gave range values from 9-15.3 cm, 17.0-23.1 cm, 23.8-28.5 cm, 29.0-32.2 cm, and 32.4-34.8 cm for ages I, II, III, IV, and V years, respectively for Senegal. Ofori-Danson (1989) presents length-at-age estimates of 14.4 cm, 23.6 cm, 29.2 cm, and 33.0 cm for age groups I, II, III, and IV. From these, estimates of $L = 0.43\ year^{-1}$ were obtained for gray triggerfish from Ghana. Approximate average lengths for fish aged 1, 2, 3, 4, 5, 10, and 12 years are 10.9 cm, 22.6 cm, 30.2 cm, (0.59 kg), 35.6 cm (1.45 kg), 54.6 cm, and 55.9 cm (Manooch, 1984). The studies above indicate that size-at-age for African fish are different than the Gulf of Mexico. These differences may be the result of different environments, biology, methods of capture, or ageing (Johnson and Salomon, 1984). Population parameters are summarized in Table 5.

Summary

Total Gulf of Mexico gray triggerfish landings increased from 1.54 million pounds in 1986 to a peak harvest of 2.85 million pounds in 1990. Since 1990, estimated total gray triggerfish landings from the Gulf of Mexico have steadily declined to .88 million pounds during 1996. It is unclear if fishery restrictions or changes in target species preferences alone could explain this decline. The recreational sector accounts for the majority of gray triggerfish landings with an annual average of 82.9% as compared to an annual average of 17.1% for the commercial sector. The charter boat fishing mode dominates the recreational sector harvest and accounts for 59.1% by number and 63.4% by weight of recreational harvest for the 1986-1996 period.

Concerns and observations made by scientists, ie; Caveriviere (1979,1981,1982) off Senegal, Ofori-Danson (1989) off Ghana, Matsuura and Katsuragawa (1981) off Brazil, and others off Africa, should be carefully examined. In these geographical areas, gray triggerfish exploitation concerns have existed since the 1970's. Gray triggerfish management experiences from other regions may serve

as a useful model and valuable source of information in any attempts to manage gray triggerfish in the Gulf of Mexico.

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Table 1. Estimated Gulf of Mexico gray triggerfish landings (pounds), 1986-1996.
Data sources: Recreational sector - MRFSS estimate files
Commercial sector - Accumulative Landings data files on SEFHOST

RECREATIONAL SECTOR

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986	1,295,155	76,442		33,564	35,606	1,440,767
1987	1,647,995	47,998	2,225	8,928	35,593	1,742,739
1988	1,273,235	231,517	1,671	20,270	66,930	1,593,623
1989	1,020,319	413,598	4,875	98,632	98,960	1,636,384
1990	947,303	1,099,739	24,309	257,581	61,376	2,390,308
1991	1,740,748	340,797	1,234	147,791	59,907	2,290,477
1992	1,003,740	368,024	9,611	64,217	200,208	1,645,800
1993	853,044	381,913	4,152	54,580	152,448	1,446,137
1994	931,600	232,968	8,337	87,892	101,560	1,362,357
1995	515,175	415,673	18,238	147,633	100,829	1,197,548
1996	300,021	223,749	9,720	25,694	66,066	625,250

COMMERCIAL SECTOR

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986	70,978	5,881	4,008	14,493	572	95,932
1987	92,742	3,778	5,550	21,941	289	124,300
1988	140,790	7,641	8,242	36,980	1,885	195,538
1989	238,974	10,389	7,682	60,856	429	318,330
1990	359,553	16,613	9,027	69,798	6,951	461,942
1991	332,674	6,993	7,991	90,572	6,242	444,472
1992	321,883	6,551	12,433	101,495	7,941	450,303
1993	374,260	10,413	27,045	123,484	11,287	546,489
1994	247,156	8,389	50	96,757	15,428	367,780
1995	208,449	5,268	3	75,736	26,168	315,624
1996	158,511	2,867	198	76,151	17,226	254,953

