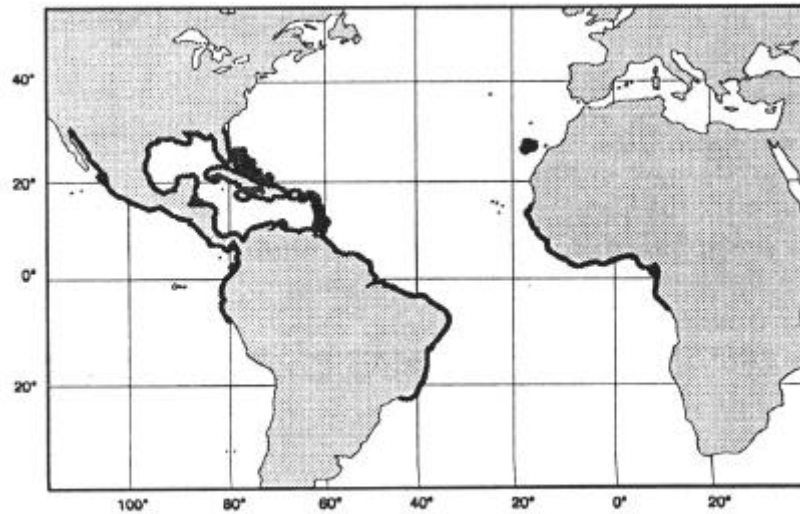


## Goliath Grouper (*Epinephelus itajara*)



**Figure 1.** Distribution of the Goliath Grouper (marked by the thick lines)

### Background to the Red List Assessment

#### Abundance

There are many studies on the population and density of *E. itajara* throughout some of the species' range, especially in the Gulf of Mexico, except for the eastern Atlantic; and information was not available from the Pacific. These sources of information include underwater visual censuses, interviews with commercial and recreational fishers and fishery-based information. Collectively, these reports indicate, that, until recently, there have been declining populations in all studied locations even after the implementation of a fishing moratorium in the early 90s in US waters and in parts of the Caribbean. *E. itajara* is considered to be generally rare (Huntsman *et al.* 1999, Ferreira and Maida 1995, Sluka *et al.* 1996, Sadovy and Eklund 1999).

More recently, however, there are encouraging signs that the population is coming back in one area, the Gulf of Mexico, especially off the southwest area of Florida, probably because of the high water quality mangrove habitat in the Ten Thousand Island area and the fact that goliaths prefer tropical-subtropical areas. Therefore, in the Gulf of Mexico, there are encouraging indications that the population is now recovering following the fishing moratorium.

In tropical areas where goliath populations are not protected, they are probably still declining. In French Guiana, apparently, fishing pressure is causing declining goliath populations (J. Semelin pers. comm.). Brazil temporarily outlawed fishing for Goliath Grouper in 2002 because of declines in numbers in unprotected areas relative to other groupers and reef fishes.

Surveys about to be initiated in the USA (in Spring 2006) will provide more definitive data on possible recovering numbers in this country. The species is naturally uncommon compared to other reef fish species.

## **Fishery-independent Data**

Underwater visual surveys and interviews with commercial and recreational fishers have shown that the decline in inshore *E. itajara* populations began in the 1950s or 1960s. Exploitation of deep-water *E. itajara* populations had started by the time that declines were noted.

Bullock *et al.* (1992) estimated that the spawning stock biomass per recruit was close to 1%, far below the recommended minimum of 30%. Its large size (1,100–1,150 mm TL for male; 1,200–1,350 mm TL for female) and high age (4–6 years for male; 6 or 7 years for female) at sexual maturity (Bullock *et al.* 1992) makes *E. itajara* particularly vulnerable to over-exploitation.

Commercial catch mainly consists of juveniles. Large individuals are sought by recreational anglers and spearfishers, and reproductively active adults are sometimes caught from spawning aggregations (Sadovy and Eklund 1999).

