SEDAR

Southeast Data, Assessment, and Review

Complete Stock Assessment Report
of

Yellowtail Snapper
in the
Southeastern United States

SEDAR3
Assessment Report 1

SEDAR/SAFMC
One Southpark Circle #306
Charleston, SC 29414
(843) 571-4366

<u>CONTENTS</u>

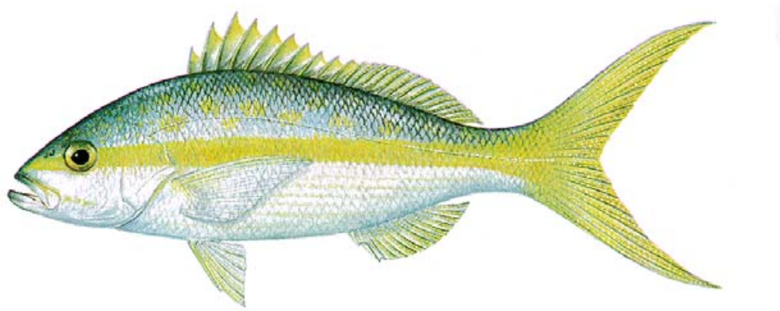
SEDAR

SouthEast Data, Assessment, and Review

Stock Assessment Report

Yellowtail Snapper
in the
Southeastern United States

A stock assessment of yellowtail snapper, *Ocyurus chrysurus*, in the Southeast United States



Final Report Submitted to the National Marine Fisheries Service, the Gulf of Mexico Fishery Management Council, and the South Atlantic Fishery Management Council as part of Southeast Data, Assessment, and Review (SEDAR) III

Robert G. Muller
Michael D.Murphy
Janaka de Silva
Luiz R. Barbieri

14 August 2003

FWC-FMRI Report: IHR 2003-10

Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
100 Eighth Avenue Southeast
St. Petersburg, FL 33701-5020

Executive Summary

The status of yellowtail snapper was assessed through the National Marine Fisheries Service's SEDAR process with the Florida Fish and Wildlife Conservation Commission (FWC) taking the lead. The SEDAR process consists of three workshops. The Data Workshop was held 3-4 March 2003 at FWC's Florida Marine Research Institute in St. Petersburg and the Stock Assessment Workshop was held 9-13 June 2003 at the same venue. The Peer-Review Workshop was held 28-31 July 2003 in Tampa, Florida.

The following is a summary of the biology, fishery, and assessment of yellowtail snapper with comments about important discussions and conclusions made by the Stock Assessment Workshop Panel and the Peer-Review Panel.

Yellowtail snapper, *Ocyurus chrysurus*, is a reef fish species that occurs from North Carolina to southern Brazil and is abundant in south Florida. Adult yellowtail snapper typically inhabit sandy areas near offshore reefs at depths of 10–70 m (32–230 feet). Yellowtail snapper eat fish, shrimp, and crabs near the bottom but also feed in the water column.

The spawning season in south Florida is in spring and summer with a peak during May-July. Females reach the 50% maturity ogive at 209 mm TL at an average age of 1.7 years. Yellowtail snapper grow quickly initially but size is a poor indicator of age because of the extensive overlap in ages for a given sized fish. The Data Workshop Panel recommended not pursuing sex-specific differences in growth because, based on the analysts, the available data did not show any obvious differences in size at age between sexes. There were detailed discussions about the potential difficulties in using age-structured assessment approaches when so much variability in length at age was observed. The Stock Assessment Panel finally agreed on the assessment approach after looking at catch-at-age data generated using direct aging of the catch and various pooling strategies for the development of age-length keys. Based on the maximum age of sampled yellowtail snapper (17 years old, confirmed since the Data Workshop) and the established nature of the fishery, the Panel recommended using a lower natural mortality rate than suggested at the Data Workshop. A baseline rate of 0.2 yr^{-1} was used with additional runs also at 0.15 yr^{-1} and 0.25 yr^{-1}. After discussion, the Peer-Review Panel found no reason to change either the baseline rate or the range.

The commercial fishery for yellowtail snapper occurs throughout the tropical, western Atlantic and average landings from the Caribbean for 1997-2000 have been 3,458 metric tons (mt) and, of that total, the United States landings have averaged 747 mt with Puerto Rico and the U.S. Virgin Islands accounting for another 220 mt. The fishery has occurred in the Florida Keys for over a century and mostly uses hook-and-line gear especially after entangling gear was prohibited in 1990, five years before Florida's

constitutional amendment banning the use of entangling gear from state waters.

For this stock assessment, data from the yellowtail snapper fisheries were divided into two regions: the Atlantic region which primarily is from Palm Beach county south through Miami-Dade county and the Keys which is Monroe county and west. The Stock Assessment and Peer-Review Panels concurred with the approach to estimate catch-at-age for the MRFSS recreational, headboat, and commercial sectors separately for the Atlantic (Dade county north) and Keys regions (Monroe county north). Although there are commercial landings data from earlier years, recreational data are only available since 1981 and, therefore, we have confined the analyses to the years: 1981-2001.

Total landings during these years increased from 1,000 mt in 1981 to 1,648 mt in 1993 and then decreased to 802 mt in 2001. Despite recommendations from the Data Workshop panel that sensitivity analysis include temporal increases in unreported commercial catch, the Stock Assessment Panel did not recommend including this as a sensitivity analysis due to the lack of empirical evidence for changes in reporting. Effort followed a similar trend as that of total landings, increasing to a peak and then decreasing. The number of commercial fishers has decreased from a peak of 8,343 Saltwater Products license (SPL) holders in 1989 to 2,659 SPLs in 2001. Recreational trips declined from 2.3 million trips in 1988 in the Atlantic regions to 1.7 million trips in 2001 and from 1.2 million trips in 1993 in the Keys to 0.4 million trips in 2001. Similarly, the headboat effort was highest in 1981 with 155,000 angler-days in the Atlantic region and generally declined to 63,000 angler-days in 2001 and from 82,000 angler-days in 1989 in the Keys to 45,000 angler-days in 2001.

The Stock Assessment Panel discussed the estimation of commercial discard rate and discard mortality and agreed to use the preliminary discard data from commercial logbooks instead of the 10% discard mortality rate suggested during the Data Workshop. The Peer-Review Panel noted that the paucity of discard data was unsatisfactory and fishers on the Panel indicated that these rates were too high. In the assessment runs, we increased the landings to account for discards. Based on a single year’s reef fish logbook data in 2001-2002, commercial discards of yellowtail snapper averaged 16% of the landings and approximately 28% of those discarded were dead. Recreational discards are estimated directly as Type B2 numbers of fish. With the absence of headboat discard information, the Stock Assessment Panel concluded, after much discussion and examination of the age distribution of the fishery-dependent and fishery-independent samples by region for 1999-2001, that the proportion of fish that would have been discarded by headboat could be estimated by the fraction of the catch of the fishery independent hook-and-line data that was smaller than the legal size limit (305 mm TL) (37% in the Atlantic region and 27% in the Keys region). The Panel discussed the 30% discard mortality rate used with the recreational and headboat fisheries and found insufficient evidence to suggest changes to these rates that were suggested at the Data Workshop.

Commercial landings in weight were converted to landings in number based upon biostatistical sampling of the landings that measured lengths from landings with different gears. Biostatistical samplers visit fish houses interview fishers, measure fish, and collect hard parts for age determinations. Landings are estimated directly in numbers in the recreational fisheries. Ages were assigned to the lengths based upon region, fishery, gear, and year.

The Stock Assessment Panel noted differences in age composition between the Atlantic and Keys for all fishery dependent and fishery independent data. This was most evident for maximum age, 7 years in the Atlantic and 17 years in the Keys. The age-length data were sufficient from 1997 onward to derive year-specific age-length keys for both regions. The Panel noted that the composite age-length keys could act to obscure year-class strength information. For earlier years when sample sizes were insufficient, the Stock Assessment Panel recommended combining data from the same region and year but from different gears. When data from an alternative gear were not available, the second choice for substitution was to use data from the same region and from different gears in different years. A composite was formed for the years 1980-1986 and 1987-1996. Finally the Panel investigated using age data from 1994 through 2001 to directly age the catch. However, the abrupt change in the younger ages from the composite age-length keys to direct aging led the Panel to recommend not using the direct aging method.

We used tuning indices to improve the statistical population models. The two fishery-independent indices were based on visual surveys conducted by the National Marine Fisheries Service and the University of Miami. These indices were the number of fish less than 197 mm (7 ¾ inches) per 177 m^2 that was used for age-1 fish and the number of fish greater than 197 mm per 177 m^2 that was used for fish age-2 and older. The Panel discussed the change in the number of strata used to develop these indices. However, a subsequent conversation with the analyst that developed the indices confirmed that these indices were the most comparable and that the increase in the number of strata was to account for protected areas in the Keys and the partitioning of patch reefs to afford finer resolution. The Panel rejected the use of the third fishery independent index, REEF visual survey. The coarseness of the classification of abundance, i.e. 0, 1-10, 11-100, >100 individuals, was considered to be too great to use the REEF index as a quantitative index for yellowtail snapper abundance.

In addition to the fishery independent indices, we originally developed five fishery dependent indices that were standardized with generalized linear models: the commercial kilograms per trip with combined gears (1985-2001), commercial kilograms per hook-and-line trip from trip tickets (1992-

2001), commercial kilograms per hook-and-line trip from Reef Fish Permit logbooks (1993-2001), MRFSS recreational total number of fish per trip (1981-2001), and headboat number of fish landed per trip that was divided into two time periods,1981-1991 and 1992-2001 because of the aggregate bag limit. After much discussion, the Panel agreed that the original CPUE indices for headboat and commercial sectors derived by the analysts before the Assessment Workshop were valid indices. However, these indices were derived under the philosophy of including many reef trips, only coarsely filtered for yellowtail snapper trips. The Panel also felt that another set of valid CPUE indices should be derived based on anglers that were targeting yellowtail snapper. We developed two additional indices: the kilograms per trip from commercial hook-and-line trips by 107 Reef Fish Permit holders that landed at least 500 kilograms of yellowtail snapper in five out the most recent seven years and a headboat indices from seven vessels that landed at least 100 yellowtail snapper per year. The Peer-Review Panel pointed out that including interaction terms with year in the indices may not reflect underlying population changes and recommended calculating the indices with just main effects. They also requested an analysis without the commercial index because they thought that perhaps the increase in that index was due to increased efficiency instead of a population increase. The run without the commercial index produced the same trends as before.

Finally the Stock Assessment Panel noted that the flat CPUE indices with declining landings implied declining effort. Subsequent analyses requested by the Panel confirmed declining annual number of angler-days for the headboat sector, the overall number of trips in MRFSS recreational sector and in the commercial sector.

We used two types of models to assess the condition of yellowtail snapper: surplus production and age-structured, statistical models. However, the two surplus production models, ASPIC a non-equilibrium model and ASP an age-structured model, were not stable and, most likely, the instability was due to lack of contrast in the tuning indices or catch rates. The Stock Assessment Panel noted that the generally flat or monotonic CPUE indices could create parameter estimation convergence issues with surplus production models.

Both the Stock Assessment and Peer-Review Panels agreed with the Data Workshop recommendation that age-structured assessment approaches were appropriate for yellowtail snapper. Year-specific aging information was available for 1994-2001 and age-structured approaches could make use of all available data increasing our confidence in the predictions of the current status of the stock.

We used two age-structured, statistical models. The first was Integrated Catch-at-Age which used the combined catch-at-age from the three fisheries and tuning indices to estimate the population sizes by age in the most recent year, fishing mortality rates on the earliest fully recruited age of fish, selectivity patterns by age, and catchability coefficients for the tuning indices (76 parameters in this configuration). In the base case run, the full fishing mortality rate in 2001 was 0.21 per year and the spawning biomass in 2001 was 4,943 mt.

The numbers of age-1 fish and the spawning biomass a year earlier were used to estimate the biomass based management benchmarks given a steepness of 0.8 and alternatives of 0.7 and 0.9. The steepness is merely the proportion of the recruitment at a spawning biomass of 20% of the virgin biomass to the recruitment at the virgin biomass. With the Stock Assessment Panel recommendation of using a steepness value of 0.8, the maximum sustainable yield (MSY) was 941 mt and the F_{2001}/F_{msy} ratio was 0.62 and the SSB_{2001}/SSB_{msy} ratio was 1.35 indicating that the stock was not undergoing overfishing and not overfished. The ratios were 0.57 and 1.43 when the analyses were rerun using indices calculated without the interaction terms.

The second age-structured model allows estimating separate fishing mortality rates for the three fisheries simultaneously. This fishery-specific model estimated the population sizes in the first year (1981), recruitment from a stock-recruit relationship, selectivities by fishery and two periods corresponding to before and after the 12 inch (305 mm) size limit was implemented in 1983, and catchability coefficients for the tuning indices. This model estimated the sum of the fishing mortality rates on fully recruited fish in 2001 at 0.24 per year and a spawning biomass of 5,200 mt which is similar to the 0.21 per year and 4,900 mt estimated by ICA. The fishery-specific model estimated a higher MSY of 1,366 mt but only a slightly higher F_{msy} (0.36 per year as compared to 0.33 per year from ICA). The biomass based benchmarks were $F_{2001}/F_{msy} = 0.65$ and $SSB_{2001}/SSB_{msy} = 1.06$. Using the revised indices, the fishing mortality rates on fully recruited fish in 2001 remained 0.24 per year and the estimated spawning biomass increased slightly to 5,300 mt. The revised biomass based benchmarks were $F_{2001}/F_{msy} = 0.72$ and $SSB_{2001}/SSB_{msy} = 0.99$ supporting the same conclusion that the stock was neither undergoing overfishing nor overfished.

The retrospective analyses using terminal years of 1998, 1999, 2000, as well as 2001 did not indicate that the models consistently over- or under-estimated either the fishing mortality rates in the last year or the spawning biomass.

Landings of yellowtail snapper differ widely by subregion. Yellowtail snapper were rarely landed north of Florida's Palm Beach county on the Atlantic coast. From Palm Beach county south through Miami-Dade county, yellowtail snapper were consistently landed; however the majority of landings came from the Florida Keys in all three fishing sectors. The fishers from counties north of the Keys on the Gulf side also rarely landed yellowtail snapper. This assessment focused on Southeast Florida (Palm Beach through Miami-Dade counties) and the Florida Keys because of the concentration of landings in those two subregions. The geographical distribution of yellowtail snapper landings reflects the distribution of coral reefs in Florida. Effort in terms of fishing trips was proportionately higher in Southeast Florida than in the Keys but there were still more trips in the Keys. Also, the catch rates were higher in the Florida Keys than in Southeast Florida in all three sectors.

There was high compliance with the 12-inch minimum size (305 mm) with only 3% for the commercial fishery, 5% with the recreational fishery, and 2% for the headboat fishery in the Atlantic region being under the limit. In the Keys, the compliance was also high with 2% for the commercial fishery, 4% with the recreational fishery, and 3% for the headboat fishery. While we evaluated the 10-fish aggregate limit by assuming that all of the snappers were yellowtail snapper, most of the recreational anglers caught less than two fish per trip. Only 0.2% of the anglers in the Atlantic region exceeded 10 fish per trip and 1.3% of the anglers in the Keys.

1. Introduction

Most of the yellowtail snapper landed in the United States come from the Florida Keys and, to a lesser extent, southeastern Florida. This species is popular with recreational and headboat anglers as well as with commercial fishers. Yellowtail snappers have been a component of Florida's reef fish landings for more than a century. Collins and Smith (1891) note that the landings of yellowtail snapper in 1890 were included in the 47,303 lbs (21.5 metric tons) of "Snappers gray and others".

As part of the Councils' coming into compliance with the Sustainable Fisheries Act requirements, yellowtail snapper was identified as a species thought to be undergoing overfishing. However, fishers claimed that the stock was in good shape. To resolve the issue, the Florida Fish and Wildlife Conservation Commission (FWC) volunteered to develop a stock assessment for yellowtail snapper because this species is caught mostly in the waters off Florida and the species has not been the subject of a focused stock assessment. Previous assessments for yellowtail snapper have been part of large-scale assessments of reef fish communities (NMFS 1990, Ault et al. 1998).

1.1 SEDAR – Southeast Data, Assessment, and Review

The Southeast Data, Assessment, and Review (SEDAR) process was developed in 2002 by the National Marine Fisheries Service and the fishery management councils to make stock assessments more open and to ensure that assessments reflect the best thinking of fishery scientists. The process entails three workshops. A Data Workshop is conducted to identify the sources of information and the most appropriate methods of summarizing and analyzing the data. Participants from the various sectors of the fishery are invited to attend and give the industry's insights on the species in question. The second workshop is the Stock Assessment Workshop bringing assessment scientists, biologists, Council staff, and others together to analyze the data identified earlier with a suite of methods that will provide indicators of the stock condition. Participants in the second workshop look at the data, discuss the preliminary results, suggest additional analytical methods, and develop model runs to make sure that their conclusions as to stock condition are technically sound. The final workshop brings outside people who are experts in data analysis and assessment methods together to review the stock assessment. To facilitate their review, the draft stock assessment, data, and assessment techniques were provided to the panel members prior to the workshop so that they can become familiar with the species and the analytical methods. The intention is that this process of openness and multiple reviews will improve stock assessments developed in the Southeastern United States. For yellowtail snapper, the Data Workshop was held at FWC- Florida Marine Research Institute (FMRI) in St. Petersburg, 3 – 4 March 2003 and the Stock Assessment Workshop also was held at FWC-FMRI in St. Petersburg, 9-13 June 2003. The Peer-Review was held 28-31 July 2003 in Tampa, Florida. The SEDAR Peer-Review Report is included here as Appendix 1 and the SEDAR Stock Status Report is included as Appendix 2. This final report has incorporated many of the Peer-Review Panel's recommendations.

2. Biological Characteristics

2.1 Data Sources

Most studies on the life history and population dynamics of yellowtail snapper have been based on fishery dependent samples obtained from headboat samples (Johnson 1983, Garcia et al. unpublished manuscript), commercial samples (Allman et al. 2003), commercial hook-and-line and trap fisheries collections in St. Thomas and St. Croix, U.S. Virgin Islands, and Puerto Rico (Manooch and Drennon 1987), and Jamaica (Thompson and Munro 1974). Information on age and growth, reproduction, and feeding habits from fishery independent collections in southeast Florida (including the Florida Keys) were obtained from Barbieri and Colvocoresses (2003) and Vose and Shank (FWC-FMRI unpublished manuscript).

2.2 Stock Distribution

Yellowtail snapper, *Ocyurus chrysurus*, is an important tropical reef fish species that inhabits warm, temperate and tropical waters of the western Atlantic, with distribution ranging from North Carolina to southeastern Brazil, including the Gulf of Mexico and Caribbean Sea (Fisher 1979). However, they are abundant in waters off south Florida and the Bahamas, and in the Caribbean (Manooch and Drennon 1987).

Yellowtail snapper from the southeastern U. S. are believed to constitute a single stock. Hoffman et al. (2003) sequenced a 404-base pair region of mitochondrial DNA and analyzed six microsatellite DNA loci from yellowtail snapper collected from seven locations in southern Florida and from Puerto Rico. They noted that there was little population structuring between the Florida Keys, southeast Florida, and Puerto Rico groups of yellowtail snapper. However, they said that there was some evidence for isolation-by-distance between south Florida and the Puerto Rico samples. Attendees at the Data Workshop recognized that yellowtail snapper larvae may be exchanged between assessment areas but assumed that the majority of recruits to each stock assessment area probably came from adults occupying that area. They also felt that adult movement between assessment areas was probably very limited and recommended using a single stock.

2.3 Habitat Requirements and Distribution Pattern

Yellowtail snapper is a shallow-water member of the tropical fish fauna with a streamlined body and a deeply forked tail. It is reported to exhibit a niche requirement close to that of vermillion snapper, *Rhomboplites aurorubens*, because unlike many other snapper species, yellowtail snapper are usually seen well above the substrate, swimming in large schools or in small groups (Grimes 1976).

Yellowtail snapper are found in a variety of habitats. Larvae are pelagic and widely dispersed (Riley et al. 1995). Juveniles are found in shallow coastal waters over back reefs and on grass beds (especially turtle grass, *Thallasia testudinum*). Adult yellowtail snapper typically inhabit sandy areas near offshore reefs at depths ranging from 32 to 230 feet (10-70 m). Large fish roam greater distances, whereas smaller individuals remain close to shelter.

2.4 Food Habits

Snappers are generally nocturnal predators. The yellowtail snapper is an important reef fish predator and generally considered to be opportunistic and a generalist in terms of its feeding habits (Fallows 1984, Parrish 1987). Although their mode of feeding is reported to change continually with growth, both juveniles and adults feed primarily on fish, shrimp, and crabs (Bortone and Williams 1986).

Although most snappers lead a primarily demersal existence—i.e., they usually remain within a few meters of the bottom, where most feeding seems to occur—yellowtail snapper are perhaps least constrained in its feeding environment. It occurs over a variety of depths and forages freely throughout much of the water column (Vose and Shank unpublished manuscript). Because of that behavior, water column feeding resources (e.g., larval stages, pelagic mollusks and polychaetes, gelatinous invertebrates, and other holoplankton) appear to represent a significant part of the diets of adults (Schroeder 1980, Parrish 1987). However, a variety of crustaceans appear to be taken from the substrate and the water column, and a number of studies show considerable amounts of other fully benthic prey groups (Parrish 1987).

2.5 Reproductive Life History

Yellowtail snapper are gonochoristic, i.e., following sexual differentiation an individual remains the same sex throughout its lifetime. Reproductive seasonality is reported to vary among populations, from extended spring-summer spawning (e.g., southeast Florida) to year-round spawning in the Bahamas and in the Caribbean (Grimes 1997). For example, Thompson and Munro (1974) reported that yellowtail snapper spawn off Jamaica during February, with a second spawn during September and October. In south Florida, spawning is concentrated in the Florida Keys (Barbieri and Colvocoresses 2003) and the Riley's Hump area near the Dry Tortugas (Lindeman et al. 2000), and although spawning extends over most of the spring and summer, peak spawning occurs during May-July.

Large spawning aggregations of yellowtail snapper are reported to occur seasonally off the coasts of Cuba, the Turks and Caicos, and the U.S. Virgin Islands. In the continental U.S., a large spawning aggregation is reported to form during May-July at Riley's Hump near the Dry Tortugas area off Key West, Florida.

Spawning appears to take place mainly from late afternoon through the evening hours in open waters and the eggs—which contain an oil droplet—are planktonic. The eggs hatch within 24 hours, producing sparsely pigmented larvae (Clarke et al. 1997). Young yellowtail snappers recruit into shallow inshore waters, gradually moving into deeper offshore areas with growth.

Yellowtail snappers are multiple (i.e., batch) spawners with indeterminate fecundity (Barbieri and Colvocoresses 2003). The Data Workshop recommended using fishery independent data to estimate life history aspects such as maturity. The FWC-FMRI Fish Biology Section sampled yellowtail snapper using traps and hook-and-line gear fished off southeast Florida and the Florida Keys during 2000-2002. Samplers measured these fish to the nearest mm and they removed the otoliths and gonads. From these data we calculated maturity equations by total length and by age. Gonads were assigned stage numbers based upon histological examination: stage-1 were immature, stages-2 through -6 were considered mature, and fish with stage-7 gonads (resting) were omitted from the analyses. We also included only female fish that were collected during the spawning season of April through October. We used a logistic regression to calculate the proportion mature (*mat*) as a function of total length (*TL* mm) from 218 fish (Figure 2.5 a):

$$mat = \exp(0.0114 * TL - 2.383) / (1 + \exp(0.0114 * TL - 2.383))$$

(0.00302) (0.9948).

The numbers in parentheses under the equation are the standard errors for the coefficients. This equation indicates that approximately 50% of the fish at 209 mm TL were mature.

Similarly, we used a logistic regression to calculate the proportion mature (*mat*) as a function of age (yr) from 205 fish (Figure 2.5 b):

$$mat = \exp(2.349 * Age - 4.004) / (1 + \exp(2.349 * Age - 4.004))$$

(0.4572) (0.9780).

As above, the numbers in parentheses under the equation are the standard errors for the coefficients. Approximately 50% of the fish were mature by 1.70 years of age.

2.6 Age and Growth

A variety of methods have been used to age yellowtail snapper. Scales and whole otoliths (sagittae) were found unsuitable for aging because marks (i.e., presumed annuli) were not sufficiently distinct, especially for older ages (Piedra 1969, Johnson 1983). Additionally, scales were frequently regenerated or damaged making them difficult to use as aging structures.

Sectioned otoliths have been found to be more legible than whole otoliths (Johnson 1983, Manooch and Drennon 1987), and have become the preferred method of age determination for yellowtail snapper (e.g., Johnson 1983, Manooch and Drennon 1987, Garcia et al. unpublished manuscript, Barbieri and Colvocoresses 2003).

Yellowtail snapper are relatively long-lived, with a reported maximum age of 17 years for both the U.S. Virgin Islands (Manooch and Drennon 1987) and southern Florida (Allman et al. 2003). In a recent fishery-independent study in southeast Florida (Barbieri and Colvocoresses 2003) fish with ages from 0 to 14 were recorded, but most of the fish collected had ages of from one to four especially in southeast Florida (Figure 2.6). Marginal increment analysis showed that annuli are formed once a year during April-June. To keep year classes together, all fish were assumed to advance one year in age on Jan 1. For bookkeeping purposes, fish captured between Jan and June which had not formed an annulus were assigned an age equal to number of annuli +1. All fish captured after June were assigned an age equal to their number of annuli. Age-1 individuals are therefore 3-9 months old on January 1st.

Despite the high variability in sizes-at-age, observed lengths for ages 1-14 fit the von Bertalanffy growth model well (r^2=0.99; n=1,501). No differences in growth rate were found between sexes. The von Bertalanffy growth function for observed total length at age (pooled sexes, regions, and gears) is:

$$\text{Total length (mm)} = 446.5\,(1 - e^{-0.527(\text{Age} + 0.6301)}).$$

2.7 Natural mortality

The Stock Assessment and Peer-Review Panel discussed natural mortality rates. In light of additional ageing information not available at the Data Workshop that showed older individuals than previously observed, the Stock Assessment Panel recommended a lower natural mortality rate range than the 0.2 to 0.4 per year recommended by the Data Workshop. A baseline rate of 0.2 per year was used with a range of 0.15 to 0.25/year. This range was based on 17-year old individuals, (M = 3/17 or 0.18/year, Gabriel et al. 1989). The ages of the older individuals were confirmed between the data workshop and stock assessment workshop. The Peer-Review Panel pointed out that Gabriel et al.'s equation refers to the maximum age in an unfished population. However, the natural mortality rate of 0.2 per year is the same rate that was used by the NMFS Snapper Grouper Plan Development Team (1990) and is similar to the 0.214 per year that Ault et al. (1998) based on a maximum age of 14 years. Dennis (1991) estimated a higher rate of 0.32 per year for Puerto Rico from back-calculated ages in Manooch and Drennon (1987). Acosta and Beaver (1998) used Pauley's equation to obtain an estimate of M = 0.59 per year for yellowtail snapper in Florida but that value was unrealistically high when compared to our catch curve estimate of total mortality of 0.54 per year (Figure 2.7). The natural mortality rate was consistent with stock assessments for other reef species in the Southeastern United States used similar values for natural mortality (red porgy, M = 0.225 per year, maximum age = 15+ years; black sea bass, M = 0.30 per year, maximum age = 10+ years; and vermilion snapper, M = 0.25 per year, maximum age = 12+ years). The Peer-Review Panel agreed that there was little information on natural mortality for yellowtail snapper and that there were no grounds to change the Stock Assessment's range of 0.15 to 0.25 per year.

2.8 Morphometrics

Measurements for developing the morphometric equations came from two sources: the National Marine Fisheries Service's Marine Recreational Fisheries Statistics Survey (MRFSS) samplers routinely measure fork length but they also measured total length and standard lengths from 409 yellowtail snapper and the fishery independent samplers measured standard lengths, total lengths, and total weights from 1,547 yellowtail snappers. However, not all measurements were taken from every fish. The estimated length-length and length-weight relationships with the standard errors underneath in parentheses for yellowtail snapper were:

Total length (mm) = 1.3126 * Fork length (mm) –23.1166 (n = 409),
(0.0091) (2.9754)

Total length (mm) = 1.3341 * Standard length (mm) + 18.8671 (n = 1547),
(0.0103) (2.6206)

Fork length (mm) = 0.7473 * Total length (mm) + 23.4645 (n = 409),
(0.0052) (2.1059)

Fork length (mm) = 1.1080 * Standard length (mm) + 10.3715 (n = 409),
(0.0070) (1.9936)

Standard length (mm) = 0.8883 * Fork length (mm) – 4.7384 (n = 409), and
(0.0056) (1.8283)

Standard length (mm) = 0.6867 * Total length (mm) + 7.9526 (n = 1547)
(0.0053) (1.9006).

The length-weight data were log-transformed prior to fitting the equation because of the pattern in the residuals. The weight of yellowtail snapper in g from total length in mm is:

Ln(Weight (g)) = 2.7388 * Ln(Total length (mm)) – 16.9735 (n = 1421).
(0.0231) (0.1342).

The back-transformed equation is:

Weight (g) = 4.2512×10^{-8} * Total length(mm) $^{2.7388}$.

3. Fishery Characteristics

3.1 Fishery Description

As noted in the introduction, fishers have caught yellowtail snappers for more than 100 years in south Florida. The fishery for yellowtail snapper operates from Palm Beach in southeast Florida throughout the Keys with only occasional landings reported from outside of that area (McClellan and Cummings 1998). McClellan and Cummings also report that fishers target yellowtail snapper during full moons. Recreational and headboat anglers use hook-and-line gear as do most commercial fishers (approximately 97% of the commercial landings by weight) to catch yellowtail although some other commercial fishers have reported using spears, gill nets, cast nets and fish traps. Anchored gill nets were used until 1986 when use of nets was prohibited by the Florida Marine Fisheries Commission in the Atlantic waters of the Florida Keys and later were prohibited as an allowable gear in 1990. A common method used by both the recreational and commercial sectors is to bring yellowtail snappers up by deploying chum bags (Acosta and Beaver 1998, McClellan and Cummings 1998).

Review of fishery independent and fishery dependent information indicated that in United States waters there appeared to be differences in age composition between the Miami to Palm Beach area and the Keys area (Figure 2.6). Therefore, the Data Workshop and Stock Assessment panels agreed to the following geographic regions: Atlantic (Miami-Dade county and north) and the Keys (Monroe County and west) (Figure 3.1).

3.2 Commercial Harvest

3.2.1 Western Atlantic landings

To provide a geographical perspective, annual yellowtail snapper landings from the Western Atlantic were obtained from the United Nations Food and Agriculture Organization's Fisheries Information, Data and Statistics Unit, Fisheries Department for the period 1970 through 2000 (the latest available year). These data were incomplete for the United States and its possessions after 1979 and were augmented with landings data from the National Marine Fisheries Service's website: www.st.nmfs.gov/st1 (personal communication from the National Marine Fisheries Service, Fisheries Statistics and Economics Division, Silver Spring, MD) for the period of 1950 through 2001. The Caribbean Fishery Management Council supplied commercial harvest information for Puerto Rico and the U. S. Virgin Islands.

Western Atlantic commercial landings of yellowtail snapper have averaged 3,458 metric tons during 1997-2000 (Table 3.2.1, Figure 3.2.1). Mexico was the highest producer of yellowtail snapper with average landings of 1,413 mt per year (1997-2000) followed by the U.S. with an average of 747 mt per year and Cuba with an average of 498 mt. Puerto Rico and the U. S. Virgin Islands accounted for another 215 mt.

3.2.2 United States Commercial Landings

The Data Workshop identified the NMFS's commercial fisheries site (www.st.nmfs.gov/st1/commercial/index.html) and Florida's Marine Resources Information System also known as the trip ticket system as sources of commercial landings. However landings data from the NMFS website after 1977 listed all landings from Florida as coming from "Pooled Gear". Fortunately, NMFS Southeast Fisheries Science Center provided a third data base (General Canvass) with gear for landings for yellowtail snapper from 1962 into 1996. Although Florida's trip ticket program began in 1984, the program did not collect gear on each trip until late 1991. Therefore, the commercial landings by gear for yellowtail snapper were a composite of landings by gear from the NMFS website for the period of 1950 to 1977, from General Canvass data for 1978 to 1985 for landings and 1978 to 1991 for proportion on landings by gear, and from Florida's trip tickets from 1986 for landings and from 1992 for gear used per trip.

Although most of the landings of yellowtail snapper come from south Florida, there have been occasional landings reported from other southern states such as North Carolina or Texas but landings outside of south Florida are rare (Table 3.2.2.1). Historical commercial landings in the U.S. increased from 100-200 metric ton levels in the late 1950s to approximately 500 metric tons in the early 1970s followed by another decline to about 400 metric tons in the early 1980s and then climbed to the all time highs of 950 metric tons in the early 1990s. Landings have been declining since 1993. The reported commercial landings in 2001 were 644 metric tons (Table 3.2.2.2, Figure 3.2.2). Landings from the Keys accounted for 92% of the total commercial landings in 2001.

Fishers at the Data Workshop pointed out that not all landings of yellowtail snapper are reported. Prior to 1984, commercial fishers were not required to land their fish at fish houses and these fishers felt that about 30% was sold directly to restaurants and were not reported and that even today, there are restaurant sales. They felt that the unreported share was increasing. At the Stock Assessment Workshop, a representative of the industry agreed that there probably were unreported landings but he did not see that there was any trend. The Stock Assessment Panel recommended against making a sensitivity run because they did not have any evidence of any changes in reporting.

3.2.3 Commercial Effort

Prior to Florida's trip ticket program collecting landings by individual trip beginning in October 1984, the only available measures of effort were the number of vessels by port and the number of persons employed in the fishing sector. The trip ticket program allowed characterization of the fishery by the numbers of persons fishing for a particular species. For each trip, the ticket includes the Saltwater Products License (SPL) number, the dealer, the date landed, county landed, trip duration, wholesale dealer purchasing the fish, area fished, depth fished, market category of species landed, volume of landings, and price per pound. Initially gear was retrieved from the SPL record but frequently the license holder claimed more than one gear. Also when the Florida legislature initially approved the trip ticket program, it prohibited the retention of the SPL on the landings record. The legislature removed the prohibition in 1986 and SPL numbers began to be included on the trip ticket record. Beginning in late 1991, trip tickets included a series of check boxes for common gears and a gear code box for specific gear information.

Commercial effort as measured by either the number of fishers or the number of trips decreased steadily after 1989 partly in response to Florida's then Marine Fisheries Commission and the Gulf of Mexico Fishery Management Council implementation of stricter regulations for reef fishing in 1990 and the South Atlantic Fishery Management Council's regulations in 1992. Commercial landings and trips by region and year are shown in Table 3.2.3.1. There was no available effort information for those occasional landings of yellowtail snapper from other states. Using SPL numbers to identify fishers, the peak number of fishers from Florida landing yellowtail snappers was 8,343 in 1989 and by 2001 that number had decreased to 2,659 fishers (Table 3.2.3.2). As with most fisheries, there are many fishers producing landings but in the last decade an average 8% of the license holders produced an average of 88% of the landings and 80% of the fishers land less than 50 kilograms of yellowtail snapper per year.

3.2.4 Commercial Discards

The Stock Assessment Panel discussed methods for estimating discard rates and discard mortality. For commercial catch, the Panel used data from the period of 1 August 2001 through 31 July 2002 presented at the Data Workshop and collected by the National Marine Fisheries Service in a program designed to collect information on discards from a subsample of permitted vessels which submit log books (Poffenberger 2003). The working group assumed that the 24 vessels which reported discarding yellowtail snapper were representative of the fishery. Those vessels reported 480 trips on which discards of any species were reported and 233 of those trips landed yellowtail snapper. One hundred eighty-one trips of the 233 reported discarding yellowtail snapper. The total landings of yellowtail snapper on those 181 trips was 16,844 lb which corresponded to 15,313 fish landed. The discard rate per fish landed was calculated to be 16% [=(3178/15313) * (181/233)] and the discard mortality rate was calculated to be 28% (from Poffenberger Table 1 using all categories other than released alive). The total number of yellowtail snapper that were discarded and died from commercial fishing was calculated as the product of the annual numbers landed, the discard fraction and the discard mortality rate. The commercial discards by region, year, and gear are shown in Table 3.2.4.

3.2.5 Lengths of fish harvested by commercial fishers

Lengths of commercially landed fish were used to compare the sizes of fish landed by year, region, or gear and to convert landings from weight units to numbers of fish. As pointed out in the Data Workshop, both NMFS and FWC have port samplers that visit fish houses (wholesale dealers) to measure fish and interview boat captains. This information is stored in the Trip Interview Program (TIP) maintained by NMFS's Southeast Fisheries Science Center (SEFSC) in Miami. The TIP program began in 1984. The SEFSC provided all available yellowtail snapper records. Additional length measurements came from age and growth work that was conducted by NMFS's Beaufort and Panama City laboratories.

Lengths were assigned to commercial landings whenever possible by matching year, region (Atlantic or Keys), and gear. There were only a few measurements from the commercial sector prior to the implementation of TIP in 1984 but afterwards the numbers of lengths measured in the Keys region were adequate for assigning lengths to landings caught with hook-and-line gear. However, the sampling in the Atlantic was very light prior to 1991. During the entire 21-year period there were only 64 fish measured from the other gear category. A further complication in assigning lengths to landings arises from dealers sorting yellowtail snapper into size categories especially after the late 1990s. We compared the lengths by category and found that the dealers differed in what they called a medium or large fish so we collapsed the reported categories into four: small, medium (formerly medium and large), large (formerly extra large), and unsorted (Figure 3.2.5). Eighty-six percent of the landings in weight were matched with lengths from the same strata. We used a hierarchical system by region to assign lengths to those landings strata without matching measurements. If the strata did not get a match, we collapsed the measurements by region and size category across years and that matched another 14% of the landings. We matched the balance of the landings, less than 0.5%, by combining the lengths for the other gear category. The final stragglers were assigned lengths by collapsing across commercial gears within a coast. The commercial catches-at-length by region and year are shown in Tables 3.2.5.1.a (Atlantic) and b (Keys).

Participants at the Stock Assessment Workshop recommended that future assessments fill missing hook-and-line gear and unsorted-sizes strata with length measurements from the headboat fishery. We evaluated the efficacy of this procedure by developing another catch-at-length matrix using lengths from the headboat fishery for the hook-and-line fishery on the Atlantic coast by year for 1981 through 1991 and on the Gulf coast for 1982 and 1983 (Tables 3.2.5.2.a and b). This method smoothed the catches-at-length especially for those region-year combinations with few length samples.

3.3 Recreational Harvest

Two sources of recreational information other than headboat information were mentioned at the Data Workshop: NMFS's Marine Recreational Fishery Statistics Survey (MRFSS) and Texas's inshore creel survey. Dr. Mark Fisher of Texas Parks and Wildlife Department said that their creel survey rarely encounters yellowtail snapper and that source was not considered again in the assessment. The National Marine Fisheries Service monitors fishing activity made by recreational anglers fishing from shore, private or rental boats, and from charterboats (fishing modes) through the Marine Recreational Fishery Statistics Survey (MRFSS). These data were obtained from the MRFSS website: http://www.st.nmfs.gov/st1/recreational/. The MRFSS began in 1979 but the data from the first two years were not consistent with later data and MRFSS recommends not using them. The survey is divided into two parts: 1) a random telephone survey of households in Atlantic and Gulf coastal counties of the United States excluding those in Texas to determine the number of recreational fishing trips conducted by the three fishing modes during two-month time periods and 2) angler interviews made within the same sampling design. Recreational landings from 2002 were not used in the assessment models.

In recent years in Florida, MRFSS contractors made approximately 100,000 telephone calls to identify fishing households and obtain the number of saltwater fishing trips per two-month period. Samplers for MRFSS conducted approximately 40,000 interviews per year in Florida. The interviews contain information on the number of fish that were seen by the samplers (Type A) and the number of fish that were caught but were unavailable to the sampler (Type B). Beginning in 2000, the number of estimated trips in the charterboat mode on the gulf coast of Florida has been developed from a separate telephone survey that calls a random sample of 10% of the charterboat operators each week. The MRFSS callers ask the charterboat operator how many trips had they made in the previous week. Samplers verify the information by visiting a sub-sample of the chosen operator's boat slips and recording which days the boats were away from the dock. The estimated charterboat catches using the new trip estimates were lower in both years than the previous method of estimating charterboat effort (58% lower in 2000 and 45% lower in 2001) (Table 3.3). Unfortunately, we only have two years to base a comparison and so we are using the published MRFSS estimates in the base run and evaluating the impact of the difference with a sensitivity run using charterboat estimates from the Keys calculated using the old method.