TOTAL COMBINED SECTORS

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986	1,366,133	82,323	4,008	48,057	36,178	1,536,699
1987	1,740,737	51,776	7,775	30,869	35,882	1,867,039
1988	1,414,025	239,158	9,913	57,250	68,815	1,789,161
1989	1,259,293	423,987	12,557	159,488	99,389	1,954,714
1990	1,306,856	1,116,352	33,336	327,379	68,327	2,852,250
1991	2,073,422	347,790	9,225	238,363	66,149	2,734,949
1992	1,325,623	374,575	22,044	165,712	208,149	2,096,103
1993	1,227,304	392,326	31,197	178,064	163,735	1,992,626
1994	1,178,756	241,357	8,387	184,649	116,988	1,730,137
1995	723,624	420,941	18,241	223,369	126,997	1,513,172
1996	458,532	226,616	9,918	101,845	83,292	880,203

Table 2. Recreational harvest estimates for Gulf of Mexico gray triggerfish by state and fishing mode, 1986-1996. Data Sources: MRFSS estimate files

SHORE MODE

	Florida		Alabama		Mississippi		Louisiana		Texas		TOTAL GULF	
Year	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)
1986												
1987												
1988												
1989												
1990	27,485	60,405	30,765	73,397							58,250	133,802
1991	41,830	116,116	5,664	17,482							47,494	133,598
1992	27,981	20,523									27,981	20,523
1993	4,192	4,199									4,192	4,199
1994			1,265	3,381							1,265	3,381
1995	2,728	3,634									2,728	3,634
1996												

HEADBOAT

	Florida		Alabama		Mississippi		Louisiana		Texas		TOTAL GULF	
Year	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)
1986	17,419	42,434	11,604	24,008			407	907	15,611	21,771	45,041	89,120
1987	13,732	23,796	8,301	15,992			612	1,010	16,085	22,436	38,730	63,234
1988	15,818	26,848	11,304	20,232			1,927	3,013	39,511	39,826	68,560	89,919
1989	36,101	79,963	19,516	33,146			1,355	2,617	23,536	35,470	80,508	151,196
1990	58,506	84,948	46,829	69,020			3,915	7,023	21,650	37,390	130,900	198,381
1991	31,612	51,791	26,507	43,979			7,028	13,434	24,100	43,526	89,247	152,730
1992	37,720	58,843	31,204	50,814			5,862	10,844	35,890	49,197	110,676	169,698
1993	32,276	53,648	26,511	44,487			5,958	14,020	38,226	70,529	102,971	182,684
1994	28,837	44,632	24,629	37,527			6,678	13,465	50,034	90,024	110,178	185,648
1995	24,731	38,289	21,093	33,622			3,916	7,967	47,925	91,505	97,665	171,383
1996	19,687	30,918	16,508	26,539			2,828	5,355	37,501	61,819	76,524	124,631

CHARTER

	Florida		Alabama		Mississippi		Louisiana		Texas		TOTAL GULF	
Year	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)
1986	394,156	1,177,180	13,958	49,658			1,725	5,443			409,839	1,232,281
1987	463,119	1,287,557	10,266	21,460	13	20	1,803	3,907	1,388	3,008	476,589	1,315,952
1988	320,627	698,851	85,830	208,796	909	1,671	1,341	2,857	203	432	408,910	912,607
1989	247,969	394,354	129,322	321,138	4,655	4,875			102	217	382,048	720,584
1990	278,075	552,423	319,421	805,368	82	201	5,093	13,337	315	825	602,986	1,372,154
1991	552,408	1,438,373	94,231	261,052			56,612	132,430	137	320	703,388	1,832,175
1992	245,722	504,452	91,477	204,164	72	140	14,409	25,243	1,870	3,276	353,550	737,275
1993	269,817	552,749	95,899	204,504	930	2,072	16,834	37,177			383,480	796,502
1994	420,498	779,447	64,069	150,909	1,361	2,720	22,272	40,031	30	54	508,230	973,161
1995	273,115	451,957	131,656	243,842	1,029	2,156	27,739	60,708			433,539	758,663
1996	110,406	191,902	77,498	143,508	4,560	6,870	4,980	16,609	26	87	197,470	358,976

Table 2 (cont.). Recreational harvest estimates for Gulf of Mexico gray triggerfish by state and fishing mode 1986-1996. Data Sources: MRFSS estimate files