Since 1993 the Reef Environmental Education Foundation's (REEF) Fish Survey Project ([www.reef.org](http://www.reef.org); accessed on 11<sup>th</sup> Jan 2006) allows volunteer SCUBA divers and snorkelers to collect and report information on marine fish populations in the USA and a comprehensive survey of the species is about to be commenced on the populations off Florida and adjacent waters. However, to date there has been no monitoring of their populations. Adult presence as rare, common, or abundant is noted for fishes recorded by REEF. Spawning aggregations have been monitored by Chris Koenig, Ann-Marie Eklund and co-workers since 1996, primarily off SW Florida. A new spawning aggregation started off Riviera Beach (east coast) several years ago and is being monitored: many individuals return to the same spawning location. Other monitoring initiatives of reef fishes occur throughout the Florida Gulf coast with the help of dive groups and other volunteer organizations, including REEF ([www.gulfcouncil.org/oldstories/2000-07-20-jewfish-update.htm](http://www.gulfcouncil.org/oldstories/2000-07-20-jewfish-update.htm), accessed on 31<sup>st</sup> Dec 2005). Throughout the sampling period 1993–2005, it seems that the sighting frequency of *E. itajara* has increased to a fairly stable, albeit low, level (2.6% of all surveys) since the late 1990s. Details of the findings are listed below.

## **Fishery-independent data by country**

### Bahamas

Very rare in the central Bahamas; only one large individual (1.5 m) observed despite 70 sites surveyed (Sluka *et al.* 1996).

### Brazil

According to a preliminary questionnaire survey carried out in 1994, the findings indicated that *E. itajara* has become a rare and vulnerable species in the Brazilian coast. Its abundance has declined drastically in the last 10 years, probably due to spearfishing with SCUBA (Ferreira and Maida 1995).

In Brazil during ReefCheck surveys *E. itajara* is used as an indicator species and they have been conducted since 2002 at 13 sites located along 3,000 km of coast where coral reefs are distributed (not continuously). Only one individual of *E. itajara* was counted in 400 transects. Other individuals were sighted on only two other occasions, but not along the transects (see text below); in all cases the place was a park or reserve with no fishing. A report on the monitoring results will be published in the proceedings from the recent International Coral Reef Symposium held in Okinawa (the status of coral reefs in Brazil, Ferreira *et al.* in press).

*Here is an extract from the report.* “Indicator species of fish, including lutjanids, scarids, serranids and ornamental species were significantly less abundant in the sustainable use MPAs, where fishing and collecting were allowed .... Larger species of groupers were generally absent from all areas with very few exceptions. In Fernando de Noronha, the area where individual groupers larger than 30 cm of total length were more abundant, the category was mainly represented by the coney *Cephalopholis fulva*, a small grouper with maximum length is less than 40 cm. The rarity of larger groupers there and in most places, indicates that the threat level for these large predators is very high, as pointed out by Myers and Worm (2002) and Coleman *et al.* (2000). The Goliath Grouper was only observed in Atol das Rocas and in a 3 sq km no take zone within the APA Costa dos Corais, both places where only research is allowed. In some places, the absence of large groupers can indicate that the protection measures have not been sufficient to maintain populations. In Noronha for instance, fishing is banned only from the coast to the 50 meter isobath, what is probably not compatible with the mobility range of larger individuals, frequently caught outside these boundaries.”

According to Floeter *et al.* 2006 “not a single specimen of the Goliath Grouper (*Epinephelus itajara*) was observed at any of the sites, despite that these sites fall within the historic range of the species (and older fishermen report the species used to be common), indicating heavy threat to certain species”.

#### Colombia

From 1993 to 1996, a total of 356.44kg groupers were captured, in which 1.77% were *E. itajara* (Gomez and Zapata 1999).

#### USA

Based on the information from REEF, the sighting frequency (SF; a value calculated by dividing the number of surveys with *E. itajara* encountered [n] by the total number of surveys carried out in a particular year [N]) of *E. itajara* in tropical western Atlantic and eastern Pacific increased from about 1% in 1993–1997 to a mean of 2.6% in 1998-2005 ([www.reef.org/data](http://www.reef.org/data); accessed on 10<sup>th</sup> Jan 2006).