3.3.1 Recreational Landings

Recreational landings, in numbers of fish, have been variable but decreasing over the entire 21-year period (Table 3.3.1, Figure 3.3.1). Recreational landings in terms of kilograms landed per year had a peak in 1991 and then have since declined. The landings in 2001 were 85,600 fish on the Atlantic coast and 102,900 fish in the Keys. As noted above, the method of estimating charterboat effort was changed in 2000 and the landings in 2001 would be 58,800 fish higher (57%) in the Keys if the new estimates of effort were used to calculate the catch (Table 3.3). For scale, in the first full year of MRFSS data, 1982, landings were 422,300 fish on the Atlantic coast and 1,173,300 fish in the Keys.

3.3.2 Recreational Effort

The telephone portion of MRFSS estimates the number of fishing trips by sub-region, year, two-month time period, and fishing mode. We used the post-stratification program developed by MRFSS to combine the trips from the telephone survey with interviews to partition the number of fishing trips into distance from shore and geographical sub-areas. We used only the data from 1986 and later because in earlier years headboat trips were mixed with charterboat trips. The annual numbers of trips for charterboat and private/rental boat modes are shown in Table 3.3.2 and Figure 3.3.2. Charterboat trips increased markedly from an estimated 324,900 trips in 1986 to a peak of 880,000 trips in 1995 and then declined to 415,400 trips in 2001. Similarly, private/rental boats doubled from 1,561,800 trips in 1986 to 3,088,400 trips in 1991 and then declined back to 1,552,200 trips in 2001.

3.3.3 Recreational Discards

Recreational discards are included as part of the MRFSS interviews. The MRFSS protocol asks anglers how many fish they released alive. Estimates of the number of fish released alive (Type B2 fish) are included in the published landings. The proportion of fish released alive frequently exceeded the landed portion of the catch after 1985 (Table 3.3.3). In 2001, recreational anglers released 137,100 (160% of landings) yellowtail snapper on the Atlantic and 221,800 fish (216% of landings) in the Keys. The discard mortality rate was approximated as 30%.

3.3.4 Lengths of fish caught by anglers

The two components used to produce the landings by size were length measurements of yellowtail snapper from the MRFSS intercept data and the MRFSS landings by numbers. Preliminary examination of the MRFSS length data indicated that the most appropriate level to assign a size distribution to landings would be at the region-year level. While many different approaches to creating a weighted length distribution were examined, only the approach settled upon is described.

For each year within a region (Atlantic or Keys), the size distribution of yellowtail snapper (in 10-mm classes) was used to partition the landings to size classes. For the Keys, the length data were adequate for 20 of 21 years, while in the Atlantic 11 of 21 years had fewer than 50 length measurements. For all region-year combinations where there were less than 50 fish, size measurements for that region from the adjoining years to the low count cell were appended to the cell and used to augment the size frequency distribution. These size distributions were used to apportion the Type A (kept) landings to size. For the Type B2 estimates (the number of fish that were released alive) information from the intercept data sets were used to determine the proportion of releases that were sub-legal. This information was used to divide the Type B2 estimates into legal and sub-legal estimates and legal was assumed to be above the 12-inch (305 mm) minimum size. For the period 1981-1990, the intercept data sets contained no information on legal/sub-legal releases. For 1981-1990, an average percent of sub-legal fish by region (based on estimates from 1991-2001) was used to partition Type B2 estimates into the legal and sub-legal components. For the legal component of the Type B2 estimates, the size frequency distributions applied to Type A landings were used to partition estimates by size. For the sub-legal portion of the Type B2 estimates, length data collected from the FWC-FMRI's fishery independent samples by region were used to develop three size distributions of sub-legal (< 305 mm) yellowtail snapper. For each region, the size distributions consisted of a composite distribution to be used for 1981-1999 and year specific distributions for 2000 and 2001. These size distributions were applied to the sub-legal Type B2 estimates. Since there was no information on the size of Type B1 estimates, a size distribution based on a mix of Type A and Type B2 estimates (adjusted for a release mortality of 30%) were applied to the Type B1 estimates. The numbers of fish by region, year, and 10-mm length category are shown in Table 3.3.4.

3.4 Headboat Harvest

The headboat fishery is administered out of the NMFS's Beaufort Laboratory in North Carolina. This program began in 1979 and expanded into south Florida in 1981. The program collects headboat operator trip reports containing the trip type (trip duration), date, area fished, number and weight landed by species, and the number of anglers. These data provide estimates of landings and catch rates. The primary areas for yellowtail snapper were Area 11 (Southeast Florida) and Areas 12,17,18 (the Keys). Headboat landings for 2000 and 2001 were unavailable for the Gulf of Mexico north of the Keys which only accounts for a small portion of the landings so we substituted the 1999 values for those two years in that area. A complementary program has headboat samplers meeting a sample of the headboats to confirm species identifications, measure fish, and remove hard parts for aging.

3.4.1 Headboat Landings

Headboat landings for yellowtail snapper are usually much less than either the other recreational or the commercial sectors. Landings in the early 1980s averaged 48,100 fish per year on the Atlantic coast which increased slightly to an average of 53,700 fish per year during 1991-1995 and then decreased to only 5,000 fish in 2001 (Table 3.4.1, Figure 3.4.1.a). In the Keys, the landings followed the same trend of being low in the early 1980s (123,900 fish per year), increasing to an average of 180,300 fish per year in 1986-1989 and then declining to 93,900 fish in 2001 (Figure 3.4.1.b).

3.4.2 Headboat Effort

Effort in the headboat fishery is measured in angler-days. The number of angler-days have decreased from 155,000 angler-days in the Atlantic in 1981 to 62,000 angler-days in 2001 and from 82,000 in the Keys in 1987 to 45,000 angler-days in 2001 (Table 3.4.2, Figure 3.4.2).

3.4.3 Lengths of fish caught by headboat anglers

For the headboat data, landings by size were constructed using length data for yellowtail snapper collected for the fishery, together with the landings by numbers. Landings by size were assigned at a region-year level. For the Atlantic coast, two subregions consisting of areas north of Fort Pierce, FL and Fort Pierce to Miami, FL were used. For the Gulf, two subregions were also used one for landings made between Key Largo and the Dry Tortugas and the other for landings in all areas north of the Keys. Size distributions within these subregions by year were assigned in a hierarchical form and based on length classes in 10 mm increments. For subregion-year combinations where there were more than 50 length measurements, the size distribution for the subregion for that year was applied to the landings. For subregion-years with less than 50 measurements, a size distribution based on the region (i.e., Atlantic or Keys) for that year was applied to the landings for that subregion. In the Atlantic there were no length measurements in 1996 for either subregion. As such, for the Atlantic coast in 1996, length measurements from the adjoining years were substituted for 1996 estimates and the composite was used to determine the size distribution for that year. The catch-at-length for the headboat fishery is shown in Table 3.4.3.

3.4.4 Headboat discards

There is no direct measure of the number of fish discarded by the headboat fishery. To account for some level of removals by discards made by this sector, we used the ratio of under-sized fish to total fish measured in the fishery independent, hook-and-line samples taken in the Atlantic and the Keys. In the Atlantic, there were 131 yellowtail snapper caught and 48 of these fish were undersized (37%) and samplers in the Keys caught 653 yellowtail snapper with hook-and-line gear and 175 were undersized (27%). We used these proportions to approximate the discard rate and then we applied the same 30% release mortality rate that was used in the other recreational sector. The estimated annual number of fish discarded by headboat anglers and the number that were believed to die subsequently are shown in Table 3.4.4.

3.5 Total Harvest

The total harvest of yellowtail snapper was stable at an average of 2.2 million fish in the 1980s then increased to an average of 2.6 million fish in the early 1990s and then has decreased to an average of 1.9 million fish in the late 1990s and 1.6 million fish in 2001 (Table 3.5). Expressed in weight of landings, the total harvest of yellowtail snapper had a different trend in the early years. Landings increased from an average of 1,067 metric tons in the early 1980s to an average of 1,498 metric tons in the early 1990s and then has decreased to an average of 980 metric tons in the late 1990s. The total harvest was 802 metric tons in 2001.

3.6 Assigning ages to catch-at-length by fishery

Catch-at-age matrices for the commercial, MRFSS and headboat fisheries were developed from the catches-at-length using the fishery dependent age-length keys and the landings by size for each of the three fisheries. Otoliths were aged by personnel at NMFS's Panama City and Beaufort Laboratories and by personnel from FWC-FMRI. We included the ages from Jennifer Potts' (NMFS Beaufort Laboratory) re-reading the otoliths from fish used in Garcia's age and growth study (Garcia et al. unpublished manuscript). Consistency among readers was evaluated with a test set of otoliths and there was less than 5% disagreement among readers. In addition, fishery-independent ages were used to age the discards. Ideally, we would like to create age-length keys by area, gear, and year but there were not sufficient otoliths in most years (Table 3.6.1). Therefore, we grouped the age-data by coast and based upon the number of otoliths available into seven time periods: 1980-1986, 1987-1996, 1997, 1998, 1999, 2000, and 2001 (Figure 3.6). There were only 64 fish collected from non-hook-and-line gears, ages were assigned without regard to gear. The fishery dependent age-length keys had no data for yellowtail snapper less than 220 mm TL. However, only a small portion of the landings in each of the fisheries was less than 220 mm TL. For these sizes, the FWC-FMRI fishery independent age-length key for fish less than 220 mm TL was applied to make a composite key and applied to the landings of fish in that size range. Similarly, the fishery dependent age-length keys also had a low number of samples for fish > 670 mm TL. As such, it was not possible to always get a direct age match for a size group > 670 mm TL. Given the large age-size variability in yellowtail snapper, the fishery dependent age-length data for fish > 670 mm TL within the specific region was used in a bootstrap procedure to develop an age profile for the landings in the missing age-size range. This was achieved using the following procedure:

1) For fish > 670 mm TL, pool the fishery dependent age-length information by region.

2) Using the landings of fish in numbers (*n*) in the missing age-size class, randomly pick *n* ages with replication from the pooled data.

3) Use those randomly picked ages to develop an age profile and apply it to the missing age-size landings.

When these keys were applied to the catch-at-length data by fishery or gear, any holes that appeared were filled by first using a composite age-length key of all years for the appropriate coast, and then, for those length categories that did not have any ages for that coast, randomly selected ages from the surrounding length categories were applied.

In addition to the age-length key approach, the Stock Assessment Panel also examined the feasibility of using age composition developed directly from age samples (proportion at age by year times catch) for 1994-2001 and multi-year age length keys for 1981-1986 and 1987-1993. The preliminary results of this direct aging approach were not considered reliable possibly due to the stratification used (gear and region as well as year for 1994-2001). The revised catch at age data showed an abrupt change (i.e., inconsistent or unreasonable changes in numbers at ages in successive years) between 1993 and 1994 in the estimated numbers of younger aged yellowtail snapper (Table 3.6.2). The Panel determined that the abrupt change was likely due to changes in aging criterion from age-length key to direct aging. After careful examination of two versions of the estimated catch-at-age data, the Panel concluded that the original estimated catch-at-age data were the most appropriate for stock assessment analyses (See Table 4.2.2.1.1). The Panel recommended further exploration of this type of approach in the future.

4. Assessment

4.1 Trends in Availability

The basic assumption in using catch rates to tune assessment models is that changes in catch rates reflect similar changes in population size. We standardized the catch rates (Kimura 1981) in an attempt to account for confounding influences such as season, region, differing trip durations, or numbers of anglers.

4.1.1 Fishery Independent Indices

The Data Workshop identified two fishery independent sources: the National Marine Fisheries Service and University of Miami Reef Visual Census (RVC) conducted from 1979 through 2001 and Reef Environmental Education Foundation visual surveys (REEF) conducted from 1993 into 2002 (Reef 2003). We considered developing an index from Southeast Area Monitoring and Assessment Program collections but that program rarely catches yellowtail snapper in their samples (Dr. Scott Nichols, NMFS Pascagoula Laboratory, personal communication).

4.1.1.1 National Marine Fisheries Service and University of Miami Reef Visual Census

We used two of the measures of density from the National Marine Fisheries Service and University of Miami Reef Visual Census (RVC) as indices. The first was the annual density of juvenile yellowtail snapper (fish < 197 mm TL) that was applied to age-1 fish and the other index was for adult fish (fish > 197 TL mm) that was applied to fish age-2 and older. Although the area sampled by the visual surveys is from Key Biscayne National Park to Dry Tortugas National Monument, the yellowtail snapper indices did not include dives from the Dry Tortugas. The RVC uses a two-stage, stratified design. The design uses seven primary strata based on reef habitat, these strata are sub-divided into 200 m x 200 m squares. The secondary sampling units are randomly selected within a stratum and the number of sites is proportional to the stratum's area. Protected areas in the Florida Keys were treated as separate strata beginning in 1997. The visual observations are the sum of usually two divers counting the fish they observed in a cylinder of water 15 m in diameter extending from the surface to the bottom at a site. Divers record the number of fish observed by species, the average size, the minimum size and maximum size. The three size measurements are used to pro-rate the fish into a triangular length distribution by stratum. The details of calculating the density estimates can be found in Ault et al. (2002, Section 2.0). The Stock Assessment Workshop Panel was concerned about the consistency of these indices with increasing numbers of strata. We contacted Dr. Steven G. Smith (University of Miami) and he said that they increased the number of strata because of the protected areas that were implemented in the Keys. They also subdivided the patch reef stratum. Dr. Smith thought that these densities were representative. The yellowtail snapper densities are in Table 4.1.1.1 and Figure 4.1.1.1. The Peer-Review Panel recommended further investigation of these indices and their use in stock assessments.

4.1.1.2 Reef Environmental Education Foundation visual survey

REEF provided 14,890 dive observations from Florida. The information provided by dive included diver experience (expert or novice), geographic zone code, site name, survey date, surface temperature in degrees Celsius, bottom temperature in degrees Celsius, bottom time in minutes, starting dive time, visibility categories (1 – under 10 ft, 2 – 10-24 ft, 3 – 25-49 ft, 4 – 50-74 ft, 5 – 75-99 ft, 6 – 100-149 ft, and 7 – over 149 ft), current (1 – strong, 2 - weak, and 3 – none), species, and abundance (1 – 1 fish, 2 – 2-10 fish, 3 – 11-100 fish, and 4 – more than 100 fish). For the purposes of developing an index, we restricted the dives to those from southeast Florida (Palm Beach – Dade counties and Monroe county) from 1994 onwards (8,072 dives). The habitats that were sampled frequently included: 1 – mixed habitat, 2 – high profile reefs, and 9 - broken coral, rock, boulders. We would have included ledge habitats but there were few observations from ledge habitat. Previous studies using these data considered the abundance categories as $\log_{10}$ values and so we re-coded them to 0, 1 – 1-10, 2 – 11-100, and 3 – more than 100.

The index was calculated using a generalized linear model with an identity link because abundance was considered to be already $\log_{10}$-transformed. The annual values were adjusted for coast, wave (two-month time periods), habitat, diver experience, visibility, and current. Bottom temperature, depth, and bottom time were considered covariates. We were unable to include interaction terms probably due to the low number of dives from southeastern Florida during 1994-1997. An alternative model used the delta-lognormal method analogous to that used for the fishery dependent indices (see Section 4.1.2). The proportion of positive trips was model with a binomial distribution and the abundance was modeled with the procedure as described before except that only dives that observed yellowtail snapper were included in the analysis. The index value was then the product of the annual proportion positive times the annual mean abundance of positive dives. One thousand estimates were developed using the annual means and standard errors of the terms to create empirical distributions. As with the other analyses, the delta-lognormal method results were higher than those generated using the negative binomial distribution but the pattern was similar.

The Stock Assessment Workshop recommended not including the REEF index because they felt that the categorical scale was not sensitive enough to capture changes in yellowtail snapper abundance.

4.1.2 Fishery Dependent Indices

Yellowtail snapper associate with reefs such that one can fish the reef and perhaps catch mutton snapper or gray snapper on some days and yellowtail snapper and gray snapper on other days on the same reef. Commercial and headboat trips only record what was landed; thus, just using the trips with yellowtail snapper underestimates the actual effort because there could be other trips that caught some other reef species but not yellowtail snapper. To identify these potential yellowtail trips, we extracted all of the species from the commercial trip tickets that included yellowtail snapper from 2000 and 2001. That exercise produced 156 species although many were caught infrequently. We narrowed the list by selecting the species that were frequently caught with yellowtail snapper (those species that were caught on more than 1,000 trips per year) from hook and line trips and included species that were known to be associated with reefs. However, the Data Workshop Panel suggested that we look at how associated species were identified for yellowedge grouper (Cass-Calay and Bahnick, 2002). Cass-Calay and Bahnick used 25% percent common occurrence with a minimum number of 25 trips and they used a species association index developed by Dennis Heineman (formerly with the NMFS Southeast Fisheries Science Center). We extracted all the commercial trips from 1992-2001 and calculated these indices plus Jaccard's Index of Similarity (Krebs 1989) and noticed that the association index did not provide any additional information over common occurrence and Jaccard's Index only provided relative rankings for the species. Therefore, we defined potential yellowtail snapper trips as trips that caught any species with a total number of trips greater than 1% of the total trips and co-occurred with yellowtail snapper on at least half of their trips (50% common occurrence, Table 4.1.2).

We used generalized linear models to estimate the annual, fishery dependent indices. These techniques have frequently been used to create indices in stock assessment (Ortiz 2003, Anonymous 2002, Cass-Calay and Bahnick 2002). We used delta-lognormal distributions (Lo et al. 1992, Ortiz 2003) to model the uncertainty when the response variables were continuous (for example weight landed per trip) and negative binomial distributions when the response variables were not continuous but discrete (like the number of fish). Usually annual indices were adjusted for categorical variables such as month, area, gear, or trip type and also for some covariates like time fished or the number of anglers. The delta-lognormal method models the proportion of non-zero trips independently from the weight landed per trip on those trips that caught yellowtail snapper and then combines those results by year into the index value. The proportion of positive trips was modeled with a generalized linear model that used a binomial distribution and a logit link. The logit link means that the computer program produces least-square estimates (*est*) in the form *est = Ln(p/(1-p))* that have to be translated back to get the proportions (*p*). The proportion is *p = exp(est)/(1 + exp(est))*. The uncertainty surrounding the annual estimates were modeled by creating 1000 estimates per year from the annual means and the standard errors of both the proportion of non-zero trips and the number of fish per trip.

4.1.2.1 Commercial catch rates

Ten reef species in addition to yellowtail snapper met the criteria of 50% common occurrence with yellowtail snapper and being caught on at least 1% of the total commercial trips (Table 4.1.2). The 2002 data became available just after the Data Workshop so we have included it here. Using trip tickets with any of these species being reported, we calculated two commercial indices: 1) the kilograms of yellowtail snapper on all trips from 1985-2002 that caught any of the identified reef species and 2) a subset of those data from 1992-2002 that reported using hook-and-line gear. The combined gear index used 191,894 commercial trips from either the Atlantic or Keys regions, depths of no more than 107 m (350 ft) and trip durations of less than three weeks. The regions were assigned based upon area fished if that field was available otherwise we used the county of landing. The maximum time limit was intended to eliminate aggregate trips. The annual proportions of successful yellowtail trips were modeled with a generalized linear model that used a binomial distribution and the kilograms per trip were modeled with a lognormal distribution. The classification variables were region and month with interaction terms and the covariates were depth and trip duration in days. If the trip duration was reported in hours, we converted the time to days with 12-hours equal to one day.

All of the terms used in the model were significant and the summary statistics are shown in Table 4.1.2.1.1. Regions (Atlantic and the Keys) had the largest effect on the proportion of positive trips while not surprisingly, trip duration had the largest effect on the landings of successful trips. While variable there has been a general increase in the commercial catch rate over the 18-year period (Table 4.1.2.1.2, Figure 4.1.2.1.1).

Another constructed index used just the commercial hook-and-line trips, a subset of the combined-gear data set. Trips were included if they specified either the hook-and-line or bandit check boxes or the gear codes for rod-and-reel (6110), hand reel (6120), or electric reel (6130). These 147,907 trips used the same spatial, depth, and trip duration limits. The generalized linear model used the same configuration as with the combined-gear model. Similar to the combined-gear index, all of the terms were significant. Region had the largest effect on the proportion of successful trips and trip duration had the largest effect on the kilograms of yellowtail snapper per successful trip (Table 4.1.2.1.3). The index declined from 1993 to 1996 and then increased with a dip in 2000 and 2001 (Table 4.1.2.1.4, Figure 4.1.2.1.2). The standard errors were sufficiently tight, because of the numerous trips, that any fluctuation was significant.

The two commercial indices based on trip tickets were strongly correlated over the years that they overlapped ($r = 0.99$, $df = 11$, $P < 0.05$) so we only used the longer time series in subsequent analyses.

A third commercial index used NMFS's reef fish logbook data and six additional reef species that met the selection criteria (Table 4.1.2). Because Florida fishers were not required to complete logbooks until 1993, we restricted our analysis to hook-and-line trips in the Atlantic and Keys regions from 1993-2001 if any of the identified reef species were landed and the trip duration was less than three weeks. Because this index also used the yellowtail snapper kilograms landed per trip, we used the delta-lognormal approach in the generalized linear model. The variables were similar to those used in the trip ticket analyses, annual yellowtail snapper kilograms landed per trip was adjusted for region and month while time fished was considered a covariate.

There were 86,776 logbook trips that met these restrictions and of those there were 71,152 trips that landed yellowtail snapper. All of the terms including the interaction terms were significant (Table 4.1.2.1.5). The pattern in the index was similar to the trip ticket hook-and-line index with a decline to 1996 followed by an increase to 1999 with another drop in 2000 and 2001 (Table 4.1.2.1.6, Figure 4.1.2.1.3) and because this index was significantly correlated ($r = 0.93$, $df = 9$, $P < 0.05$) with the longer commercial combined gear, this index also was not included in the Integrated Catch-at-Age analyses.

While reviewing the fishery dependent indices, the Stock Assessment Workshop Panel suggested focusing on just the higher producers in the fishery. We used the Reef Fish Permit logbook data to evaluate this suggestion. After tallying the annual landings by vessel from the logbook data, we identified a sampling universe of 107 vessels that landed at least 500 kg of yellowtail snapper in five of the last seven years (1995-2001). We then extracted all of the landings for those 107 vessels and summarized the species that they caught as noted above. However, for the trips made by these vessels, there were no other species caught on the trips that reported yellowtail snapper; therefore, the alternate index was calculated using all of the trips for these 107 vessels (Table 4.1.2.1.7 and 4.1.2.1.8, Figure 4.1.2.1.4).

The Peer-Review Panel questioned the use of interaction terms in calculating these catch rate indices and recommended recalculating the indices without the interaction terms. The recalculated index for commercial combined gear was similar to the original index until 1999 but was higher afterwards while the logbook index was similar throughout (Figure 4.1.2.15). The Peer-Review also recommended using non-linear approaches when incorporating covariates such as trip duration. We were unable to do this at this time but will consider doing so in future assessments.

4.1.2.2 Recreational catch rates

The 2002 MRFSS estimates and interviews became available just after the Data Workshop so we have included them here so the MRFSS data encompassed 1981 through 2002. Following the recommendation of MRFSS (ASMFC 1999), we subset the interviews to just those with one contributor and to those where the angler caught or targeted any of 16 species that were identified by examining the species as being caught with yellowtail snapper (Table 4.1.2). From 1981 through 1985, headboat and charterboat interviews were combined into a single mode but we were able to exclude the headboat interviews by using MRFSS's variable (mode_f). We also excluded shore interviews from the index. Region (Atlantic or Keys) was based on county where the interview occurred and, as with the commercial indices, we only included interviews from southeast Florida (Atlantic) and the Keys. We developed an index of the annual total number of fish caught per trip adjusted for region, two-month wave, mode of fishing (charterboat and private/rental), and whether the angler targeted yellowtail snapper. Hours fished was considered a covariate.

There were 6,836 interviews used in the generalized model. Neither mode of fishing nor two-month wave were significant in the full model so those variables were excluded in the reduced model. All of the terms including the interaction terms were significant in the reduced model (Table 4.1.2.2.1). Again region had the largest effect. Because of the log link, the index values were converted back to their arithmetic means. Recreational catch rates were high in 1981 and 1982 (Table 4.1.2.2.2, Figure 4.1.2.2.1) and quite uncertain because of the small sample size (less than 100 interviews for both regions combined). The rates were lower from 1983 to 1989 followed by an increase in 1990 and 1991 followed by a general decline to 1996-1998 after which the catch rates increased. The commercial catch rates had a similar low in 1996.

We also ran the index using the same data with a delta-lognormal approach as has been developed for Spanish mackerel (Ortiz 2003) even though the total catch in number of fish is discrete not continuous. The two indices were the same after 1982 and the delta-method index was higher than the negative binomial index in both of those early years (Figure 4.1.2.2.2).

As with the commercial indices, the MRFSS recreational index was recalculated using a delta lognormal error structure and without the interaction terms . The recalculated index was similar but smoother and without the high values in the early years and in the later years (Figure 4.1.2.2.3).

4.1.2.3 Headboat catch rates

As with the other fisheries, we had to subset the headboat data to ensure that we used the most comparable data. For the purposes of developing an index, we only used trips from vessel type = 1 (headboats), period = 0 (updated coding for time of day), Area 11 (Fort Pierce to Miami) and Area 12 (Key Largo – Key West), trip types 2 (full day) and 9 (1/2 day night), and if the trip reported any of the reef species. The occasional trips to the Dry Tortugas were not included in the catch rate analyses. Initially, we included trip type 3 (3/4 day) but could not get convergence because there were only 5 trips in 1983. We also did not include trip type 1 (1/2 day morning trips) because there were no trips of this type reported between 1984 and 1994 which caused a spike in 1995 that reflected a change in sampling not a change in yellowtail snapper. We also followed the Data Workshop's recommendation to divide the trips into two time periods: 1981-1991 and 1992-2001 because of enactment of the aggregate bag limit. The index was the annual number of yellowtail snapper landed per headboat trip adjusted with a generalized linear model using a negative binomial distribution with a log link. The classification variables were month, trip type, and area. The number of anglers was considered as a covariate. We did not include a year * month interaction term because trips were not reported in all months in all years.

There were 39,256 headboat trips used in the analyses. All of the terms in the model were significant and area, which is equivalent to region in the other indices, had the largest effect in the first time period but trip*area had the largest effect in the later period (Table 4.1.2.3.1). The catch rate of full day trips in the Atlantic region (area 11) was much lower when compared to the other trip type and area. The headboat catch rate declined in 1983 and was low until it began to increase in 1987 and continued to increase until 1994 then the rate declined and steadied except for jumps in 1998 and 1999 (Table 4.1.2.3.2, Figure 4.1.2.3.1).

As noted in the logbook section (Section 4.1.2.1), the Stock Assessment Panel suggested focusing on just the higher producers in the fishery. We tallied the annual landings of yellowtail snapper by vessel (135), there were 22 headboats that landed more than 100 yellowtail snapper in any year in the most recent seven years (1995-2001) and seven headboats that landed at least 100 yellowtail snapper in five of the last seven years (1995-2001). We then extracted all of the trips for those seven vessels and calculated a "targeting" index of the number of yellowtail snapper per trip with a generalized linear model using the delta-lognormal approach. Because there were so few headboats, interaction terms were not appropriate (Table 4.1.2.3.3). The results had a different pattern from before -- the original index dropped in the early 1980s and then increased and was then essentially flat in the 1992-01 period while the catch rates of "targeting" headboats were mostly flat during the first period (1981-1991) and then increasing from 1992 through 2001. Part of the early period trend was a marked jump in 1990 and 1991 that the Stock Assessment Workshop Panel felt was unreal and replaced those two year's values with the 1987-1989 average (Table 4.1.2.3.3 Figure 4.1.2.3.2).

The recalculated indices with a delta lognormal error structure and without interaction terms were similar to the original indices (Figure 4.1.2.3.3).

4.2 Assessment models

A variety of assessment models were developed to identify population trends in yellowtail snapper. The models included surplus production (ASPIC, a non-equilibrium surplus production model, Prager 1994; and ASPM, an age-structured surplus production model, Porch 2002) and age-structured (Integrated Catch-at-Age, Patterson 1997; Fleet-specific Statistical Catch-at-Age, Murphy this assessment).

4.2.1 Surplus production models

4.2.1.1 Non-equilibrium surplus production model (ASPIC)

ASPIC is a non-equilibrium surplus production model that incorporates covariates which means that this model can use auxiliary data to assist the program in coming to a solution that approximates the dynamics of yellowtail snapper (Prager 1994). The model is very straight-forward in that the change in population biomass is by a rate of increase, *r*, that is modified by how close the population is to the carrying capacity, *K*. The equation for that is:

$$B_{t+1} = B_t + rB_t - rB_t^2/K - F_tB_t$$

where B_{t+1} is the biomass at time *t+1*, B_t is the biomass at time *t*, *r* is the intrinsic rate of increase, *K* is the carrying capacity, and F_t is the biomass fishing mortality rate at time *t*. We also need some estimate of the biomass at the beginning of the time series. In this case, we solve for the ratio of the starting biomass to the carrying capacity, B_1K. For each fishery, *j*, the fishing mortality is defined as the product of the catchability for that fishery, q_j, and the effort for that fishery at time *t*, f_{jt} , or

$$F_{jt} = q_j * f_{jt}.$$

Therefore, the model solves for r, K, B_1K, and a q for each fishery from a time series of catch and either effort or catch rates. We configured the model for the three fisheries (headboat, MRFSS recreational, and commercial) and used the annual landings by fishery expressed in biomass and the standardized catch rates also expressed in biomass. The headboat and the MRFSS recreational indices were multiplied by their annual average weight. In addition to running this model in ASPIC, we also developed similar models in Excel and AD Model Builder (Version 4, Otter Research Ltd.).

The headboat and commercial indices generally increased while the MRFSS index had a slight decrease and, although the decrease in MRFSS was not statistically significant, we had to run the ASPIC model with the index checking turned off. One configuration of the model fit the data well but we found the model to be unstable in that changing the starting values for the parameters produced different results. A frequent solution was with a very high carrying capacity and extremely low fishing mortality rates on the order of less than 0.01 per year. This instability typically results from indices without sufficient contrast. We concurred with the Stock Assessment Workshop Panel recommendation to drop this model and will present no results from the model.

4.2.1.2 Age-structured surplus production model

Dr. Clay Porch of NMFS's Southeast Fisheries Science Center developed a preliminary age-structured surplus production (ASP) model for yellowtail snapper while at the Stock Assessment Workshop. He used the same data as was used in the ASPIC model. However, he chose a starting year of 1940 to approximate an unfished stock and let the model increase fishing mortality in a linear fashion until 1981 when the model began to fit the observed effort data. This model came to similar conclusions as the earlier surplus production model that there was little fishing mortality on yellowtail snapper and that there was a large number of fish. The Stock Assessment Workshop Panel recommended that this model be only mentioned as a conceptual model.

4.2.2 Age-structured models

Two age-structured models were deemed appropriate for stock assessment analyses of yellowtail snapper: Integrated Catch at Age (ICA, Patterson 1997) and a fleet-specific, statistical catch at age (Murphy this assessment). The ICA model combines all sectors into a single fishery, while the fleet-specific model estimates the individual selectivities and fishing mortality rates for each fishery. The models also differ in that ICA is a hybrid model (i.e., combination of separable and classical VPA), and the fleet-specific model fits a restricted spawner-recruit model (i.e., user specifies the steepness).

4.2.2.1 Integrated Catch-at-Age Analysis

Integrated Catch-at-Age Analysis (ICA) is a hybrid of a separable virtual population analysis (SVPA) and a conventional VPA developed by FRS Marine Laboratory in Scotland. The program has been evaluated and meets ICES's Quality Control specifications and is available from ICES. In the case of yellowtail snapper, the model is configured with a composite catch-at-age of the numbers of fish by year and age from the three fisheries using ages 0 through 15 with 15 being a plus group that includes all fish of older ages (Table 4.2.2.1.1). For the base run, we used a natural mortality rate 0.20 per year. The indices used to tune the model were the NMFS/UM juvenile (age-1) and adult indices (ages 2+), commercial combined gear, MRFSS recreational(ages 2+), and headboat 1981-1991 (ages 2+) and headboat 1992-2001 (ages 2+) (Table 4.2.2.1.2). The weights-at-age for the catch were derived by applying the age-length keys to the catch-at-length times the average weight of the length categories. We used the average weight by age from the fishery independent sampling for the weights-at-age of the stock. The spawning season extends from April through October so we used mid-July for the offset from the beginning of the year for calculating spawning biomass. The model was specified as separable from 1987 through 2001 (the program's maximum of 15 years) and conventional VPA in manner similar to ADAPT (Gavaris 1988) for 1981-1986. Two separate selectivity patterns were fitted: 1997 – 2001 when the catch-at-length and catch-at-age data were matched with adequate samples and 1987-1996 which used the two regional age-length keys for the entire period. The catches-at-age from the earlier period were downweighted using the ratio of the number of age observations in a year to the average number of ages sampled during 1997-2001. The weights for these earlier years ranged from 0.012 to 0.643 (Table 4.2.2.1.3). We also downweighted age-0 (weight = 0.1) and ages 13-15 (weight = 0.5) because the numbers of fish in these ages were quite variable and constitute only a small portion of the catch. We chose the linear option for the relation between catchability and population size for the indices.

Integrated Catch-at-Age uses a backward projection instead of the more familiar forward projection method; thus, ICA solves for the population numbers in the most recent year (2001) and the number of age-14 fish which together with the selectivity and annual fishing mortality rates allows the calculation of the numbers of fish by age and year and the corresponding predicted catch-at-age. Given the inputs, the model solved for 76 parameters (Table 4.2.2.1.4) including the fishing mortality rates on the reference age (the earliest age believed to be fully recruited) for 1987-2001 (15 parameters), the selectivity by age for the two time periods (26 parameters), the 2001 population size in numbers (15 parameters), the number of fish at age-14 (14 parameters), and the catchability coefficients for each of the indices (6 parameters). The errors in the catch-at-age and in the indices are believed to be lognormally distributed.

In a separable model, the fishing mortality on any age and year is:

$$F_{a,y} = Sel_a * F\_full_y,$$

where Sel_a is the selectivity for age a, and F_full_y is the fishing mortality on fully recruited ages for year y. The number of fish at age and year, $N_{a,y}$, is solved backward from the most recent year using the fishing mortality by age and year, $F_{a,y}$, and the natural mortality rate, $M_{a,y}$, from

$$N_{a-1,y-1} = N_{a,y} / exp(-F_{a-1,y-1} - M_{a-1,y-1}) \text{ and}$$

the average population during the year , $N\_bar_{a,y}$, is given by

$$N\_bar_{a,y} = N_{a,y} * (1- exp(-F_{a,y} - M_{a,y}))/(F_{a,y} + M_{a,y}).$$

Therefore, the predicted catch-at-age, $Pred\_C_{a,y}$, is

$$Pred\_C_{a,y} = F_{a,y} * N\_bar_{a,y}$$

Predicted index values are calculated from the number of fish at age or the biomass and a catchability coefficient, *q*. The spawning biomass at the time of spawning is adjusted by multiplying the fishing and natural mortality rates by the fraction of the year between the beginning of the year and the spawning season. For the aged indices, the number of fish at age *a* is summed across the ages that the index applies to and solving for the catchability, $q_{a,A}$, or

$$Pred\_I_{a,y,A} = q_{a,A} * \sum_a (N_{a,y} * exp((-Fa,y-Ma,y)*Fraction_A))$$

where $Fraction_A$ adjusts for when the survey is conducted during the year.

The objective function, *SS*, minimizes the differences between the observed and predicted catches-at-age and between the observed and predicted indices or more formally

$$SS = \sum_a \sum_y \lambda_{a,y}(ln(C_{a,y}) - ln(Pred\_C_{a,y}))^2 + \sum_b \sum_y \lambda_B(ln(I_{y,B}) - ln(Pred\_I_{y,B}))^2 + \sum_a \sum_y \sum_A \lambda_A(ln(I_{A,a,y}) - ln(Pred\_I_{A,a,y}))^2$$

where the first term minimizes the catch at age and year, $C_{a,y}$, and $\lambda_{a,y}$ is the age-year weight, the second term minimizes the annual biomass indices, $I_{y,B}$, and B refers to which biomass index and λ_B is the biomass index weight, and the third term minimizes the age based indices $I_{A,a,y}$ where A refers to the index, λ_A is the numerical index weight, and *a* and y refers to the age and year.

The model fits are shown in Table 4.2.2.1.5 and Figures 4.2.2.1.1 and 4.2.2.1.2 for the base run which used a natural mortality rate of 0.20 per year. All of the model fits were significant at the 0.05 level except the NMFS/UM adult index (P = 0.085). The selectivities by age for 1987-1996 and 1997-2001 are shown in Figure 4.2.2.1.3. While the maximum landings were in 1991, fishing mortality rates on the fully recruited ages peaked in 1994 (F_{1994} = 0.50 per year) and stayed high through 1997 and then declined (Table 4.2.2.1.6, Figure 4.2.2.1.4). The fishing mortality rate in 2001 was 0.21 per year. The number of fish in the stock has remained relatively stable around 26 million fish with peaks in 1991 and 2001 (Table 4.2.2.1.7). The population estimate in 2001 was 32.7 million fish. The total estimated biomass increased slowly until 1992 reaching 8,200 mt and then decreased until 1998 (6,700 mt) and increased again (Figure 4.2.2.1.5). The total estimated biomass in 2001 was 8,193 mt. The maximum estimated spawning biomass occurred in 1988 (4,996 mt) and the lowest spawning biomass occurred in 1997 (3,881 mt) and the spawning biomass in 2001 was 4,943 mt. Recruitment has been variable without trend (Test of slope =

zero; $t = 1.32$, $df = 19$, $P = 0.20$) at a level of 5.67 million age-1 fish (CV = 15%, Figure 4.2.2.1.6). A plot of yield per recruit and static spawning potential ratios together with the fishing mortality rate for 2001 is shown in Figure 4.2.2.1.7.

We also calculated the biomass based management benchmarks. The 1981-2000 estimated spawning biomass and the number of age-1 fish at the beginning of the year (1982-2001) are plotted in Figure 4.2.2.1.8. There is no obvious relationship between the two variables indicating that this fishery is not experiencing recruitment overfishing. Therefore, the Stock Assessment Workshop Panel recommended a steepness of 0.8 based on life history considerations (Rose et al. 2001) with sensitivity calculations using alternative values of steepness of 0.7 and 0.9. The Beverton-Holt spawner recruit curve was fit by setting the steepness value and solving for the recruitment at the unfished stock level. A simple equation for the Beverton-Holt spawner recruit relationship is

$$R = S / (\alpha + \beta S)$$

where R is the number of age-1 fish and S is the spawning biomass in kilograms. Recasting the terms α and β in terms of steepness, h, and spawning biomass per recruit at F = 0, Φ, and the recruitment at the unfished stock level, R_0, gives:

$$\alpha = \Phi * (1-h)/(4h), \text{ and}$$

$$\beta = (5h-1)/(4hR_0).$$

Shepherd (1982) noted that for a given fishing mortality rate, a spawner-recruit relationship, and the spawning biomass per recruit at F = 0, one can calculate the equilibrium spawning stock, the recruitment, and yield. For the equations shown above, the spawning biomass for a given fishing mortality rate, S_f, is:

$$S_f = (\Phi - \alpha) / \beta,$$

and the recruitment at that level of spawning biomass, R_f, is:

$$R_f = S_f / (S/R)_f,$$

and the yield (Y_f) is:

$$Y_f = (Y/R)_f * R_f.$$

What this means is that one can develop the biomass based benchmarks by searching across fishing mortality rates and identifying the fishing mortality rate that has the highest equlibrium yield or maximum sustainable yield (MSY). The fishing mortality rate producing MSY is F_{msy} and the spawning biomass at F_{msy} is SSB_{msy}. The default rule for Minimum Stock Size Threshold

(MSST) is SSB_{msy}*(1.0 – M) (Restrepo et al. 1998) and for yellowtail snapper with a natural mortality rate of 0.20 per year the MSST is 0.8 * SSB_{msy}. The Maximum Fishing Mortality Threshold (MFMT) is F_{msy}. The ratio of F_{2001} to F_{msy} was 0.62 and the ratio of SSB_{2001} to SSB_{msy} was 1.35 (Table 4.2.2.1.8). The downweighting of the earlier years increased the variability shown in the phase plot (Figure 4.2.2.1.9) and there were 450 out of 1000 outcomes that met the criteria of F_{2001} <= MFMT and SSB_{2001} >= MSST. The run without downweighting the earlier years (Run 5) had 864 out of 1000 outcomes that met the criteria.