PRIVATE/RENTAL

	Florida		Alabama		Mississippi		Louisiana		Texas		TOTAL GULF	
Year	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)
1986	34,769	75,541	2,222	2,776			8,643	27,214	4,394	13,835	50,028	119,366
1987	144,246	336,642	4,224	10,546	1,429	2,205	2,029	4,011	5,134	10,149	157,062	363,553
1988	272,252	547,536	941	2,489			7,449	14,400	13,797	26,672	294,439	591,097
1989	395,900	546,002	38,941	59,314			49,453	96,015	32,589	63,273	516,883	764,604
1990	110,496	249,527	75,262	151,954	9,291	24,108	89,753	237,221	8,763	23,161	293,565	685,971
1991	47,553	134,468	10,177	18,284	1,399	1,234	1,055	1,927	8,793	16,061	68,977	171,974
1992	209,148	419,922	57,702	113,046	3,607	9,471	13,435	28,130	70,559	147,735	354,451	718,304
1993	110,028	242,448	52,531	132,922	983	2,080	1,619	3,383	39,204	81,919	204,365	462,752
1994	50,259	107,521	24,761	41,151	3,022	5,617	18,788	34,396	6,272	11,482	103,102	200,167
1995	15,102	21,295	74,389	138,209	7,868	16,082	37,592	78,958	4,439	9,324	139,390	263,868
1996	50,010	77,201	29,748	53,702	1,828	2,850	2,054	3,730	2,291	4,160	85,931	141,643

ALL MODES

	Florida		Alabama		Mississippi		Louisiana		Texas		TOTAL GULF	
Year	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)	N	Wt.(lbs)
1986	446,344	1,295,155	27,784	76,442	0	0	10,775	33,564	20,005	35,606	504,908	1,440,767
1987	621,097	1,647,995	22,791	47,998	1,442	2,225	4,444	8,928	22,607	35,593	672,381	1,742,739
1988	608,697	1,273,235	98,075	231,517	909	1,671	10,717	20,270	53,511	66,930	771,909	1,593,623
1989	679,970	1,020,319	187,779	413,598	4,655	4,875	50,808	98,632	56,227	98,960	979,439	1,636,384
1990	474,562	947,303	472,277	1,099,739	9,373	24,309	98,761	257,581	30,728	61,376	1,085,701	2,390,308
1991	673,403	1,740,748	136,579	340,797	1,399	1,234	64,695	147,791	33,030	59,907	909,106	2,290,477
1992	520,571	1,003,740	180,383	368,024	3,679	9,611	33,706	64,217	108,319	200,208	846,658	1,645,800
1993	416,313	853,044	174,941	381,913	1,913	4,152	24,411	54,580	77,430	152,448	695,008	1,446,137
1994	499,594	931,600	114,724	232,968	4,383	8,337	47,738	87,892	56,336	101,560	722,775	1,362,357
1995	315,676	515,175	227,138	415,673	8,897	18,238	69,247	147,633	52,364	100,829	673,322	1,197,548
1996	180,103	300,021	123,754	223,749	6,388	9,720	9,862	25,694	39,818	66,066	359,925	625,250

Table 3. Estimated Gulf of Mexico gray triggerfish commercial landings by gear type.
Data source: Accumulated Landings data files on SEFHOST

HANDLINES

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986	58,517	5,834	4,008	7,178	35	75,572
1987	69,375	3,687	5,550	21,593		100,205
1988	127,241	7,470	7,269	35,956		177,936
1989	195,848	9,598	7,682	51,254		264,382
1990	275,944	13,835	9,027	60,291	2,443	361,540
1991	286,488	5,474	7,991	78,236	1,414	379,603
1992	286,362	6,041	12,218	87,670	4,882	397,173
1993	311,693	9,240	27,045	106,644	4,074	458,696
1994	222,101	8,139	50	83,578	5,589	319,457
1995	180,865	4,557	3	65,420	9,445	260,290
1996	133,779	2,600	198	65,779	6,217	208,573