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N	102	2469	2539	3089	3370	3627	4716	6411	9961	12047	10925	9538	5837
n	0	23	28	28	27	79	136	164	272	323	312	221	141
SF	0.0%	0.9%	1.1%	0.9%	0.8%	2.2%	2.9%	2.6%	2.7%	2.7%	2.9%	2.3%	2.4%

Note that goliath population densities around Florida are highly variable, from SF's of as high as 70% (southwest Florida) to about 4% along the Florida Keys reef tract, so the value that appears in the above table depends to a large extent on the distribution of survey dives. Divers like to make surveys in the relatively clear waters off the Keys rather than in the less than clear waters off SW Florida often preferred by this species (note in REEF that several thousand reef surveys have been done off the Keys). So, one problem with these surveys is that goliaths are most abundant in waters that are not attractive to divers.) Therefore, the data may obscure possible early increases. For example, a comparison of the proportions (above) shows that 1998 through 2005 is a homogeneous group (i.e., not significantly different from each other), as is 1994 through 1997, and 1993 is different from all the rest ( $p < 0.05$ ); so there is a two-step increase. Most of the juveniles are coming out of the Ten Thousand Islands; this is to be expected in this recovering population.

#### Gulf of Mexico

DeMaria (pers. comm. cited in Sadovy and Eklund 1999) noted that the number of *E. itajara* on each of four aggregation sites in the eastern Gulf of Mexico declined shortly after discovery. On deep-water wrecks, known aggregations of up to 100–150 Goliath Grouper had declined to 0–10 fish by 1989. The decline in abundance is likely greater than the numbers suggested because of the low water visibility.

In 2000, the National Marine Fisheries Service (NMFS) observed 18 to 26 *E. itajara* in the Ten Thousand Island area. Based on the hook-and-line catch rates of juvenile *E. itajara* caught for tagging purposes, it was estimated by the NMFS that, if these areas were open to harvest, it would take just 1,300 hook hours in each area to harvest all of the *E. itajara*. The tagging program has recaptured the same *E. itajara*, in some cases, up to eight times ([www.gulfcouncil.org/oldstories/2000-07-20-jewfish-update.htm](http://www.gulfcouncil.org/oldstories/2000-07-20-jewfish-update.htm), accessed on 31<sup>st</sup> Dec 2005).

From 1979 to 1994, there were no observations of *E. itajara* in any of the NMFS SEFSC Reef Team visual point counts or predator searches from Biscayne National Park to the Dry Tortugas, Florida, off the Florida Keys (SEFSC, NMFS, NOAA, 75 Virginia Beach Drive, Miami FL 33149, unpublished data cited in Sadovy and Eklund 1999).

According to the logs of a boat Captain Don DeMaria from 1982 to 1997, the abundance of *E. itajara* in four spawning aggregation sites decreased from 213 in 1982 to nine in 1990, then increased to 81 in 1997 after the implementation of moratorium in 1990. 79 adult jewfish were tagged in 1996 and 138 were tagged in 1997, with very few resightings ( $N = 5$ ) on the spawning aggregations; fish that were tagged on one trip were not observed on site on the next trip. However, other evidence shows resightings of a number of individuals on the same spawning sites, as well as apparently home-range sites. (C. Koenig pers. comm.)

Based on the findings of interviews with sport fishermen from 165,734 fishing trips from 1973 to 1999 by Everglades National Park (ENP), 1.8% of the trips captured the *E. itajara*. Among 420 *E. itajara* landed within the park from 1974 to 2001, the majority were juveniles. After standardizing the statistics for a well-balanced design, 26% of the sport fishing trips from 1973 to 1981 had captures of one or more *E. itajara*. This percentage declined to about 12% from 1982 to 1992. But from 1993 to 1999, the percentage increased substantially to about 26% (Cass-Calay and Schmidt 2003).