We made several additional runs of the model. These runs investigated the sensitivity of the results to different natural mortality rates (0.15 and 0.25 per year), to substituting the "targeting" logbook index for the commercial combined gear index and the "targeting" headboat indices for the orginal headboat indices, to the weights assigned to the earlier years, the revised commercial catch-at-length, and to the method of estimating charterboat effort. A summary of these additional runs is presented with the base run in (Table 4.2.2.1.8). If the natural mortality was 0.15 per year instead of 0.20 per year and all of the other inputs remain the same including the steepness at 0.8, then the fishing mortality rate in 2001 goes up to 0.24 per year from 0.21 per year, and the ratio of F_{2001} to F_{msy} goes to 1.03 and the ratio of SSB_{2001} to SSB_{msy} goes to 0.83 which is slightly below the MSST of 0.85 (Table 4.2.2.1.8). On the other side, if the natural mortality were 0.25 per year, then the fishing mortality in 2001 decreases to 0.16 per year and the ratio of F_{2001} to F_{msy} drops to 0.43 and the ratio of SSB_{2001} to SSB_{msy} goes to 2.64. The Peer-Review Panel requested additional runs: 1) omitting the commercial index, 2) choosing the option to iteratively reweight the indices, and 3) the indices calculated without the interaction terms. The results of these runs are included as runs 8-12 in Table 4.2.2.1.8. The Panel also requested a fourth run that downweighted the early years by 0.001 but that configuration denied the model enough information to estimate selectivity and the total catches in those years. The results of this run were not included in the table. The run without the commercial index and the iterative reweighting estimated similar fishing mortality rates in 2001 when compared to the base run while the runs using indices without interaction terms had lower fishing mortality rates and high spawning biomass estimates.

4.2.2.2 Fleet-specific statistical catch-at-age analysis

An age-structured statistical-catch-at-age model was developed to estimate sector-specific estimates of fishing mortality. Three basic sectors of the fishery were included: commercial, headboat, and MRFSS recreational fisheries. The observed-data inputs were based on the same information used in the Integrated Catch at Age model except that fleet-specific catches were retained. Mortality was estimated for ages $0\text{-}15^{+}$. The 'plus-group' mortality was used to extend the estimated abundances out to age 20 to include all age groups that we assumed would be present in an unfished yellowtail snapper stock. Seven indices of abundance were used in the model, of which five were fishery dependent. A separability assumption was used to estimate selectivity for each of two periods for each sector, 1981-83 and 1984-2001, corresponding to changes in the size limit. Catchability was assumed constant throughout the period for all fishery sectors. The model was run with year-specific weighting of the catch-at-age likelihoods for all fisheries; during 1984-1993 these were set to one-tenth the weighting used during the other years (following the Stock Assessment Workshop Panel's lower confidence in these data). In the following description of the model, the variable symbols representing calculated values show a carrot '^' above them, parameter estimates show a dot '˙' above them, and observed data have no embellishments over them.

The basic model structure assumed that sector-specific fishing mortality was proportional to fishing effort expended by that sector:

$$\hat{F}_{f,y} = \dot{q}_f \hat{E}_{f,y},$$

where $\hat{F}_{f,y}$ is the fully recruited instantaneous fishing mortality for fleet *f* in year *y*, $\dot{q}_f$ is the catchability coefficient for fleet *f*, and $\hat{E}_{f,y}$ is the calculated fishing effort for fleet *f* in year *y*. In the case of the recreational fishery (*f*=2), annual fishing effort was observed (or more correctly, estimated outside the model), therefore we used:

$$\hat{E}_{2,y} = E_{2,y} e^{\dot{\varepsilon}_{2,y}},$$

where the calculated effort was estimated as the observed effort times the multiplicative error, $e^{\dot{\varepsilon}_{2,y}}$, term. Estimates of age-specific fishing mortality were calculated using the separability assumption that:

$$\hat{F}_{f,y,a} = \hat{F}_{f,y} \hat{s}_{f,a}$$

where $\hat{s}_{f,a}$ is the fleet-specific selectivity for age a modeled as a two-parameter logistic function:

$$\hat{s}_{f,a} = 1/(1 + e^{-(a-\dot{\alpha})/\dot{\beta}}).$$

Total mortality, $\hat{Z}_{y,a}$, was:

$$\hat{Z}_{y,a} = \sum_{f=1}^{f=3} \hat{F}_{f,y,a} + M_a,$$

where fishing mortality was summed across the three sectors and M_a was a vector of assumed-known, age-specific instantaneous natural mortality rates.

Estimates of the abundance of fish at age each year, $\hat{N}_{y,a}$, were made in a forward-projected manner beginning with parameter estimates of the first-year's age structure as:

$$\hat{N}_{1,0} = \dot{R}_1 \quad \text{and} \quad \hat{N}_{1,a} = \dot{N}^* e^{\dot{\eta}_a},$$

where $\dot{R}_1$ is the number of recruits (age 0) in the first year and $\hat{N}^* e^{\dot{\eta}_a}$ represents the initial year's abundance at each age *a*. The term $e^{\dot{\eta}_a}$ represents the multiplicative error at age *a* around an average abundance parameter, $\dot{N}^*$. For subsequent years (y = 2,..,n) recruitment estimates, $\hat{N}_{y,0}$, were made using the reparameterized Beverton-Holt relation:

$$\hat{N}_{y,0} = \frac{0.8\dot{R}_o\dot{h}\hat{S}_{y-1}}{0.2\dot{R}_o\hat{S}_{y-1}\hat{\Phi}(1-\dot{h}) + \hat{S}_{y-1}(\dot{h}-0.2)} e^{\dot{v}_y},$$

where $\dot{h}$ is the steepness, $\dot{R}_o$ is the number of recruits produced at virgin spawning stock biomass levels, $\hat{S}_{y-1}$ is the estimated spawning stock biomass in the previous year, and $\hat{\Phi}$ is the calculated spawning stock biomass per recruit under no fishing. A multiplicative error term, $e^{\dot{v}_y}$, was included in the estimate of recruitment. Forward-estimated abundances by year and age followed as:

$$\hat{N}_{y+1,a+1} = \hat{N}_{y,a} e^{-\hat{Z}_{y,a}},$$

except that the 'plus-group' (k = age 15^+) abundance also included survivors of the previous years plus-group, such that:

$$\hat{N}_{y+1,k} = \hat{N}_{y,k-1} e^{-\hat{Z}_{y,k-1}} + \hat{N}_{y,k} e^{-\hat{Z}_{y,k}}.$$

The average spawning stock biomass in year y, $\hat{S}_y$, was calculated as:

$$\hat{S}_y = \sum_{a=1}^{k} \hat{N}_{y,a} \frac{(1-e^{-\hat{Z}_{y,a}})}{\hat{Z}_{y,a}} O_a B_a + \sum_{a=k+1}^{m} \hat{N}_{y,k} \frac{(1-e^{-\hat{Z}_{y,k}(a-k)})}{\hat{Z}_{y,a}(a-k)} O_k B_k + \hat{N}_{y-1,k} \frac{(1-e^{-\hat{Z}_{y-1,k}(m-k)})}{\hat{Z}_{y-1,k}(m-k)} O_k B_k$$

where O_a is the observed age-specific proportion mature and B_a is the observed average weight at age in the population. The second and third terms in the equation used to calculate spawning biomass extend the calculation to include all potential ages included in the unfished stock. We assume that the mortality rate, average weight, and proportion mature for the 'plus-group' applies to each of these additional ages. In the initial year's estimation of S the third term was the expected contribution of the survivors of the prior year's maximum age group.

The average spawning stock biomass per recruit in the unfished state, $\hat{\Phi}$, was estimated in similar manner as $\hat{S}_y$ but on a per recruit basis, i.e., $N_0 = 1$, using $\hat{Z}_{y,a} = M_a$ and giving:

$\hat{\Phi} = \sum_{a=0}^{k} \hat{N}_a \frac{(1-e^{-M_a})}{M_a} O_a B_a$, plus the added terms for extending the age structure to the maximum expected in the unfished stock. Catch at age was estimated using the Baranov catch equation:

$$\hat{C}_{f,y,a} = \hat{N}_{y,a} \frac{\hat{F}_{f,y,a}}{\hat{Z}_{y,a}} (1-e^{-\hat{Z}_{y,a}}).$$

Indices, $\hat{I}_{i,y}$, were related to abundance or to biomass depending on the catch-per-unit-effort metric. Fisheries-dependent indices were related to mean abundance or biomass during the year as:

$\hat{I}_{i,y} = \dot{q}_i \hat{s}_{y,a} \hat{N}_{y,a} \frac{(1-e^{-\hat{Z}_{y,a}})}{\hat{Z}_{y,a}}$ or $\hat{I}_{i,y} = \dot{q}_i \hat{s}_{y,a} \hat{N}_{y,a} W_{y,a} \frac{(1-e^{-\hat{Z}_{y,a}})}{\hat{Z}_{y,a}}$, respectively.

where $W_{y,a}$ is the average weight of landed fish in year *y* and of age *a*. Fishery-independent indices, which were all in numbers of fish, were calculated as:

$$\hat{I}_{i,y} = \dot{q}_i^* \hat{N}_{y,a} e^{-\hat{Z}_{y,a} p_i} ,$$

where $\dot{q}_i^*$ was the survey catchability coefficient of index *I* and p_i is the proportion of the year past before the midpoint of the survey's time frame. For all indices only a select group of ages (those caught most often) were considered in the indices. For fishery-independent surveys these ages were considered to be fully recruited, i.e., $\hat{s}_{y,a} = 1$.

The objective function contained likelihoods for total catch, catch-at-age, effort, and indices, such that:

$$L = \sum_{f=1}^{f=l}\sum_{y=1}^{y=n}\frac{(T_{f,y}-\hat{T}_{f,y})^2}{2.0\sigma_f^2} + \sum_{f=1}^{f=l}\sum_{y=1}^{y=n}\sum_{a=1}^{a=k}\frac{(C_{f,y,a}-\hat{C}_{f,y,a})^2}{2.0\sigma_{f,a}^2} + \sum_{y=1}^{y=n}\frac{(\ln(E_{2,y})-\ln(\hat{E}_{2,y}))^2}{2.0\sigma_2^2} + \sum_{i=1}^{i=s}\sum_{y=1}^{y=n}\frac{(\ln(I_{i,y})-\ln(\hat{I}_{i,y}))^2}{2.0\sigma_i^2}$$

with $T_{f,y}$ representing the total catch by the sector *f* in year *y*, $C_{f,y,a}$ representing the catch-at-age by each sector, $E_{2,y}$ representing the fishing effort of only the recreational sector (which was estimated separately from the recreational fishery-dependent index), and $I_{i,y}$ representing the abundance index for index *i*. Estimates of σ^2 were derived as the mean square error of the linear regression of observed total catch on year for each fleet, σ_f^2; as the mean square error of the linear regression of observed catch for an age on year for each fleet, $\sigma_{f,a}^2$; as the mean square error of the linear regression of log fishing effort on year, σ_i^2.and as the mean square error of the linear regression of log index values on year, σ_i^2. Additionally the likelihood functions for the error terms for recruitment each year, $\sum_{y=1}^{y=n}\dot{v}_y$, and for initial age structure, $\sum_{a=1}^{a=k}\dot{\eta}_a$, were included in the objective function. The error term assumed for the observed recreational fishing effort is included in the likelihood for effort above. Finally, all MSY-based estimates assumed that the allocation of fishing mortality among the three fishery sectors was the same as the average allocation in the last three years, 1999-2001.

Based on the Stock Assessment Panel's recommendations, nine model runs were conducted using combinations of M = 0.15, 0.20, 0.25 per year and h = 0.7, 0.8, 0.9. Sensitivity analyses were run using the M=0.2-h=0.8 base model and the "targeting" indices for headboat and logbook indices. Below is a discussion of the results under the base model run. When the parameter estimates being discussed are used in the estimation of management benchmarks, i.e., fully-recruited instantaneous fishing mortality and spawning stock biomass, tables are given that show estimates for the base model run and the eight alternative runs.

Diagnostics of the statistical catch-at-age model's fit indicated an overall close correspondence between the observed data and predicted values. A partitioning of the variance of the observed data into that explained by the model and that unexplained indicated significant fits to each component of the objective function (Table 4.2.2.2.1). Fits to the total catch of yellowtail snapper for each sector showed good correspondence between the observed and predicted data except for a consistent model overestimate of the recreational catch during 1994-2001 (Figure 4.2.2.2.1). The catch-at-age estimates for each sector showed a fairly random assortment of positive and negative residuals with a few exceptions (Figure 4.2.2.2.2). Catches for ages 4-9 during 1987-1993 were consistently overestimated in the recreational and headboat sectors. Also, during 1994-2001 the recreational catches at ages 0-3 were consistently underestimated reflecting the underestimation of total catch of yellowtail snapper seen for this sector during these years. Only the observed recreational fishery's fishing effort was included in the objective function since effort in the commercial and headboat sectors were implied in the fishery-dependent catch-per-unit-effort indices used in the model. Observed recreational effort was fit well by the model estimates especially since 1992 (Figure 4.2.2.2.3). An exception to this good fit was the poor correspondence of the model estimate to the abrupt and short-lived spike in effort seen in 1998. General trends in most of the indices of abundance were fit well by the model (Figure 4.2.2.2.4). The fits seemed to follow the increasing trend seen in the commercial combined gear index the best followed by the 1981-1991 headboat index, the commercial Reef Fish Permit logbook index, and the recreational MRFSS index. The model was unable to fit the high NMFS/UM age-1 index values during 1991-1997 or the NMFS/UM age-2+ index during 1981-1987. Finally the estimated coefficients of variation for the parameters were generally less than 12% (Table 4.2.2.2.2). The coefficients of variation of the 'shape' parameter for the logistic selectivity function was greater than this for the commercial fishery during the period 1981-1983 (C.V. = 15.6%) and for the recreational fishery during the period 1984-2001 (C.V. = 33.5%).

The distribution of fishing mortality across ages or the selectivity showed marked differences between fishery sectors and also between the periods 1981-1983 and 1984-2001 for some sectors. The recreational fishery has consistently selected for younger fish than did either the headboat or commercial sectors (Figure 4.2.2.2.5). The age at 50% recruitment to the recreational sector in 1984-2001 was 2.2 year old while the ages at 50% recruitment for the headboat and commercial fisheries during this period were 3.2 and 3.9 years old, respectively. Between the two periods of similar selectivity, 1981-1983 and 1984-2001, selectivity changed little in the recreational fishery but shifted upwards about 0.15 years age for the commercial sector and 0.3 years age for the headboat sector.

The fully recruited instantaneous fishing mortality rate on yellowtail snapper attributed to the commercial fishery has recently been about 0.20 yr^{-1} compared with much lower rates of about 0.02 yr^{-1} attributed to each of the MRFSS recreational and headboat sectors. Up through the mid 1980s the fishing mortality attributed to the MRFSS recreational and commercial sectors was about equal, 0.20 yr^{-1}, after which the MRFSS recreational fishery declined to less than 0.05 yr^{-1} by 1987 and the commercial fishery increased rapidly to 0.33 yr^{-1} in 1987 and to a peak of 0.42 yr^{-1} in 1990 (Table 4.2.2.2.3; Figure 4.2.2.2.6). The commercial sector fishing mortality declined throughout the 1990s while the MRFSS recreational sector's fishing mortality remained relatively steady between 1988 and 1999. There has been a recent drop in the MRFSS recreational fishing mortality from 0.06 yr^{-1} in 1998 to 0.02 yr^{-1} in 2001. During the entire time frame examined, 1981-2001, fishing mortality attributed to the headboat sector has been relatively low, peaking at 0.04-0.05 yr^{-1} in the mid 1980s before declining to less than 0.02 yr^{-1} in recent years.

The estimated abundance of yellowtail snapper has trended upward over the period of time examined for this assessment. Recruitment of age-0 yellowtail snapper peaked during the late 1980's-early 1990's then held steady at lower levels during 1993-1998 (Figure 4.2.2.2.7). Since 1999 recruitment has been at the highest levels estimated by the model. The average abundance of older yellowtail snapper ages 4+ has shown a steady increase since 1985.

Estimates of spawning stock biomass for yellowtail snapper showed increases during the period 1984-1988, little change during 1989-1998 then an increase in recent years. The spawning biomass of yellowtail snapper was estimated to be 2,570 mt in 1985, which expanded to about 4,500 mt during the 1990's (Table 4.2.2.2.4, Figure 4.2.2.2.8). The most recent estimate, 2001, is almost 5,200 mt.

Over the range of spawning stock biomasses observed, there appears to be little relation between spawning stock biomass and recruitment. At the lowest observed spawning stock biomass levels of 2,600-3,700 mt the range for production of new recruits (7.5-10.1 million fish) is about the same as the production of new recruits at the highest spawning stock biomasses observed, 4,400-4,700 mt (Figure 4.2.2.2.9).

Time-trajectories of the management benchmark ratios of spawning stock biomass or fishing mortality to their respective estimates at maximum sustainable yield were calculated for the most recent period of constant selectivity, 1984-2001. For the base model run the F-ratios (F_{2001}/F_{msy}) increased to above 1.0 during 1987-1991 then fluctuated around 1.0 through 1997 before declining in recent years, to 0.65 in 2001 (Figure 4.2.2.2.6a). This same trajectory was apparent for other model runs with all except the runs for M=0.15 and h=0.7 or 0.8 resulting in F_{2001}/F_{msy} ratios of less than 1.0 (Table 4.2.2.2.5).

Spawning-stock-biomass ratios (SSB_{2001}/SSB_{msy}) for the base model increased from 1984 through 1989 before stabilizing at an average of 0.91 between 1989 and 1999. The SSB-ratio increased after 1999 reaching 1.07 in 2001 (Figure 4.2.2.2.8). The 2001 SSB-ratio was estimated as less than

1.0 for all model runs assuming M=0.15 and for one run (h=0.7) at M=0.20. All other SSB-ratios were greater than 1.0 (Table 4.2.2.2.5).

In terms of management thresholds, only two of the ten model runs indicated that both fishing mortality was higher than the F_{msy} threshold and the spawning stock biomass was less than the MSST (SSB_{msy}*(1-M)). These were model runs using the lowest natural mortality rate, 0.15 per year, and the lower two steepness values, 0.7 and 0.8 (Table 4.2.2.2.5, Figure 4.2.2.2.10). One other model run, M=0.20 per year and h=0.7, estimated the spawning stock biomass below the threshold level in 2001.

In terms of management targets, six of the ten model runs provided F-ratios and SSB-ratios that met targeted levels. These included the base model run, the base model run with sensitivity to targeted indices, the model run with M=0.20 and h=0.9, and all runs using M=0.25 (Table 4.2.2.2.5, Figure 4.2.2.2.10).

The estimated maximum sustainable annual yields for yellowtail snapper ranged from 1,342 – 1,965 mt. The base model estimate of MSY was 1,366 mt. The current landings level in the yellowtail snapper fishery is about 800-900 mt, down from a peak of 1,895 mt in 1991. These do not include the estimated weight of the unlanded harvest of discards or those that died after release. Using the average weight of landed yellowtail snapper (0.51-0.53 kg per fish) and the total number of killed fish (1.7 to 2.0 million fish) the recent total harvest is about 850 to 1000 mt.

4.2.3 Retrospective Analysis

A retrospective analysis reviews earlier assessments and looks for estimated fishing mortality rates and biomass that change with additional years of data (Cadrin and Vaughan 1997, Parma 1993). A retrospective bias would show consistently higher or lower values in the last year of any assessment when those values changed with additional years of data. However, we did not have any prior assessments with yellowtail snapper that used age-structured models. Therefore, we ran the fleet-specific model with three different terminal years: 1998, 1999 and 2000 and compared the results to the base run (Figure 4.2.3). The different trajectories for fishing mortality rates overlapped extensively while the 1998 and 2001 trajectories for spawning biomass were very similar but lower than estimates for the 1999 and 2000. The retrospective runs for ICA were only run back to 1999 because of the requirement that ICA have at least three years of data to develop the selectivity. The fishing mortality rate in 1999 was higher in the run using 1999 as the terminal year and the fishing mortality rates were essentially the same in the runs for 2000 and 2001. The Peer-Review Panel acknowledged that only a small retrospective trend was found and noted that a more extensive treatment would involve using simulated data.

4.3 Present and Possible Future Condition of the Stock

After reviewing the results of the assessment models, the Stock Assessment Workshop Panel determined that the best estimate of stock status should be based on a M=0.2 per year and a steepness value of 0.8 and concluded that yellowtail snapper was neither overfished nor undergoing overfishing. The Peer-Review Panel noted that the stock status conclusions depend upon the choice of natural mortality rates and steepness and agreed that these were the best available information. The Stock Assessment Panel did note that the fishing mortality rate in 2001 was lower than in previous years. However, when we used a five-year average (1997-01) for fishing mortality and spawning biomass estimated from the ICA model's base run, the fishing mortality ratio increased to 0.95 and the spawning biomass ratio decreased to 1.17 and the conclusions did not change.

The Stock Assessment Panel was of the opinion that yellowtail snapper was between a low resilient species (threshold of F at 40% SPR) and a highly resilient species (threshold F at 30% SPR). The life history of yellowtail supports a species that is moderately to highly resilient and the Panel determined that F at 35% SPR was appropriate as a proxy to F_{msy}. This stock seems resilient to fishing as indicated by anglers catching fish that are in their teens in the Keys, the core of the fishery. We believe that the persistence of this fishery is partly due to the early maturation at a small size and the larger minimum size. Comparison of the selectivities by fishery and proportion mature by age shows that both the commercial and the headboat fisheries which accounted for 88% of the landings in numbers in 2001 select for mature fish (Figure 4.3). The Peer-Review Panel recommended convening a workshop to address natural mortality and steepness and their use in developing biomass-based benchmarks for reef fish species in addition to yellowtail snapper.

After the Peer-Review meeting in Tampa, we discovered that when we made the runs for the tables in the SEDAR III Stock Status Report (included here as Appendix 2), we used the original headboat index not the recalculated the headboat index without interaction terms. Also, some Panel members noted discrepancies in the Table 2 of the Stock Status Report. Therefore, we revised those tables and included them as Appendix 3. Most of the differences were in the ICA model results

4.4 Comparison to previous stock assessments

Neither of the previous stock assessments used tuned, age-structured models to evaluate the condition of yellowtail snapper. The NMFS Snapper-Grouper Plan Development Team (NMFS 1990) analyzed fisheries dependent data from southeast Florida for the period 1981-1988 and values for growth and length-weight from the literature to estimate total mortality values of 0.48 per year to 0.56 per year using catch curves and they assumed a natural mortality rate of 0.20 per year. They calculated spawning stock ratios of 43% using headboat fishery data and 42% using commercial fishery data.

Ault et al. (1998) used annual average lengths from the visual survey (see Section 4.1.1.1) to estimate annual total mortality rates and spawning potential ratios (SPR) for 1979-1996. They used a natural mortality rate based on a longevity of 14 years of 0.214 per year and estimated SPR for yellowtail snapper as 44% (their Figure 7).

4.5 Regional Considerations

Yellowtail snapper is a tropical species found in association with coral reefs and, thus, Florida is at the northern extent of its distribution. While the center of the stock in Florida is on the reefs of the Florida Keys, some yellowtail snapper occur further north. In this discussion, we divide the Southeastern United States into four subregions: 1) from North Carolina to Palm Beach county, 2) southeast Florida (Palm Beach county through Miami-Dade counties), 3) the Florida Keys (Monroe county), and 4) the Gulf which includes the remainder of the Gulf of Mexico.

Florida Fish and Wildlife Conservation Commission conducted a life history study of mutton, lane, gray, and yellowtail snappers from 2000 to 2002 setting traps and hook-and-line gear weekly in southeast Florida and the Keys subregions. Samples were collected from nearshore reefs to depths of 60 meters. There were some life history differences between yellowtail snapper from southeast Florida and those from the Keys. Fish from southeast Florida were similar in size to those from the Keys but fish in southeast Florida tended to be younger (Figures 2.6 and 3.6). None of the yellowtail snapper collected in the life history study from southeast Florida were older than five years while 18% of the yellowtail snapper collected in the Keys by the study were age-6 or older (Figure 2.6). Overall in the fishery-dependent sampling, only 5% of the fish that were collected in southeast Florida from the hook-and-line fisheries were age-6 or older while 29% of the hook-and-line caught fish from the Keys were age-6 or older. In addition to having younger ages in southeast Florida, the FWC-FMRI life history study did not collect any female yellowtail snapper with hydrated eggs indicating active spawning in southeast Florida although spent females were collected. At the same time, samplers in the Keys did collect females with hydrated eggs as well as spent females. The younger ages and the lack of evidence of immediate spawning have led us to speculate that the fish off southeast Florida are replenished from the Keys; however, movement information is sparce for yellowtail snapper. Only 84 fish were tagged between 1962-1965 as part of the Schlitz Tagging Program and of those fish only five were recaptured. There was only location information provided for two fish, both of which were recaptured within a mile of their release site (Topp 1963, Beaumariage 1964, Beaumariage and Wittich 1966, and Beaumariage 1969).

Landings differed among the subregions. Using the average landings from 1997-01 by subregion and sector for comparison, landings from North Carolina to Palm Beach county accounted for less than 1% of the total landings in the commercial sector (Table 4.5.1, Figure 4.5.1a), less than 3% of the MRFSS recreational sector (Table 4.5.2, Figure 4.5.2a), and less than 1% of the headboat (Table 4.5.3, Figure 4.5.3a) sector. Landings from southeast Florida accounted for 6% of the total commercial landings, twentyfour percent of the total MRFSS recreational landings, and 14% of the headboat total landings. The Florida Keys accounted for 93% of the total commercial landings, seventy-two percent of the total MRFSS recreational landings, and 82% of the total headboat landings. Landings from the remainder of the U. S. Gulf of Mexico averaged less than 1% of the commercial landings, two percent of the MRFSS recreational landings, and 3% of the headboat landings. The differences in the levels of landings by subregion are partially due to available habitat. The Keys and the Dry Tortugas have extensive reef tracts, while southeast Florida has fewer reefs and in the more northern subregions there are only isolated patch reefs. The assessment has focused on the Keys and southeast Florida because the high proportion of landings in those subregions.

Subregional effort does not follow the same pattern as landings in that the northern subregions (1 and 4) had higher proportions of trips than landings. Using the average number of trips from 1997-01 by subregion and sector, trips from North Carolina to Palm Beach county accounted for less than 1% of the commercial yellowtail snapper trips (Table 4.5.1, Figure 4.5.1b), twenty-one percent of the total MRFSS recreational trips estimated by post-stratification (Table 4.5.2, Figure 4.5.2b), and 28% of the total headboat trips (Table 4.5.3, Figure 4.5.3b). Higher recreational effort was not surprising because MRFSS recreational anglers and headboats operate throughout the southeastern United States targeting fish other than reef fish species. When we subdivide MRFSS's recreational effort using the proportion of interviews that caught reef species, then only 1% of reef trips were from the subregion north of Palm Beach instead of 28% (Table 4.5.2, Figure 4.5.1c). Southeast Florida accounted for 13% of the commercial trips, forty percent of the MRFSS recreational trips or 43% of the reef fish trips, and 13% of the headboat trips. The Florida Keys accounted for 85% of the commercial trips, twenty-two percent of the MRFSS recreational trips or 42% of the MRFSS recreational reef trips, and 9% of the headboat trips. The trips from the Gulf of Mexico north and west of the Keys accounted for 2% of the total commercial trips, seventeen percent of the total MRFSS recreational trips or 14% of the reef fish trips, and 50% of the total headboat trips. When we look at Saltwater Products Licenses holders that landed yellowtail snapper by subregion (Table 4.5.1c, Figure 4.5.1c), we see higher proportions from the other subregions again reflecting that these fishers catch reef species other than yellowtail snapper.

In addition to summarizing landings and effort by subregion, we developed standardized catch rates by sector for southeast Florida and the Keys. The commercial catch rate in kilograms per trip was modeled with a generalized linear model using a delta-lognormal distribution and simulation to estimate the combined variability. The annual mean kilograms per trip were adjusted for month and the trip duration in days. With the reduced number of trips available by subregion, we were unable to estimate the least-squares means when interaction terms were included in the model and so the reduced model only had main effects. Commercial catch rates for combined gears increased in southeast Florida until 1993 and then slightly tapered off while the commercial catch rates in the Keys generally increased reaching a peak in 1999 followed by a dip (Table 4.5.4, Figure 4.5.4). Overall, the commercial catch rates in the two subregions were not that different until 1999 when the Keys catch rates continued to increase while the southeast Florida catch rates remained flat. The commercial catch rates from Reef Fish Permit holders (logbooks) was similar to the other commercial catch rates except that the catch rate in 2001 continued to decline instead of remaining flat as in the other commercial index (Table 4.5.5, Figure 4.5.5).

The reduced model for the MRFSS recreational catch rates, a generalized linear model with a negative binomial distribution and a log link, included only the two-month wave as a categorical variable and the hours fished as a covariate. There was a lot of overlap in the 95% confidence intervals but the pattern in southeast Florida of MRFSS recreational catch rates was a decline from 1981 to 1988 and an increase until 1993 and then mostly variable and level with a bump up in 1999 (Table 4.5.6, Figure 4.5.6). The MRFSS recreational catch rates in the Keys had a dip in the mid 1980s and then a general increase to 1991 followed by a decline in 1992 and another decline in 1997 and variable and level since then.

Annual headboat catch rates in number of fish per trip were standardized with a generalized linear model with a negative binomial distribution and a log link that used month and trip type as categorical variables and the number of anglers was a covariate. As before, the headboat time series was divided into 1981-1991 and 1992-2001. The catch rate patterns (reported number of fish per trip) were similar in the two subregions with a dip in the early 1980s followed by an increase to 1991 and then the headboat catch rates were variable and level with high amplitude variability in southeast Florida (Table 4.5.7, Figure 4.5.7).

5. Management

5.1 History of Management

The minimum size of 12 inches (305 mm) total length for yellowtail snappers was first implemented by the South Atlantic Fishery Management Council (SAFMC) effective August 1983 in the original Snapper-Grouper Fishery Management Plan. Florida's then Marine Fisheries Commission (MFC) adopted the same minimum size effective July 1985 for state waters. Although yellowtail snapper were explicitly listed in the Gulf of Mexico Fishery Management Council's Reef Fish Fishery Management Plan (GMFMC) that was implemented in November 1984, the Gulf Council did not adopt the 12-inch minimum size until Amendment 1 in January 1990.

Florida's MFC established a 10-fish per day recreational aggregate bag limit for snappers in December 1986 excluding lane, vermilion, and yelloweye snappers. Florida did allow a two-day possession limit off the water. The GMFMC implemented the 10-fish aggregate limit in January 1990 with Amendment 1 and the SAFMC implemented the aggregate limit in January 1992 with Amendment 4.

Other regulations include the MFC eliminating stab nets (anchored, bottom gill nets) in December 1986. The GMFMC prohibited the use of entangling gear for direct harvest in 1990, reduced the maximum limit from 200 fish traps to 100 fish traps per trap permit holder, and required a reef fish vessel permit established with an income qualification. In May 1992, the GMFMC established a moratorium on new reef fish permits which was extended at various times and now is in effect through 2005. In December 1992, Florida's MFC required the appropriate federal permit to exceed the recreational bag limit. In the Florida Keys, reef fishers have access to both the Atlantic and Gulf waters and so in October 1993, the MFC allowed fishers to land fish if they had either federal reef fish permit. This provision was extended in July 1995 and again in January 1996. In March 1997, the GMFMC established a 10-year phase out of fish traps. The SAFMC established transferable permit program and non-transferable permits with an allowance of 225-pound (102 kg) per trip.

5.2 Size limit and Bag Limit compliance

We used data from the years 1993-2001 (after most of regulations had been in place for at least a year) to evaluate compliance with size limits. To evaluate compliance with the minimum size limit, we used the length information weighted by landings from the catch-at-length tables (Tables 3.2.5.1, 3.3.4, 3.4.3) except for the recreational MRFSS lengths because those data included estimated landings for fish that were not directly observed so MRFSS compliance was determined solely from the lengths weighted by the estimated landings of only the observed fish (Type A). Overall compliance in the size of landed fish was high. The commercial fishers landed an average of only 3% undersized fish in the Atlantic region and 2% in the Keys. Similarly, headboat clients averaged 2% undersized fish in the Atlantic region and 3% in the Keys. MRFSS recreational anglers were slightly higher with 5% undersized fish in the Atlantic region and 4% in the Keys.

We could only evaluate compliance with bag limit using the number of fish landed from MRFSS interviews because headboat landings are vessel reports and not for individual anglers. Because the aggregate bag limit was phased in starting with state waters in late 1986, Gulf waters in 1990, and South Atlantic waters in 1992, we compared the proportion of anglers with more than 10-fish per trip from two time periods: 1981-1986 (before the limit was implemented) and 1993-2001. For comparison purposes, we considered the aggregate bag limit to be a 10-yellowtail snapper limit, so the actual yellowtail snapper compliance would be higher than we show here. We tallied the interviews by coast and the number of fish kept. There were some trips with high numbers of fish kept per angler but these trips only occurred occasionally therefore we weighted the numbers of fish and the number of anglers by the number of years for which a particular number of fish were kept (Table 5.2.2). Few anglers exceeded the 10-fish limit. The number of anglers with 10 or more fish per trip was 0.7% in the Atlantic region and 2.9% in the Keys before any limit was put in place and these dropped to 0.2% and 1.3% in the later period. As expected the proportion of the kept fish from anglers with more than 10 fish was higher, at 10% in the Atlantic region and 26% in the Keys, prior to the limit and decreased to 2.9% and 3.3% afterwards. The average angler kept less than two fish per trip in either period.

6. Research and Data Needs

As with other fisheries, we need data on all removals from the fishery. Lacking other data, we applied the discard information from one year of commercial logbook data to all previous years. We need to collect annual discard information from all sectors of the fishery. We had no direct data for headboat discards. Fortunately, headboat landings comprise only a small portion of the total. Perhaps this could be addressed by having samplers occasionally ride on headboat trips and collect discard data.

An improvement for the assessment would be to develop a probabilistic aging procedure that accounts for selectivity and mortality that uses the catch-at-length and fishery-independent and fishery-dependent ages and lengths.

We need to investigate the inclusion of interaction terms in the calculation of standardized catch rates. We also need to investigate whether the increases in the commercial catch rates reflects improvements in fishing methods such that the increase does not reflect the underlying population. We also need to review the methodology of the Reef Visual Census and its use as a fishery independent index of population trends. Another catch rate issue is whether the change in contractors for MRFSS was responsible for the patterns in the recreational catch rates.

Stock assessments in the Southeastern U. S. would benefit from a workshop addressing natural mortality and steepness and how the stock status conclusions depend on the chosen values.

The performance of the assessment models could be evaluated for retrospective bias by running the models with simulated data.

7. Literature Cited

Acosta, A. and R. Beaver. 1998. Fisheries, growth, and mortality of yellowtail snapper, *Ocyurus chryurus*, in the Florida Keys, Florida, U. S. A. Proceedings of the Gulf and Caribbean Fisheries Institute 50:851-870.

Allman, RJ., L. Barbieri, B.K. Barnett., J. Tunnell, and L. Lombardi-Carlson. 2003. Age and growth of yellowtail snapper, *Ocyurus chrysurus*, off South Florida 1980-2002. National Marine Fisheries Service and Florida Marine Research Institute. Panama City Laboratory Contribution Series 03-04. 28 p.

Anonymous. 2002. Report of the First SEDAR (Southeast Data, Assessment, and Review) stock assessment cycle: Assessment, review and management recommendations for the red porgy, *Pagrus pagrus,* stock of the southeastern United States. NOAA Technical Memorandum. NMFS_SEFSC. In review.

Atlantic States Marine Fisheries Commission. 1999. MRFSS user's manual. A guide to the use of the National Marine Fisheries Service Marine Recreational Fisheries Statistics Survey database.

Ault, J. S., J. A. Bohnsack, and G. A. Meester. 1998. A retrospective (1979-1996) multispecies assessment of coral reef fish stocks in the Florida Keys. Fish. Bull. 96:395-414.

Ault, J. S., S. G. Smith, G. A. Meester, J. Luo, J. A. Bohnsack, and S. L. Miller. 2002. Baseline multispecies coral reef fish stock assessment for Dry Tortugas. NOAA Technical Memorandum NMFS-SEFSC-487. 117 p.

Barbieri, L. R. and J. A. Colvocoresses. 2003. Southeast Florida reef fish abundance and biology. Five-year performance report to the U.S. Department of Interior, U.S. Fish and Wildlife Service, Federal Aid in Sport Fish Restoration, Grant F-73.

Beaumariage, D. S. 1964. Returns from the 1963 Schlitz Tagging Program. Florida State Board of Conservation Marine Laboratory. Technical Series No. 43. St. Petersburg, FL. 34 p.

Beaumariage, D. S. and A. C. Wittich. 1966. Returns from the 1964 Schlitz Tagging Program. Florida State Board of Conservation Marine Laboratory. Technical Series No. 47. St. Petersburg, FL. 50 p.

Beaumariage, D. S. 1969. Returns from the 1965 Schlitz Tagging Program including a cumulative analysis of previous results. Florida State Board of Conservation Marine Laboratory. Technical Series No. 59. St. Petersburg, FL. 38 p.

Bortone, S. A., and J. L. Williams, 1986. Species profiles: life history and environmental requirements of coastal fisheries and invertebrates (South Florida) – gray, lane, mutton, and yellowtail snappers. U.S. Fish Wildl. Serv. Biol. Rep. 82 (11.52). U.S. Army Corps of Engineers, TR EL-82-4. 18 p.

Cadrin, S. X. and D. S. Vaughan. 1997. Retrospective analysis of virtual population estimates for Atlantic menhaden stock assessment. Fish. Bull. 95:445-455.

Cass-Calay, S. L. and M. Bahnick. 2002. Status of the yellowedge grouper fishery in the Gulf of Mexico. Sustainable Fisheries Division Contribution No. SFD-02/03-172. Southeast Fisheries Science Center. Miami. Fl.

Clarke, M. E., M. L. Domeier, and W.A. Laroche. 1997. Development of larvae and juveniles of the mutton snapper (*Lutjanus analis*), lane snapper (*Lutjanus synagris*) and yellowtail snapper (*Lutjanus chrysurus*). Bull. Mar. Sci. 61:511-537.

Collins, J. W. and H. M. Smith. 1891. A statistical report on the fisheries of the Gulf states. Bulletin, U. S. Fish Commission. Pp 93-184.

Dennis, G. D. 1991. The validity of length-frequency derived growth parameters from commercial catch data and their application to stock assessment of the yellowtail snapper (*Ocyurus chrysurus*). Proceedings of the 40th Gulf and Caribbean Fisheries Institute: 126-138.

Fallows, J. A. 1984. The behavioural ecology of feeding in the yellowtail snapper, *Ocyurus chrysurus*, (Family Lutjanidae). Ph.D. Dissertation, University of Newcastle Upon Tyne, 157 p.

Fisher, W., editor. 1979. FAO species identification sheets for fishery purposes, western central Atlantic, volume III. Food and Agriculture Organization of the United Nations, Rome, Italy.

Gabriel, W. L., M. P. Sissenwine, and W. J. Overholtz. 1989. Analysis of spawning stock biomass per recruit: an example for Georges Bank haddock. N. A. J. of Fish. Man. 9:383-391.

Garcia, E. R., J. C. Potts, R.A. Rulifson, and C.S. Manooch. Age and growth of yellowtail snapper, *Ocyurus chrysurus*, from the Southeastern United States. Unpublished manuscript.

Gavaris, S. 1988. An adaptive framework for the estimation of population size. Can. Atl. Fish. Sci. Adv. Comm. (CAFSAC) Research Doc. 88/29.

Grimes, C. B. 1976. Certain aspects of the life history of the vermilion snapper, *Rhomboplites aurorubens* (Cuvier) from North and South Carolina waters. Ph.D. Dissertation, University of North Carolina, Chapel Hill, North Carolina. 240 p.

Grimes, C. B. 1987. Reproductive biology of the Lutjanidae: a review. Pages 239-294 *In* J.J. Polovina and S. Ralston (eds.) Tropical snappers and groupers: biology and fisheries management. Westview Press. Boulder, Colorado.

Hoffman, E. M., T. M. Bert, and M. M. Wilson. 2003. Genetic stock structure assessment of yellowtail snapper (*Ocyurus chryurus*) in southern Florida, estimated by mtDNA D-loop sequencing. Florida Fish and Wildlife Conservation Commission. Florida Marine Research Institute. FWC-FMRI Report Number IHC2003-006. St. Petersburg, FL.