LONGLINES

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986	12,461			7,315	537	20,313
1987	23,339			348	289	23,976
1988	13,051			613	1,885	15,549
1989	30,166			9,512	429	40,107
1990	71,299	2,581		9,247	4,500	87,627
1991	9,918	95		11,999	4,828	26,840
1992	5,142		215	13,446	3,055	21,858
1993	9,049	303		16,359	7,208	32,919
1994	1,144	11		13,119	9,831	24,105
1995	4,783			10,033	16,440	31,256
1996	11,975			10,089	11,000	33,064

TRAPS

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986						
1987						
1988	33					33
1989	12,537					12,537
1990	12,050					12,050
1991	34,150					34,150
1992	29,780					29,780
1993	52,406					52,406
1994	22,815					22,815
1995	19,900					19,900
1996	12,185					12,185

Table 3 (cont.). Estimated Gulf of Mexico gray triggerfish commercial landings by gear type.
Data source: Accumulated Landings data files on SEFHOST

TRAWLS

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986		47				47
1987		91				91
1988		171	973	411		1,555
1989		791		90		881
1990	139	197		260	8	604
1991	350	1,424		338		2,112
1992		510		379	4	893
1993	80	870		461	6	1,417
1994	41	239		60	8	348
1995	71	711		283	283	1,348
1996	19	267		284	9	579

OTHER

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986						
1987	28					28
1988	465					465
1989	423					423
1990	121					121
1991	1,768					1,768
1992	603					603
1993	1,033					1,033
1994	1,055					1,055
1995	2,831					2,831
1996	553					553

COMBINED ALL GEARS

Year	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1986	70,978	5,881	4,008	14,493	572	95,932
1987	92,742	3,778	5,550	21,941	289	124,300
1988	140,790	7,641	8,242	36,980	1,885	195,538
1989	238,974	10,389	7,682	60,856	429	318,330
1990	359,553	16,613	9,027	69,798	6,951	461,942
1991	332,674	6,993	7,991	90,573	6,242	444,473
1992	321,887	6,551	12,433	101,495	7,941	450,307
1993	374,261	10,413	27,045	123,464	11,288	546,471
1994	247,156	8,389	50	96,757	15,428	367,780
1995	208,450	5,268	3	75,736	26,168	315,625
1996	158,511	2,867	198	76,152	17,226	254,954

Table 4. Estimated Gulf of Mexico gray triggerfish commercial landings by grid, 1986-1996.

Grid	Florida	Alabama	Mississippi	Louisiana	Texas	Total Gulf
1	4,787					4,787
2	33,361					33,361
3	21,141					21,141
4	26,550					26,550
5	162,749					162,749
6	379,884					379,884
7	227,022					227,022
8	196,623					196,623
9	322,904		148			323,052
10	618,663	65,051	5,740			689,454
11	425,172	13,286	14,573			453,031
12	41,777		161	1,682		43,620
13	40,444	1,241	4,665	266,836		313,186
14	18,066		6,951	316,449		341,466
15	9,521		9,292	106,082		124,895
16	9,366		9,995	47,707	415	67,483
17	5,509	5,196	14,600	27,630	1,291	54,226
18	2,170	9	10,750	1,877	51,649	66,455
19			3,683		15,430	19,113
20			887		886	1,773
21	269		784		24,747	25,800
Total	2,545,978	84,783	82,229	768,263	94,418	3,575,671

Table 5. Population parameters for gray triggerfish available from the literature.