On the Pacific coast of Baja California, it was reported that spawning aggregations of *E. itajara* have been extinguished and *E. itajara* has not been fished or observed in

most of the area since 1995 according to interviews with the local fishers (Sala *et al.* 2003).

Studies carried out after moratorium indicated *E. itajara* are increasing in number and size (J. Bohnsack, National Marine Fisheries Service, pers. comm. cited in Huntsman *et al.* 1999).

Some fishing groups claim that the stocks have recovered sufficiently to warrant a reopening of the fishery, but scientific data are lacking to support these claims. The suspicion is that while juveniles may be more abundant since the closure, insufficient time has elapsed for adult populations to have actually rebounded (Coleman *et al.* 2002).

### **Fishery-dependent Data**

Available data on the landings of *E. itajara* quoted from different studies and sources show a decline of the quantity (by weight or number of individuals) before the moratorium in 1990. However, the extent of its recovery needs to be studied to gather more information so as to evaluate the stock of *E. itajara* under the existing fishery management; such studies are about to begin in 2006 and will be important for assessing possible recovery of this species in Florida.

#### Stock assessment

Based on modelling using Jolly-Seber mark-recapture methods, absolute abundance of juveniles of all sizes (ages) [underlying assumptions: 1. all sizes were present in all systems, 2. recruitment was constant, and 3. mortality was uniform across all age groups] in mangrove habitat of the Everglades National Park and all of the Ten Thousand Islands mangrove island habitat was estimated to be 15,740 and 54,553 juveniles, respectively (Koenig *et al.* in press). Modelling indicates that by 2006 and 2012, there is a probability of 50% and 95% for the population recovering to a spawning potential ratio of 50%, respectively (Porch *et al.* 2003); a more conservative estimate from the same study predicted a 50% chance of recovery by 2008 and 80% by 2012. Relative biomass was suggested to increase steadily since the moratorium in 1990, at which that biomass was thought to have fallen to around 5% of the pristine level. Three independent visual surveys (REEF, MR. D. DeMaria and Everglades National Park) showed that biomass had increased since the early 1990s (Kingsley 2004). After standardization using a stepwise approach to build general linear models of logged counts (isolating the effects of year), visual surveys to count the number of adults by DeMaria (pers. comm. cited in Porch and Eklund 2003 and REEF surveys) were thought to give valid indices of abundance for adults (Kingsley 2004).

### **Fishery-dependent data by country**

#### Belize

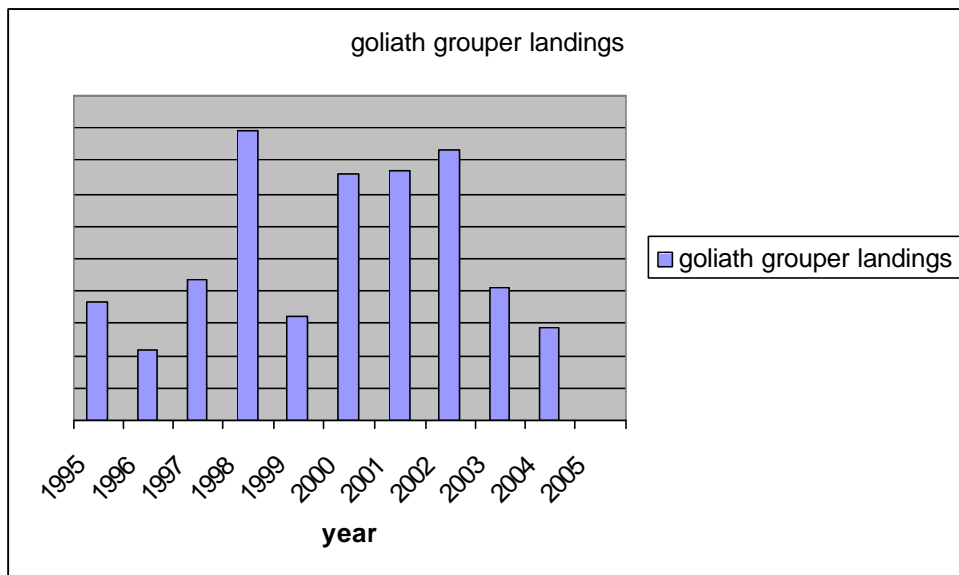
A commercial fishery for *E. itajara* still exists at aggregations off Belize. No landings data were available (S. Wells pers. comm. cited in Sadovy and Eklund 1999).