Johnson, A. G. 1983. Age and growth of yellowtail snapper from South Florida. Trans. Am. Fish. Soc. 112:173-177.

Kimura, D. K. 1981. standardized measures of relative abundance based on modeling log(c.p.u.e.), and their application to Pacific ocean perch (*Sebastes alutus)*. J. Cons. Int. Explor. Mer 39:211-218.

Krebs, C. J. 1989. Ecological methodology. Harper Collins. New York, New York . 654 p.

Lindeman, K. C., R. Pugliese, G. T. Waugh, and J. S. Ault. 2000. Developmental patterns within a multispecies reef fishery: management applications for essential fish habitats and protected areas. Bull. Mar. Sci. 66: 929-956.

Lo, N. C. H., L. D. Jacobson, and J. l. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal methods. Can. J. Fish. Aquat. Sci. 49:2515-2526.

Manooch, C.S., III, and C.L. Drennon. 1987. Age and growth of yellowtail snapper and queen triggerfish collected from the U.S. Virgin Islands and Puerto Rico. Fish. Res. 6:53-68.

McClellan, D. B. and B. J. Cummings. 1998. Fishery and biology of the yellowtail snapper, *Ocyurus chryurus,* from the southeastern United States, 1962 through 1996. Proceedings of the 50th Gulf and Caribbean Fisheries Institute 50:827-850.

National Marine Fisheries Service. 1990. Snapper-grouper assessment. Plan Development Team Report. Southeast Fisheries Science Center, Beaufort, N. C. 527 p.

Ortiz, M. 2003. Standardized catch rates of king (*Scomberomorus cavalla)* and Spanish mackerel (*S. maculatus*) from U. S. Gulf of Mexico and South Atlantic recreational fisheries. Sustainable Fisheries Division Contribution No. SFD-02/03-006. Southeast Fisheries Science Center. Miami. Fl.

Parma, A. M. 1993. Retrospective catch-at-age analysis of Pacific halibut: implications on assessment of harvesting policies. *In*: G. Kruse, D. M. Eggers, R. J. Marasco, C. Pautzke, and T. J. Quinn II (editors). Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant Program Report No. 93-02. University of Alaska Fairbanks. Pp 247-265.

Parrish, J. D. 1987. The trophic biology of snappers and groupers. Pages 405-463 *In* J.J. Polovina and S. Ralston (eds.) Tropical snappers and groupers: biology and fisheries management. Westview Press. Boulder, Colorado.

Patterson, K. R. 1997. Integrated catch at age analysis. Version 1.4. User's manual. FRS Marine Laboratory. Aberdeen Scotland.

Piedra, G. 1969. Materials on the biology of the yellowtail snapper (*Ocyurus chrysurus* Black). Pages 251-296 *in* A.S. Bogdanov, editor. Soviet-Cuban fishery research. Translated from Russian: Israel Program for Scientific Translations, Jerusalem, Israel.

Poffenberger, J. 2003. Yellowtail snapper discards. Sustainable Fisheries Division. Southeast Fisheries Science Center. Miami, Fl. Unpublished manuscript.

Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fish. Bull. 92:374-389.

Restrepo, V. R., G. G. Thompson, P. M. Mace, W, L, Gabriel, L. L. Low, A. D. MacCall, R. D. Methot, J. E. Powers, B. L. Taylor, P. R. Wade, and J. F. Witzig. 1998. Technical Guidance on the use of the precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SPO. Dated July 17, 1998.

Riley, C. M., G. J. Holt, and C. R. Arnold. 1995. Growth and morphology of larval and juvenile captive bred yellowtail snapper, *Ocyurus chrysurus*. Fish. Bull. 93:179-185.

Rose, K. A., J. H. Cowan, Jr., K. O. Winemiller, R. A. Myers, and R. Hilborn. 2001. Compensatory density dependence in fish populations: importance, controversy, understanding, and prognosis. Fish and Fisheries 2:293-327.

Shepherd, J. G. 1982. A versatile new stock-recruitment relationship for fisheries and the construction of sustainable yield curves. J. Cons. Cons. Int. Explor. Mer 40:67-75.

Schroeder, R. E. 1980. Philippine shore fishes of the western Sulu Sea. National Media Production Center, Manila, 226 p.

Thompson, R., and J. L. Munro. 1974. The biology, ecology and bionomics of Caribbean reef fishes: Lutjanidae (snappers). Zoology Dep., Univ. West Indies, Kingston, Jamaica Res. Rep. 3.

Topp, R. 1963. The tagging of fishes in Florida 1962 program. Florida State Board of Conservation Marine Laboratory. Professional Paper Series No. 5. St. Petersburg, FL 76 p.

Vose, F. E., and B. Shank. Feeding ecology of four species of snappers (Lutjanidae) from southeast Florida waters. Florida Marine Research Institute unpublished manuscript. St. Petersburg, FL.

List of Tables

List of Tables (Continued)

List of Tables (Continued)

List of Tables (Continued)

List of Tables (Continued)

List of Tables (Continued)

Table 3.2.1. Western Atlantic landings (mt) of yellowtail snapper. Data from UN FAO Data and Statistics Section and NMFS.

	Country							Western,Central	Southwest	Western
Year	British Virgin Islands	Cuba	Dominican Republic	Mexico	United States	Venezuela	Puerto Rico and US VI	Atlantic Sub Total	Atlantic Brazil	Atlantic Total
1970	...	700	-	300	500	100		1600	2100	3700
1971	...	800	-	400	500	200		1900	2400	4300
1972	...	900	-	300	500	200		1900	3300	5200
1973	...	1100	-	500	400	100		2100	3900	6000
1974	...	700	285	446	473	130		2034	2952	4986
1975	...	800	246	822	362	110		2340	3435	5775
1976	...	1100	...	655	443	124		2322	2344	4666
1977	...	800	...	630	300	132		1862	3956	5818
1978	...	600	182	723	300	172		1977	4181	6158
1979	...	600	285	519	300	301		2005	1360	3365
1980	...	590	321	1261	296	820		3288	1711	4999
1981	...	748	320	2224	332	200		3824	2677	6501
1982	...	959	202	1803	622	211		3797	1870	5667
1983	...	923	276	1627	436	212		3474	1821	5295
1984	...	898	254	1173	430	262		3017	2300	5317
1985	...	947	155	274	374	473		2223	2784	5007
1986	...	904	210	1752	508	351		3725	3099	6824
1987	...	1070	191	2164	618	388		4431	3195	7626
1988	...	851	194	1520	640	464		3669	2792	6461
1989	...	948	197	2519	838	674		5176	2862	8038
1990	...	740	180	3226	796	715		5657	2800	8457
1991	...	704	183	2320	844	659		4710	2862	7572
1992	...	745	267	1132	806	659		3609	2810	6419
1993	...	539	273	910	1079	678		3479	2800	6279
1994	...	592	671	1184	1000	684		4131	2800	6931
1995	...	592	248	825	842	511		3018	4766	7784
1996	...	1176	793	858	662	338		3827	4167	7994
1997	5	727	529	840	759	335	206	3402	5000	8402
1998	9	457	190	1900	691	272	197	3716	3317	7033
1999	9	409	234	1554	833	220	209	3469	4541	8010
2000	0	400	249	1357	702	291	246	3246	4540	7786

Table 3.2.2.1. United States landings of yellowtail snapper by state and year. Florida is treated as two states in these data.

Year	Texas	Louisiana	Mississippi	Alabama	Florida West Coast	Florida East Coast	Georgia	South Carolina	North Carolina	Total
1962	0.0	0.0	0.0	0.0	412.7	40.1	0.0	0.0	0.0	452.7
1963	0.0	0.0	0.0	0.0	330.7	46.6	0.0	0.0	0.0	377.3
1964	0.0	0.0	0.0	0.0	406.6	65.4	0.0	0.0	0.0	472.0
1965	0.0	0.0	0.0	0.0	427.1	55.8	0.0	0.0	0.0	482.9
1966	0.0	0.0	0.0	0.0	341.3	35.2	0.0	0.0	0.0	376.6
1967	0.0	0.0	0.0	0.0	385.5	51.1	0.0	0.0	0.0	436.6
1968	0.0	0.0	0.0	0.0	465.1	73.9	0.0	0.0	0.0	539.0
1969	0.0	0.0	0.0	0.0	366.4	73.6	0.0	0.0	0.0	440.0
1970	0.0	0.0	0.0	0.0	447.6	94.9	0.0	0.0	0.0	542.6
1971	0.0	0.0	0.0	0.0	430.4	65.5	0.0	0.0	0.0	495.9
1972	0.0	0.0	0.0	0.0	392.6	70.2	0.0	0.0	0.0	462.8
1973	0.0	0.0	0.0	0.0	379.0	48.6	0.0	0.0	0.0	427.6
1974	0.0	0.0	0.0	0.0	425.4	47.6	0.0	0.0	0.0	473.0
1975	0.0	0.0	0.0	0.0	306.4	55.5	0.0	0.0	0.0	361.8
1976	0.0	0.0	0.0	0.0	418.3	25.1	0.0	0.0	0.0	443.5
1977	0.0	0.0	0.0	0.0	345.8	21.0	0.0	0.0	0.0	366.9
1978	0.0	0.0	0.0	0.0	376.7	18.2	0.0	0.0	0.0	394.9
1979	0.0	0.0	0.0	0.0	331.9	21.9	0.0	0.0	0.0	353.8
1980	0.0	0.0	0.0	0.0	275.1	20.4	0.0	0.0	0.0	295.5
1981	0.0	0.0	0.0	0.0	314.9	17.0	0.0	0.0	0.0	331.9
1982	0.0	0.0	0.0	0.0	605.5	16.3	0.0	0.0	0.6	622.4
1983	0.0	0.0	0.0	0.0	405.7	30.5	0.0	0.0	0.0	436.2
1984	0.0	0.0	0.0	0.0	413.5	16.2	0.1	0.0	0.0	429.8
1985	0.0	0.3	0.0	0.0	355.7	18.7	0.0	0.0	0.0	374.7
1986	0.0	0.0	0.0	0.0	465.6	41.9	0.0	0.0	0.0	507.5
1987	3.8	0.0	0.0	0.6	574.0	40.2	0.1	0.0	0.0	618.7
1988	0.0	0.0	0.0	0.5	589.4	50.8	0.0	0.0	0.0	640.7
1989	0.0	0.9	0.0	0.6	776.2	62.2	0.0	0.0	0.0	839.8
1990	0.0	0.1	0.0	0.0	738.1	58.1	0.1	0.0	0.0	796.3
1991	0.5	0.0	0.0	0.0	776.3	67.5	0.0	0.0	0.0	844.4
1992	0.0	0.0	0.0	0.0	727.0	77.1	0.0	2.1	0.0	806.3

Table 3.2.2.1. (Continued) United States landings of yellowtail snapper by state and year. Florida is treated as two states in these data.

Year	Texas	Louisiana	Mississippi	Alabama	West Coast West Coast	East Coast East Coast	Georgia	South Carolina	North Carolina	Total
1993	0.0	0.0	0.0	0.0	994.6	84.2	0.0	0.0	0.2	1079.0
1994	0.0	0.0	0.1	0.0	923.8	76.4	0.0	0.0	0.1	1000.4
1995	0.0	0.0	0.0	0.0	784.3	57.9	0.0	0.0	0.0	842.3
1996	0.0	0.0	0.0	0.0	612.2	49.5	0.0	0.0	0.0	661.8
1997	0.0	0.0	0.1	0.0	693.6	65.7	0.0	0.0	0.0	759.4
1998	0.0	0.0	0.0	0.0	633.9	57.3	0.0	0.0	0.1	691.3
1999	0.0	0.1	0.0	0.0	783.4	53.9	0.0	0.0	0.0	837.4
2000	0.0	0.1	0.0	0.0	674.5	47.5	0.0	0.0	0.0	722.1
2001	0.0	0.0	0.0	0.0	590.4	54.0	0.0	0.0	0.1	644.5

Table 3.2.2.2. Composite yellowtail snapper, commercial landings in metric tons by coast and gear types

Landings (mt)

	Atlantic			Gulf			Southeast United States			
Year	H & L	Other	Total	H & L	Other	Total	H & L	Other	Total	Data Source
1950	42.9	0.9	43.8	113.4		113.4	156.3	0.9	157.2	NMFS Website
1951	103.3		103.3	95.2		95.2	198.5	0.0	198.5	NMFS Website
1952	79.2		79.2	97.7		97.7	176.9	0.0	176.9	NMFS Website
1953	60.9		60.9	92.2	4.5	96.7	153.1	4.5	157.6	NMFS Website
1954	50.3	10.3	60.6	39.7	51.1	90.8	90.0	61.4	151.4	NMFS Website
1955	42		42	65.2		65.2	107.2	0.0	107.2	NMFS Website
1956	45.5		45.5	74.1	0.1	74.2	119.6	0.1	119.7	NMFS Website
1957	66.6		66.6	134.5		134.5	201.1	0.0	201.1	NMFS Website
1958	39.2		39.2	118.5		118.5	157.7	0.0	157.7	NMFS Website
1959	39.2		39.2	184.3		184.3	223.5	0.0	223.5	NMFS Website
1960	44.5		44.5	239.3		239.3	283.8	0.0	283.8	NMFS Website
1961	43.1		43.1	290.3		290.3	333.4	0.0	333.4	NMFS Website
1962	40.1		40.1	412.7		412.7	452.8	0.0	452.8	NMFS Website
1963	46.6		46.6	330.7		330.7	377.3	0.0	377.3	NMFS Website
1964	65.4		65.4	406.6		406.6	472.0	0.0	472	NMFS Website
1965	55.8		55.8	427.2		427.2	483.0	0.0	483	NMFS Website
1966	35.2		35.2	341.3		341.3	376.5	0.0	376.5	NMFS Website
1967	51.1		51.1	385.5		385.5	436.6	0.0	436.6	NMFS Website
1968	73.9		73.9	465.1		465.1	539.0	0.0	539	NMFS Website
1969	73.6		73.6	366.4		366.4	440.0	0.0	440	NMFS Website
1970	94.9		94.9	447.7		447.7	542.6	0.0	542.6	NMFS Website
1971	65.5		65.5	430.4		430.4	495.9	0.0	495.9	NMFS Website
1972	70.2		70.2	392.6		392.6	462.8	0.0	462.8	NMFS Website
1973	48.6		48.6	379		379	427.6	0.0	427.6	NMFS Website
1974	47.6		47.6	425.4		425.4	473.0	0.0	473	NMFS Website
1975	55.5		55.5	306.4		306.4	361.9	0.0	361.9	NMFS Website
1976	25.1		25.1	418.4		418.4	443.5	0.0	443.5	NMFS Website
1977	21.0		21.0	345.8		345.8	366.9	0.0	366.9	Nmfs-GC
1978	15.9	2.4	18.2	376.7		376.7	392.5	2.4	394.9	Nmfs-GC

Table 3.2.2.2. (Continued) Composite yellowtail snapper, commercial landings in metric tons by coast and gear types

Landings (mt)

	Atlantic			Gulf			Southeast United States			
Year	H & L	Other	Total	H & L	Other	Total	H & L	Other	Total	Data Source
1979	19.2	2.7	21.9	297.8	34.1	331.9	317.0	36.8	353.8	Nmfs-GC
1980	15.6	4.9	20.4	247.9	27.2	275.1	263.4	32.1	295.5	Nmfs-GC
1981	13.1	3.9	17.0	303.8	11.0	314.9	316.9	14.9	331.9	Nmfs-GC
1982	14.3	2.6	16.9	600.3	5.1	605.5	614.6	7.8	622.4	Nmfs-GC
1983	15.7	14.8	30.6	398.9	6.7	405.7	414.7	21.6	436.2	Nmfs-GC
1984	16.0	0.2	16.3	396.4	17.1	413.5	412.4	17.4	429.8	Nmfs-GC
1985	18.6	0.1	18.7	337.9	18.1	356.0	356.5	18.1	374.7	Nmfs-GC
1986	38.0	3.9	41.9	446.9	18.7	465.6	484.9	22.6	507.5	Nmfs-GC
1987	34.0	6.3	40.3	574.1	4.3	578.4	608.2	10.5	618.7	Nmfs-GC
1988	36.4	14.3	50.8	567.9	22.1	589.9	604.3	36.4	640.7	Nmfs-GC
1989	42.0	20.2	62.2	753.3	24.3	777.7	795.3	44.5	839.8	Nmfs-GC
1990	44.3	13.8	58.2	719.3	18.9	738.2	763.6	32.7	796.3	Nmfs-GC
1991	59.4	8.1	67.5	760.5	16.4	776.9	819.9	24.5	844.4	Nmfs-GC
1992	76.9	3.1	80.0	717.3	42.5	759.8	794.2	45.7	839.8	Fla - TT
1993	82.0	2.2	84.2	935.5	59.2	994.8	1017.5	61.5	1079.0	Fla - TT
1994	74.0	2.3	76.4	891.9	32.1	924.0	965.9	34.5	1000.4	Fla - TT
1995	54.3	3.7	58.0	756.2	28.0	784.2	810.5	31.7	842.2	Fla - TT
1996	48.5	1.0	49.5	596.2	16.2	612.4	644.7	17.2	661.9	Fla - TT
1997	64.8	0.8	65.7	678.2	15.4	693.6	743.1	16.2	759.3	Fla - TT
1998	56.6	0.7	57.3	614.2	19.8	633.9	670.8	20.5	691.2	Fla - TT
1999	53.1	0.8	53.9	759.1	24.2	783.4	812.2	25.1	837.3	Fla - TT
2000	46.6	0.9	47.5	666.4	8.1	674.5	713.0	9.0	722.0	Fla - TT
2001	53.5	0.5	54.0	583.8	6.6	590.4	637.3	7.1	644.4	Fla - TT

Table 3.2.3.1. Commercial trips and landings by region and year from Florida's trip ticket system.

	Regions			
	Atlantic		Keys	
Year	Trips	Landings (mt)	Trips	Landings (mt)
1985	785	18.7	11044	356.0
1986	1360	41.9	11197	465.6
1987	1597	40.3	16050	578.4
1988	1647	50.8	15874	589.9
1989	1986	62.2	18722	777.7
1990	1932	58.2	16979	738.2
1991	2295	67.5	16327	776.9
1992	2505	80.0	16151	759.8
1993	2552	84.2	16987	994.8
1994	2351	76.4	15587	924.0
1995	1978	58.0	13798	784.2
1996	1798	49.5	11725	612.4
1997	2269	65.7	12267	693.6
1998	1502	57.3	9949	633.9
1999	1268	53.9	9672	783.4
2000	1304	47.5	7926	674.5
2001	1167	54.0	8100	590.4

Table 3.2.3.2. Commercial landings summary from Florida's trip ticket program including the number of Saltwater Products Licenses (SPL) reporting landings of yellowtail snapper, the number of commercial trips, and the landings in metric tons categorized by the annual total landings of yellowtail per SPL.

		Landings categories								
Description	Year	< 50 Kg	50 - 99 Kg	100 - 199 Kg	200 - 499 Kg	500 - 999 Kg	1000 - 4,999 Kg	5000 - 9,999 Kg	10,000 Kg +	Total
SPL	1987	5803	283	252	225	119	107	14	2	6805
	1988	6375	306	246	249	144	116	12	2	7450
	1989	7173	329	257	241	166	154	17	6	8343
	1990	5290	227	226	255	143	182	20	4	6347
	1991	4181	209	188	203	135	183	28	4	5131
	1992	3827	200	173	220	152	180	24	9	4785
	1993	3566	179	150	196	170	203	37	12	4513
	1994	3590	167	185	198	137	205	38	9	4529
	1995	3258	167	160	176	128	161	24	10	4084
	1996	2794	139	145	189	110	125	17	8	3527
	1997	2732	140	135	196	123	136	22	8	3492
	1998	2544	121	119	147	112	121	19	11	3194
	1999	2242	91	98	112	102	124	21	23	2813
	2000	2273	86	91	113	73	101	20	18	2775
	2001	2142	90	101	121	83	89	20	13	2659
Trips	1987	33659	2652	3176	3749	3115	4370	427	3130	54278
	1988	34994	2761	2816	4004	2937	4053	456	2731	54752
	1989	39916	3123	3155	3751	3659	6045	455	2284	62388
	1990	28757	1838	2371	4254	3460	6920	595	1060	49255
	1991	27378	1791	2505	3739	3589	7393	1148	93	47636
	1992	29496	2228	2271	4125	3456	6903	1433	381	50293
	1993	27917	1966	1999	3563	4412	7909	1194	594	49554
	1994	27074	1792	2049	3808	3242	7385	1182	397	46929
	1995	22426	1692	1977	3196	3479	5627	792	381	39570
	1996	20663	1574	1756	3261	2922	4405	313	533	35427
	1997	20347	1623	1581	3261	2982	5198	565	671	36228

Table 3.2.3.2. (Continued) Commercial landings summary from Florida's trip ticket program including the number of Saltwater Products Licenses reporting landings of yellowtail snapper, the number of commercial trips, and the landings in metric tons categorized by the annual total landings of yellowtail per SPL.

		Landings categories								
Description	Year	< 50 Kg	50 - 99 Kg	100 - 199 Kg	200 - 499 Kg	500 - 999 Kg	1000 - 4,999 Kg	5000 - 9,999 Kg	10,000 Kg +	Total
	1998	20245	1123	1257	2327	2504	3860	710	642	32668
	1999	17328	1004	1162	1802	2311	4342	704	957	29610
	2000	18094	912	1004	2196	1721	3161	681	768	28537
	2001	17059	1065	1248	2298	2075	2726	714	976	28161
Landings	1987	22.0	20.3	35.5	71.6	82.9	208.6	102.4	70.9	614.2
Metric tons	1988	22.4	21.6	34.7	77.3	102.9	238.7	81.0	61.2	639.8
	1989	24.9	23.2	36.5	78.1	113.9	308.5	125.5	128.8	839.4
	1990	19.1	16.2	32.2	83.1	97.9	338.7	138.6	71.0	796.8
	1991	15.5	14.9	26.8	65.3	98.8	376.1	202.3	44.5	844.2
	1992	12.0	14.5	24.5	70.3	110.0	346.9	153.9	107.4	839.6
	1993	12.5	12.6	21.0	63.9	121.9	436.1	257.4	153.3	1078.8
	1994	12.2	12.1	26.1	65.0	94.2	416.7	261.4	112.7	1000.3
	1995	11.9	12.0	22.6	56.7	96.4	344.4	169.3	128.9	842.1
	1996	9.9	10.3	20.4	61.2	78.1	275.7	104.6	101.6	661.7
	1997	9.7	10.2	19.4	64.1	89.0	301.1	162.5	103.2	759.1
	1998	8.7	8.9	17.2	46.0	80.8	264.7	139.4	125.5	691.2
	1999	6.5	6.6	14.0	37.7	73.6	254.3	147.0	297.6	837.3
	2000	6.4	6.2	13.0	37.3	54.0	204.0	146.6	254.5	722.1
	2001	5.5	6.5	13.8	40.6	60.2	190.0	142.8	185.1	644.4

Table 3.2.4. Commercial discard mortality in numbers of fish by region, gear, and year.

	Region						
	Atlantic		Keys		Total		
Year	HL	Other	HL	Other	HL	Other	All gears
1981	1204	233	21378	756	22582	989	23571
1982	1311	158	50794	352	52105	510	52615
1983	1446	887	33754	462	35200	1349	36549
1984	1480	10	30311	2800	31791	2810	34601
1985	1711	3	13579	1239	15289	1242	16531
1986	2138	105	47866	963	50003	1068	51071
1987	2682	329	51474	349	54156	678	54834
1988	2272	702	66004	2479	68276	3181	71457
1989	3229	1008	83249	2417	86478	3426	89903
1990	3006	761	83286	1618	86292	2378	88671
1991	3790	366	81616	750	85406	1116	86522
1992	7783	163	53901	1234	61684	1397	63082
1993	7729	100	84970	3304	92699	3404	96103
1994	5963	96	81997	2341	87960	2438	90397
1995	2981	191	71662	2239	74643	2430	77073
1996	4064	16	50848	1419	54912	1435	56347
1997	5682	41	61368	1175	67051	1216	68266
1998	4970	24	56755	1415	61724	1439	63163
1999	3508	37	68162	1970	71670	2007	73677
2000	2901	15	60501	390	63402	405	63807
2001	3203	24	51592	329	54795	354	55149

Table 3.2.5.1.a. Commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
210																					
220																					
230																					
240	6	7	7	8	9	11	14		17					1666	0	18		0	0	0	44
250	12	14	15	15	18	22	28	1480	33						0	36		170	0	0	45
260	59	65	71	73	84	105	132		159			147			0	169		765	192	34	178
270	131	143	157	161	186	233	292		352			294			0	374		2296	336	103	134
280	296	323	356	365	421	527	661		795			147			1	847	101	766	1629	1336	491
290	743	809	892	913	1056	1319	1655		1993		1584	1911	1346	1672	10	2135	1741	5018	3046	1919	1205
300	1417	1543	1702	1742	2014	2516	3157		3801			4703	8134	103	131	4277	7390	5445	3787	4480	3530
310	1623	1768	1949	1996	2307	2882	3616		4353			11612	8163	3468	173	4940	9570	6891	4708	3538	3233
320	2110	2298	2534	2595	2999	3747	4701		5659			10436	10998	1997	404	6747	12081	6891	6464	6652	4939
330	2135	2325	2564	2625	3034	3791	4757		5726		1584	14992	13572	8518	1101	6521	13417	9974	6646	3428	4747
340	2278	2482	2736	2802	3238	4046	5077	1480	6112	2148	7921	19549	19055	15329	5585	7250	10495	7590	6789	5776	4996
350	1913	2084	2298	2353	2719	3398	4263	1480	5132		1584	21754	19212	11973	3754	6001	8570	11166	5447	2396	3459
360	1954	2128	2347	2403	2777	3470	4353	1480	5241	2148	1584	16021	11371	7338	571	6563	8241	8468	5481	5391	4606
370	1950	2125	2343	2399	2772	3464	4346	1480	5232	2148	1584	16315	15264	15768	4815	6409	8159	9737	4501	3146	5949
380	1732	1887	2080	2130	2462	3076	3860	5920	4646	8592	9506	13816	12602	9954	5304	6582	7551	7289	4537	4415	4572
390	1535	1673	1844	1888	2182	2727	3421	2960	4119	4296	4753	11906	18029	11134	6709	5490	7561	5083	4246	2261	5845
400	1261	1373	1514	1551	1792	2239	2809	7400	3382	10740	7921	7055	4654	3288	962	5171	7189	3189	3193	4018	4218
410	1186	1292	1424	1458	1686	2106	2643	7400	3181	10740	9506	6467	10160	12976	4228	4664	4917	4232	3444	2944	3727
420	815	887	978	1002	1158	1447	1815	7400	2185	8592	9506	4556	3349	9015	3855	2993	5811	2949	2004	1356	2623
430	696	758	836	856	989	1236	1551	2960	1867	4296	7921	3234	1732	794	3060	2764	3876	2615	1405	2143	2397
440	568	619	682	699	807	1009	1266	4440	1524	6444	7921	2646	3069	3811	5455	2090	2155	2274	1883	1087	1863
450	487	530	585	599	692	865	1085	1480	1306	2148	1584	1470	2857	2079	245	1790	1108	1180	1703	1840	1862
460	321	350	386	395	457	571	716	2960	862	4296	3169	1176	1482	1874	1848	1121	1372	1769	1283	480	817
470	250	272	300	307	355	443	556		670		1584	147	1658	281	1030	988	1165	845	1103	817	776
480	212	231	255	261	302	377	473		569			735	1587	192	6145	794	1187	743	456	509	896
490	215	235	259	265	306	382	480		578				1413	154	93	768	484	590	672	1143	946
500	137	150	165	169	195	244	306		368			294	105	3443	1789	500	321	584	396	509	537

Table 3.2.5.1.a. (Continued) Commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
510	125	136	150	154	177	222	278		335		1584	294		72	2627	426	304	402	216	577	537
520	91	99	109	111	129	161	202		243		1584	294	1342	33	1744	293	101	493	192	303	358
530	78	85	94	96	111	139	174		209					72	42	292	202	329	96	789	313
540	44	48	52	54	62	78	97		117						0	125		0	335	103	178
550	56	61	67	69	80	100	125		151					1666	862	160		0	335	137	223
560	22	24	26	27	31	39	49		59		1584		35	1690	14	85		0	96	126	134
570	25	27	30	31	35	44	56		67					32	19	102		0	228	132	92
580	47	51	56	58	67	83	104		126				1	17	873	152		85	383	132	137
590	16	17	19	19	22	28	35		42			147		8	5	52	101	85	48	34	1
600	22	24	26	27	31	39	49		59			294	35	8	5	70	202	0	96	0	45
610	6	7	7	8	9	11	14		17						0	18		85	48	0	0
620	22	24	26	27	31	39	49		59						0	62	101	0	96	69	89
630	3	3	4	4	4	6	7		8					1666	0	9		0	0	0	0
640	9	10	11	12	13	17	21		25						0	27		0	48	0	89
650	3	3	4	4	4	6	7		8						0	9		0	0	0	44
660	6	7	7	8	9	11	14		17						0	18		0	0	34	44
670	3	3	4	4	4	6	7		8						0	9		0	0	34	0
680	9	10	11	12	13	17	21		25						862	27		0	48	34	0
690																					
700	6	7	7	8	9	11	14		17						0	18		85	0	34	0
710	3	3	4	4	4	6	7		8						0	9		0	48	0	0
720																					
730	6	7	7	8	9	11	14		17						862	18		0	48	0	0
740	3	3	4	4	4	6	7		8						0	9	101	0	0	0	0
750																					
760	6	7	7	8	9	11	14		17						862	18	101	0	0	0	0
770	3	3	4	4	4	6	7		8						0	9		0	0	0	44
780																					
790																					
800																					

Table 3.2.5.1.a. (Continued) Commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Hook-and-line									Year											
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
810	3	3	4	4	4	6	7		8						0	9	101	0	0	0	0
820																					
830	3	3	4	4	4	6	7		8						0	9	101	0	0	0	0
HL Total	26663	29045	32027	32792	37901	47357	59416	50323	71530	66587	83968	172411	171225	132090	66044	90035	125879	110084	77711	64258	70965

Gear	Other																				
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
210																					
220																					
230																					
240																					
250																					
260																					
270																					
280																					
290	101	68	385	4	1		143	305	438		159		43	42	80	7		6	101	5	11
300	101	68	385	4	1		143	305	438		159	226	43	42	80	8	22	24	18	10	11
310	505	342	1925	22	7		715	1524	2189		795	1129	214	210	401	36	51	73	42	37	53
320														0		1	22	18	18	5	
330	303	205	1155	13	4		429	914	1314		477	678	129	126	241	21	22	37	18	20	32
340	101	68	385	4	1		143	305	438		159		43	42	81	9	37	36	131	13	11
350	101	68	385	4	1		143	305	438		159	226	43	42	81	7	7	12	6	7	11
360	202	137	770	9	3	93	286	609	876		318		86	84	161	14	8	19	107	12	21
370	202	137	770	9	3		286	609	876		318	452	86	84	163	14	16	25	12	14	21
380													2	0	6	0	12	6	6	2	0
390	303	205	1155	13	4		429	914	1314		477	452	130	126	246	20	4	19	101	16	32
400	101	68	385	4	1		143	305	438		159		44	42	87	7	4	6	101	6	11
410													1		6		4			0	0
420	101	68	385	4	1	93	143	305	438		159		44	42	86	7	4	6		6	11
430	202	137	770	9	3	93	286	609	876		318		87	84	166	13	191	13		11	21

Table 3.2.5.1.a. (Continued) Commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Other										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
440	404	274	1540	17	6	93	572	1219	1752	16850	636		172	167	325	27	385	31	6	23	42
450	404	274	1540	17	6	186	572	1219	1752		636	226	173	168	327	27	18	37	113	24	42
460	303	205	1155	13	4	279	429	914	1314		477		130	126	245	20	3	19		16	32
470	303	205	1155	13	4	279	429	914	1314		477		131	126	249	20	6	19		16	32
480	202	137	770	9	3	186	286	609	876		318		88	84	169	13	6	13		11	21
490	202	137	770	9	3	186	286	609	876		318		89	84	173	14	16	19	6	13	21
500	101	68	385	4	1	93	143	305	438		159		45	42	87	7	5	6		6	11
510	303	205	1155	13	4	186	429	914	1314		477	226	132	126	253	21	23	31	12	20	32
520	202	137	770	9	3	186	286	609	876		318		87	84	166	13	4	13		11	21
530													2	0	6	0	12	6	6	2	0
540													1	0	3	0	10	6	6	2	0
550	101	68	385	4	1	93	143	305	438		159		44	42	85	7	3	6		6	11
560	101	68	385	4	1	93	143	305	438		159		44	42	83	7	2	6		5	11
570													1		5		3			0	0
580	101	68	385	4	1	93	143	305	438		159		44	42	83	7	2	6		5	11
590													1		4		3			0	0
600	101	68	385	4	1	93	143	305	438		159		43	42	83	7	2	6		5	11
610													1		2		2			0	0
620													0		1		1			0	0
630													0		0		0			0	0
640													0		1		1			0	0
650													0		1		1			0	0
660													0		1		1			0	0
670													0		0		0			0	0
680													0		0		0			0	0
690													0		0		0			0	0
700													0		0		0			0	0
710													0		0		0			0	0
720																					
730													0		0		0			0	0

Table 3.2.5.1.a. (Continued) Commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Other										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
740													0		0		0			0	0
750													0		0		0			0	0
760													0		0		0			0	0
770																					
780																					
790																					
800													0		0		0			0	0
810																					
820																					
830																					
Other Total	5153	3489	19639	222	71	2322	7291	15542	22332	16850	8112	3614	2223	2136	4241	353	912	525	810	330	541

Table 3.2.5.1.b. Landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
210		38	25								611										
220																					
230		266	177					9313							247						
240		342	227					5322		2037					494	797					267
250		949	631	705				5322		6111			1861		5190	1594				484	
260	6033	1139	757	4232				6652		2716			3101	783	5190	797					267
270		1253	832	4232				6652	1479	2716		807	4341	78	6735	477	672	257		242	267
280	9049	4176	2775	28918			5571	11974	4437	6111	1223	1616	8063	1175	13222	3265	2031	923	1661	5298	878
290	18098	19625	13042	18338		35344	31571	47895	34014	61115	34851	8890	30561	30961	18658	15206	21231	14510	14291	16888	10210
300		59293	39402	38792	690	88360	85427	152999	162675	198962	158358	37961	91585	92218	99778	56360	76339	70930	71791	44128	36523
310	18098	82790	55017	19043		164940	103998	155660	220351	247175	201157	69438	118352	177673	166442	90834	121471	100307	73736	67308	63583
320	3016	86510	57489	39497	1380	70688	81713	180938	202605	241742	237231	83149	164279	175218	169731	88120	122260	109879	161188	86562	82641
330	30164	89091	59204	12695	1380	153158	142997	179608	226266	236989	250071	62174	143296	182693	141623	83629	139690	99071	105568	76505	72665
340	30164	95734	63619	28918	2070	123705	137426	167634	229224	205753	221946	76688	163352	185310	140293	83441	127556	137848	176379	138614	96943
350	54295	84346	56051	25391	2070	70688	64999	150338	207041	185381	162638	83934	176479	146921	147938	85339	125360	107358	117229	140387	83543
360	30164	83473	55471	41613	5519	47126	92855	111756	186337	158898	137570	75837	170462	141401	122334	84516	112214	123813	180087	184881	94678
370	30164	75616	50249	28918	1380	88360	42713	69182	99084	87598	109444	94369	133607	114517	119530	71531	93431	79706	77154	98719	103780
380	24131	62558	41572	48666	10349	47126	40856	35922	48803	57719	61753	84680	119149	87998	85028	54523	58203	69213	87966	117445	76321
390	24131	56788	37737	21159	5519	58907	40856	29269	34014	35311	36074	68549	98712	80206	57170	62620	48871	48839	55622	65468	80929
400	21115	39744	26411	43024	6899	23563	24142	25278	34014	18334	22623	45967	79163	50646	33039	35412	35180	41270	54857	51939	59748
410	6033	44944	29867	63477	6209	5891	37142	21287	26620	15618	28737	49190	74889	56540	30381	41276	37731	36768	59141	41918	61772
420	21115	32683	21719	30328	3450	5891	29714	9313	16268	9507	23234	39513	46714	45552	25673	48184	37784	30691	33020	25077	42042
430	6033	26344	17507	38086	8279	17672	27857	15965	23662	6111	18954	26611	38087	35771	18217	35948	24752	22415	37846	25578	30871
440	30164	24104	16018	20454	4139	5891	20428	13304	16268	5432	9783	24193	27529	30362	26474	32413	26245	32012	24209	20721	22247
450	3016	19739	13117	19749	17248		5571	15965	16268	3395	12840	24192	29505	29977	15817	16518	14261	18604	23516	16443	23238
460	15082	16437	10923	7758	10349		16714	9313	8873	6111	9171	25806	17836	19123	18421	24442	15371	15269	17975	15094	15199
470	6033	17499	11629	13401	35875	5891	9286	6652	4437	3395	9171	16129	20637	18677	15016	19613	12803	21657	22180	13787	16440
480	3016	14614	9712	9169	15178		11143	6652	13310	3395	6114	23386	16422	16137	12423	18587	12966	16818	17137	10604	12401
490	6033	12109	8047	13401	25526		9286	1330	4437	4753	3669	16128	15678	12101	14297	8843	9109	13067	16756	12474	12765
500	12066	10970	7290	7758	18627	5891	7428	3991	1479	4074	5503	15321	10464	10109	11638	8297	12618	10118	13232	9130	8656

Table 3.2.5.1.b. (Continued) Landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
510	12066	9034	6004	9169	28286		7428	3991	2958	2716	6114	8064	9558	8093	8057	9005	11381	6103	11611	8507	5690
520	15082	8541	5676	2821	13798	5891	3714	1330	2958	3395	3669	18547	5787	8443	12050	7467	9439	8206	13425	8557	6033
530	3016	7060	4692	6348	15178	11781	1857		1479	2716	3057	13709	14978	10211	3985	4588	9425	5996	9819	6159	4192
540	3016	7250	4818	2116	7589		11143	1330	2958	4074	3669	22579	11519	7919	8036	11305	7442	4060	5827	6710	4007
550	9049	5504	3658	4937	9659	5891	3714			3395	1834	12902	9749	6116	4580	4654	7018	3168	4488	6329	2953
560	12066	4897	3254	1411	3450	5891	9286		1479	3395	5503	13709	5808	5277	6421	3609	5802	2114	5088	3806	2989
570	3016	3986	2649	2821	3450	11781	7428		2958	1358	4280	13709	4726	7078	3827	3142	4586	1046	5467	3057	1273
580	6033	3758	2497	1411	3450		7428		4437	1358	4280	8064	3583	5156	2212	3495	2761	1922	3835	3828	2075
590		2505	1665	3527	1380		9286		2958	2037	2446	8064	1925	2784	3162	1104	3487	914	2252	1210	738
600		2695	1791	1411	690		5571			2037	3057	7257	6916	3098	4429	1104	3816	1361	813	3519	1540
610	3016	1822	1211	2116	3450		1857			679	1834	4032	476	3703	2753	1901	1776	329	1668	1430	636
620		1442	959	2821	4829						611	4032	1955	2136	2752	307	2040	24	917	726	267
630		911	605	705	2070		1857			679	1223	4032	159	1118	2848	330	1200	144	565	462	802
640		607	404	705	3450						1834	0	397	392	1360	102		257	271	242	535
650		266	177	1411	1380						611	0				102	460		271		
660		418	277		2760							806	620	392		797	329		271		267
670		190	126		690					679		0				797		257	271		
680		152	101		1380						611			392							
690		342	227		4829						611	0		392							
700		114	76		1380														271		
710		76	50		690														271		
720		76	50		690									392							
730		114	76		1380												329				
740																					
750		152	101		1380									783							
760		38	25		690																
770		38	25											392							
780																					
790																					
800		38	25		690																

Table 3.2.5.1.b. (Continued) Landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear Hook-and-line											Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
810																					
820																					
830																					
Total	473573	1125201	747736	671451	300796	1060326	1140261	1462142	1844145	1844984	1807970	1194034	1882279	1816413	1587472	1126392	1359442	1257244	1509943	1340234	1142875