Von Bertalnffy Growth coefficients			Mortality coefficients				Maximum age (yr)	Maximum length (cm)	Age at maturity (yr)	Length at maturity (cm)	Sex	Area	Reference
						Estimation							
k	**Loo (cm)**	**to (yr)**	***a***	***s***	***i***	**Method***							
0.199	57.1	0.015									unsexed	SE USA	Escorriola, 1991
0.383	43.75 FL	0.150	0.36	0.64	0.45	1	12	56.1 FL			female	NE GOM	Johnson and Saloman, 1984
			0.32	0.68	0.38	2					female	NE GOM	Johnson and Saloman, 1984
			0.45	0.55	0.59	3					female	NE GOM	Johnson and Saloman, 1984
			0.47	0.53	0.64	4					female	NE GOM	Johnson and Saloman, 1984
0.382	49.19 FL	0.227	0.33	0.67	0.40	1	13	54.4 FL			male	NE GOM	Johnson and Saloman, 1984
			0.32	0.67	0.39	2					male	NE GOM	Johnson and Saloman, 1984
			0.44	0.56	0.57	3					male	NE GOM	Johnson and Saloman, 1984
			0.53	0.47	0.75	4					male	NE GOM	Johnson and Saloman, 1984
0.382	46.60 FL	0.189	0.34	0.66	0.41	1					unsexed	NE GOM	Johnson and Saloman, 1984
			0.33	0.64	0.40	2					unsexed	NE GOM	Johnson and Saloman, 1984
			0.44	0.56	0.58	3					unsexed	NE GOM	Johnson and Saloman, 1984
			0.49	0.51	0.67	4					unsexed	NE GOM	Johnson and Saloman, 1984
0.43	40.8 FL								1	14.5 FL	unsexed	Ghana	Ofori-Danson, 1989
							11-12		1-2		unsexed	N GOM	Wilson et al., 1995
0.03481	38.0	-0.233									female	Senegal	Caveriere et al., 1981
0.04488	37.5	0.217									male	Senegal	Caveriere et al., 1981
0.03058	40.7	-0.283									unsexed	Senegal	Caveriere et al., 1981
0.01126	41.0	-1.800									unsexed	Ivory Coast	Caveriere et al., 1981

Legend:

Mortality coefficents

a = annual mortality
s = annual survival
i = instantaneous mortality

* Estimation methods(from Table 8, Johnson and Saloman, 1984)

1 - Hencke, 1913
2 - Jackson, 1939
3 - Robson and Chapman, 1961
4 -Regression analysis