#### Brazil

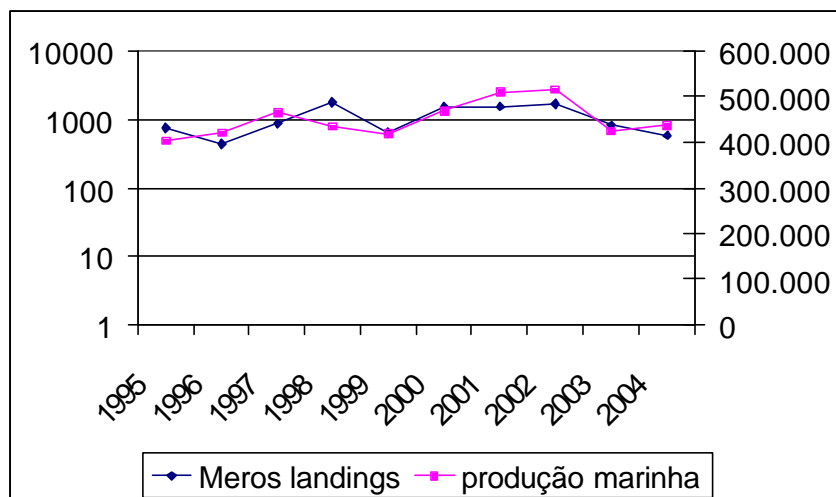
In September 2002 a moratorium was declared for a period of 5 years, banning catches, landings and selling of *E. itajara* in the whole Brazilian coast. Later, an agreement was made with fishers in Pará state (the state with higher catches) to

tolerate incidental catches, as long as they were not superior to 5% of total landings. According to reports generated by Estatpesca IBAMA (Brazil's Environment Agency official statistics), after the moratorium in 2002 landings of Goliath Grouper *Epinephelus itajara* decreased in 2003 and 2004 to values less than 50% of those recorded during previous years.

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Landings (tonnes)	742.528	431.863	868	1,792.107	638.44	1,513.155	1,537.634	1,671.465	809.892	574



A comparison between total landings showing the overall tendency of fisheries production (see figure below) in Brazil compared with Goliath Grouper landings (see figure above)



Data compiled by Ricardo Corbetta, University of Itajaí, Santa Catarina State (UNIVALI) (meros are groupers and producao marinha is marine production).

USA (Gulf of Mexico region, including Monroe County)

According to the NMFS, the annual recreational harvest estimates of both number (N) and weight (in lbs) of Goliath Grouper decreased during the period between 1981 to 1989 before the implementation of the moratorium in the Gulf of Mexico region.

(Note: there are very large proportional standard errors (PSE) associated with the annual estimates of landings by number, which suggest these are rare-event landings in the recreational fisheries of the Gulf of Mexico.) (T. Sminsky, Statistician of the Fisheries Statistics Division of the NMFS, pers. comm.).

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Est. N	22871	9643	-	629	7238	5932	2290	2316	1717	0	0
lbs	-	1137813	-	57953	188295	34148	43232	3574	-	0	0

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Est. N	0	0	0	0	0	0	0	0	0	0	*729	0	0
lbs	0	0	0	0	0	0	0	0	0	0	0	0	0

\*This estimated number was derived from one landed fish in 2002 with PSE=100.