Gear Other																					
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
210																					
220																					
230																					
240	72	33	44		117		33							0	3	0	1	0	924	1	3
250	18	8	11		29		8							0	1	0	0	0	231	0	1
260	18	8	11		29		8							0	1	341	0	0	1	0	1
270	18	8	11		29		8							0	1	227	0	0	77	0	1
280	101	47	62	13926	166		47							0	4	455	1	0	157	1	4
290	268	125	164	7596	440		124	1408				1139	423	1	677	910	284	183	1468	3	10
300	644	300	394	21522	1056	117	297	1408	4359	1605		1139	3572	2	2914	2687	1572	1103	2567	226	360
310	835	389	510	5064	1368	156	385	1408	4359	1070	2373	1139	3763	635	3797	4298	3225	1905	6352	415	221
320	853	397	521	8862	1398	39	393	7041	3114	2139		1139	3265	951	6385	2687	1574	1104	3572	306	875
330	960	447	587	2532	1573	20	443	2817	1868	4814	2373	1139	3149	2530	4659	3028	2980	2741	3883	619	372
340	889	414	543	1266	1456	98	410	16899	1868	1070		1139	4724	3009	6499	3156	2029	1959	4510	636	171
350	698	325	426	1266	1143	98	322	8450	3736	3744		1139	3803	1582	2687	976	939	1339	2875	525	55
360	775	361	474		1271	508	358	5633	9963	2674	2373	1139	5916	17899	2839	985	1041	613	1586	452	314
370	943	439	576		1544	450	435	5633	8095	4279		1139	5684	2846	3418	1874	1250	2132	3180	671	356
380	1092	508	667		1788	1427	503	2817	8718	4279			6223	3719	2210	1759	1222	2978	1510	965	352
390	716	333	437		1173	821	330	1408	1245	1605	2373	1139	2535	4033	1383	885	1213	2004	778	439	306
400	895	417	547		1466	1916	413		2491	2139		1139	2535	3086	1147	558	852	732	344	291	316
410	990	461	605		1622	2072	457		1245	535		2278	5133	3642	1140	665	1034	1642	644	368	318
420	579	269	354		948	958	267		623	535		1139	3380	2846	711	317	743	1276	620	126	300
430	871	406	532		1427	2228	402		623	535		3418	423	636	857	203	840	732	553	51	312
440	447	208	273		733	958	206			535			1690	1266	778	352	428	975	654	392	315

Table 3.2.5.1.b. (Continued) Landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear Other	Year																				
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
450	781	364	477		1280	2170	360					1139	423	319	953	1007	632	1405	1015	298	108
460	280	131	171		459	489	129			1605	2373		423	633	671	187	164	729	355	115	285
470	495	231	303		811	1212	228			535		1139	2113	319	647	245	126	731	453	222	55
480	298	139	182		489	430	138						1690	2	905	473	498	1094	369	142	808
490	274	128	168		450	626	127		623		2373	1139	845	3	612	379	461	976	945	143	347
500	185	86	113		303	254	85		623	1070		1139		633	192	221	381	729	327	207	37
510	179	83	109		293	489	83						3443	2	978	659	537	494	1085	262	368
520	149	69	91		244	156	69			535			2113	1	171	210	464	365	385	124	32
530	185	86	113		303	371	85						845	317	698	503	272	793	705	95	62
540	125	58	77		205	195	58					1139	845	317	482	456	416	247	553	151	47
550	149	69	91		244	313	69					1139	1690	1	277	194	262	2	131	38	28
560	84	39	51		137	195	39						845	1	92	51	142	1	160	24	17
570	101	47	62		166	235	47					1139	423	1	275	194	75	183	129	38	26
580	54	25	33		88	117	25						423	316	79	45	41	1	72	99	14
590	95	44	58		156	274	44						423	317	107	60	56	1	97	29	20
600	78	36	47		127	215	36						423	1	68	38	36	1	62	96	13
610	78	36	47		127	254	36							1	72	40	38	1	65	19	14
620	95	44	58		156	274	44				2373			1	39	20	19	182	35	10	9
630	36	17	22		59	117	17							0	5	2	2	0	5	1	2
640	66	31	40		108	195	30			535				0	26	13	13	0	23	7	6
650	72	33	44		117	215	33							0	26	13	107	0	23	7	6
660	72	33	44		117	215	33							0	38	20	19	1	111	10	8
670	30	14	18		49	98	14							0	9	4	4	0	8	2	2
680	18	8	11		29	59	8							0	5	2	2	0	4	1	1
690	6	3	4		10	20	3							0	8	4	4	0	7	2	1
700	12	6	7		20	39	6							0	12	7	6	0	11	3	2
710	12	6	7		20	39	6							0	4	2	2	0	4	1	1
720	42	19	26		68	137	19							0	2	0	0	0	1	0	2
730														0	4	2	2	0	3	1	1
740	12	6	7		20	39	6							0	8	4	4	0	7	2	2
750														0	4	2	2	0	3	1	1

Table 3.2.5.1.b. (Continued) Landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear Other	Year																				
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
760														0	8	4	4	0	7	2	1
770																					
780																					
790																					
800														0	4	2	2	0	3	1	1
810	6	3	4		10	20	3							0	0	0	0	0	0	0	0
820																					
830																					
Total	16751	7801	10235	62033	27443	21327	7724	54923	53553	35834	16610	27341	73181	51870	49590	31429	26022	31357	43649	8643	7292

Table 3.2.5.2.a. Revised commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
170														1141				0	0	0	0
180																					
190							55							1141				0	0	0	0
200									68									0	0	0	0
210	27						55											0	0	0	0
220									68		271			1141				0	0	0	0
230				26			55	98	203		271			1141				0	0	0	0
240				52	33		55		68					1141				0	0	0	45
250			164	129	132	33	111	197	203					1141				170	46	0	45
260		44	23	155	428	132	388	394	135	710		147						763	227	34	178
270	27		117	155	297	165	222	98	406	710	1628	294			165			2290	318	102	134
280	55	218	164	181	362	165	887	197	542	946	814	147	661		330	1965	101	764	1589	1323	491
290	302	131	258	310	527	793	2994	1377	271	1419	1899	1908	1327	2290	668	4599	1747	5005	3023	1900	1204
300	247	393	422	620	725	1157	3937	2853	1287	3785	4612	4697	6700	125	1290	5488	7446	5430	4041	4435	3528
310	411	698	633	775	1483	1686	5767	2460	2439	5441	9496	11744	10034	3590	2655	7535	9641	6872	5005	3499	3231
320	686	393	703	723	1549	1619	5601	3050	3116	8280	13565	10422	15480	3824	5045	9292	12173	6896	6577	6569	4936
330	850	524	938	1291	2076	1652	7431	3935	4268	7333	10581	14973	11403	8219	4705	7499	13490	10091	6978	3387	4745
340	686	655	961	1575	2175	2809	3826	6296	5081	7333	13565	19670	21440	11821	6213	9971	10569	7725	6702	5704	4994
350	1755	1048	1172	1523	2307	3074	4381	5509	3523	7097	10310	21726	16959	10621	4108	6299	8601	11293	5569	2365	3457
360	1207	1004	1852	2066	2043	4032	4270	4526	3726	5914	7054	16001	13198	9854	5355	5936	8246	8474	5289	5331	4605
370	933	1397	1454	1575	2175	2347	2884	3148	3658	5678	7597	16294	13722	13331	8398	4768	8157	9701	4647	3116	5948
380	1371	1397	1243	1317	1779	1157	2107	3148	3794	4968	7868	13799	11758	9595	8681	6694	7537	7262	4693	4388	4569
390	1070	1484	1289	1394	2142	1752	1664	1771	3523	4495	7054	11890	11817	10248	9040	6326	7540	5064	4245	2257	5845
400	795	1266	1618	1549	1713	991	2052	1968	2642	4022	2442	7046	7885	3874	4186	5145	7165	3170	3141	3991	4216
410	878	1659	1219	1317	1483	1322	1275	1476	2371	2129	3256	6459	9345	9288	5510	3883	4885	4215	3420	2979	3725
420	466	1571	985	1188	1549	1355	832	1279	1829	4022	2984	4551	4616	8670	3846	3447	5784	2935	2040	1415	2623
430	576	1659	1266	1084	758	1157	1054	1181	2845	3075	3527	3229	3025	1922	2914	1911	3861	2603	1435	2130	2397
440	521	917	1172	775	758	859	1386	1181	2303	2602	2713	2642	1699	3895	3399	1115	2138	2263	1811	1115	1863
450	576	480	633	878	692	760	1275	1279	1219	1893	1085	1468	1492	2688	2041	1211	1101	1175	1652	1827	1862
460	494	567	703	723	626	1091	555	787	1016	1419	271	1174	799	4769	2590	1346	1367	1761	1235	544	818
470	494	611	563	671	527	628	555	98	813	237	1357	147	1631	276	1971	926	1151	842	1061	880	776
480	905	524	492	516	330	496	111	394	948		814	734	2223	1330	2086	1003	1177	736	440	507	897
490	686	436	703	258	758	297	333	689	881	710	814		732	1293	746	642	481	587	652	1143	947
500	357	218	422	413	395	463	222	197	881		271	294	763	2392	886	924	316	580	387	506	538

Table 3.2.5.2.a. (Continued) Revised commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year									
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
510	494	218	516	155	165	595	166	295	881		271	294	1322	70	699	395	304	397	213	574	537
520	329	262	305	439	165	496	277	197	406	237	271	294	662	1174	514	361	101	488	182	303	359
530	137	87	305	103	165	562	111	492	339		271			70	204	68	203	326	91	798	313
540	274	87	258	232	264	99	111	295	203						330			0	318	102	178
550	219	218	117	155	231	297	111	197	339					1141	495			0	318	136	223
560	192	131	117	207	99	33		197	135		271		34	1165	13	23		0	91	130	134
570	82	131	47	52	66	165			68					31	182	30		0	220	133	92
580	82	262	117	26	33	132	55		68				1	17	176	19		85	363	133	137
590	82		70		33	33	111	98			271	147	661	8	4	8	101	85	45	34	1
600	27		70									294	34	8	4	8	203	0	91	0	45
610	27		23			165	55		68									85	45	0	0
620			47	26		66											101	0	91	68	89
630			47				55		68					1141				0	0	0	0
640		44					55											0	45	0	89
650			47	26			55											0	0	0	45
660		44																0	0	34	44
670																		0	0	34	0
680															165			0	45	34	0
690																					
700			23	26														85	0	34	0
710																		0	45	0	0
720			23															0	0	0	0
730			23												165			0	45	0	0
740																	101	0	0	0	0
750		44	23	26														0	0	0	0
760															165		101	0	0	0	0
770																		0	0	0	44
780						33												0	0	0	0
790				26														0	0	0	0
800																					
810																	101	0	0	0	0
820																					
830																	101	0	0	0	0
HL total	18322	20820	23350	24737	31040	34669	57504	51355	56706	84453	117477	172483	171420	135588	89946	98839	126092	110220	78476	63995	70948

Table 3.2.5.2.a. (Continued) Revised commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Other										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
170																					
180																					
190																					
200																					
210																					
220																					
230																					
240																			24		
250																			6		
260																9					
270																6			2		
280	249	169	950	11	3		353									11			4		
290	159	107	605	7	2		224	756				29	19		125	23	12	3	40		
300	567	384	2159	24	8	14	802	756	3032	1038	451	102	94		399	55	54	14	44	7	14
310	272	184	1037	12	4	19	385	756	3032	692	451	116	38	55	374	78	106	21	112	9	7
320	385	261	1468	17	5	5	545	3779	2166	1384	601	102	113	83	1046	55	52	13	68	11	35
330	159	107	605	7	2	2	224	1511	1300	3115	1504	116	75	221	722	63	114	43	78	29	50
340	363	246	1382	16	5	12	513	9069	1300	692	301	102	113	166	972	58	64	25	81	26	35
350	295	199	1123	13	4	12	417	4534	2599	2423	1053	160	169	166	449	20	34	21	65	27	42
360	453	307	1728	19	6	63	641	3023	6931	1730	902	218	263	140	475	20	39	8	34	23	42
370	385	261	1468	17	5	53	545	3023	5631	2769	1203	189	188	248	530	37	49	35	67	33	57
380	363	246	1382	16	5	169	513	1511	6065	2769	1203	189	244	276	338	37	54	13	28	51	85
390	68	46	259	3	1	97	96	756	866	1038	601	131	113	304	237	20	57	35	19	23	43
400	113	77	432	5	2	227	160		1733	1384	601	102	113	221	185	11	40	13	7	14	29
410	45	31	173	2	1	246	64		866	346	150	102	116	221	186	14	48	29	13	19	36
420	23	15	86	1	0	116	32		433	346	150	131	150	248	111	6	36	23	13	5	15
430	68	46	259	3	1	267	96		433	346	150	58	19	55	137	3	44	13	11	1	8
440	45	31	173	2	1	116	64			692	150	58	75	110	83	4	34	22	15	21	36
450	45	31	173	2	1	262	64					44	19	28	59	16	38	35	25	15	14
460	45	31	173	2	1	65	64			1038	601	15	19	55	107	3	9	13	7	5	14
470	45	31	173	2	1	151	64			346	150	87	94	28	82	3	5	13	7	9	14
480	91	61	346	4	1	56	128					58	75		134	9	22	19	5	5	29
490	136	92	518	6	2	79	192		433		150	44	38		10	1	23	22	17	4	7
500	91	61	346	4	1	32	128		433	692	301	15		55	6	3	16	13	4	9	14

Table 3.2.5.2.a. (Continued) Revised commercial landings of yellowtail snapper in numbers of fish in the Atlantic region by gear, year, and 10-mm length category

Gear	Other										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
510	136	92	518	6	2	63	192					29	41		36	4	31	19	21	11	15
520	113	77	432	5	2	23	160			346	150	73	94		6	3	20	6	6	5	7
530	159	107	605	7	2	44	224					29	38	28	55	6	15	19	14	3	0
540	113	77	432	5	2	23	160					44	38	28	28	6	22	9	12	7	7
550	159	107	605	7	2	39	224					73	75		29	3	11		0	0	0
560	159	107	605	7	2	26	224					29	38		3		6		2	0	0
570	91	61	346	4	1	28	128					29	19		28	3	2	3	0	0	0
580	45	31	173	2	1	16	64					15	19	28	2		1		0	5	7
590	45	31	173	2	1	32	64					15	19	28	2		2		0	0	0
600	23	15	86	1	0	28	32					15	19		1		1		0	5	7
610	23	15	86	1	0	30	32								1		1		0	0	0
620	91	61	346	4	1	32	128				150				1		0	3	0	0	0
630	45	31	173	2	1	14	64								0		0		0	0	0
640						23				346	150				0		0		0	0	0
650	23	15	86	1	0	26	32								0		4		0	0	0
660						26									1		0		2	0	0
670						12									0		0		0	0	0
680						7									0		0		0	0	0
690						2									0		0		0	0	0
700						5									0		0		0	0	0
710						5									0		0		0	0	0
720						16															
730															0		0		0	0	0
740						5									0		0		0	0	0
750															0		0		0	0	0
760															0		0		0	0	0
770	23	15	86	1	0		32														
780																					
790																					
800															0		0		0	0	0
810						2															
820																					
830																					
Other total	5711	3867	21767	246	79	2589	8080	29474	37253	23534	11126	2514	2541	2791	6961	587	1068	508	852	383	672

Table 3.2.5.2.b. Revised commercial landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
170																					
180																					
190																					
200																					
210											611										
220																					
230								9313							231						
240								5322		2037					462	819					269
250			710	705				5322		6111			1903		5496	1637				513	
260	6033	11920	4259	4232				6652		2716			3172	816	5496	819					269
270			4259	4232				6652	1479	2716		807	4441	74	7100	458	666	269		256	269
280	9049	17880	29105	28918			5571	11974	4437	6111	1223	1616	8247	1224	13970	3242	1989	922	1668	5029	879
290	18098	35759	18457	18338		35344	31571	47895	34014	61115	34851	8890	30755	31109	18399	14865	20956	14486	14280	16725	10215
300			39044	38792	690	88360	85427	152999	162675	198962	158358	37961	89815	91636	97418	54909	74933	68839	70197	43252	36325
310	18098	35759	19167	19043		164940	103998	155660	220351	247175	201157	69438	115410	174066	161313	88700	119635	98008	72663	66642	63564
320	3016	5960	39754	39497	1380	70688	81713	180938	202605	241742	237231	83149	160310	171599	164731	85720	119221	106531	157505	84709	82287
330	30164	59599	12778	12695	1380	153158	142997	179608	226266	236989	250071	62174	139443	178813	136373	81474	137143	96405	103738	76384	72594
340	30164	59599	29105	28918	2070	123705	137426	167634	229224	205753	221945	76688	160203	182953	135984	81510	125157	134167	171500	137430	96569
350	54295	107278	25556	25391	2070	70688	64999	150338	207041	185381	162638	83934	173955	144327	145779	83875	122901	104675	115189	137879	83399
360	30164	59599	41883	41613	5519	47126	92855	111756	186337	158898	137569	75837	169065	139457	121355	83543	110489	120318	176266	180315	94327
370	30164	59599	29105	28918	1380	88360	42713	69182	99084	87598	109444	94369	133473	114481	120013	71370	93250	78990	77118	98410	103932
380	24131	47679	48982	48666	10349	47126	40856	35922	48803	57719	61753	84680	120159	88000	85890	54711	59020	69819	87751	116297	76222
390	24131	47679	21297	21159	5519	58907	40856	29269	34014	35311	36074	68549	100097	81391	57932	63541	49758	50013	56602	66693	81122
400	21115	41719	43303	43024	6899	23563	24142	25278	34014	18334	22623	45967	80321	51581	33468	35695	35694	41969	55001	51830	59722
410	6033	11920	63890	63477	6209	5891	37142	21287	26620	15618	28737	49190	75994	57381	30660	41755	38467	37642	59802	43341	61827
420	21115	41719	30525	30328	3450	5891	29714	9313	16268	9507	23234	39513	47263	46237	26153	48983	38480	31519	33481	25945	42147
430	6033	11920	38334	38086	8279	17672	27857	15965	23662	6111	18954	26611	38624	36376	18360	36530	25165	22841	38130	26120	30877
440	30164	59599	20587	20454	4139	5891	20428	13304	16268	5432	9783	24193	27853	30929	27450	33003	26701	33126	24848	21330	22296
450	3016	5960	19877	19749	17248		5571	15965	16268	3395	12840	24192	29949	30711	16184	16671	14524	19120	23646	17165	23244
460	15082	29799	7809	7758	10349		16714	9313	8873	6111	9171	25806	18089	19481	19074	24817	15693	15776	18429	15571	15234
470	6033	11920	13488	13401	35875	5891	9286	6652	4437	3395	9171	16129	20967	19050	15540	19975	13020	22378	22510	14059	16472
480	3016	5960	9229	9169	15178		11143	6652	13310	3395	6114	23386	16677	16405	12790	18839	13131	17405	17632	11081	12447
490	6033	11920	13488	13401	25526		9286	1330	4437	4753	3669	16128	15922	12338	14695	8835	9100	13396	17016	12833	12802
500	12066	23840	7809	7758	18627	5891	7428	3991	1479	4074	5503	15321	10626	10249	12040	8354	12830	10426	13662	9443	8683

Table 3.2.5.2.b. (Continued) Revised commercial landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear	Hook-and-line										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
510	12066	23840	9229	9169	28286		7428	3991	2958	2716	6114	8064	9686	8110	8207	9135	11541	6264	11824	8618	5711
520	15082	29799	2840	2821	13798	5891	3714	1330	2958	3395	3669	18547	5857	8568	12427	7504	9528	8460	13875	8532	6052
530	3016	5960	6389	6348	15178	11781	1857		1479	2716	3057	13709	15210	10374	3911	4571	9531	6122	10074	6068	4183
540	3016	5960	2130	2116	7589		11143	1330	2958	4074	3669	22579	11715	8063	8332	11502	7562	4178	5991	6879	4013
550	9049	17880	4969	4937	9659	5891	3714			3395	1834	12902	9927	6170	4634	4696	7154	3255	4625	6311	2961
560	12066	23840	1420	1411	3450	5891	9286		1479	3395	5503	13709	5905	5293	6662	3682	5929	2171	5266	3803	2994
570	3016	5960	2840	2821	3450	11781	7428		2958	1358	4280	13709	4792	7147	3913	3181	4668	1037	5664	2934	1276
580	6033	11920	1420	1411	3450		7428		4437	1358	4280	8064	3618	5231	2242	3573	2824	1984	4000	3903	2083
590			3549	3527	1380		9286		2958	2037	2446	8064	1913	2807	3287	1117	3576	946	2305	1282	739
600			1420	1411	690		5571			2037	3057	7257	7043	3141	4630	1117	3914	1400	854	3347	1545
610	3016	5960	2130	2116	3450		1857			679	1834	4032	466	3796	2897	1936	1821	339	1722	1439	638
620			2840	2821	4829						611	4032	1968	2164	2898	298	2093	23	954	769	269
630			710	705	2070		1857			679	1223	4032	155	1125	2986	318	1218	140	583	413	806
640			710	705	3450						1834	0	389	408	1434	99		269	285	256	538
650			1420	1411	1380						611	0				99	469		285		
660					2760							806	634	408		819	338		285		269
670					690					679		0				819		269	285		
680					1380						611			408							
690					4829						611	0		408							
700					1380														285		
710					690														285		
720					690									408							
730					1380												338				
740																					
750					1380									816							
760					690																
770														408							
780																					
790																					
800					690																
810																					
820																					
830																					
HL Total	473573	935703	675811	671451	300796	1060326	1140261	1462142	1844145	1844984	1807968	1194034	1872012	1805941	1572816	1119113	1350430	1245896	1498082	1333806	1142068

Table 3.2.5.2.b. (Continued) Revised commercial landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear	Other										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
170																					
180																					
190																					
200																					
210																					
220																					
230																					
240														0	1	0	0	0	1007	0	
250														0	0	0	0	0	252	0	
260														0	0	377	0	0	0	0	
270														0	0	251	0	0	84	0	
280	708	330	432	1098	1159		326							1	7	502	2	1	175	3	
290	450	210	275	699	738		208	1408				361	431	1	699	1005	247	189	1600	3	
300	1608	749	983	2495	2635	117	742	1408	4359	1605	936	1083	3549	3	2560	2611	1244	676	2068	150	151
310	772	359	472	1197	1265	156	356	1408	4359	1070	936	541	3647	627	2807	3884	2466	843	5134	221	135
320	1094	509	668	1696	1792	39	504	7041	3114	2139	1248	1263	3285	940	6091	2566	1176	617	3050	216	318
330	450	210	275	699	738	20	208	2817	1868	4814	3121	902	3118	2500	4355	2987	2464	2366	3489	543	441
340	1029	479	629	1597	1686	98	475	16899	1868	1070	624	1263	4677	3142	5939	2872	1533	1230	3648	503	347
350	836	389	511	1297	1370	98	386	8450	3736	3744	2185	1805	3883	1876	2582	927	730	1189	2815	496	357
360	1286	599	786	1996	2108	508	593	5633	9963	2674	1873	2707	6041	17394	2754	938	829	439	1417	427	365
370	1094	509	668	1696	1792	450	504	5633	8095	4279	2497	1985	5707	2814	3363	1880	1109	1933	3094	661	539
380	1029	479	629	1597	1686	1427	475	2817	8718	4279	2497	2346	6305	3761	2313	1862	1156	2838	1507	1005	806
390	193	90	118	299	316	821	89	1408	1245	1605	1248	1263	2589	4071	1578	1004	1156	2071	915	490	434
400	322	150	197	499	527	1916	148		2491	2139	1248	1263	2589	3134	1250	606	802	756	377	319	303
410	129	60	79	200	211	2072	59		1245	535	312	1263	4834	3767	1276	742	979	1695	731	405	368
420	64	30	39	100	105	958	30		623	535	312	1624	3452	2813	845	362	728	1319	717	163	192
430	193	90	118	299	316	2228	89		623	535	312	722	431	628	1005	242	820	756	650	90	138
440	129	60	79	200	211	958	59			535	312	722	1726	1251	1026	479	692	1110	972	452	390
450	129	60	79	200	211	2170	59					361	431	316	1304	1260	1116	1655	1550	376	263
460	129	60	79	200	211	489	59			1605	1248	180	431	626	741	197	183	754	389	133	165
470	129	60	79	200	211	1212	59			535	312	1083	2157	314	599	194	99	754	387	211	163
480	257	120	157	399	422	430	119					722	1726	2	928	467	454	1130	341	147	294
490	386	180	236	599	632	626	178		623		312	541	863	3	645	367	630	1110	1080	147	167
500	257	120	157	399	422	254	119		623	1070	624	180		626	146	181	323	753	275	200	154

Table 3.2.5.2.b. (Continued) Revised commercial landings of yellowtail snapper in numbers of fish in the Keys region by gear, year, and 10-mm length category

Gear	Other										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
510	386	180	236	599	632	489	178					180	3109	3	1197	772	972	715	1487	305	274
520	322	150	197	499	527	156	148			535	312	902	2157	2	150	182	407	378	361	122	97
530	450	210	275	699	738	371	208					361	863	314	805	573	485	922	912	114	78
540	322	150	197	499	527	195	148					541	863	313	610	551	617	357	786	176	121
550	450	210	275	699	738	313	208					902	1726	1	247	165	221	2	80	31	27
560	450	210	275	699	738	195	208					361	863	1	73	27	120	1	138	21	18
570	257	120	157	399	422	235	119					361	431	1	221	156	44	189	61	24	21
580	129	60	79	200	211	117	59					180	431	313	48	18	26	1	36	93	71
590	129	60	79	200	211	274	59					180	431	313	62	23	33	1	45	18	16
600	64	30	39	100	105	215	30					180	431	0	32	12	17	1	24	88	66
610	64	30	39	100	105	254	30							0	34	13	18	1	25	10	9
620	257	120	157	399	422	274	119				312			1	20	6	10	189	16	6	4
630	129	60	79	200	211	117	59							0	4	1	2	0	3	1	0
640						195				535	312			0	12	4	6	0	9	3	3
650	64	30	39	100	105	215	30							0	12	4	88	0	10	4	3
660						215								0	17	6	9	0	97	5	4
670						98								0	4	1	2	0	3	1	1
680						59								0	2	1	1	0	2	1	0
690						20								0	4	1	2	0	3	1	1
700						39								0	6	2	3	0	4	2	1
710						39								0	2	1	1	0	1	1	0
720						137								0	1	0	0	0	1	0	
730														0	2	1	1	0	1	1	0
740						39								0	4	1	2	0	3	1	1
750														0	2	1	1	0	1	1	0
760														0	4	1	2	0	3	1	1
770	64	30	39	100	105		30							0	1	0	0	0	1	0	
780																					
790																					
800														0	2	1	1	0	1	1	0
810						20								0	0	0	0	0	0	0	
820																					
830																					
Other total	16210	7549	9904	25147	26557	21327	7474	54923	53553	35834	23097	28336	73180	51874	48391	31290	24032	28941	41836	8390	7310

Table 3.3 Comparison of the methods used to estimate charterboat catches. The old method was based on responses of Florida residents and the new method calls 10% of the charterboat operators each week and asks for the number of trips that they made the previous week.

	Old Method			New Method					
	Landings	Releases	Total	Landings	Releases	Total		% Difference	
Year	Numbers	Numbers	Numbers	Numbers	Numbers	Numbers	Landings	Releases	Total
2000	90,017	27,166	117,183	36992	12369	49361	-59%	-54%	-58%
2001	112,648	23,039	135,687	53892	20151	74043	-52%	-13%	-45%

Table 3.3.1. Estimated recreational landings in numbers of fish by fishing mode, region, and year. Type A fish are fish that the samplers observed, Type B1 fish were caught but not observed by the samplers, and Type B2 fish were released alive by the anglers.

		Fishing mode											
		Shore			Charterboat			Private/rental boat			Regional total		
Region	Year	Type A	Type B1	Type B2	Type A	Type B1	Type B2	Type A	Type B1	Type B2	Type A	Type B1	Type B2
Atlantic	1981	69490	20338	48491	0	0	0	164218	60743	25957	233708	81081	74448
	1982	864	0	1850	0	0	0	56783	300112	77673	57647	300112	79523
	1983	11682	0	8741	11889	0	0	92955	47742	35769	116526	47742	44510
	1984	699	0	0	4056	0	205	75844	5057	44378	80599	5057	44583
	1985	1195	1200	14978	1405	0	0	16801	315144	33158	19401	316344	48136
	1986	0	47356	35517				43854	12017	116318	43854	59373	151835
	1987				1456	0	0	29927	24286	151289	31383	24286	151289
	1988	0	3286	0	58087	0	0	102605	34279	12150	160692	37565	12150
	1989	2656	0	7237	2593	0	0	32135	35097	54707	37384	35097	61944
	1990	0	6400	32135	490	0	0	15315	94264	119057	15805	100664	151192
	1991	0	0	34338	0	1051	0	14040	123337	144552	14040	124388	178890
	1992	0	1113	54067	7488	0	7107	58590	87070	347124	66078	88183	408298
	1993	3336	4201	26209	2511	0	2709	112703	106795	226217	118550	110996	255135
	1994	0	7814	18078				44809	60365	141181	44809	68179	159259
	1995	635	8398	5375				33870	31158	240146	34505	39556	245521
	1996	0	0	3479	8311	0	0	43156	22130	169303	51467	22130	172782
	1997	0	1138	8812	579	0	0	15686	38667	107513	16265	39805	116325
	1998	0	0	6365	6773	15589	7601	65970	18695	116498	72743	34284	130464
	1999	0	1220	6920	7036	0	7425	37406	19746	179388	44442	20966	193733
	2000	2355	1407	22941	6681	1388	20140	65369	36180	156693	74405	38975	199774
	2001	1266	0	35423	35073	2582	10654	21652	25063	90980	57991	27645	137057
	2002	3016	1413	13451	14420	1334	6594	27806	14468	114704	45242	17215	134749

Table 3.3.1. (Continued) Estimated recreational landings in numbers of fish by fishing mode, region, and year. Type A fish are fish that the samplers observed, Type B1 fish were caught but not observed by the samplers, and Type B2 fish were released alive by the anglers.

		Fishing mode											
		Shore			Charterboat			Private/rental boat			Regional total		
Region	Year	Type A	Type B1	Type B2	Type A	Type B1	Type B2	Type A	Type B1	Type B2	Type A	Type B1	Type B2
Keys	1981	87455	13781	4663	19145	0	1770	1114020	97929	105185	1220620	111710	111618
	1982	33769	122158	39772	66563	0	0	773275	124308	199515	873607	246466	239287
	1983	61461	137397	34946	57824	11764	57191	82870	97446	78489	202155	246607	170626
	1984	120637	50670	142532	11694	1745	2328	191897	1003249	744297	324228	1055664	889157
	1985	22224	8218	15505	1843	1870	0	292523	87667	75752	316590	97755	91257
	1986	25385	13077	26155	24344	3559	5246	86631	84696	94533	136360	101332	125934
	1987	13786	0	117739	23538	41211	19056	284980	44959	457394	322304	86170	594189
	1988	0	2273	66519	42936	27109	73891	177386	40865	280694	220322	70247	421104
	1989	11537	0	131305	31739	9293	9874	386599	182694	526928	429875	191987	668107
	1990	10360	2587	37171	36362	12968	38182	592389	59731	352150	639111	75286	427503
	1991	46888	19445	413588	69516	14618	180205	702966	9270	2432028	819370	43333	3025821
	1992	12910	0	110445	134114	86296	89919	67092	70969	514919	214116	157265	715283
	1993	13154	8611	246477	75028	32871	73463	172761	126168	828246	260943	167650	1148186
	1994	11836	1462	96335	78666	19922	27258	123578	119940	495663	214080	141324	619256
	1995	2982	10461	143817	49209	38348	50051	116002	134081	483201	168193	182890	677069
	1996	11822	0	76299	77743	6350	31392	130397	12906	486557	219962	19256	594248
	1997	0	4107	102224	122868	7205	72128	191783	795	816119	314651	12107	990471
	1998	0	0	141019	117192	9907	70737	118134	0	329552	235326	9907	541308
	1999	787	0	27347	102244	11341	33976	84866	3059	264588	187897	14400	325911
	2000	11842	0	46228	36127	865	12369	83032	0	173741	131001	865	232338
	2001	0	0	88456	52447	1445	20151	44440	4552	113167	96887	5997	221774
	2002	0	0	24214	80624	793	24131	106653	22375	153262	187277	23168	201607

Table 3.3.2. Numbers of recreational trips by region and year. The number of trips were post-stratified to those from Palm Beach-Dade counties and those from Monroe county.

	Palm Beach-Dade		Monroe		Total	
Year	Charterboat	Private/rental	Charterboat	Private/rental	Charterboat	Private/rental
1986	261997	1270121	62933	291677	324930	1561798
1987	430645	1868502	92658	341888	523303	2210390
1988	582077	2021493	84275	345729	666352	2367222
1989	369727	1741539	95200	492153	464926	2233693
1990	232594	1656442	95112	568457	327706	2224899
1991	222301	2014621	164485	1073799	386786	3088420
1992	226120	1843769	206936	824146	433056	2667915
1993	338573	1460533	337557	901044	676130	2361578
1994	363709	1461094	292449	791685	656158	2252779
1995	463421	1416781	416647	660237	880068	2077018
1996	450509	1212639	388582	733128	839091	1945767
1997	407569	1285227	380603	818322	788172	2103549
1998	376113	1297351	321167	408870	697279	1706221
1999	221910	994729	291902	313000	513812	1307729
2000	204057	1204010	265818	360465	469874	1564474
2001	177737	1249253	237637	302963	415374	1552216
2002	163974	1571691	225705	179958	389679	1751649

Table 3.3.3. Recreational landings, discards, release mortality, and total kill by region and year. Release mortality was approximated as 30% of the fish that were released alive. The numbers are in thousands of fish.

	Atlantic				Keys			
Year	Landings	Releases	Rel Mort	Total kill	Landings	Releases	Rel Mort	Total kill
1981	314.8	74.4	22.3	337.1	1332.3	111.6	33.5	1365.8
1982	357.8	79.5	23.9	381.6	1120.1	239.3	71.8	1191.9
1983	164.3	44.5	13.4	177.6	448.8	170.6	51.2	499.9
1984	85.7	44.6	13.4	99.0	1379.9	889.2	266.7	1646.6
1985	335.7	48.1	14.4	350.2	414.3	91.3	27.4	441.7
1986	103.2	151.8	45.6	148.8	237.7	125.9	37.8	275.5
1987	55.7	151.3	45.4	101.1	408.5	594.2	178.3	586.7
1988	198.3	12.2	3.6	201.9	290.6	421.1	126.3	416.9
1989	72.5	61.9	18.6	91.1	621.9	668.1	200.4	822.3
1990	116.5	151.2	45.4	161.8	714.4	427.5	128.3	842.6
1991	138.4	178.9	53.7	192.1	862.7	3025.8	907.7	1770.4
1992	154.3	408.3	122.5	276.8	371.4	715.3	214.6	586.0
1993	229.5	255.1	76.5	306.1	428.6	1148.2	344.5	773.0
1994	113.0	159.3	47.8	160.8	355.4	619.3	185.8	541.2
1995	74.1	245.5	73.7	147.7	351.1	677.1	203.1	554.2
1996	73.6	172.8	51.8	125.4	239.2	594.2	178.3	417.5
1997	56.1	116.3	34.9	91.0	326.8	990.5	297.1	623.9
1998	107.0	130.5	39.1	146.2	245.2	541.3	162.4	407.6
1999	65.4	193.7	58.1	123.5	202.3	325.9	97.8	300.1
2000	113.4	199.8	59.9	173.3	131.9	232.3	69.7	201.6
2001	85.6	137.1	41.1	126.8	102.9	221.8	66.5	169.4
2002	62.5	134.7	40.4	102.9	210.4	201.6	60.5	270.9

Table 3.3.4.a. Numbers of recreational (MRFSS) harvested fish by region, year, and 10-mm total length category.

Region	Atlantic										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
110																					
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	6126	724	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	6126	1809	4130	834	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190	0	724	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	3063	362	0	0	281	1271	494	2143	343	0	0	590	2044	404	0	0	0	0	0	0	0
210	6126	1085	1377	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	6126	1809	1377	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
230	9189	1447	0	1668	281	0	0	0	343	368	206	0	0	0	332	1009	117	0	0	0	0
240	0	1447	2753	1668	281	0	0	0	343	368	206	0	0	0	0	0	0	0	0	0	0
250	6126	1809	1377	1668	281	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
260	12252	2532	0	834	281	636	247	0	343	368	0	590	2044	404	0	0	0	0	0	1145	0
270	18379	4341	2753	2502	561	636	494	2143	1029	735	206	590	0	0	0	0	117	0	753	0	0
280	0	724	0	834	140	0	0	0	0	0	0	0	0	0	0	0	0	0	753	0	0
290	6126	2171	2753	1668	281	0	494	4285	1029	368	619	1770	0	807	1327	2018	819	8313	2260	1145	1500
300	12252	2171	1377	834	561	1907	741				206	590		404	995	2018	819	3118	753	2289	5749
310	15316	2532	2753	1668	982	3178	1236			368	1239	4130	2044	1211	2654	6055	1755	5196	4520	4579	5249
320		362	1377	2502	561	636	494	4285	686		206	590		807	1991	4037	819	1039	3013	2289	3250
330	12252	3256	5506	834	140						1445	6490	8176	2018	995	2018	936	5196	6026	3434	4499
340	33694	4703	2753	4170	842	1271	494	2143	343	368	1032	3540	2044	1211	1659	3027	1287	8313	3013	2289	3749
350	21442	4703	5506	2502	421	636	247				826	5310	10220	2826	1991	4037	1170	3118	753	11447	5499
360		1085	2753	1668	281		247	2143	1029	1103	1239	3540	4088	2422	2986	5046	1053	4157	4520	3434	5499
370	39821	8682	11012	1668	561	1907	1236	6428	1029		619	4720	10220	3633	3650	7064	1521	5196	3766	6868	4499
380	12252	3618	6883	8340	1403		741	6428	1029			2360	8176	3633	2654	3027	1053	6235		6868	3250
390	6126	2171	5506	4170	701		494	4285	686	735	619	4130	8176	3633	2322	2018	1287	8313	2260	2289	2000
400		1447	4130	834	140	636	247		343	368	413	4130	12264	2826	332		117	1039	2260	2289	2000
410	3063	1809	2753	9174	1683	1271	988	6428	1372	368	206	3540	10220	2422	664	1009	1521	10392	1507	1145	2500
420	3063	2894	8259	8340	1403		741	6428	1029		206	1180	2044	404	332	1009	702	5196	753		2000
430	6126	2894	5506	9174	2805	6991	3707	14998	3430	1470	1239	3540	2044	1211	995	1009	234	1039	2260	2289	2250

Table 3.3.4.a. (Continued) Numbers of recreational (MRFSS) harvested fish by region, year, and 10-mm length category.

Region	Atlantic										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
440	3063	1809	5506	5838	1543	3813	2965	14998	2744	368	206	1770	4088	1211	995	2018	234		1507	1145	1000
450		1809	6883	2502	561	636	988	6428	1029	368	413	1770	2044	1211	995	1009	117			5723	1750
460	3063	2894	8259	15012	4068	7627	2965	10713	3430	1838	413	1770	6132	1211	664	2018	234		753	4579	500
470		724	1377	2502	421	636	988	6428	1029	368	206	1180	2044	404					1507	2289	500
480		2171	2753	834	140	1907	741					1770	6132	2018	995	1009	117			1145	
490		362	1377		140	636	741	6428	1715	735		1180	4088	1211	332					2289	750
500		2532	8259	834	140		741	6428	1029			590	2044	404	332	1009	234	1039	753	1145	
510				834	140		494	4285	1029	368				404	332						
520		724	2753	1668	982	3813	2718	10713	2744	1103	413	590	2044	807	332						
530		362	1377		421	1907	1730	8570	3430	2205	413	1180	2044	404							
540		1085	2753		140	1271	494	2143	1372	1103	826	590		1615	1327						
550		362	1377				247	2143	343					1615	1327						
560		724	1377	6672	1262	636	247	2143	343	368	413	1770	2044	1615	995						
570																			753		
580		1085	2753																		
590		362	1377				247	2143	343											1145	
600	3063	724					247	2143	343			590	2044	404						1145	
610							247	2143	343												
620							247	2143	343												
630		362	1377																		
640																					
650																					
660																					
670		362	1377																		
680																					
690							247	2143	343												
700							247	2143	343												
710																					
720																					
730																					
740																					
750																					
760																					
770																					

Table 3.3.4.a. (Continued) Numbers of recreational (MRFSS) harvested fish by region, year, and 10-mm length category.