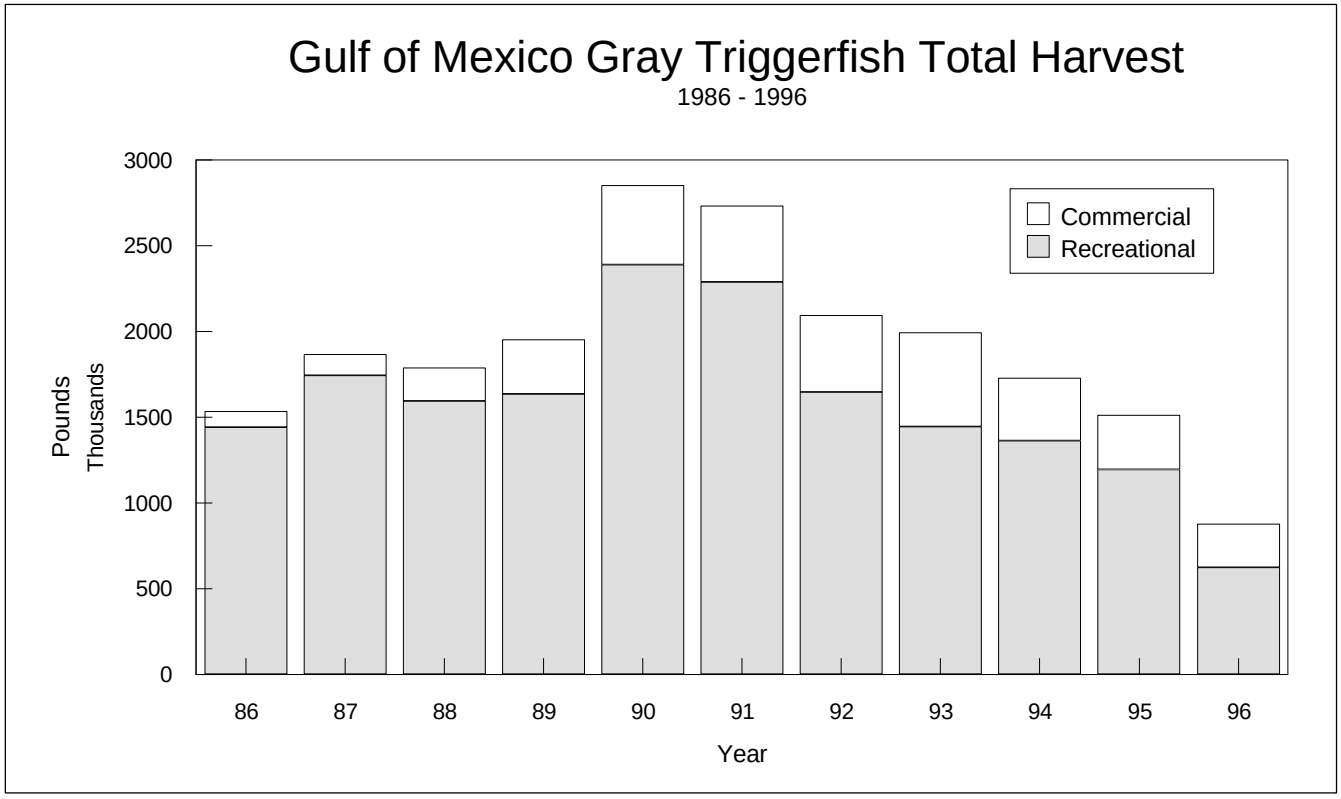

Figure 1. Estimated Gulf of Mexico gray triggerfish annual landings by weight for commercial and recreational sectors for the period 1986 through 1996.