#### Florida, USA

Commercial landings (lbs) of *E. itajara* for the Atlantic and Gulf of Mexico coasts of Florida from 1979 to 1990 (Sadovy and Eklund, 1999)

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Atlantic	-	-	-	-	-	-	-	10492	17911	12931	8669	1814
Gulf of Mexico	34107	41591	54950	49894	68615	70374	107355	108952	99951	135715	93066	7488

#### Monroe County, Florida, USA

Prior to a moratorium on harvest, commercial landings in Monroe County, Florida, remained relatively stable between 1977 (14,558 kg) and 1989 (11,236 kg). Formerly very abundant in recreational landings; 57,942 kg (N=534) and 104,405 kg (N=14,330) landed in 1980 and 1982, respectively; compared to only 8,644 kg (N=235) and 16,781 kg (N=380) landed in 1986 and 1987, respectively (Bohnsack *et al.* 1994).

Commercial landings by weight (kg) of *E. itajara* for Monroe County from 1977 to 1992 (Bohnsack, *et al.* 1994)

Year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
kg	14558	14821	7681	6065	10311	8468	8826	5587	8708	10432	11916	11045	11236	596	-	-

#### All states, USA

Although 5,000 to 17,000 fish were once taken recreationally each year, by the early 1990s less 5,000 were caught and released annually. Total number of *E. itajara* caught in the US recreational fishery in the Atlantic Ocean, the Gulf of Mexico and all states from 1979 to 1993 (Sadovy and Eklund 1999).

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Atlantic	0	6884	995	0	262	6492	0	1	932	821	610	0	1163	0	0
Gulf of Mexico	3823	16905	14330	10175	178	5240	15096	8147	3159	736	7138	1849	2997	2772	4989
All states	3823	23789	15325	10175	262	11732	15096	8148	4091	1557	7748	1849	4160	2772	4989

Commercial landings (lbs) of *E. itajara* caught in the US commercial fishery in all states from 1979 to 1993. A total ban was implemented in 1990 (Sadovy and Eklund 1999).

Year	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total	36797	44478	61012	63995	82942	77614	120531	120317	119032	152726	101868	11807	798	0	16

According to the NMFS record of annual commercial fishery landings, between 1950 and 1989 landings ranged from 37.6 to 46.1 metric tonnes, and peaked at 120.6 metric tonnes in 1968. Over 80 metric tonnes were taken annually from 1964 to 1983. After the moratorium in 1990, the reported annual landings decreased sharply to 5.2 and 0.4 metric tonnes in 1990 and 1991, respectively. And there is no further commercial harvest of *E. itajara* so that no more figures are available since then ([www.st.nmfs.gov](http://www.st.nmfs.gov), accessed on 5<sup>th</sup> Jan 2006) (levels of illegal harvest are unknown):

Year	Metric Tons	US\$	Year	Metric Tons	US\$
1950	57.0	7,357	1971	89.0	17,281
1951	88.2	12,766	1972	108.1	23,616
1952	77.1	15,990	1973	109.9	27,630
1953	128.9	26,571	1974	107.3	35,083
1954	52.3	8,750	1975	112.9	38,110
1955	37.6	5,298	1976	115.2	43,905
1956	26.4	3,631	1977	123.9	62,994
1957	27.9	4,336	1978	97.1	40,721
1958	60.1	11,439	1979	82.0	42,967
1959	59.7	11,108	1980	101.7	64,788
1960	52.4	8,939	1981	92.1	83,539
1961	46.2	7,666	1982	79.7	76,028
1962	40.7	6,531	1983	90.9	92,950
1963	63.4	10,358	1984	49.0	65,065
1964	109.4	21,907	1985	50.3	74,197
1965	107.5	21,043	1986	54.2	87,541
1966	82.8	16,149	1987	53.8	90,227
1967	90.8	17,057	1988	67.6	113,330
1968	120.6	23,873	1989	46.1	82,755
1969	91.1	19,439	1990	5.2	10,567
1970	105.0	21,142	1991	.4	359
			<b>GRAND TOTALS:</b>	<b>3,161.5</b>	<b>1,455,003</b>