Region	Atlantic										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
780																					
790							247	2143	343												
800							247	2143	343												
Total	254239	81760	133525	104248	24967	43854	31383	160692	37384	15805	14040	66078	118550	44809	34505	51467	16265	76899	44442	74404	57992

Table 3.3.4.b. Numbers of recreational (MRFSS) harvested fish by region, year, and 10-mm length category.

Region Keys	Year																				
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
110			1378																		
120																					
130		4485																			
140		4485																			
150		4485	1378																		
160		8971	2756																		
170	7538	4485	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	7538	13456	0	18902	5939	631	0	0	0	0	0	0	0	814	0	0	0	0	318	0	0
190	15076	4485	0	0	0	0	0	0	0	0	0	0	0	0	1099	0	0	0	0	0	0
200	22614	8971	1378	12602	5939	631	0	0	0	0	0	0	1261	814	0	0	0	0	0	0	0
210	37689	8971	0	12602	5939	1894	2755	0	4018	0	0	0	0	0	0	0	0	0	0	0	0
220	22614	13456	1378	0	0	0	0	0	0	0	0	0	1261	0	0	0	0	0	0	0	0
230	37689	17941	1378	0	5939	1263	2755	0	0	10477	0	0	0	0	0	0	0	0	0	0	0
240	7538	4485	2756	12602	0	0	0	0	0	0	0	0	0	0	0	0	0	531	0	0	0
250	97992	8971	2756	6301	5939	1894	2755	0	0	0	0	1338	0	0	0	0	0	531	0	250	0
260	67841	0	5512	0	5939	2525	8264	0	4018	0	5426	0	2521	0	0	5365	0	531	0	0	0
270	75379	22427	13780	31504	0	1894	5509	2654	4018	10477	5426	0	2521	1628	0	0	0	0	318	0	0
280	37689	4485	2756	0	5939	631	0	0	8035	0	0	1338	0	3256	3298	5365	1374	1062	0	501	0
290	67841	22427	19292	31504	0	2525	8264	7963	4018	0	10853	0	8824	814	3298	10730	9618	2656	2229	2505	342
300	37689	17941	8268	31504	5939	1263	2755	5309	12053	10477		4015	17648	8954	4397	2682	15114	5312	3822	1252	2054
310	82916	35883	27561	12602		1894	8264	13272	4018	20954	21705	1338	18909	8954	6596		23358	13811	7643	6012	3766
320	30151	17941	8268		5939	2525	5509	2654	12053	20954	10853	4015	15127	5698	12092		16488	13280	10828	7514	2739
330	15076	49339	28939	6301		5050	19283	10618	12053	73341	43410	5353	22691	11396	6596	5365	28854	18061	14968	10019	3424
340	15076	26912	31695	6301		5682	24793	5309	20088	31432	5426	2676	25212	13024	12092	10730	13740	22311	10828	7264	6847
350	67841	26912	27561	25203	23758	5682	13774	7963	20088	52386	16279	2676	8824	8954	15390	10730	16488	13811	14013	10771	5478
360	15076	4485	6890	6301	5939	2525	8264	2654	12053	10477	27131	5353	27733	11396	12092	2682	13740	20717	12102	12023	4108
370	22614	53824	15158	37805	17818	8838	30302	2654	24105	31432	43410	5353	21430	18722	18688	5365	20610	19124	19745	8767	7532
380	37689	22427	20670	12602	23758	5050	11019		24105	31432	27131	6691	16388	23606	14291	8047	21984	15936	9873	11522	5478
390	45227	17941	11024	6301	11879	5682	16528	7963	32140	20954	54263	6691	10085	8140	8794	37554	19236	13280	13057	8015	7874
400	52765	13456	8268	6301	5939	5682	8264	2654	4018	10477	5426	5353	3782	9768	6596	13412	9618	10093	8280	3507	4108
410	67841	58310	20670	6301	17818	10732	22038	5309	4018	41909	43410	4015	15127	13024	7695	18777	17862	11687	10509	5260	7874
420	15076	40368	11024	18902		5682	11019	10618	20088	52386	32558	12044	10085	7326	6596	21460	19236	9031	8917	6012	3766
430	22614	17941	4134		17818	3156	5509	18581	20088	52386	32558	12044	1261	8140	4397	8047	8244	6375	5732	2505	3424

Table 3.3.4.b. (Continued) Numbers of recreational (MRFSS) harvested fish by region, year, and 10-mm length category.

Region Keys											Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
440	30151	17941	12402		11879	4419	13774	21236	8035	52386	21705	14720	1261	8140	3298	24142	6870	5843	3503	4258	3766
450	7538	35883	1378	6301	5939	3156	11019	5309	4018	10477	10853	14720	1261	3256		5365	6870	3187	4459	2505	4108
460	7538	49339	4134	6301	11879	3788	11019	10618	16070	41909	37984	13382	3782	4070		2682	2748	3187	2866	2254	3766
470	7538	26912	12402	6301	17818	5682	16528		4018	10477	32558	9368	1261	2442	2199	8047	1374	2656	3822	1503	2396
480	15076	62795	6890	6301	5939	1894	5509	10618	12053		32558	9368	3782	3256	4397	2682	5496	4781	1592	2254	3424
490	15076	8971	1378		5939	1263	2755	18581	12053		10853	5353	1261	3256	1099		5496	2656	3503	2254	1369
500		17941	2756	6301	11879	1263		2654	12053	20954	27131	8029	1261	3256	2199		10992	2656	4459	1252	342
510	7538	26912		18902	5939	2525	5509		4018		37984	9368	1261	1628		2682	2748	2125	2229	501	1369
520	15076	17941	1378	12602	17818	2525			20088			5353		1628	2199		2748		1592	1753	2054
530	7538	4485	1378	6301	5939	631		2654	16070		5426	4015	5042	814					1911	751	685
540		22427			5939	3156	5509	10618	8035		37984	6691	2521	3256	2199		2748	1594	1911	1753	685
550	7538	8971		6301		1894	2755	2654	8035		10853	4015		2442	2199		1374	531	637	751	1027
560	7538	8971		12602	5939	4419	8264		8035		32558	2676		1628	1099	8047		531	637	501	685
570	15076	13456			5939	1263			4018			4015	1261	2442	2199		1374	2125	318	751	685
580		17941		6301	11879	3788	5509	7963	8035	10477	65115	2676	2521	1628			1374	531	318	751	342
590	7538				5939	2525		2654	8035		21705	2676		1628	1099		1374	1062	318	751	342
600	15076	8971	1378	6301	11879	3788	5509	7963	8035		16279	5353	1261				1374	531		1002	342
610	7538	4485				1263	5509	2654			5426	5353					1374			250	342
620	7538		1378			631		5309	12053	10477	5426			2442			1374	1594	637	250	
630		4485							4018		16279	1338	1261	814						250	
640						1894	5509				5426										342
650						1263						4015		814				531		250	
660																		531		250	
670	7538								8035				1261							501	
680														814							
690																	1374				
700																					
710																		531			
720												1338									
730																					
740								2654													
750																					
760																					
770																					

Table 3.3.4.b. (Continued) Numbers of recreational (MRFSS) harvested fish by region, year, and 10-mm length category.

Region Keys										Year											
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
780																					
790																					
800																					
Total	1221133	919501	333483	403249	326669	136360	322304	220322	429876	639112	819369	214116	260942	214080	168192	219962	314651	235326	187896	131001	96886

Table 3.4.1. Annual headboat landings in numbers, weight, and average weight by region and year.

	Atlantic			Keys		
Year	Numbers	Kilograms	Ave_wgt (kg)	Numbers	Kilograms	Ave_wgt (kg)
1981	85545	61202	0.72	74428	42781	0.57
1982	60536	45147	0.75	140757	87668	0.62
1983	34994	22578	0.65	170331	91253	0.54
1984	33961	22271	0.66	122354	71620	0.59
1985	25770	15586	0.60	111863	59468	0.53
1986	30530	19816	0.65	175664	99895	0.57
1987	37043	18753	0.51	198487	109201	0.55
1988	55253	32394	0.59	236124	151501	0.64
1989	45494	28453	0.63	121417	74678	0.62
1990	49226	24658	0.50	169573	123963	0.73
1991	53551	23247	0.43	159995	135423	0.85
1992	55624	25735	0.46	149879	91797	0.61
1993	46052	24194	0.53	172735	147718	0.86
1994	77001	38630	0.50	166190	83801	0.50
1995	36444	20042	0.55	121101	54389	0.45
1996	23445	11812	0.50	114190	52187	0.46
1997	27014	16721	0.62	112850	51294	0.45
1998	16159	9463	0.59	104394	46295	0.44
1999	24786	13220	0.53	84491	34869	0.41
2000	12234	5839	0.48	102276	37115	0.39
2001	5039	2474	0.49	101191	41166	0.44

Table 3.4.2. Headboat effort in thousands of angler-days for southeast Florida (Area 11) and the Florida Keys (Areas 12,17,18).

	Region	
Year	Atlantic	Keys
1981	154.747	71.709
1982	154.558	71.614
1983	129.643	64.721
1984	122.446	71.314
1985	119.169	67.227
1986	128.513	76.218
1987	136.723	82.174
1988	115.978	76.641
1989	132.944	81.586
1990	147.006	81.182
1991	127.765	68.468
1992	107.043	68.002
1993	91.020	74.698
1994	113.326	64.656
1995	94.293	58.261
1996	93.797	58.821
1997	64.450	56.059
1998	53.946	49.605
1999	65.261	41.781
2000	76.250	46.228
2001	62.271	45.321

Table 3.4.3.a Numbers of yellowtail snapper landed by headboat anglers by region, year, and 10-mm length category.

Region	Atlantic										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
180																					
190							36								2						
200									56						1			19			
210	1						36								3				45		
220									56		35				3	16		56			
230				36			36	4	168		35		127		2	47	66	19			
240				72	29		36		56			12			1	16	34	19	45		
250			233	181	87	30	72	4	168				127			16			45		
260		9	12	217	205	35	252	457	112	244			9			93	33	19	5	22	10
270	133		134	217	230	65	143	4	282	244	436	186				47	34	37	45		10
280	267	575	208	253	204	65	573	118	339	94	104	709	9	156		109	199	206	179	110	39
290	1335	425	406	399	460	701	1929	1490	224	661	776	1057	382	623		451	465	338	195	221	147
300	936	876	538	869	576	978	2535	3315	956	1589	1953	4565	2199	5140	461	1741	630	600	637	572	236
310	1869	1602	845	1050	1208	1436	3715	2858	1963	2619	4848	6354	2444	5924	827	1757	996	937	1208	749	315
320	3070	611	1032	1014	1322	1433	3606	2993	2469	4979	7185	4740	3489	6393	2206	1835	1328	1069	1174	1143	207
330	4003	1036	1325	1810	1669	1493	4787	4462	3367	5058	5066	5530	4497	8415	1747	1912	1559	993	1263	1210	295
340	2938	1461	1387	2136	1868	2384	2464	6435	4094	4342	5684	6587	3643	6085	1471	1539	1825	919	1995	902	440
350	8274	3134	1770	1957	1955	2772	2821	5847	2805	4688	4804	3950	4969	8884	1934	1912	1925	806	1906	991	470
360	5738	2727	2764	2860	1725	3655	2749	5148	2974	3681	3287	3729	3179	6547	2393	1664	2423	1031	2258	989	235
370	4139	3603	2112	2208	1840	2074	1858	3328	2972	3658	3810	3543	2653	4371	3221	1943	2057	1031	2108	748	412
380	6141	4268	1855	1810	1355	1036	1358	3658	3030	2824	3549	2300	2998	4522	3036	1384	2257	1312	1727	660	441
390	5071	4418	1979	1919	1811	1497	1071	1617	2751	2997	3592	2858	2053	3271	3496	1244	2389	1012	1095	661	411
400	3869	3710	2496	2136	1494	884	1321	2286	2186	1841	1221	1441	2707	2648	3313	1182	1493	1031	1040	462	343
410	4269	5384	1869	1846	1237	1159	822	1494	1907	787	1404	1278	2562	2960	4231	1322	1759	825	1503	528	157
420	2268	4967	1550	1665	1350	1248	535	1372	1513	2383	1107	2161	2317	2025	1655	637	1294	1012	1258	660	166
430	2802	5251	1968	1449	633	1036	679	1372	2354	1990	1029	883	1417	1870	2116	451	1161	487	1353	396	186
440	2402	2975	1845	1050	661	762	894	1262	1797	1573	959	906	1817	1403	553	420	664	675	1269	418	157
450	2802	1558	921	1231	603	642	821	1486	1009	1377	593	1603	282	1558	1103	498	1029	375	626	132	137
460	2401	1842	1107	942	546	1004	357	914	841	787	148	186	909	1869	737	311	498	244	676	220	69
470	2401	1983	861	905	460	578	357	114	673	197	593	395	264	779	184	311	365	338	403	220	39
480	4270	1700	750	724	287	456	72	457	785		445	70	9	156	829	140	133	244	408	66	59

Table 3.4.3.a (Continued) Numbers of yellowtail snapper landed by headboat anglers by region, year, and 10-mm length category.

Region	Atlantic										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
490	3335	1284	1057	362	661	274	214	800	729	417	445	12	382	467	460	62	33	131	89	66	39
500	1734	708	664	579	345	426	143	229	729		148	372	127	312	92	47	66	94	89		10
510	2401	708	787	217	144	548	107	343	729				27			31	66	75	50	22	10
520	1601	850	480	615	144	398	178	118	336	197		23	18	156	92	78	33	75	45		
530	667	283	455	109	116	517	71	572	280		148		136	312	276	62	66	56		22	
540	1069	283	406	326	202	91	72	233	168				136	156		31		19		22	
550	1067	708	185	217	173	274	71	229	280									19	5		
560	934	425	185	290	58	30		118	112							31		19			
570	400	425	74	72	57	152			56				9			16				22	
580	400	584	185	36	29	122	36		56							16	33				
590	268		111		29	30	71	114			148										
600	133		60										9								
610	133		37			152	36		56				9			47					
620			74	36		61															
630			49				36		56				9			16					
640		142					36												45		
650			74	36			36					174					33				
660		9											127			16					
670																					
680																	33				
690																					
700			37	36																	
710																					
720			37																		
730			37																		
740																	33				
750		9	37	36																	
760																					
770																					
780						30												19			
790				36																	
800																					

Table 3.4.3.a (Continued) Numbers of yellowtail snapper landed by headboat anglers by region, year, and 10-mm length category.

Region	Atlantic										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
810																					
820																					
830																					
840																					
Total	85545	60536	34994	33961	25770	30530	37043	55253	45494	49226	53551	55624	46052	77001	36444	23445	27014	16159	24786	12234	5039

Table 3.4.3.b Numbers of yellowtail snapper landed by headboat anglers by region, year, and 10-mm length category.

Region Keys											Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
180												168									
190		70																			
200		70																			
210	68	70	185	63																	
220	406	280	556	63	62	82		208	161			168				78	71	150			
230	608	630	1297	188	62			208		126			109			82	142	75			
240	1284	1261	2687	814	620	163	214		161	378	239	337	544	95	194	78	212		170		
250	2028	1190	2966	1817	806			208			479	842	652	190	194	78	142	374	96		
260	3380	2381	7321	3947	1798	489	434	2285	241	378	359	2020	544	190		236	212	75	348	204	674
270	2096	3011	5004	4448	1860	629	975	3264	325	126	1796	1016	652	380	97	234	212	224	252	306	
280	2839	3011	6580	5701	1922	1830	1182	1869	401	756	838	673	1196	951	387	390	212	2617	82	1430	449
290	4394	5252	7599	6390	4217	5534	5046	9784	1926	1638	3233	2188	1413	1426	2130	2261	2265	4038	1471	2860	794
300	3312	3782	7970	5200	5705	5987	7408	15138	3218	6676	6586	5386	9349	8081	7841	8504	9198	8078	5728	6954	5165
310	3042	3361	7414	5263	4465	5217	6649	15045	2901	6676	7304	5561	10762	9888	10842	8656	9693	10245	10469	13076	12577
320	3921	5882	8340	5889	5643	8329	10623	16478	6429	10835	8628	6570	10653	13025	10164	9202	12311	12264	8010	10828	13700
330	4259	6022	7877	5952	5891	10657	9877	15647	4743	8064	4793	7749	12175	14356	11907	9516	12665	12488	8664	11952	8310
340	3177	5742	8433	5200	6139	13383	12872	13442	7480	12470	11256	12636	14892	15497	10745	7642	7853	8600	7601	11551	7748
350	3448	7353	8804	5701	6139	15362	10625	13582	8994	12218	9699	7250	10327	10271	8809	9436	7429	7702	8909	11339	11566
360	4732	9944	10287	6140	7565	13967	15883	11043	10041	8691	5272	6260	7935	10933	8519	8268	8136	6431	5966	6749	7411
370	3515	8333	8989	6202	7131	12649	14808	14735	10362	10959	9100	8610	10762	12074	8712	9438	6651	8899	6293	7457	8310
380	2839	6793	9638	5952	6077	11322	12551	10339	7790	8823	8385	10474	11088	12454	9487	6394	6014	4412	5313	4188	5390
390	3245	9734	10935	6891	6697	10181	13835	11217	7885	8188	8864	6564	10544	8937	5421	5931	5236	4861	3269	3371	3706
400	2569	7703	5931	5325	6387	8795	8687	7893	4816	5290	6705	6240	5109	6275	5227	5537	3891	2991	3106	2860	4716
410	2163	5182	6394	6954	4837	7151	10081	12255	8275	7812	6945	7923	7071	5894	7357	6397	4387	2019	1880	1634	2807
420	1352	5112	6765	5200	4093	6802	7510	8724	4823	6303	3832	4557	2826	4563	3194	3041	3325	1271	1063	1430	1011
430	1284	4482	4448	3884	4527	5883	8365	5608	4670	8064	6466	9095	6740	5514	2130	2183	2406	897	1063	1022	1797
440	1690	3151	3244	2819	2418	3179	3432	5816	2087	2393	6945	5891	4674	3232	774	2105	2123	1570	736	306	1011
450	1082	4062	1575	2318	2232	1830	1716	1454	2328	4913	3353	3534	3044	3232	678	2495	1627	523	1308	511	1011
460	1217	4412	4634	3070	2108	3342	4826	8309	2974	4535	3472	2369	2174	2187	1839	1560	1203	1047	572	511	674
470	676	2171	2687	2506	1550	3750	5899	6231	3776	5419	4430	2195	2826	1997	774	1560	708	523	245	306	561

Table 3.4.3.b (Continued) Numbers of yellowtail snapper landed by headboat anglers by region, year, and 10-mm length category.

Region	Keys										Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
480	946	2451	1575	1566	1178	2609	3003	4154	2729	3401	4191	2861	3044	2567	387	702	1132	598	490	102	225
490	1149	2521	1946	1629	2046	3646	5041	3947	1686	2645	2874	2356	3044	1141	581	312	425	523	82		449
500	946	2031	834	1253	1178	1934	2359	4362	1365	3149	2395	1016	1413	1141	387	158	778	150	327		225
510	608	2731	1483	1065	744	2283	3003	1869	1689	2141	2994	343	978	761	290	156	283	150	82		112
520	811	1681	1019	814	806	1060	1823	1454	1043	1889	2754	3878	2174	1331	388	390	142	150		102	225
530	406	1471	927	313	620	1060	643	1454	562	1763	1916	1010	978	1331	290	312	71		82	204	112
540	676	1541	556	313	744	652	858	415	883	2774	3233	2525	1957	1331	97	156	283	224	82	204	
550	541	910	556	188	558	1037	322	208	1124	2015	1676	1515	1087	285			212	75	327	306	112
560	879	1541	741	626	1116	1630	3110	2285	803	2267	2155	2020	1739	1046	387	156	283	75	163		112
570	541	560	556	313	496	1141	1180	831	642	1386	1197	842	1848	856		78				102	112
580	270	770	463	63	124	163	536	623	241	378	1078	1690	1631	1236	97	78	354		82	102	
590	541	210	278		186		322	208	241	504	1676	1521	870	285			142			204	120
600	473	560	463	125	620	1386	2038	1869	963	2393	1078	505	1196	190	290		71		82		
610	203	350		125	186	163	429	415	321	252	239	511	435	190		234	71	75		102	
620	135	210	93	63	62			208		252	120	337	217	285	194				82		
630	338	350					214	208	161		479	337	1087	285	194	78					
640	68	70			124					252	359		326	95							
650	135	140	93			222	107	208		126	120	168	326		97						
660		70	93		62					126	120					78	142				
670		70	93											95							
680	68							208	80					95							
690	68										120										
700		70																			
710													217								
720						82											71				
730												168									
740									80												
750																					
760																					
770								208			120										
780																	71				

Table 3.4.3.b (Continued) Numbers of yellowtail snapper landed by headboat anglers by region, year, and 10-mm length category.

Region Keys											Year										
TL mm	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
790										126											
800																					
810																					
820								208													
830					62																
840						82					120		109								
Total	74428	140757	170331	122354	111863	175664	198487	236124	121417	169573	159995	149879	172735	166190	121101	114190	112850	104394	84491	102277	101191

Table 3.4.4. Approximated headboat discards and release mortality in number of fish by region and year.

	Region			
	Atlantic		Keys	
Year	Fish discarded	Release mortality	Fish discarded	Release mortality
1981	31345	9404	19946	5984
1982	22181	6654	37722	11317
1983	12822	3847	45648	13694
1984	12443	3733	32790	9837
1985	9443	2833	40988	12296
1986	8182	2455	64366	19310
1987	9928	2978	72728	21819
1988	20245	6074	63280	18984
1989	16670	5001	32539	9762
1990	18037	5411	45445	13633
1991	19622	5887	42878	12863
1992	20381	6114	40167	12050
1993	16874	5062	46292	13887
1994	28214	8464	44538	13362
1995	13353	4006	32455	9736
1996	8591	2577	30602	9181
1997	9898	2969	30244	9073
1998	5921	1776	27977	8393
1999	9082	2724	22644	6793
2000	4483	1345	27409	8223
2001	1847	554	27119	8136

Table 3.5 Directed landings, release mortality and total removals in number of fish by region, fishery, and year

Atlantic

	Directed landings			Sub-total	Release mortality			Sub_total	Total
Year	Commercial	MRFSS	Headboat	Directed	Commercial	MRFSS	Headboat	Rel Mort	Removals
1981	31816	314789	85546	432151	1269	22334	9404	33007	465158
1982	32536	357759	60535	450830	1355	23857	6654	31866	482696
1983	51666	152379	34993	239038	1694	13353	3847	18894	257932
1984	33015	81600	33960	148575	1483	13313	3733	18530	167105
1985	37972	334340	25771	398083	1712	14441	2833	18985	417068
1986	49679	103227	30530	183436	628	45551	2455	48633	232069
1987	66707	55669	37045	159421	843	45387	2978	49208	208629
1988	65865	198257	55253	319375	2468	3645	6074	12187	331562
1989	93863	72481	45494	211838	3511	18583	5001	27095	238933
1990	83437	116469	49227	249133	3219	45358	5411	53988	303121
1991	92079	138428	53552	284059	3893	53667	5887	63447	347506
1992	176024	154261	55623	385908	7829	122489	6114	136432	522340
1993	173447	229546	46052	449045	7758	76541	5062	89360	538405
1994	134225	112988	77000	324213	5990	47778	8464	62232	386445
1995	70285	74061	36443	180789	3035	73656	4006	80697	261486
1996	90385	73597	23445	187427	4069	51835	2577	58481	245908
1997	126791	56070	27014	209875	5694	34898	2969	43561	253436
1998	110613	107027	16159	233799	4976	39139	1776	45892	279691
1999	78521	65408	24785	168714	3518	58120	2724	64363	233077
2000	64588	113380	12235	190203	2905	59932	1345	64182	254385
2001	71506	85636	5040	162182	3210	41117	554	44881	207063

Keys

	Directed landings			Sub-total	Release mortality			Sub_total	Total
Year	Commercial	MRFSS	Headboat	Directed	Commercial	MRFSS	Headboat	Rel Mort	Removals
1981	490327	1313185	74428	1877940	6198	32954	5984	45136	1923076
1982	1133002	1053510	140757	2327269	14321	71786	11317	97424	2424693
1983	757973	379174	170331	1307478	9581	34031	13694	57305	1364783
1984	733484	1366453	122355	2222292	9271	266049	9837	285157	2507449
1985	328237	410632	111863	850732	13925	27377	12296	53599	904331
1986	1081657	237692	175665	1495014	48135	37780	19310	105225	1600239
1987	1147985	408474	198488	1754947	51571	178257	21819	251647	2006594
1988	1517065	290569	236123	2043757	19175	126331	18984	164490	2208247
1989	1897697	621862	121418	2640977	23987	200432	9762	234180	2875157
1990	1880817	714397	169573	2764787	23773	128251	13633	165657	2930444
1991	1824580	862703	159996	2847279	23062	907746	12863	943672	3790951
1992	1221374	371381	149881	1742636	15438	214585	12050	242073	1984709
1993	1955457	428593	172734	2556784	24717	344456	13887	383060	2939844
1994	1868281	355404	166192	2389877	23615	185777	13362	222753	2612630
1995	1637062	351083	121103	2109248	20692	203121	9736	233549	2342797
1996	1157821	239218	114190	1511229	14635	178274	9181	202090	1713319

Table 3.5 (Continued) Directed, release mortality and total removals in number of fish by region and year

Keys

	Directed landings			Sub-total	Release mortality			Sub_total	Total
Year	Commercial	MRFSS	Headboat	Directed	Commercial	MRFSS	Headboat	Rel Mort	Removals
1997	1385464	326758	112852	1825074	17512	297141	9073	323726	2148800
1998	1288599	245233	104393	1638225	16288	162392	8393	187073	1825298
1999	1553593	202297	84493	1840383	19637	97773	6793	124203	1964586
2000	1348876	131866	102276	1583018	17050	69701	8223	94974	1677992
2001	1150166	102884	101191	1354241	14538	66532	8136	89206	1443447

Table 3.6.1. Numbers of yellowtail snapper otoliths aged by region, year, fishery, and gear.

		Commercial		MRFSS	Headboat	
Region	Year	HL	Other	HL	HL	Total
Atlantic	1980	0	0	0	56	56
Atlantic	1981	0	0	0	109	109
Atlantic	1982	0	0	0	175	175
Atlantic	1983	0	0	0	546	546
Atlantic	1984	0	0	0	214	214
Atlantic	1985	0	0	0	180	180
Atlantic	1986	0	0	0	65	65
Atlantic	1987	0	0	0	52	52
Atlantic	1988	0	0	0	9	9
Atlantic	1989	0	0	0	9	9
Atlantic	1990	0	0	0	120	120
Atlantic	1991	0	0	0	5	5
Atlantic	1992	74	0	0	15	89
Atlantic	1993	123	0	0	0	123
Atlantic	1994	183	0	0	43	226
Atlantic	1995	198	0	0	233	431
Atlantic	1996	313	0	0	67	380
Atlantic	1997	606	0	0	95	701
Atlantic	1998	319	0	0	343	662
Atlantic	1999	649	0	0	183	832
Atlantic	2000	317	9	0	59	385
Atlantic	2001	304	0	0	30	334
Keys	1980	0	0	0	243	243
Keys	1981	153	0	0	91	244
Keys	1982	0	0	0	62	62
Keys	1983	0	0	0	51	51
Keys	1984	0	0	0	3	3
Keys	1985	0	0	0	0	0
Keys	1986	0	0	0	9	9
Keys	1987	0	0	0	0	0
Keys	1988	0	0	0	1	1
Keys	1989	0	0	0	1	1
Keys	1990	0	0	0	0	0
Keys	1991	0	0	0	29	29
Keys	1992	33	0	0	0	33
Keys	1993	32	19	0	0	51
Keys	1994	78	1	0	37	116
Keys	1995	71	1	0	39	111
Keys	1996	86	1	0	0	87
Keys	1997	332	18	0	0	350
Keys	1998	185	8	0	0	193
Keys	1999	183	1	0	0	184
Keys	2000	214	1	1	9	225
Keys	2001	320	5	13	0	338

Table 3.6.2. Catch-at-age using direct aging for 1994-2001 and composite age length keys for the earlier years.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1981	1886	323075	758177	573056	361470	167124	94662	73936	45357	49359	15923	15439	13140	515	1284	3576
1982	15621	246997	623777	672592	468562	336799	220325	150960	117963	52135	21502	33223	11992	221	226	3367
1983	4983	110156	536112	554353	381049	168104	98895	65951	37457	18961	6837	9905	6113	196	233	1039
1984	57	317603	937003	641069	362393	207822	144278	91665	76116	44212	21495	26531	10012	53	121	3152
1985	812	130017	328618	371394	243364	169973	103425	82364	54887	42025	11735	15985	10986	293	750	1834
1986	657	71176	336667	435315	312375	160414	93916	66428	41846	28805	12923	13345	8874	82	182	3350
1987	785	95811	437299	557720	425124	201367	129004	86122	63761	18644	14752	26634	17282	800	2479	1802
1988	403	60436	483224	699579	467556	202271	144107	120100	56175	22611	21961	18233	15272	1604	10718	2286
1989	240	93092	554741	751141	612753	257636	166893	99977	82426	25882	33628	32613	20422	1445	23273	2083
1990	496	117171	647564	876946	602579	247820	164582	144848	74483	12113	17977	29697	18637	704	15582	2166
1991	1016	297668	1066536	1027982	666997	304872	156930	209728	96246	48312	23236	33482	23559	1561	20780	2357
1992	1329	146702	555667	631597	478645	214780	164224	130169	79554	28984	22394	32282	31066	1544	9857	7935
1993	989	179770	852221	1023482	678147	274169	146323	112140	76128	16521	27022	35464	19855	2389	6197	3227
1994	1	23368	167319	584013	472816	295498	223441	247291	273033	327133	111165	96572	73139	47746	48154	95478
1995	2	17556	142283	752059	779828	450056	201541	196830	104570	149045	921	950	383	1	266	186
1996	1	52775	239426	315844	368446	420470	287900	78695	131691	98558	32215	32652	74881	55	1	13
1997	1	16310	147719	574740	329442	385696	446816	187453	90899	61029	26248	191543	37667	8354	31	14
1998	1	48193	262832	570827	451781	235204	159439	165376	92694	40973	22689	37520	1117	3501	90935	721
1999	6	43532	234877	368897	461397	432659	238592	149211	143798	55892	45686	2194	646	15694	123804	74
2000	1	15827	260816	369206	571931	314005	202421	111788	29043	69390	21273	26815	1859	13238	32826	14
2001	1	13967	253712	387523	333717	184275	251918	96945	77209	33942	20663	26210	24839	3671	1	25693

Table 4.1.1.1. Density of yellowtail snapper from National Marine Fisheries Service and University of Miami Reef Visual Census for juveniles (TL < 197 mm) and adults (TL > 197 mm). Also included are the number of strata sampled each year, the number of 200 x 200 m squares in the strata, the numbers of dives and the standard errors of the estimates.

				Juveniles		Adults	
Year	Number of strata	Number of 200 x 200 m	Number of Dives	Number per 177 m^2	Std Err	Number per 177 m^2	Std Err
1979	1	4	13	0.28	0.16	7.40	3.31
1980	1	9	145	4.00	1.02	4.19	1.56
1981	1	25	213	1.14	0.28	3.87	1.00
1982	1	19	189	0.66	0.12	4.19	0.90
1983	1	16	505	0.89	0.30	3.25	0.61
1984	1	15	227	1.08	0.23	2.17	0.79
1985	1	8	124	3.11	0.86	1.55	0.55
1986	1	8	32	1.20	0.56	3.71	1.78
1987	1	6	70	1.71	0.67	4.25	1.79
1988	3	22	263	2.24	0.35	2.45	1.19
1989	3	24	318	0.81	0.30	1.01	0.37
1990	3	23	282	2.12	0.52	0.97	0.36
1991	3	20	280	3.99	1.94	2.44	1.18
1992	3	21	256	3.09	0.89	0.40	0.24
1993	3	22	196	5.56	1.84	2.10	0.76
1994	3	23	91	2.97	0.53	2.13	0.77
1995	3	55	283	1.91	0.29	1.88	0.78
1996	3	38	157	5.63	1.50	2.74	0.97
1997	10	68	404	7.21	4.72	3.12	2.08
1998	10	78	462	1.26	0.24	0.71	0.19
1999	10	159	438	2.13	0.30	1.12	0.28
2000	11	215	487	3.15	0.53	1.72	0.23
2001	11	294	720	2.18	0.26	1.88	0.26

Table 4.1.2. Reef fish species landed with yellowtail snapper that occurred on at least 1% of the trips and reported yellowtail snapper on at least 50% of their trips.

	Fishery		
Commercial	Commercial Logbook	Headboat	MRFSS
SNAPPER, YELLOWTAIL	SNAPPER,YELLOWTAIL	YELLOWTAIL SNAPPER	YELLOWTAIL SNAPPER
BLUE RUNNER	BLUE RUNNER	AFRICAN POMPANO	JOLTHEAD PORGY
CERO	CREVALLE	BAR JACK	BLACK GROUPER
GROUPER, BLACK	GRUNT,BLUESTRIPED	BIGEYE	BLUESTRIPED GRUNT
GROUPER, RED	GRUNT,FRENCH	BLACK GROUPER	CERO
GRUNTS	SNAPPER,GRAY	BLACK MARGATE	GAG
JACK, MIXED	SNAPPER,MUTTON	BLUE RUNNER	GROUPERS, Spp.
MISC. BOTTOM FISH		BLUEFISH	MUTTON SNAPPER
SNAPPER, GRAY		BLUESTRIPED GRUNT	RED GROUPER
SNAPPER, LANE		CERO	SHEEPSHEAD
SNAPPER, MUTTON		COBIA	
		DOCTORFISH	
		FRENCH GRUNT	
		GAG	
		GRAY SNAPPER	
		GRAY TRIGGERFISH	
		GRAYSBY	
		GREAT BARRACUDA	
		GREATER AMBERJACK	
		HOGFISH	
		JOLTHEAD PORGY	
		KNOBBED PORGY	
		LANE SNAPPER	
		LITTLEHEAD PORGY	
		MARGATE	
		MUTTON SNAPPER	
		OCEAN TRIGGERFISH	
		PORKFISH	
		QUEEN TRIGGERFISH	
		RAINBOW RUNNER	
		RED GROUPER	
		RED HIND	
		ROCK HIND	
		SAUCEREYE PORGY	
		SCAMP	
		SCHOOLMASTER	
		SHEEPSHEAD PORGY	
		SPANISH MACKEREL	
		SQUIRRELFISH	
		TOMTATE	
		WHITE GRUNT	

Table 4.1.2.1.1 Variables used to standardize the commercial combined gear index.

Number of commercial trips	191894
Number of positive trips	117172

Proportion of positive trips

Log Likelihood	-116271
Deviance	232543
Degrees of freedom	191647

Source	df	Sum of squares	Prob Ho
region	1	6070.29	<.0001
year	17	515.02	<.0001
month	11	451.07	<.0001
DEPTH	1	489.32	<.0001
TIMEFISH	1	263.09	<.0001
region*year	17	380.02	<.0001
month*year	187	1522.99	<.0001
region*month	11	913.41	<.0001

Kilograms landed per trip

Log Likelihood	-204171
Deviance	223799
	116925
Scale	1.382

Source	df	Sum of squares	Prob Ho
region	1	129.31	<.0001
year	17	718.56	<.0001
month	11	324.77	<.0001
DEPTH	1	1079.17	<.0001
TIMEFISH	1	17710.9	<.0001
year*region	17	347.09	<.0001
year*month	187	1874.14	<.0001
month*region	11	304.19	<.0001

Table 4.1.2.1.2 Annual kilograms landed per trip by the commercial fishery for combined gears standardized with the delta-lognormal method. The annual means and coefficients of variation (CV) were estimated with a Monte Carlo simulation of 1000 values.

Year	Mean	CV	Trips
1985	3.96	6.11	2088
1986	5.65	9.46	1881
1987	5.02	10.02	1217
1988	5.85	9.25	1023
1989	7.65	6.59	2049
1990	5.30	6.27	2356
1991	8.17	3.12	8540
1992	7.68	2.95	10439
1993	8.75	2.54	13754
1994	8.51	2.58	13383
1995	7.57	2.28	16319
1996	6.74	2.24	19959
1997	8.02	1.88	21004
1998	8.92	2.27	18201
1999	10.96	2.35	15743
2000	9.27	2.36	14299
2001	9.18	2.70	14940
2002	10.76	2.43	14699

Table 4.1.2.1.3 Variables used to standardize the commercial hook-and-line index.

Number of commercial trips	147907
Number of positive trips	101563

Proportion of positive trips

Log Likelihood	-83575
Deviance	167150
Degrees of freedom	147751

Source	df	Sum of squares	Prob Ho
region	1	9858.13	<.0001
year	10	494.92	<.0001
month	11	475.96	<.0001
DEPTH	1	94.32	<.0001
TIMEFISH	1	717.48	<.0001
region*year	10	483.04	<.0001
month*year	110	1053.84	<.0001
region*month	11	185.94	<.0001

Kilograms landed per trip

Log Likelihood	-174306
Deviance	184062
Degrees of freedom	101407
Scale	1.3462

Source	df	Sum of squares	Prob Ho
region	1	550.2	<.0001
year	10	596.98	<.0001
month	11	304.16	<.0001
DEPTH	1	668.56	<.0001
TIMEFISH	1	18400.8	<.0001
year*region	10	204.36	<.0001
year*month	110	1456.27	<.0001
month*region	11	310.45	<.0001

Table 4.1.2.1.4 Annual kilograms landed per trip by the commercial fishery for hook-and-line gear from trip tickets standardized with the delta-lognormal method. The annual means and coefficients of variation (CV) were estimated with a Monte Carlo simulation of 1000 values.

Year	Mean	CV	Trips
1992	9.51	3.10	6986
1993	10.98	2.50	11492
1994	10.38	2.49	11275
1995	8.87	2.22	14103
1996	7.95	2.20	17600
1997	9.42	1.80	18345
1998	10.72	2.19	15661
1999	12.85	2.26	13806
2000	10.87	2.38	12455
2001	10.73	2.57	13292

Table 4.1.2.1.5 Variables used to standardize the commercial logbook hook-and-line index.

Number of commercial trips	86776
Number of positive trips	71152

Proportion of positive trips

Log Likelihood	-37965
Deviance	75931
Degrees of freedom	86647

Source	df	Sum of squares	Prob Ho
yr	8	777.05	<.0001
month	11	152.04	<.0001
days_fished	1	235.68	<.0001
region	1	3024.79	<.0001
yr*region	8	338.88	<.0001
yr*month	88	629.68	<.0001
month*region	11	77.75	<.0001

Kilograms landed per trip

Log Likelihood	-118393
Deviance	116146
Degrees of freedom	71023
Scale	1.2776

Source	df	Sum of squares	Prob Ho
yr	8	299.17	<.0001
month	11	454.07	<.0001
days_fished	1	18022	<.0001
region	1	72.98	<.0001
yr*region	8	116.65	<.0001
yr*month	88	1319.72	<.0001
month*region	11	165.08	<.0001

Table 4.1.2.1.6 Annual kilograms landed per trip by the commercial fishery for hook-and-line gear from Reef Fish Permit logbook data standardized with the delta-lognormal method. The annual means and coefficients of variation (CV) were estimated with a Monte Carlo simulation of 1000 values.

Year	Mean	CV	Trips
1993	21.72	2.15	8727
1994	21.60	1.83	10012
1995	19.43	1.96	9977
1996	16.03	2.06	9819
1997	18.92	1.85	11371
1998	22.24	2.09	9742
1999	24.88	2.19	9663
2000	20.37	2.44	8599
2001	17.89	2.59	8866

Table 4.1.2.1.7 Variables used to standardize the commercial "targeting" logbook
hook-and-line index

Number of logbook trips	28412
Number of positive trips	24208

Proportion of positive trips

Log Likelihood	-11543
Deviance	23086
Degrees of freedom	28390

Source	df	Sum of squares	Prob Ho
yr	8	114.4	<.0001
month	11	259.88	<.0001
days_fished	1	14.18	0.0002
region	1	354.61	<.0001

Kilograms landed per trip

Log Likelihood	-36854.5
Deviance	29774
Degrees of freedom	24186
Scale	1.109

Source	df	Sum of squares	Prob Ho
yr	8	600.96	<.0001
month	11	962.12	<.0001
days_fished	1	9496.46	<.0001
region	1	78.7	<.0001

Table 4.1.2.1.8 Annual kilograms landed per trip by the commercial fishery using hook-and-line gear from Reef Fish Permit logbook "targeting" data standardized with the delta-lognormal method. The annual means and coefficients of variation (CV) were estimated with a Monte Carlo simulation of 1000 values.