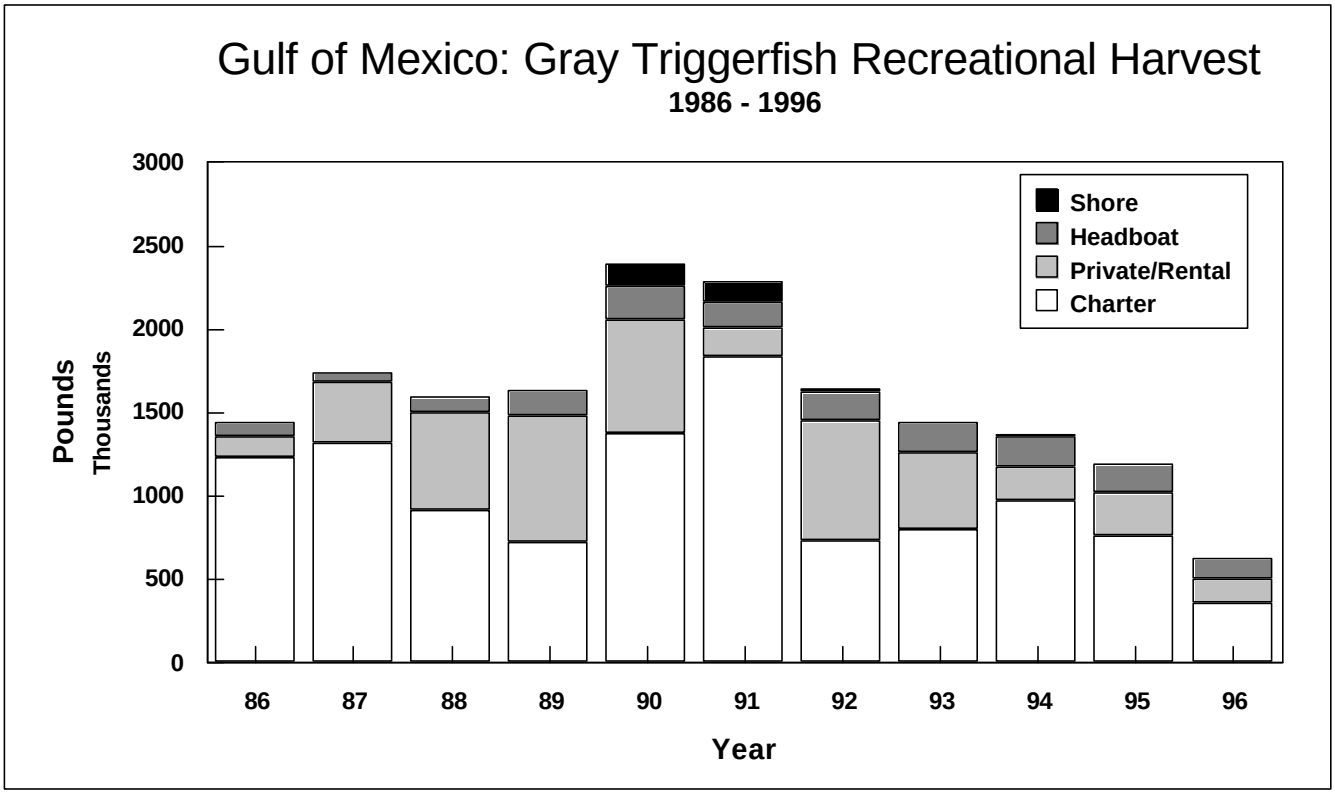

Figure 2. Estimated Gulf of Mexico gray triggerfish annual recreational landings in weight by mode for the period 1986 through 1996.

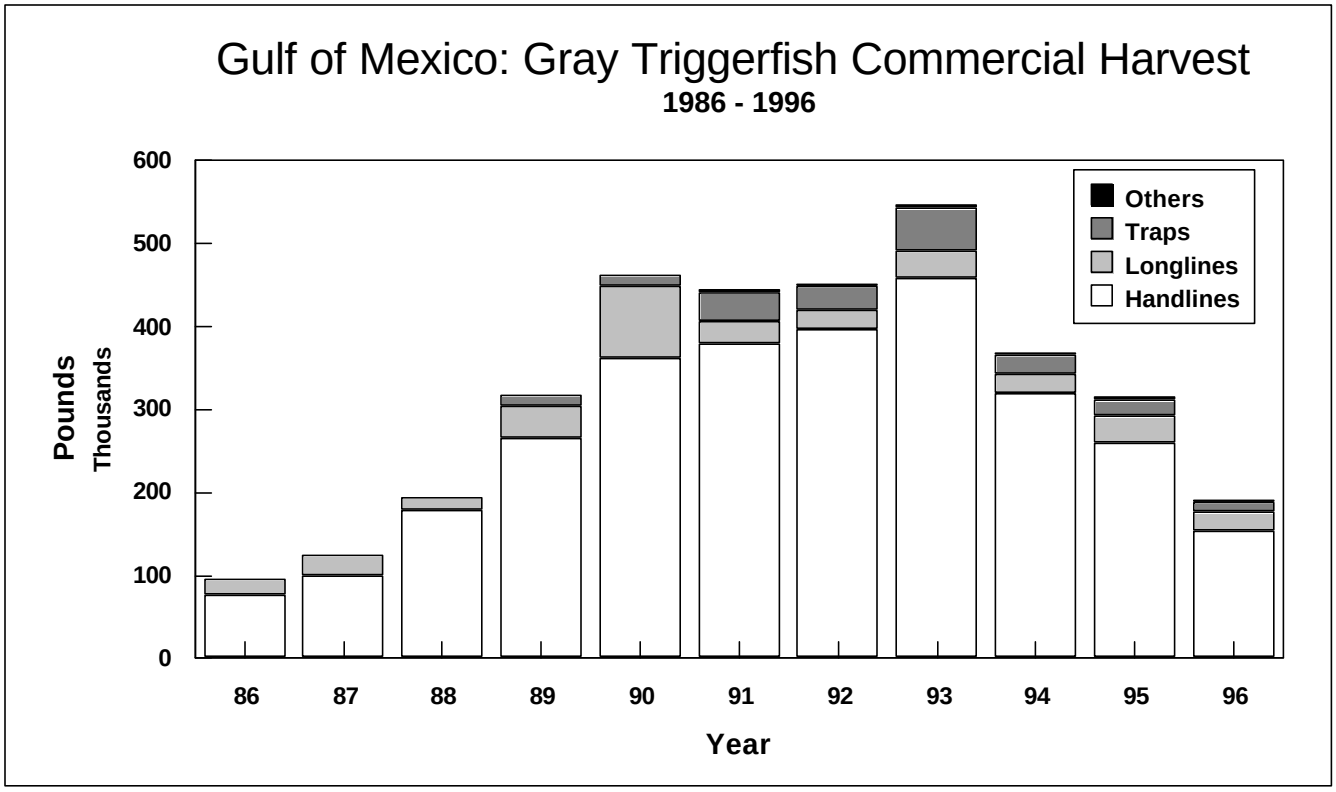

Figure 3. Estimated Gulf of Mexico gray triggerfish annual commercial landings by gear for the period 1986 through 1996.

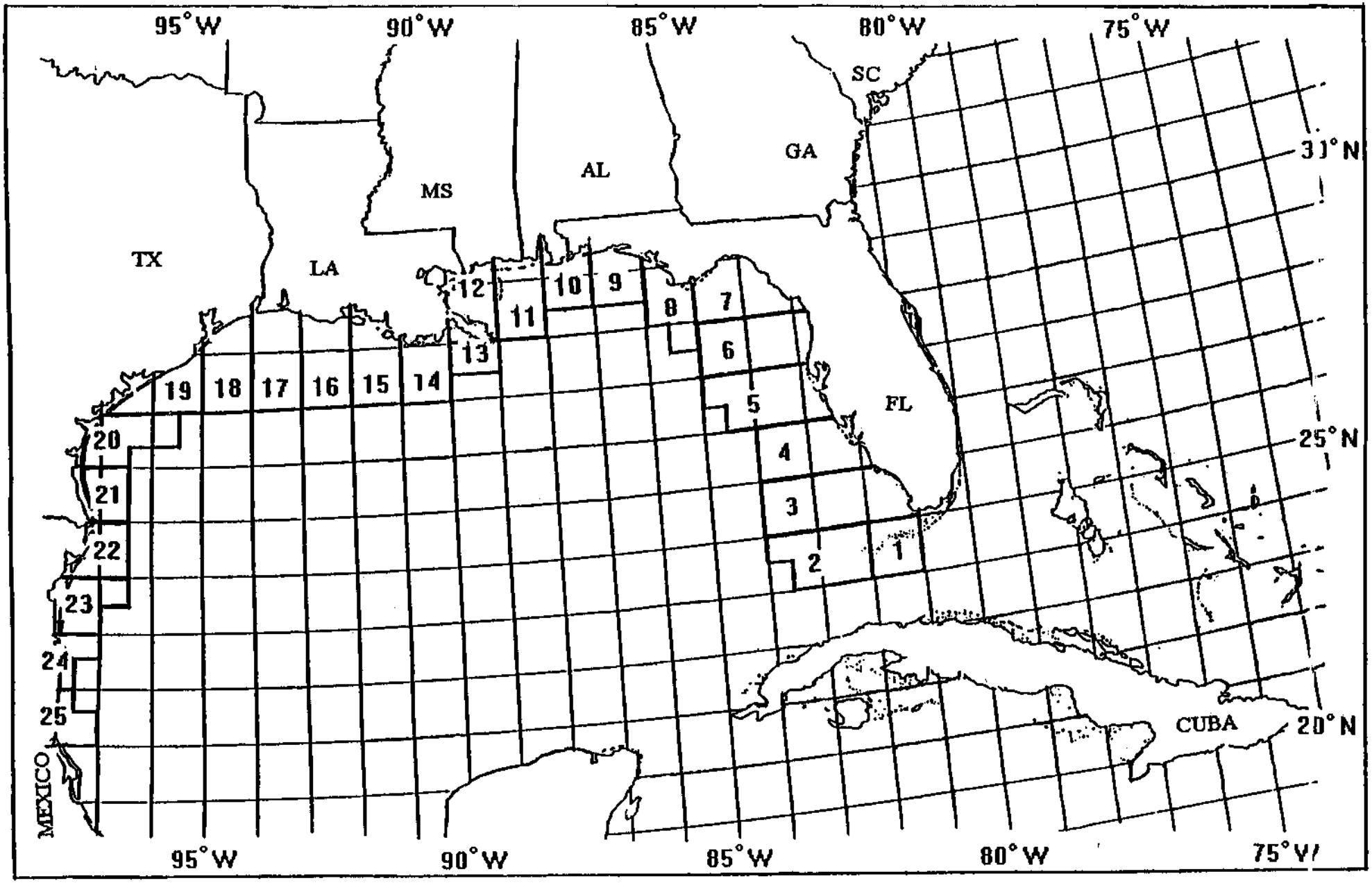

Figure 4. Gulf of Mexico statistical grid map.