Year	Mean	CV	Trips
1993	36.89	2.81	2335
1994	35.02	2.66	2780
1995	34.33	2.62	2912
1996	30.26	2.54	3305
1997	35.69	2.38	3707
1998	45.73	2.37	3470
1999	54.50	2.30	3821
2000	48.08	2.50	3099
2001	42.90	2.71	2983

Table 4.1.2.2.1 Variables used to standardize the MRFSS recreational index using a negative binomial distribution.

Number of recreational trips	6836
Log Likelihood	4958
Deviance	5507
Degrees of freedom	6768
Dispersion	3.144

Source	df	Sum of squares	Prob Ho
YEAR	21	123.24	<.0001
region	1	213.87	<.0001
target	1	10.41	0.0013
YEAR*region	21	111.14	<.0001
YEAR*target	21	61.92	<.0001
region*target	1	27.07	<.0001
HRSF	1	76.3	<.0001

Table 4.1.2.2.2 Annual number of fish caught per trip by MRFSS recreational anglers standardized with a generalized linear model using a negative binomial distribution. The annual means and coefficients of variation (CV) were estimated with a Monte Carlo simulation of 1000 values.

Year	Mean	Low 95%	Upper 95%	Interviews
1981	2.85	1.26	5.58	46
1982	2.96	1.61	5.00	89
1983	2.06	1.06	3.61	55
1984	1.23	0.75	1.89	109
1985	1.35	0.50	2.97	56
1986	1.40	1.01	1.90	215
1987	1.32	1.00	1.70	284
1988	1.52	1.16	1.96	298
1989	1.36	0.99	1.83	201
1990	1.86	1.39	2.44	234
1991	2.55	2.00	3.20	295
1992	1.88	1.62	2.16	760
1993	1.95	1.61	2.34	518
1994	1.31	1.06	1.62	406
1995	1.77	1.41	2.20	317
1996	0.81	0.59	1.10	408
1997	1.01	0.62	1.56	340
1998	0.57	0.37	0.84	322
1999	1.72	1.36	2.15	527
2000	1.26	0.96	1.62	455
2001	1.69	1.25	2.23	354

Table 4.1.2.3.1 Variables used to standardize the headboat index using a negative binomial distribution. Areas 11 and 12 only.

Years:	1981-1991		
Number of headboat trips			23327
Log Likelihood			851643
Deviance			23577
Dispersion			2.9889
Degrees of freedom			23259

Source	df	Sum of squares	Prob Ho
YEAR	10	582.55	<.0001
MONTH	11	491.13	<.0001
TRIP	1	306.27	<.0001
AREA	1	4059.9	<.0001
YEAR*TRIP	10	266.32	<.0001
YEAR*AREA	10	88.36	<.0001
MONTH*TRIP	11	46.41	<.0001
MONTH*AREA	11	176.29	<.0001
TRIP*AREA	1	451.75	<.0001
ANGLERS	1	105.25	<.0001

Years:	1992-2001		
Number of headboat trips			15929
Log Likelihood			1554942
Deviance			19069
Degrees of freedom			15864
Dispersion			1.2706

Source	df	Sum of squares	Prob Ho
YEAR	9	223.27	<.0001
MONTH	11	332.43	<.0001
TRIP	1	258.11	<.0001
AREA	1	909.63	<.0001
YEAR*TRIP	9	112.42	<.0001
YEAR*AREA	9	151.57	<.0001
MONTH*TRIP	11	98.92	<.0001
MONTH*AREA	11	300.47	<.0001
TRIP*AREA	1	1130.07	<.0001
ANGLERS	1	18.93	<.0001

Table 4.1.2.3.2 Annual number of fish landed per trip by headboat anglers standardized with a generalized linear model using a negative binomial distribution Areas 11 and 12 only.

Year	Mean	Low 95%	Upper 95%	Trips
1981	7.93	7.26	8.65	1992
1982	7.52	6.92	8.16	2317
1983	5.52	5.07	5.99	2196
1984	5.34	4.91	5.80	2155
1985	5.41	4.94	5.91	1985
1986	6.17	5.64	6.73	2562
1987	8.17	7.56	8.81	2630
1988	11.90	10.80	13.08	1911
1989	11.20	10.15	12.32	1862
1990	10.32	9.41	11.28	1994
1991	13.70	12.51	14.97	1723
1992	14.41	13.72	15.12	2684
1993	15.01	14.23	15.82	2362
1994	15.06	14.28	15.87	2609
1995	10.77	10.17	11.40	2207
1996	10.00	9.29	10.75	1568
1997	10.48	9.56	11.47	1101
1998	13.61	12.37	14.95	1112
1999	16.05	13.96	18.37	904
2000	10.74	8.61	13.23	776
2001	10.14	8.04	12.63	606

Table 4.1.2.3.3 Variables used to standardize the headboat "targeting" index using a delta-lognormal distribution. Area 12 (Key Largo - Key West) only.

Years: 1981-1991

Number of logbook trips	1517
Number of positive trips	1313

Proportion of positive trips

Log Likelihood	-514.9
Scaled Deviance	1030
Degrees of freedom	1494

Source	df	Sum of squares	Prob Ho
YEAR	10	131.49	<.0001
MONTH	11	25.3	0.0082
ANGLERS	1	20.71	<.0001

Kilograms landed per trip

Log Likelihood	-1782.0
Scaled Deviance	1160
Degrees of freedom	1290
Scale	0.9401

Source	df	Sum of squares	Prob Ho
YEAR	10	272.8	<.0001
MONTH	11	113.56	<.0001
ANGLERS	1	9.09	0.0026

Years: 1992-2001

Number of logbook trips	6394
Number of positive trips	5718

Proportion of positive trips

Log Likelihood	-2011.6
Scaled Deviance	4023
Degrees of freedom	6351

4.1.2.3.3 (Continued) Variables used to standardize the headboat “targeting” index
a delta-lognormal distribution. Area 12 (Key Largo - Key West) only.

Proportion of positive trips

Source	df	Sum of squares	Prob Ho
YEAR	9	50.81	<.0001
MONTH	11	105.84	<.0001
TRIP	1	16.02	<.0001
YEAR*TRIP	9	13.35	0.1476
MONTH*TRIP	11	77.12	<.0001
ANGLERS	1	6.68	0.0098

Kilograms landed per trip

Log Likelihood	-7711.3355
Scaled Deviance	4968
Degrees of freedom	5675
Scale	0.9321

Source	df	Sum of squares	Prob Ho
YEAR	9	60.42	<.0001
MONTH	11	277.96	<.0001
TRIP	1	295.29	<.0001
YEAR*TRIP	9	187.94	<.0001
MONTH*TRIP	11	84.48	<.0001
ANGLERS	1	0.23	0.6339

Table 4.1.2.3.4 Annual number of fish landed per trip by headboat anglers on headboats targeting yellowtail snapper standardized with a generalized linear model using a delta-lognormal distribution. Trips from Area 12 (Key Largo - Key West) only. The annual means and coefficients of variation (CV) were estimated with a Monte Carlo simulation of 1000 values.

Year	Mean	CV	Trips
1981	15.32	13.20	72
1982	8.28	30.85	19
1983	15.47	21.29	33
1984	13.07	16.90	49
1985	18.10	8.76	152
1986	11.98	8.83	134
1987	10.46	10.70	124
1988	7.60	13.38	98
1989	13.99	8.97	227
1990	36.57	4.95	416
1991	35.13	7.43	193
1992	21.10	6.98	340
1993	20.71	5.38	497
1994	25.76	3.44	974
1995	23.73	3.44	882
1996	22.86	3.65	846
1997	27.52	4.46	548
1998	23.24	4.05	671
1999	24.39	4.15	582
2000	30.05	4.24	585
2001	29.44	4.95	469

Table 4.2.2.1.1. Numbers of fish landed and discards by age and year for the three fisheries combined.

	Ages															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1981	6703	322883	686384	566817	359471	180589	104996	76661	53128	44908	18295	18167	12163	469	1234	3134
1982	26564	248829	656660	759289	534710	321939	207828	147442	110791	48067	21054	31360	12192	87	210	2581
1983	13343	93854	472639	554569	389649	162752	91967	67637	37613	19216	9222	10316	5700	72	189	907
1984	7131	331359	895251	629543	364730	207278	141287	90411	75197	44529	21764	26164	10324	15	4	3870
1985	4789	131548	244446	267023	166136	159706	110393	97886	65467	41848	16959	22142	10498	807	2012	4289
1986	11579	86752	453016	549169	391370	128238	65443	56987	30027	20656	12806	14420	7422	40	95	2310
1987	12251	89736	313982	525435	482635	301471	181561	88620	96341	40474	14517	22490	20108	3416	13654	6182
1988	15376	70353	368910	687086	615113	376425	190089	90490	79891	33492	11537	14959	13792	4867	11870	5370
1989	16617	94793	433561	796856	730394	474881	237169	114242	129539	53746	18000	22960	18864	2680	25454	6742
1990	17572	122026	485784	857558	759068	476270	263333	113042	106474	38090	11572	14588	10989	540	14776	3561
1991	17314	232518	649837	1037627	903801	541176	255336	163011	173745	73034	18792	39448	40811	2264	30947	18362
1992	12456	135774	385497	550008	504965	298853	220095	125008	132067	61209	25224	32885	31224	5526	13232	12840
1993	18406	162316	545095	911749	785278	456594	269519	120140	134267	58026	21413	27185	18160	1955	6789	4562
1994	17302	120963	458420	753404	673719	421356	254324	116682	121086	49769	18737	19581	18737	2442	9483	3861
1995	14776	122189	403475	666755	606249	377268	197124	91592	92855	39720	11184	12500	11504	1472	7243	1723
1996	10855	83410	286309	460752	449805	270114	185226	81017	92861	35522	11484	12273	14029	882	1220	1111
1997	12698	130310	331619	674775	356872	396056	277000	114685	41307	47202	18109	23564	17216	2331	2083	1469
1998	11704	95838	329440	649669	466163	207764	98659	142883	68885	37931	14383	19512	1014	308	1495	1237
1999	13505	91160	414291	501755	363946	412972	185606	138733	84366	18555	15148	716	269	1230	5057	872
2000	12514	97433	375074	385431	451837	286837	176927	73423	28237	28144	22219	19813	3274	12084	1870	1114
2001	10634	71354	396912	324287	361832	173162	159564	84034	46542	9270	26102	16198	5788	919	115	1198

Table 4.2.2.1.2. Tuning indices used in fitting the Integrated Catch-at-Age model

	Index								
Year	NMFS/UM Juvenile	NMFS/UM Adult	Commercial	Logbook* Targeting	MRFSS	Headboat 1981-1991	Headboat 1992-2001	Headboat* Targeting 1981-1991	Headboat* Targeting 1992-2001
1981	1.14	3.87			2.85	7.93		15.32	
1982	0.66	4.19			2.96	7.52		8.28	
1983	0.89	3.25			2.06	5.52		15.47	
1984	1.08	2.17			1.23	5.34		13.07	
1985	3.11	1.55	3.96		1.35	5.41		18.10	
1986	1.20	3.71	5.65		1.40	6.17		11.98	
1987	1.71	4.25	5.02		1.32	8.17		10.46	
1988	2.24	2.45	5.85		1.52	11.90		7.60	
1989	0.81	1.01	7.65		1.36	11.20		13.99	
1990	2.12	0.97	5.30		1.86	10.32		10.68	
1991	3.99	2.44	8.17		2.55	13.70		10.68	
1992	3.09	0.40	7.68		1.88		14.41		21.10
1993	5.56	2.10	8.75	36.89	1.95		15.01		20.71
1994	2.97	2.13	8.51	35.02	1.31		15.06		25.76
1995	1.91	1.88	7.57	34.33	1.77		10.77		23.73
1996	5.63	2.74	6.74	30.26	0.81		10.00		22.86
1997	7.21	3.12	8.02	35.69	1.01		10.48		27.52
1998	1.26	0.71	8.92	45.73	0.57		13.61		23.24
1999	2.13	1.12	10.96	54.50	1.72		16.05		24.39
2000	3.15	1.72	9.27	48.08	1.26		10.74		30.05
2001	2.18	1.88	9.18	42.90	1.69		10.14		29.44
Type	Fish. Ind.	Fish. Ind.	Fish. Dep.	Fish. Dep.	Fish. Dep.	Fish. Dep.	Fish. Dep.	Fish. Dep.	Fish. Dep.
Units	Number	Number	Weight	Weight	Number	Number	Number	Number	Number
Time	June-July	June-July	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec
Ages	1	2+			2+	2+	2+	2+	2+

* used in the targeting sensitivity run.

Table 4.2.2.1.3. Weights assigned to the years 1987-1996 based upon the ratio of the number of ages collected during a year to the average number of ages in 1997-2001 .

Year	Num Ages	Weight
1987	52	0.062
1988	10	0.012
1989	10	0.012
1990	120	0.142
1991	34	0.040
1992	122	0.144
1993	174	0.206
1994	342	0.405
1995	542	0.641
1996	467	0.553
1997	1072	1.000
1998	855	1.000
1999	1016	1.000
2000	610	1.000
2001	672	1.000
Average 1997-2001	845	

Table 4.2.2.1.4. Parameters estimated by Integrated Catch-at-Age including the maximum likelihood estimates and the 95% confidence limits around the parameters.

Parameter Number		Maximum Likelihood Estimate	CV %	Lower 95% CL	Upper 95% CL
Separable model :		Fishing mortality by year			
1	1987	0.2713	57	0.0887	0.8300
2	1988	0.2384	95	0.0370	1.5352
3	1989	0.2884	76	0.0638	1.3030
4	1990	0.2844	40	0.1282	0.6306
5	1991	0.3588	49	0.1347	0.9553
6	1992	0.3971	35	0.1996	0.7898
7	1993	0.4372	31	0.2359	0.8103
8	1994	0.4985	27	0.2892	0.8592
9	1995	0.4508	26	0.2693	0.7547
10	1996	0.3886	26	0.2302	0.6560
11	1997	0.4867	22	0.3138	0.7548
12	1998	0.3400	24	0.2109	0.5484
13	1999	0.2383	26	0.1430	0.3970
14	2000	0.3113	27	0.1804	0.5374
15	2001	0.2065	30	0.1140	0.3742
Separable model :		Selection (S1) by age from 1987-1996			
16	0	0.0049	94	0.0008	0.0317
17	1	0.0548	37	0.0260	0.1154
18	2	0.2723	37	0.1311	0.5659
19	3	0.6652	35	0.3292	1.3439
20	4	0.8765	35	0.4346	1.7674
21	5	0.7802	38	0.3700	1.6451
	6	1	Fixed : Reference Age		
22	7	0.8013	37	0.3856	1.6653
23	8	1.6324	33	0.8433	3.1596
24	9	1.1553	33	0.5991	2.2281
25	10	0.5852	36	0.2885	1.1870
26	11	0.9239	34	0.4654	1.8342
27	12	1.7619	32	0.9269	3.3489
28	13	0.2928	51	0.1062	0.8074
	14	1	Fixed : Last true age		
Separable model:		Selection (S2) by age from 1997-2001			
29	0	0.0052	72	0.0012	0.0217
30	1	0.0600	31	0.0325	0.1108
31	2	0.3118	29	0.1741	0.5585
32	3	0.5987	28	0.3436	1.0433
33	4	0.7914	27	0.4641	1.3495
34	5	1.0213	26	0.6104	1.7088
	6	1	Fixed : Reference Age		
35	7	1.1120	25	0.6708	1.8432
36	8	0.9322	25	0.5646	1.5393
37	9	0.9298	25	0.5616	1.5396

Table 4.2.2.1.4. (Continued) Parameters estimated by Integrated Catch-at-Age including the maximum likelihood estimates and the 95% confidence limits around the parameters.

Parameter Number		Maximum Likelihood Estimate	CV %	Lower 95% CL	Upper 95% CL
38	10	1.4815	24	0.9078	2.4177
39	11	1.8532	25	1.1265	3.0488
40	12	0.7975	29	0.4463	1.4249
41	13	0.8676	35	0.4363	1.7253
	14		1 Fixed : Last true age		
Separable	model:	Populations in year 2001			
42	0	12043963	154	579870	2.5E+08
43	1	6115082	34	3121323	11980251
44	2	5702503	25	3430465	9479338
45	3	3296126	23	2087305	5205011
46	4	2102036	22	1362480	3243023
47	5	1525783	21	1000911	2325894
48	6	886855	23	559737	1405145
49	7	474135	25	286272	785282
50	8	222958	28	127317	390445
51	9	124629	29	69225	224374
52	10	101703	30	55539	186238
53	11	39472	33	20272	76856
54	12	19537	40	8815	43302
55	13	5465	42	2398	12454
56	14	3191	46	1292	7884
Separable	model:	Populations at age 14			
57	1987	56919	249	428	7559150
58	1988	38327	233	396	3702307
59	1989	24986	170	889	701655
60	1990	36836	117	3670	369669
61	1991	13552	111	1524	120461
62	1992	16687	84	3214	86640
63	1993	18389	72	4424	76434
64	1994	16025	58	5052	50835
65	1995	13538	50	5050	36288
66	1996	8040	47	3184	20302
67	1997	6890	40	3106	15279
68	1998	5320	41	2358	12002
69	1999	8328	39	3809	18211
70	2000	4232	42	1829	9793
SSB	Index	catchabilities			
Comm					
Linear model fitted : Slopes at age					
71	1 Q	1.62E-06	12	1.44E-06	2.32E-06
NMFS / UM RVC Juvenile Age-1					
Linear model fitted : Slopes at age					

Table 4.2.2.1.4. (Continued) Parameters estimated by Integrated Catch-at-Age including the maximum likelihood estimates and the 95% confidence limits around the parameters.

Parameter Number			Maximum Likelihood Estimate	CV %	Lower 95% CL	Upper 95% CL
NMFS / UM RVC Juvenile Age-1						
Linear model fitted : Slopes at age						
72	1 Q		4.21E-07	11	3.78E-07	5.84E-07
NMFS / UM RVC Adult Ages 2+						
Linear model fitted : Slopes at age						
73	2 Q		1.88E-07	10	1.69E-07	2.58E-07
MRFSS Ages 2+						
Linear model fitted : Slopes at age						
74	2 Q		1.45E-07	10	1.31E-07	1.99E-07
Headboat Ages 2+		1981-1991				
Linear model fitted : Slopes at age						
75	2 Q		7.72E-07	13	6.76E-07	1.16E-06
Headboat Ages 2+		1992-2001				
Linear model fitted : Slopes at age						
76	2 Q		1.16E-06	15	9.93E-07	1.84E-06

Table 4.2.2.1.5. Summary of the fits to components of the base run of the ICA model that used a natural mortality rate of 0.20 per year.

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1987 to 2001

Variance	0.1638
Skewness test stat.	-6.8262
Kurtosis test statistic	36.5592
Partial chi-square	2.9879
Significance in fit	0
Degrees of freedom	155

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR Comm

Linear catchability relationship assumed

Variance	0.0887
Skewness test stat.	-0.8477
Kurtosis test statistic	-0.6446
Partial chi-square	0.7194
Significance in fit	0
Number of observations	17
Degrees of freedom	16
Weight in the analysis	1

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR NMFS / UM RVC Juvenile Age 1

Linear catchability relationship assumed

Age	1
Variance	0.3732
Skewness test stat.	0.5196
Kurtosis test statistic	-0.5127
Partial chi-square	10.7696
Significance in fit	0.0480
Number of observations	21
Degrees of freedom	20
Weight in the analysis	1

DISTRIBUTION STATISTICS FOR NMFS / UM RVC Adult Age 2+

Linear catchability relationship assumed

Table 4.2.2.1.5. (Continued) Summary of the fits to components of the base run of the ICA model that used a natural mortality rate of 0.20 per year.

DISTRIBUTION STATISTICS FOR NMFS / UM RVC Adult Age 2+

Variance	0.4028
Skewness test stat.	-1.5786
Kurtosis test statistic	0.3768
Partial chi-square	12.0405
Significance in fit	0.0853
Number of observations	21
Degrees of freedom	20
Weight in the analysis	1

DISTRIBUTION STATISTICS FOR MRFSS Ages 2+

Linear catchability relationship assumed

Age	2
Variance	0.1504
Skewness test stat.	-0.2897
Kurtosis test statistic	0.3504
Partial chi-square	8.0442
Significance in fit	0.0084
Number of observations	21
Degrees of freedom	20
Weight in the analysis	1

DISTRIBUTION STATISTICS FOR Headboat Ages 2+ 1981-1991

Linear catchability relationship assumed

Age	2
Variance	0.0900
Skewness test stat.	0.2478
Kurtosis test statistic	-0.9445
Partial chi-square	0.4314
Significance in fit	0
Number of observations	11
Degrees of freedom	10
Weight in the analysis	1

DISTRIBUTION STATISTICS FOR Headboat Ages 2+ 1992-2001

Linear catchability relationship assumed

Age	2
Variance	0.0348
Skewness test stat.	-0.2085
Kurtosis test statistic	-0.3908
Partial chi-square	0.1230
Significance in fit	0

Table 4.2.2.1.5. (Continued) Summary of the fits to components of the base run of the ICA model that used a natural mortality rate of 0.20 per year.

DISTRIBUTION STATISTICS FOR Headboat Ages 2+ 1992-2001

Number of observations	10
Degrees of freedom	9
Weight in the analysis	1

Weighted Analysis of Variance

Source				SSQ	Data	Parameters	d.f.	Variance
Total for model				46.5518	326	76	250	0.1862
Catches at age				25.3905	225	70	155	0.1638
SSB Indices								
Comm combined gear 1985-2001				1.4197	17	1	16	0.0887
Aged Indices								
NMFS / UM RVC		Juvenile	Age 1	7.4641	21	1	20	0.3732
NMFS / UM RVC		Adult	Age 2+	8.0554	21	1	20	0.4028
MRFSS	Age 2+			3.0087	21	1	20	0.1504
Headboat	Age 2+	1981-1991		0.9002	11	1	10	0.0900
Headboat	Age 2+	1992-2001		0.3132	10	1	9	0.0348

Table 4.2.2.1.6 Estimated fishing mortality rates by age and year from base run of ICA model. Age-6 was used as the reference age and is indicated in bold.

	Ages															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1981	0.001	0.066	0.178	0.253	0.275	0.159	**0.164**	0.166	0.156	0.539	0.269	0.818	2.953	0.668	0.692	0.692
1982	0.004	0.052	0.186	0.306	0.402	0.423	**0.276**	0.364	0.381	0.206	0.526	1.016	4.737	0.180	0.733	0.733
1983	0.002	0.020	0.131	0.237	0.254	0.204	**0.204**	0.135	0.148	0.104	0.055	0.535	0.501	1.837	0.734	0.734
1984	0.001	0.076	0.269	0.258	0.242	0.208	**0.274**	0.316	0.219	0.261	0.164	0.218	1.883	0.002	0.455	0.455
1985	0.001	0.028	0.073	0.119	0.100	0.159	**0.163**	0.311	0.399	0.182	0.150	0.250	0.128	0.779	0.422	0.422
1986	0.002	0.016	0.125	0.233	0.257	0.104	**0.090**	0.119	0.147	0.210	0.078	0.184	0.124	0.001	0.188	0.188
1987	0.001	0.015	0.074	0.180	0.238	0.212	**0.271**	0.217	0.443	0.313	0.159	0.251	0.478	0.079	0.271	0.271
1988	0.001	0.013	0.065	0.159	0.209	0.186	**0.238**	0.191	0.389	0.275	0.139	0.220	0.420	0.070	0.238	0.238
1989	0.001	0.016	0.079	0.192	0.253	0.225	**0.288**	0.231	0.471	0.333	0.169	0.266	0.508	0.084	0.288	0.288
1990	0.001	0.016	0.077	0.189	0.249	0.222	**0.284**	0.228	0.464	0.329	0.166	0.263	0.501	0.083	0.284	0.284
1991	0.002	0.020	0.098	0.239	0.314	0.280	**0.359**	0.287	0.586	0.414	0.210	0.331	0.632	0.105	0.359	0.359
1992	0.002	0.022	0.108	0.264	0.348	0.310	**0.397**	0.318	0.648	0.459	0.232	0.367	0.700	0.116	0.397	0.397
1993	0.002	0.024	0.119	0.291	0.383	0.341	**0.437**	0.350	0.714	0.505	0.256	0.404	0.770	0.128	0.437	0.437
1994	0.002	0.027	0.136	0.332	0.437	0.389	**0.499**	0.399	0.814	0.576	0.292	0.461	0.878	0.146	0.499	0.499
1995	0.002	0.025	0.123	0.300	0.395	0.352	**0.451**	0.361	0.736	0.521	0.264	0.417	0.794	0.132	0.451	0.451
1996	0.002	0.021	0.106	0.259	0.341	0.303	**0.389**	0.311	0.634	0.449	0.227	0.359	0.685	0.114	0.389	0.389
1997	0.003	0.029	0.152	0.291	0.385	0.497	**0.487**	0.541	0.454	0.453	0.721	0.902	0.388	0.422	0.487	0.487
1998	0.002	0.020	0.106	0.204	0.269	0.347	**0.340**	0.378	0.317	0.316	0.504	0.630	0.271	0.295	0.340	0.340
1999	0.001	0.014	0.074	0.143	0.189	0.243	**0.238**	0.265	0.222	0.222	0.353	0.442	0.190	0.207	0.238	0.238
2000	0.002	0.019	0.097	0.186	0.246	0.318	**0.311**	0.346	0.290	0.290	0.461	0.577	0.248	0.270	0.311	0.311
2001	0.001	0.012	0.064	0.124	0.163	0.211	**0.207**	0.230	0.193	0.192	0.306	0.383	0.165	0.179	0.207	0.207

Table 4.2.2.1.7 Estimated stock size in number of fish by age and year from base run of ICA model.

	Ages															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1981	8145374	5543317	4620790	2784150	1643025	1354224	762621	552561	405420	117836	85258	35409	13566	1050	2695	6844
1982	7790000	5454556	4247136	3164988	1769595	1021952	946044	529794	383339	284062	56269	53350	12799	580	441	5414
1983	7506115	5200192	4241231	2885916	1908856	969012	547919	587677	301372	214401	189298	27215	15816	92	396	1902
1984	7946141	5020648	4172804	3046406	1863800	1212339	646839	365803	420188	212849	158208	146661	13045	7843	12	11591
1985	9100239	5320658	3811608	2611297	1927928	1197801	805986	402538	218251	276340	134216	109924	96527	1625	6407	13659
1986	7593578	6096178	4237410	2900135	1897218	1428627	836790	560435	241602	119940	188560	94605	70079	69567	611	14847
1987	7333956	5080711	4912783	3060926	1880268	1201281	1054020	626077	407468	170749	79605	142827	64470	50685	56920	28576
1988	5774378	4909516	4098309	3735754	2092266	1213638	795902	657904	412428	214239	102181	55607	91009	32727	38329	27825
1989	9755062	3866127	3967373	3144492	2610092	1390021	825016	513423	444983	228822	133178	72766	36527	48958	24988	29548
1990	1E+07	6529707	3115653	3002832	2125075	1659647	908746	506231	333614	227522	134254	92104	45640	17992	36838	15800
1991	1.2E+07	6718131	5263360	2360783	2034815	1356051	1088451	559871	330010	171710	134118	93069	57985	22641	13554	66806
1992	8265788	7858126	5393195	3908143	1522502	1216488	839193	622507	343854	150431	92881	89013	54700	25232	16689	42946
1993	7591024	5529870	6295123	3962979	2456992	880150	730654	461910	370763	147239	77848	60278	50497	22249	18391	14109
1994	8182219	5077441	4420215	4575385	2425764	1371228	512328	386330	266396	148683	72740	49348	32949	19135	16027	10763
1995	8717869	5471220	4044962	3159519	2688792	1283028	760929	254794	212133	96664	68434	44486	25490	11208	13539	5200
1996	8573979	5830768	4370080	2929087	1916576	1482846	738971	396913	145357	83205	47011	43037	24014	9431	8042	3782
1997	7587930	5736291	4673176	3218576	1851847	1116193	896522	410195	238006	63106	43481	30661	24606	9914	6891	4172
1998	8214580	5073471	4561254	3287280	1969033	1031492	555901	451156	195473	123788	32860	17310	10186	13665	5321	4708
1999	1.1E+07	5496659	4069883	3358717	2195651	1231757	596736	323939	253079	116563	73876	16256	7547	6359	8330	4520
2000	9137430	7096444	4436373	3093510	2384279	1488700	790631	384980	203484	165930	76467	42495	8558	5109	4234	4571
2001	1.2E+07	6115084	5702505	3296128	2102038	1525784	886856	474137	222959	124630	101704	39473	19539	5466	3193	7060

Table 4.2.2.1.8. Summary of Integrated Catch-at-Age results by run including natural mortality rate, fishing mortality rate in 2001 and 95% confidence intervals on fully recruited ages, average fishing mortality on ages 2-10 in 2001, static spawning potential ratio, spawning biomass in 2001, F40%, the number of parameters, degrees of freedom (d.f.), weighted sum of squared residuals, variance of run, maximum sustainable yield, spawning biomass associated with MSY, and the ratios of F_{2001}/F_{msy} and SSB_{2001}/SSB_{msy}.

Run		Natural Mortality (M)	F2001	Confidence interval F2001 Low 95%	Up 95%	Ave F Ages 2-10	Static SPR F2001	SSB 2001 kilograms	F40%
1		0.15	0.24	0.13	0.43	0.23	29%	4035505	0.15
2	**Base**	**0.20**	**0.21**	**0.11**	**0.37**	**0.19**	**40%**	**4942806**	**0.20**
3		0.25	0.16	0.09	0.29	0.15	53%	6299543	0.29
4	Targeting	0.20	0.23	0.13	0.42	0.21	38%	4611007	0.20
5	Equal wgts	0.20	0.13	0.07	0.26	0.15	46%	5610172	0.17
6	Rev CAL	0.20	0.23	0.13	0.41	0.20	38%	4604747	0.21
7	Charterboat	0.20	0.21	0.12	0.39	0.19	39%	4944904	0.21
8	No comm ind.	0.20	0.23	0.12	0.43	0.20	38%	4640366	0.21
9	Iter. Rewgt	0.20	0.21	0.11	0.38	0.19	40%	4720829	0.21
10	Rev Indices	0.15	0.22	0.12	0.40	0.20	31%	4473155	0.15
11	Rev Indices	0.20	0.19	0.11	0.34	0.17	42%	5251003	0.21
12	Rev Indices	0.25	0.15	0.09	0.28	0.14	54%	6384995	0.28

Run		Natural Mortality (M)	Parameters	d.f.	Weighted SSQ	Variance
1		0.15	76	250	50.4569	0.2018
2	**Base**	**0.20**	**76**	**250**	**46.5518**	**0.1862**
3		0.25	76	250	76.9835	0.3079
4	Targeting	0.20	76	242	44.8055	0.1851
5	Equal wgts	0.20	76	250	65.8188	0.2633
6	Rev CAL	0.20	76	250	45.8226	0.1833
7	Charterboat	0.20	76	250	46.5479	0.1862
8	No comm ind.	0.20	75	234	45.2705	0.1935
9	Iter. Rewgt	0.20	76	250	182.5543	0.7302
10	Rev Indices	0.15	76	250	44.9496	0.1798
11	Rev Indices	0.20	76	250	45.0967	0.1804
12	Rev Indices	0.25	76	250	45.3146	0.1813

Table 4.2.2.1.8 (Continued). Summary of Integrated Catch-at-Age results by run including natural mortality rate, fishing mortality rate in 2001 and 95% confidence intervals on fully recruited ages, average fishing mortality on ages 2-10 in 2001, static spawning potential ratio, spawning biomass in 2001, F40%, the number of parameters, degrees of freedom (d.f.), weighted sum of squared residuals, variance of run, maximum sustainable yield, spawning biomass associated with MSY, the ratio of F_{2001} / F_{msy} and the ratio of SSB_{2001} / SSB_{msy}.

Run		Natural Mortality (M)	Steepness	F msy	SSB msy Kilograms	MSST Kilograms	MSY Kilograms	F2001/F msy	SSB 2001/SSB msy
1		0.15	0.7	0.19	6212963	5281019	1066744	1.28	0.65
2		0.20	0.7	0.23	4929871	3943896	935707	0.89	1.00
3		0.25	0.7	0.25	3156177	2367133	611914	0.64	2.00
4	Targeting	0.20	0.7	0.23	4687338	3749870	889093	0.99	0.98
5	Equal wgts	0.20	0.7	0.20	4848425	3878740	930666	0.69	1.16
6	Rev CAL	0.20	0.7	0.23	4851622	3881298	914215	0.97	0.95
7	Charterboat	0.20	0.7	0.23	4930154	3944123	936537	0.92	1.00
8	No comm ind.	0.20	0.7	0.23	4996225	3996980	948658	0.97	0.93
9	Iter. Rewgt	0.20	0.7	0.23	4856691	3885353	919658	0.90	0.97
10	Rev Indices	0.15	0.7	0.15	9118841	7751015	1271167	1.44	0.49
11	Rev Indices	0.20	0.7	0.23	4968212	3974570	942988	0.83	1.06
12	Rev Indices	0.25	0.7	0.36	3406984	2555238	900177	0.43	1.87
1		0.15	0.8	0.23	4881737	4149476	1011141	1.03	0.83
2	**Base**	**0.20**	**0.8**	**0.33**	**3662546**	**2930036**	**940513**	**0.62**	**1.35**
3		0.25	0.8	0.39	2390507	1792880	677009	0.41	2.64
4	Targeting	0.20	0.8	0.35	3429652	2743721	904563	0.66	1.34
5	Equal wgts	0.20	0.8	0.28	3621386	2897109	937876	0.49	1.55
6	Rev CAL	0.20	0.8	0.34	3557831	2846265	913089	0.67	1.29
7	Charterboat	0.20	0.8	0.33	3666303	2933043	941845	0.64	1.35
8	No comm ind.	0.20	0.8	0.34	3725089	2980071	957346	0.68	1.25
9	Iter. Rewgt	0.20	0.8	0.33	3593549	2874839	919377	0.63	1.31
10	Rev Indices	0.15	0.8	0.20	6256510	5318033	1082570	1.13	0.71
11	Rev Indices	0.20	0.8	0.33	3684238	2947391	945823	0.57	1.43
12	Rev Indices	0.25	0.8	0.54	2651564	1988673	979285	0.29	2.41

Table 4.2.2.1.8 (Continued). Summary of Integrated Catch-at-Age results by run including natural mortality rate, fishing mortality rate in 2001 and 95% confidence intervals on fully recruited ages, average fishing mortality on ages 2-10 in 2001, static spawning potential ratio, spawning biomass in 2001, F40%, the number of parameters, degrees of freedom (d.f.), weighted sum of squared residuals, variance of run, maximum sustainable yield, spawning biomass associated with MSY, the ratio of F_{2001} / F_{msy} and the ratio of SSB_{2001} / SSB_{msy}.

Run		Natural Mortality (M)	Steepness	F msy	SSB msy Kilograms	MSST Kilograms	MSY Kilograms	F2001/F msy	SSB 2001/SSB msy
1		0.15	0.9	0.32	3737740	3177079	993855	0.76	1.08
2		0.20	0.9	0.56	2548230	2038584	987254	0.37	1.94
3		0.25	0.9	0.70	1711668	1283751	772733	0.23	3.68
4	Targeting	0.20	0.9	0.57	2429479	1943583	942125	0.41	1.90
5	Equal wgts	0.20	0.9	0.45	2539592	2031674	985558	0.30	2.21
6	Rev CAL	0.20	0.9	0.57	2465643	1972514	955030	0.40	1.87
7	Charterboat	0.20	0.9	0.55	2553115	2042492	988883	0.39	1.94
8	No comm ind.	0.20	0.9	0.56	2595060	2076048	1007015	0.40	1.79
9	Iter. Rewgt	0.20	0.9	0.55	2496838	1997471	961536	0.38	1.89
10	Rev Indices	0.15	0.9	0.27	4503756	3828192	1020477	0.82	0.99
11	Rev Indices	0.20	0.9	0.55	2561403	2049122	991607	0.35	2.05
12	Rev Indices	0.25	0.9	0.89	1965661	1474246	1084641	0.17	3.25

The base run, indicated in bold, was configured as M = 0.20 per year and a steepness of 0.8 (Run 2).

Targeting	Uses logbook and headboat targeting indices
Equal wgts	All years are weighted equally in the objective function in fitting the catch-at-age
Rev CAL	Uses a revised catch-at-length with minimal substitutions
Charterboat	Uses MRFSS old method to estimate charterboat effort.
No comm ind.	A run with the commercial biomass index
Iter. Rewgt	Reweights indices by the reciprocal of the variance
Rev Indices	Indices were recalculated without interaction terms

Table 4.2.2.2.1. Variance partitioning of the statistical catch-at-age model and F-ratio tests for differences between the explained and unexplained variances. The parameters within each of the source categories were: for total catch, two describing the initial absolute population size; for catch at age, 12 selectivity model parameters, 15 describing initial population age structure, 22 describing the stock-recruitment function and deviations, and 21 describing deviations in recreational fishing effort; for effort, one catchability coefficient for the recreational fishery; and for indices, 7 coefficients relating abundance to the indices value. A complete list of the parameters is given in Table 4.2.2.2.2.

Source	SS	data	parms	df	variance	F	Prob > F
Explained SS							
total catch	31.39		2	2	15.697	11.926	0.0000
catch at age	99.95		70	70	1.428	6.775	0.0143
Effort	6.40		1	1	6.400	24.428	0.0199
Indices	290.35		7	7	41.478	63.336	0.0000
Total Explained	428.09		80	79	5.419	17.338	0.0000
Unexplained SS							
total catch	80.29	63		61	1.316		
catch at age	197.69	1,008		938	0.211		
effort	5.24	21		20	0.262		
indices	67.45	110		103	0.655		
Total Unexplained	350.67	1,202		1,122	0.313		
Total SS							
total catch	111.68						
catch at age	297.64						
effort	11.64						
indices	357.80						
Total	778.76			1,201			

Table 4.2.2.2.2. Statistical catch-at-age model parameter estimates, their standard deviations, approximate 95% confidence intervals (+/- 2 standard deviations), and bounds of uniform prior assumption about parameter distribution. The steepness parameter was bounded tightly and should not be considered a true parameter estimate. Overall deviation vector means and standard deviations are given.

Parameter Number	Parameter Name	Estimate	Coefficient of Variation	-2 Std Devs	+2 Std Devs	Uniform Prior Bounds Lower	Uniform Prior Bounds Upper
	1981-1983 Separable model: logistic model parameters						
1	beta - commercial	0.483	15.6%	0.333	0.633	0.0001	3.0
2	beta - recreational	0.268	11.5%	0.207	0.330	0.0001	3.0
3	beta - head boat	0.397	6.9%	0.342	0.451	0.0001	3.0
4	age50 - commercial	3.730	7.0%	3.207	4.252	0.5	7.0
5	age50 - recreational	2.259	5.8%	1.995	2.522	0.5	7.0
6	age50 - head boat	2.878	3.1%	2.701	3.055	0.5	7.0
	1984-2001 Separable model: logistic model parameters						
7	beta - commercial	0.538	4.4%	0.491	0.585	0.0001	3.0
8	beta - recreational	0.186	33.5%	0.061	0.311	0.0001	3.0
9	beta - head boat	0.477	4.7%	0.432	0.522	0.0001	3.0
10	age50 - commercial	3.872	2.4%	3.683	4.061	0.5	7.0
11	age50 - recreational	2.221	6.2%	1.946	2.495	0.5	7.0
12	age50 - head boat	3.205	2.5%	3.046	3.364	0.5	7.0
	Recreational (MRFSS) fishery effort model: catchability coefficient						
13	log_q	-15.4080	0.4%	-15.5383	-15.2777	-20.0	-8.0
	Rrecreational (MRFSS) fishery effort deviation:						
14	log_effort_devs - 1981	0.4615		0.2244	0.6985	-10.0	10.0
15	log_effort_devs - 1982	0.8322		0.6024	1.0620	-10.0	10.0
16	log_effort_devs - 1983	0.3318		-0.0634	0.7270	-10.0	10.0
17	log_effort_devs - 1984	-0.0900		-0.4430	0.2629	-10.0	10.0
18	log_effort_devs - 1985	-0.2261		-0.8218	0.3696	-10.0	10.0
19	log_effort_devs - 1986	-0.1852		-0.9496	0.5792	-10.0	10.0
20	log_effort_devs - 1987	-0.2816		-0.9397	0.3766	-10.0	10.0
21	log_effort_devs - 1988	-0.3316		-0.9943	0.3310	-10.0	10.0
22	log_effort_devs - 1989	-0.4001		-0.9345	0.1343	-10.0	10.0
23	log_effort_devs - 1990	-0.2947		-0.8518	0.2625	-10.0	10.0
24	log_effort_devs - 1991	0.4448		0.0435	0.8460	-10.0	10.0
25	log_effort_devs - 1992	-0.0037		-0.6417	0.6344	-10.0	10.0
26	log_effort_devs - 1993	0.1078		-0.4189	0.6344	-10.0	10.0
27	log_effort_devs - 1994	-0.0624		-0.4222	0.2973	-10.0	10.0
28	log_effort_devs - 1995	0.3536		-0.0209	0.7281	-10.0	10.0
29	log_effort_devs - 1996	-0.2504		-0.6457	0.1450	-10.0	10.0
30	log_effort_devs - 1997	-0.0635		-0.4171	0.2901	-10.0	10.0
31	log_effort_devs - 1998	-0.7122		-1.0935	-0.3309	-10.0	10.0
32	log_effort_devs - 1999	0.2167		-0.3430	0.7764	-10.0	10.0
33	log_effort_devs - 2000	0.0918		-0.3978	0.5815	-10.0	10.0
34	log_effort_devs - 2001	0.0614		-0.5998	0.7225	-10.0	10.0
	log_effort deviation vector	0.0000		-0.7095	0.7095		

Table 4.2.2.2.2 (continued).

Parameter Number	Parameter Name	Estimate	Coefficient of Variation	-2 Std Devs	+2 Std Devs	Uniform Prior Bounds Lower	Upper
	Abundance estimates model parameters:						
35	log_avginit_pop - 1981	12.0610		11.9481	12.1739	7.0	15.0
36	pop_log_initdevs - age 1	3.2467		3.0570	3.4364	-15.0	15.0
37	pop_log_initdevs - age 2	3.1386		2.9458	3.3314	-15.0	15.0
38	pop_log_initdevs - age 3	2.6422		2.4005	2.8839	-15.0	15.0
39	pop_log_initdevs - age 4	2.1335		1.8423	2.4247	-15.0	15.0
40	pop_log_initdevs - age 5	1.5597		1.2610	1.8584	-15.0	15.0
41	pop_log_initdevs - age 6	1.0708		0.7684	1.3732	-15.0	15.0
42	pop_log_initdevs - age 7	0.5486		0.1696	0.9275	-15.0	15.0
43	pop_log_initdevs - age 8	-0.0948		-0.5074	0.3179	-15.0	15.0
44	pop_log_initdevs - age 9	-0.4448		-0.7581	-0.1315	-15.0	15.0
45	pop_log_initdevs - age 10	-0.8607		-1.2121	-0.5092	-15.0	15.0
46	pop_log_initdevs - age 11	-1.9014		-2.4319	-1.3709	-15.0	15.0
47	pop_log_initdevs - age 12	-2.4744		-3.0039	-1.9449	-15.0	15.0
48	pop_log_initdevs - age 13	-2.8096		-3.3259	-2.2933	-15.0	15.0
49	pop_log_initdevs - age 14	-2.5447		-3.1485	-1.9409	-15.0	15.0
50	pop_log_initdevs - age 15+	-3.2099		-3.7122	-2.7076	-15.0	15.0
	pop_log_init deviation vector	0.0000		-4.5091	4.5091		
51	log_dev_N_rec - 1982	-0.3369		-0.5572	-0.1167	-20.0	20.0
52	log_dev_N_rec - 1983	-0.1010		-0.3598	0.1578	-20.0	20.0
53	log_dev_N_rec - 1984	0.0331		-0.2212	0.2874	-20.0	20.0
54	log_dev_N_rec - 1985	0.1673		-0.0586	0.3933	-20.0	20.0
55	log_dev_N_rec - 1986	0.2037		-0.0104	0.4179	-20.0	20.0
56	log_dev_N_rec - 1987	0.2114		0.0407	0.3820	-20.0	20.0
57	log_dev_N_rec - 1988	0.0883		-0.0872	0.2639	-20.0	20.0
58	log_dev_N_rec - 1989	0.0630		-0.1069	0.2330	-20.0	20.0
59	log_dev_N_rec - 1990	0.0910		-0.0576	0.2397	-20.0	20.0
60	log_dev_N_rec - 1991	0.1324		-0.0018	0.2667	-20.0	20.0
61	log_dev_N_rec - 1992	0.0006		-0.1439	0.1450	-20.0	20.0
62	log_dev_N_rec - 1993	-0.2377		-0.3891	-0.0862	-20.0	20.0
63	log_dev_N_rec - 1994	-0.1787		-0.3247	-0.0326	-20.0	20.0
64	log_dev_N_rec - 1995	-0.1842		-0.3544	-0.0140	-20.0	20.0
65	log_dev_N_rec - 1996	-0.1250		-0.2961	0.0462	-20.0	20.0
66	log_dev_N_rec - 1997	-0.1444		-0.3416	0.0528	-20.0	20.0
67	log_dev_N_rec - 1998	-0.1602		-0.3957	0.0754	-20.0	20.0
68	log_dev_N_rec - 1999	0.1876		-0.0167	0.3919	-20.0	20.0
69	log_dev_N_rec - 2000	0.1508		-0.0848	0.3863	-20.0	20.0
70	log_dev_N_rec - 2001	0.1387		-0.3367	0.6141	-20.0	20.0
	log_dev_N_rev deviation vector	0.0000		-0.3366	0.3366		
71	log_N0 - 1981	15.5370	0.7%	15.3323	15.7417	5.0	20.0
72	log_R0 - 1981	16.2180	0.4%	16.0869	16.3491	10.0	25.0
73	steepness*	0.7956	4.3%	0.7264	0.8647	0.79	0.80

Table 4.2.2.2.2 (continued).

Parameter Number	Parameter Name	Estimate	Coefficient of Variation	-2 Std Devs	+2 Std Devs	Uniform Prior Bounds Lower	Upper
	Survey/Fishery CPUE catchability indices:						
74	log_q_surva - headboat 1981-91	-13.7120	0.5%	-13.8387	-13.5853	-20.0	-8.0
75	log_q_surva -NMFS/UM age 1	-15.0410	0.8%	-15.2938	-14.7882	-20.0	-8.0
76	log_q_surva - NMFS/UM ages 2+	-15.8240	0.8%	-16.0808	-15.5672	-20.0	-8.0
77	log_q_surva - comm. Trip ticket	-13.0260	0.3%	-13.1109	-12.9411	-20.0	-8.0
78	log_q_surva - comm. reef fish logbook	-12.0730	0.5%	-12.2056	-11.9404	-20.0	-8.0
79	log_q_surva - MRFSS total-catch	-16.0660	0.5%	-16.2300	-15.9020	-20.0	-8.0
80	log_q_surva - head boat 1992-2001	-13.4620	0.4%	-13.5782	-13.3458	-20.0	-8.0

Table 4.2.2.2.3. Estimated fully-recruited instantaneous fishing mortality rate (F yr^{-1}) for the commercial and recreational sectors during 1981-2001 under the assumption of an instantaneous natural mortality rate (M) of 0.15, 0.20, or 0.25 yr^{-1}. Also included is the estimated Fs for the sensitivity run at M=0.20 yr^{-1} using the 'targeted' fishery dependent indices of abundance from the commercial logbook and headboat datasets. The estimates are from the models run using a steepness parameter (h) of 0.8 but these fishing mortality estimates differed very little from estimates from models run using h=0.7 or h=0.9.

	Commercial				Recreational			
Year	M=0.15	M=0.20t	M=0.20	M=0.25	M=0.15	M=0.20t	M=0.20	M=0.25
1981	0.17	0.14	0.15	0.12	0.22	0.18	0.19	0.16
1982	0.35	0.28	0.30	0.25	0.29	0.23	0.25	0.21
1983	0.23	0.18	0.20	0.16	0.12	0.09	0.11	0.09
1984	0.22	0.18	0.19	0.16	0.27	0.21	0.24	0.24
1985	0.20	0.16	0.18	0.15	0.10	0.10	0.09	0.09
1986	0.26	0.21	0.23	0.19	0.05	0.05	0.04	0.04
1987	0.38	0.31	0.33	0.28	0.06	0.07	0.05	0.05
1988	0.35	0.28	0.31	0.26	0.05	0.05	0.05	0.05
1989	0.36	0.29	0.32	0.27	0.08	0.07	0.07	0.07
1990	0.48	0.39	0.42	0.35	0.07	0.07	0.07	0.07
1991	0.32	0.26	0.28	0.23	0.14	0.13	0.13	0.13
1992	0.31	0.25	0.27	0.23	0.06	0.06	0.06	0.06
1993	0.36	0.29	0.32	0.26	0.09	0.07	0.08	0.08
1994	0.35	0.29	0.31	0.26	0.08	0.06	0.07	0.06
1995	0.31	0.25	0.27	0.22	0.08	0.06	0.07	0.06
1996	0.26	0.21	0.23	0.19	0.07	0.06	0.06	0.06
1997	0.32	0.26	0.28	0.23	0.08	0.07	0.07	0.07
1998	0.25	0.20	0.22	0.18	0.07	0.06	0.06	0.06
1999	0.24	0.20	0.21	0.18	0.05	0.03	0.04	0.03
2000	0.23	0.18	0.20	0.16	0.05	0.04	0.04	0.04
2001	0.23	0.18	0.20	0.16	0.03	0.02	0.02	0.02

Table 4.2.2.2.3 (continued). Estimated fully-recruited instantaneous fishing mortality rate (F yr^{-1}) for the headboat sector and for all sectors combined during 1981-2001 under the assumption of an instantaneous natural mortality rate (M) of 0.15, 0.20, or 0.25 yr^{-1}. Also included is the estimated Fs for the sensitivity run at M=0.20 yr^{-1} using the 'targeted' fishery- dependent indices of abundance from the commercial logbook and headboat datasets. The estimates are from the models run using a steepness parameter (h) of 0.8 but these fishing mortality estimates differed very little from estimates from models run using h=0.7 or h=0.9.

	Headboat				Total for all sectors			
Year	M=0.15	M=0.20t	M=0.20	M=0.25	M=0.15	M=0.20t	M=0.20	M=0.25
1981	0.03	0.02	0.03	0.02	0.41	0.33	0.36	0.31
1982	0.04	0.04	0.03	0.03	0.67	0.54	0.59	0.49
1983	0.05	0.02	0.05	0.04	0.40	0.29	0.35	0.29
1984	0.04	0.02	0.04	0.03	0.54	0.41	0.47	0.43
1985	0.03	0.01	0.03	0.03	0.34	0.27	0.30	0.27
1986	0.05	0.03	0.04	0.03	0.35	0.29	0.31	0.26
1987	0.04	0.03	0.04	0.03	0.48	0.41	0.42	0.36
1988	0.03	0.06	0.03	0.02	0.44	0.40	0.38	0.33
1989	0.02	0.02	0.02	0.02	0.46	0.38	0.40	0.35
1990	0.03	0.03	0.03	0.02	0.58	0.49	0.51	0.44
1991	0.02	0.03	0.02	0.02	0.48	0.42	0.42	0.37
1992	0.03	0.03	0.02	0.02	0.40	0.34	0.35	0.30
1993	0.03	0.03	0.02	0.02	0.47	0.39	0.41	0.36
1994	0.03	0.03	0.03	0.02	0.46	0.38	0.40	0.34
1995	0.03	0.02	0.02	0.02	0.42	0.33	0.36	0.30
1996	0.02	0.02	0.02	0.02	0.36	0.29	0.31	0.26
1997	0.02	0.02	0.02	0.02	0.43	0.34	0.37	0.31
1998	0.02	0.02	0.01	0.01	0.34	0.28	0.29	0.25
1999	0.01	0.01	0.01	0.01	0.30	0.25	0.26	0.22
2000	0.02	0.01	0.02	0.01	0.30	0.23	0.26	0.22
2001	0.02	0.01	0.02	0.01	0.27	0.22	0.24	0.20

Table 4.2.2.2.4. Estimated spawning stock biomass (SSB mt) of the yellowtail snapper population each year during 1981-2001 under different model assumptions about the rate of natural mortality (M=0.15, M=0.20, or M=0.25 yr^{-1}). Also included is the estimated SSB for the sensitivity run at M=0.20 using the 'targeted' fishery- dependent indices of abundance from the commercial logbook and headboat datasets. The estimates are from the models run using a steepness parameter (h) of 0.8 but these fishing mortality estimates differed very little from estimates from models run using h=0.7 or h=0.9.

Year	M=0.15	M=0.20t	M=0.20	M=0.25
1981	2,824	3,179	3,198	3,696
1982	2,521	2,880	2,879	3,360
1983	2,270	2,678	2,613	3,075
1984	2,227	2,713	2,570	3,033
1985	2,370	2,944	2,743	3,246
1986	2,832	3,439	3,256	3,823
1987	3,247	3,857	3,726	4,365
1988	3,584	4,217	4,112	4,817
1989	3,880	4,525	4,444	5,195
1990	3,855	4,505	4,434	5,209
1991	3,766	4,415	4,351	5,138
1992	3,890	4,524	4,494	5,310
1993	4,034	4,601	4,666	5,522
1994	3,957	4,485	4,595	5,462
1995	3,781	4,340	4,406	5,251
1996	3,711	4,345	4,326	5,156
1997	3,643	4,390	4,254	5,076
1998	3,654	4,530	4,271	5,100
1999	3,824	4,811	4,448	5,284
2000	4,064	5,118	4,699	5,548
2001	4,523	5,608	5,198	6,102

Table 4.2.2.2.5. Estimates of fishery benchmarks and supporting population dynamic estimates for yellowtail snapper. Estimates are conditional on the assumption of the instantaneous natural mortality rate (M) and the steepness parameter of the stock-recruitment relation. Spawning stock biomass (SSB) and maximum sustainable yield are given in metric tons and all rates are annual values. The transitional spawning potential ratio (tSPR) was calculated as a potential proxy for spawning stock biomass.

	Instantaneous natural mortality rate (M)									
		0.15				0.2			0.25	
Steepness	0.7	0.8	0.9	0.7	**0.8**	0.8t	0.9	0.7	0.8	0.9
SSB_{2001}	4,526	4,523	4,520	5,202	**5,198**	5,195	6,227	6,223	6,219	6,169
SSB_{msy}	11,990	7,470	5,200	7,103	**4,913**	3,329	5,062	3,692	2,625	5,197
SSB-ratio	0.38	0.61	0.87	0.73	**1.06**	1.19	1.56	1.23	1.69	2.37
F_{2001}	0.27	0.27	0.27	0.24	**0.24**	0.22	0.24	0.20	0.20	0.20
F_{msy}	0.19	0.24	0.32	0.26	**0.36**	0.36	0.57	0.39	0.58	0.96
F-ratio	1.42	1.13	0.85	0.90	**0.65**	0.60	0.41	0.52	0.35	0.21
MSY	1,965	1,503	1,342	1,497	**1,366**	1,349	1,415	1,427	1,504	1,442
$tSPR_{2001}$	28%	28%	28%	37%	**37%**	38%	37%	47%	47%	47%

Table 4.2.2.2.6. Recalculated estimates of fishery benchmarks and supporting population dynamic estimates for yellowtail snapper using indices that do not have any interaction terms. Estimates are conditional on the assumption of the instantaneous natural mortality rate (M) and the steepness parameter of the stock-recruitment relation. Spawning stock biomass (SSB) and maximum sustainable yield are given in metric tons and all rates are annual values. The transitional spawning potential ratio (tSPR) was calculated as a potential proxy for spawning stock biomass and the static spawning potential ratio (sSPR) can be considered a measure for overfishing. For example if the sSPR was less than 30% at a natural mortality rate of 0.20 per year and a steepness of 0.8, then the fishing mortality rate would be too high.

	Instantaneous natural mortality rate (M)								
	0.15			0.20			0.25		
Steepness	0.7	0.8	0.9	0.7	0.8	0.9	0.7	0.8	0.9
SSB_{2001}	4,617	4,613	4,610	5,301	5,297	5,292	6,338	6,334	6,329
SSB_{msy}	18,180	9,334	5,976	8,265	5,360	3,456	5,332	3,799	2,655
SSB-ratio	0.25	0.49	0.77	0.64	0.99	1.53	1.19	1.67	2.38
F_{2001}	0.28	0.28	0.28	0.24	0.24	0.24	0.20	0.20	0.20
F_{msy}	0.16	0.21	0.28	0.24	0.33	0.55	0.37	0.56	0.96
F-ratio	1.71	1.34	0.98	1.01	0.72	0.43	0.55	0.36	0.21
MSY	2,548	1,630	1,374	1,583	1,388	1,354	1,427	1,430	1,508
$tSPR_{2001}$	23%	23%	23%	32%	32%	32%	44%	44%	44%
sSPR	26%	26%	26%	36%	36%	36%	47%	47%	47%

Table 4.5.1. Commercial landings (a), numbers of fishers (Saltwater Products License holders, b), and the number of commercial trips (c) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 --Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys. License data only available from 1987 and later.

a. Commercial landings (kg)

Year	Region 1	Region 2	Region 3	Region 4	Total
1987	1146	33381	564413	15498	614438
1988	812	40725	579484	19039	640061
1989	1803	50174	757396	30323	839696
1990	684	52405	720679	23275	797043
1991	2453	56703	767691	17619	844466
1992	2512	74169	726972	36173	839827
1993	1405	80017	971536	26012	1078970
1994	2098	73067	910997	14234	1000395
1995	1115	53923	769791	17392	842221
1996	1627	43940	603315	12990	661873
1997	1204	59352	690648	8063	759267
1998	1566	49761	636833	3085	691245
1999	634	38506	789056	9091	837287
2000	741	32373	685812	3058	721985
2001	1754	36481	603147	2980	644362
Ave 92-96	1752	65023	796522	21360	884657
Ave 97-01	1180	43295	681099	5255	730829

Percentage of commercial landings

Year	Region 1	Region 2	Region 3	Region 4
1987	0.2%	5.4%	91.9%	2.5%
1988	0.1%	6.4%	90.5%	3.0%
1989	0.2%	6.0%	90.2%	3.6%
1990	0.1%	6.6%	90.4%	2.9%
1991	0.3%	6.7%	90.9%	2.1%
1992	0.3%	8.8%	86.6%	4.3%
1993	0.1%	7.4%	90.0%	2.4%
1994	0.2%	7.3%	91.1%	1.4%
1995	0.1%	6.4%	91.4%	2.1%
1996	0.2%	6.6%	91.2%	2.0%
1997	0.2%	7.8%	91.0%	1.1%
1998	0.2%	7.2%	92.1%	0.4%
1999	0.1%	4.6%	94.2%	1.1%
2000	0.1%	4.5%	95.0%	0.4%
2001	0.3%	5.7%	93.6%	0.5%
Ave 92-96	0.2%	7.3%	90.0%	2.4%
Ave 97-01	0.2%	6.0%	93.2%	0.7%

b. Numbers of Saltwater Products Licenses

Year	Region 1	Region 2	Region 3	Region 4	Total
1987	57	256	2048	271	2632
1988	48	351	2059	314	2772
1989	49	346	2317	305	3017
1990	55	322	1814	251	2442
1991	68	291	1456	191	2006

Percentage of licenses

Year	Region 1	Region 2	Region 3	Region 4
1987	2.2%	9.7%	77.8%	10.3%
1988	1.7%	12.7%	74.3%	11.3%
1989	1.6%	11.5%	76.8%	10.1%
1990	2.3%	13.2%	74.3%	10.3%
1991	3.4%	14.5%	72.6%	9.5%

Table 4.5.1 (Continued). Commercial landings (a), numbers of fishers (Saltwater Products License holders, b), and the number of commercial trips (c) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 --Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys. License data only available from 1987 and later.

b. Numbers of Saltwater Products Licenses

	Region				
Year	1	2	3	4	Total
1992	83	330	1316	199	1928
1993	64	313	1275	228	1880
1994	60	306	1273	202	1841
1995	58	279	1184	160	1681
1996	49	276	1067	125	1517
1997	46	305	1072	119	1542
1998	35	262	922	77	1296
1999	41	218	724	107	1090
2000	49	183	658	85	975
2001	60	186	629	77	952
Ave 92-96	63	301	1223	183	1769
Ave 97-01	46	231	801	93	1171

Percentage of licenses

	Region			
Year	1	2	3	4
1992	4.3%	17.1%	68.3%	10.3%
1993	3.4%	16.6%	67.8%	12.1%
1994	3.3%	16.6%	69.1%	11.0%
1995	3.5%	16.6%	70.4%	9.5%
1996	3.2%	18.2%	70.3%	8.2%
1997	3.0%	19.8%	69.5%	7.7%
1998	2.7%	20.2%	71.1%	5.9%
1999	3.8%	20.0%	66.4%	9.8%
2000	5.0%	18.8%	67.5%	8.7%
2001	6.3%	19.5%	66.1%	8.1%
Ave 92-96	3.5%	17.0%	69.2%	10.2%
Ave 97-01	4.2%	19.7%	68.1%	8.1%

c. Number of commercial trips

	Region				
Year	1	2	3	4	Total
1987	98	1499	15518	532	17647
1988	73	1574	15228	646	17521
1989	102	1884	18023	698	20707
1990	78	1854	16483	496	18911
1991	170	2125	15822	505	18622
1992	192	2313	15637	514	18656
1993	124	2428	16416	571	19539
1994	94	2257	15036	550	17937
1995	91	1887	13411	387	15776
1996	90	1708	11416	309	13523

Percentage of commercial trips

	Region			
Year	1	2	3	4
1987	0.6%	8.5%	87.9%	3.0%
1988	0.4%	9.0%	86.9%	3.7%
1989	0.5%	9.1%	87.0%	3.4%
1990	0.4%	9.8%	87.2%	2.6%
1991	0.9%	11.4%	85.0%	2.7%
1992	1.0%	12.4%	83.8%	2.8%
1993	0.6%	12.4%	84.0%	2.9%
1994	0.5%	12.6%	83.8%	3.1%
1995	0.6%	12.0%	85.0%	2.5%
1996	0.7%	12.6%	84.4%	2.3%

Table 4.5.1 (Continued). Commercial landings (a), numbers of fishers (Saltwater Products License holders, b), and the number of commercial trips (c) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 --Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys. License data only available from 1987 and later.

c. Number of commercial trips

	Region				
Year	1	2	3	4	Total
1997	87	2182	12028	239	14536
1998	76	1426	9823	126	11451
1999	78	1190	9479	193	10940
2000	86	1218	7759	167	9230
2001	143	1024	7947	153	9267
Ave 92-96	118	2119	14383	466	17086
Ave 97-01	94	1408	9407	176	11085

Percentage of commercial trips

	Region			
Year	1	2	3	4
1997	0.6%	15.0%	82.7%	1.6%
1998	0.7%	12.5%	85.8%	1.1%
1999	0.7%	10.9%	86.6%	1.8%
2000	0.9%	13.2%	84.1%	1.8%
2001	1.5%	11.0%	85.8%	1.7%
Ave 92-96	0.7%	12.4%	84.2%	2.7%
Ave 97-01	0.9%	12.5%	85.0%	1.6%

Table 4.5.2. Recreational MRFSS landings (a), trips (b), and reef fish trips (c) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 -- Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys.

a. Landings (number of fish, Type a + b1)

	Region					
Year	1	2	3	4	Total
1986	0	103197	232282	3559	339038
1987	0	54952	314394	7147	376493
1988	0	197363	290234	4966	492563
1989	3677	68068	641983	1716	715444
1990	0	116196	604825	0	721021
1991	7788	130427	873508	3850	1015573
1992	4091	149993	353542	27163	534789
1993	6409	222740	412743	25983	667875
1994	7767	105027	358565	4065	475424
1995	0	72438	354245	0	426683
1996	2319	69025	240383	0	311727
1997	7786	46025	332988	563	387362
1998	10031	80876	259717	886	351510
1999	9251	55216	180453	21699	266619
2000	8353	105318	172972	943	287586
2001	4200	81224	140109	1259	226792
Ave 92-96	4117	123845	343896	11442	483300
Ave 97-01	7924	73732	217248	5070	303974

Regional percentages of landings

	Region			
Year	1	2	3	4
1986	0.0%	30.4%	68.5%	1.0%
1987	0.0%	14.6%	83.5%	1.9%
1988	0.0%	40.1%	58.9%	1.0%
1989	0.5%	9.5%	89.7%	0.2%
1990	0.0%	16.1%	83.9%	0.0%
1991	0.8%	12.8%	86.0%	0.4%
1992	0.8%	28.0%	66.1%	5.1%
1993	1.0%	33.4%	61.8%	3.9%
1994	1.6%	22.1%	75.4%	0.9%
1995	0.0%	17.0%	83.0%	0.0%
1996	0.7%	22.1%	77.1%	0.0%
1997	2.0%	11.9%	86.0%	0.1%
1998	2.9%	23.0%	73.9%	0.3%
1999	3.5%	20.7%	67.7%	8.1%
2000	2.9%	36.6%	60.1%	0.3%
2001	1.9%	35.8%	61.8%	0.6%
Ave 92-96	0.9%	25.6%	71.2%	2.4%
Ave 97-01	2.6%	24.3%	71.5%	1.7%

b. Recreational trips

	Region				
Year	1	2	3	4	Total
1986	0	1311147	397779	438024	2146950
1987	0	1699989	591552	242655	2534196
1988	0	1838772	731086	44841	2614699
1989	378431	2097943	907021	421916	3805311
1990	0	1700630	1042715	33299	2776644

Regional percentages of trips

	Region			
Year	1	2	3	4
1986	0.0%	61.1%	18.5%	20.4%
1987	0.0%	67.1%	23.3%	9.6%
1988	0.0%	70.3%	28.0%	1.7%
1989	9.9%	55.1%	23.8%	11.1%
1990	0.0%	61.2%	37.6%	1.2%

Table 4.5.2 (Continued). Recreational MRFSS landings (a), trips (b), and reef fish trips (c) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 -- Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys.

b. Recreational trips

	Region				
Year	1	2	3	4	Total
1991	120424	2685499	2392040	27198	5225161
1992	762794	3524368	1709906	555669	6552737
1993	541068	2634631	2045486	970244	6191429
1994	386491	2735577	1686857	211968	5020893
1995	0	2011239	1591457	52708	3655404
1996	355797	1360491	1844626	56632	3617546
1997	769729	1575248	1610278	499988	4455243
1998	608854	1467093	1168287	496183	3740417
1999	1363007	1415921	797759	712824	4289511
2000	1180649	2331926	747358	904208	5164141
2001	938507	2285166	729927	1306542	5260142
Ave 92-96	409230	2453261	1775666	369444	5007602
Ave 97-01	972149	1815071	1010722	783949	4581891

Regional percentages of trips

	Region			
Year	1	2	3	4
1991	2.3%	51.4%	45.8%	0.5%
1992	11.6%	53.8%	26.1%	8.5%
1993	8.7%	42.6%	33.0%	15.7%
1994	7.7%	54.5%	33.6%	4.2%
1995	0.0%	55.0%	43.5%	1.4%
1996	9.8%	37.6%	51.0%	1.6%
1997	17.3%	35.4%	36.1%	11.2%
1998	16.3%	39.2%	31.2%	13.3%
1999	31.8%	33.0%	18.6%	16.6%
2000	22.9%	45.2%	14.5%	17.5%
2001	17.8%	43.4%	13.9%	24.8%
Ave 92-96	8.2%	49.0%	35.5%	7.4%
Ave 97-01	21.2%	39.6%	22.1%	17.1%

c. Reef fish recreational trips

	Region				
Year	1	2	3	4	Total
1986	0	91760	33981	10214	135955
1987	0	60714	77763	3269	141745
1988	0	74882	92297	353	167532
1989	363	132356	214257	3411	350387
1990	0	106048	50502	500	157050
1991	705	311289	135683	1214	448891
1992	2683	421484	150138	16004	590308
1993	942	236786	234095	29177	500999
1994	1640	199705	166905	7795	376044

Regional percentages of reef fish trips

	Region			
Year	1	2	3	4
1986	0.0%	67.5%	25.0%	7.5%
1987	0.0%	42.8%	54.9%	2.3%
1988	0.0%	44.7%	55.1%	0.2%
1989	0.1%	37.8%	61.1%	1.0%
1990	0.0%	67.5%	32.2%	0.3%
1991	0.2%	69.3%	30.2%	0.3%
1992	0.5%	71.4%	25.4%	2.7%
1993	0.2%	47.3%	46.7%	5.8%
1994	0.4%	53.1%	44.4%	2.1%

Table 4.5.2 (Continued). Recreational MRFSS landings (a), trips (b), and reef fish trips (c) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 -- Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys.

c. Reef fish recreational trips

	Region				
Year	1	2	3	4	Total
1995	0	166687	182167	1946	350800
1996	819	111738	142554	1870	256981
1997	2007	154480	210014	17727	384228
1998	1527	117649	126568	23197	268941
1999	5649	72464	76585	36654	191352
2000	3876	125164	77456	47303	253799
2001	2760	126954	92740	65865	288318
Ave 92-96	1217	227280	175172	11358	415027
Ave 97-01	3164	119342	116672	38149	277328

Regional percentages of reef fish trips

	Region			
Year	1	2	3	4
1995	0.0%	47.5%	51.9%	0.6%
1996	0.3%	43.5%	55.5%	0.7%
1997	0.5%	40.2%	54.7%	4.6%
1998	0.6%	43.7%	47.1%	8.6%
1999	3.0%	37.9%	40.0%	19.2%
2000	1.5%	49.3%	30.5%	18.6%
2001	1.0%	44.0%	32.2%	22.8%
Ave 92-96	0.3%	54.8%	42.2%	2.7%
Ave 97-01	1.1%	43.0%	42.1%	13.8%

Table 4.5.3. Headboat landings (a) and trips (b) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 -- Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys. Sampling in the Gulf of Mexico began in 1986. nd -- no data.

a. Headboat landings in numbers of fish

	Region				
Year	1	2	3	4	Total
1981	617	84928	74428	nd	159973
1982	465	60071	140757	nd	201293
1983	817	34177	170331	nd	205325
1984	404	33557	122354	nd	156315
1985	591	25179	111863	nd	137633
1986	1495	29035	172664	3000	206194
1987	2307	34736	193756	4731	235530
1988	2166	53087	230565	5559	291377
1989	1291	44203	115666	5751	166911
1990	2028	47198	165977	3596	218799
1991	2262	51289	155182	4813	213546
1992	1259	54365	143843	6036	205503
1993	778	45274	164595	8140	218787
1994	653	76348	160086	6104	243191
1995	490	35954	119525	1576	157545
1996	67	23378	110978	3212	137635
1997	285	26729	112110	740	139864
1998	152	16007	101312	3082	120553
1999	274	24512	77243	7248	109277
2000	207	12027	95029	nd	107263
2001	269	4770	93943	nd	98982
Ave 92-96	649	47064	139805	5014	192532
Ave 97-01	237	16809	95927	3690	116664

Percentage of landings by region

	Region			
Year	1	2	3	4
1981	0.4%	53.1%	46.5%	
1982	0.2%	29.8%	69.9%	
1983	0.4%	16.6%	83.0%	
1984	0.3%	21.5%	78.3%	
1985	0.4%	18.3%	81.3%	
1986	0.7%	14.1%	83.7%	1.5%
1987	1.0%	14.7%	82.3%	2.0%
1988	0.7%	18.2%	79.1%	1.9%
1989	0.8%	26.5%	69.3%	3.4%
1990	0.9%	21.6%	75.9%	1.6%
1991	1.1%	24.0%	72.7%	2.3%
1992	0.6%	26.5%	70.0%	2.9%
1993	0.4%	20.7%	75.2%	3.7%
1994	0.3%	31.4%	65.8%	2.5%
1995	0.3%	22.8%	75.9%	1.0%
1996	0.0%	17.0%	80.6%	2.3%
1997	0.2%	19.1%	80.2%	0.5%
1998	0.1%	13.3%	84.0%	2.6%
1999	0.3%	22.4%	70.7%	6.6%
2000	0.2%	11.2%	88.6%	
2001	0.3%	4.8%	94.9%	
Ave 92-96	0.3%	24.4%	72.6%	2.6%
Ave 97-01	0.2%	14.4%	82.2%	3.2%

Table 4.5.3 (Continued). Headboat landings (a) and trips (b) by region and year. Regions: 1 -- North of Palm Beach county, 2 -- Palm Beach through Miami-Dade counties, 3 -- Monroe county (Florida Keys), and 4 -- Gulf of Mexico north or west of the Keys. Sampling in the Gulf of Mexico began in 1986. nd -- no data.

b. Headboat trips

	Region				
Year	1	2	3	4	Total
1981	150831	154747	71709	nd	377287
1982	161439	154558	71614	nd	387611
1983	173062	129643	64721	nd	367426
1984	191413	122446	71314	nd	385173
1985	191834	119169	67227	nd	378230
1986	211515	128513	76218	301762	718008
1987	228211	136723	82174	286774	733882
1988	228045	115978	76641	279184	699848
1989	204306	132944	81586	273995	692831
1990	198625	147006	81182	275421	702234
1991	194029	127765	68468	239332	629594
1992	193776	107043	68002	269599	638420
1993	181737	91020	74698	296819	644274
1994	165667	113326	64656	317045	660694
1995	161140	94293	58261	282426	596120
1996	137310	93797	58821	257753	547681
1997	150103	64450	56059	240657	511269
1998	150531	53946	49605	270835	524917
1999	144105	65261	41781	242378	493525
2000	131413	76250	46228	nd	253891
2001	136841	62271	45321	nd	244433
Ave 92-96	167926	99896	64888	284728	617438
Ave 97-01	142599	64436	47799	251290	506123

Percentage of headboat trips by region

	Region			
Year	1	2	3	4
1981	40.0%	41.0%	19.0%	
1982	41.6%	39.9%	18.5%	
1983	47.1%	35.3%	17.6%	
1984	49.7%	31.8%	18.5%	
1985	50.7%	31.5%	17.8%	
1986	29.5%	17.9%	10.6%	42.0%
1987	31.1%	18.6%	11.2%	39.1%
1988	32.6%	16.6%	11.0%	39.9%
1989	29.5%	19.2%	11.8%	39.5%
1990	28.3%	20.9%	11.6%	39.2%
1991	30.8%	20.3%	10.9%	38.0%
1992	30.4%	16.8%	10.7%	42.2%
1993	28.2%	14.1%	11.6%	46.1%
1994	25.1%	17.2%	9.8%	48.0%
1995	27.0%	15.8%	9.8%	47.4%
1996	25.1%	17.1%	10.7%	47.1%
1997	29.4%	12.6%	11.0%	47.1%
1998	28.7%	10.3%	9.5%	51.6%
1999	29.2%	13.2%	8.5%	49.1%
2000	51.8%	30.0%	18.2%	
2001	56.0%	25.5%	18.5%	
Ave 92-96	27.2%	16.2%	10.5%	46.1%
Ave 97-01	28.2%	12.7%	9.4%	49.6%

Table 4.5.4. Annual mean commercial combined gear catch rates (kilograms per trip), 95% confidence interval, and the number of trips used in the calculations.

Subregion	Year	Mean	Low 95%	Up 95%	Trips
S.E. Florida	1985	1.23	1.00	1.46	1130
	1986	3.87	2.69	5.43	276
	1987	2.79	1.95	3.88	335
	1988	3.54	2.56	4.64	337
	1989	6.44	5.20	8.02	456
	1990	4.03	3.31	4.88	678
	1991	5.00	4.48	5.56	2017
	1992	5.20	4.69	5.80	1794
	1993	5.23	4.78	5.74	2841
	1994	5.01	4.56	5.47	2795
	1995	4.40	4.06	4.78	3632
	1996	4.01	3.71	4.33	4109
	1997	4.85	4.54	5.16	5011
	1998	4.47	4.10	4.84	4523
	1999	4.86	4.44	5.29	3582
	2000	4.07	3.74	4.41	3721
	2001	4.04	3.65	4.43	3764
	2002	4.90	4.50	5.34	3932
Keys	1985	11.76	10.35	13.20	958
	1986	8.26	7.53	9.04	1605
	1987	7.35	6.52	8.23	882
	1988	10.75	9.38	12.30	686
	1989	7.68	6.97	8.50	1593
	1990	7.83	7.14	8.60	1678
	1991	11.99	11.50	12.49	6523
	1992	10.73	10.34	11.14	8645
	1993	13.30	12.88	13.73	10913
	1994	12.71	12.30	13.12	10588
	1995	11.35	11.02	11.70	12688
	1996	10.73	10.43	11.03	15850
	1997	12.95	12.60	13.28	15993
	1998	15.58	15.12	16.07	13679
	1999	21.13	20.48	21.76	12176
	2000	18.78	18.20	19.39	10883
	2001	18.58	17.96	19.20	11461
	2002	19.74	19.11	20.35	11094

Table 4.5.5. Annual mean commercial hook-and-line gear catch rates (kilograms per trip) from logbooks, 95% confidence interval, and the number of trips used in the calculations.

Subregion	Year	Mean	Low 95%	Up 95%	Trips
S.E. Florida	1993	16.30	15.06	17.58	1561
	1994	18.04	16.93	19.18	2220
	1995	15.16	14.12	16.22	1964
	1996	11.28	10.39	12.24	2102
	1997	15.37	14.41	16.44	2521
	1998	15.57	14.39	16.87	2154
	1999	15.89	14.64	17.20	1948
	2000	12.38	11.26	13.66	1599
	2001	9.01	8.15	9.95	1652
Keys	1993	25.00	24.16	25.88	7166
	1994	23.42	22.61	24.21	7792
	1995	21.47	20.77	22.16	8013
	1996	18.88	18.27	19.53	7717
	1997	20.00	19.35	20.69	8850
	1998	26.21	25.33	27.17	7588
	1999	31.09	30.02	32.14	7715
	2000	28.37	27.38	29.41	7000
	2001	28.38	27.42	29.37	7214

Table 4.5.6. Annual mean recreational (MRFSS) catch rates (total number of fish per trip), 95% confidence interval, and the number of trips used in the calculations.

Subregion	Year	Mean	Low 95%	Up 95%	Trips
S.E. Florida	1981	0.95	0.45	2.00	30
	1982	1.65	0.83	3.28	32
	1983	0.67	0.33	1.37	37
	1984	0.60	0.32	1.12	51
	1985	1.41	0.76	2.60	43
	1986	0.79	0.57	1.10	168
	1987	0.58	0.42	0.80	197
	1988	0.31	0.22	0.44	216
	1989	0.42	0.28	0.63	140
	1990	0.93	0.67	1.29	162
	1991	0.92	0.69	1.23	206
	1992	1.37	1.13	1.66	424
	1993	1.55	1.22	1.96	301
	1994	0.84	0.62	1.15	192
	1995	1.15	0.85	1.55	188
	1996	0.77	0.56	1.05	193
	1997	0.89	0.64	1.24	164
	1998	0.98	0.70	1.37	152
	1999	1.56	1.20	2.03	225
	2000	0.93	0.72	1.20	278
	2001	1.09	0.85	1.41	259
	2002	0.66	0.52	0.85	310
Keys	1981	4.68	1.90	11.57	16
	1982	3.79	2.34	6.15	57
	1983	4.08	1.72	9.64	18
	1984	2.80	1.73	4.55	58
	1985	1.87	0.66	5.28	13
	1986	2.55	1.49	4.37	47
	1987	3.92	2.64	5.82	87
	1988	5.74	3.83	8.61	82
	1989	3.71	2.32	5.95	61
	1990	3.40	2.20	5.26	72
	1991	6.73	4.62	9.82	89
	1992	2.71	2.22	3.32	336
	1993	3.34	2.61	4.29	217
	1994	2.25	1.74	2.91	214
	1995	2.83	2.04	3.91	129
	1996	1.37	1.05	1.78	215
	1997	1.87	1.40	2.49	176
	1998	1.28	0.95	1.73	170
	1999	1.71	1.37	2.13	302
	2000	1.52	1.13	2.03	177
	2001	2.03	1.38	2.99	95
	2002	1.30	1.01	1.68	237

Table 4.5.7. Annual mean headboat catch rates (reported number per trip), 95% confidence interval, and the number of trips used in the calculations.

Subregion	Year	Mean	Low 95%	Up 95%	Trips
S.E. Florida	1981	3.48	3.06	3.96	1293
	1982	2.50	2.21	2.82	1486
	1983	1.73	1.51	1.97	1281
	1984	2.05	1.80	2.35	1252
	1985	1.68	1.48	1.91	1360
	1986	1.96	1.76	2.18	1902
	1987	2.33	2.10	2.59	1793
	1988	3.22	2.86	3.63	1349
	1989	3.38	2.98	3.84	1261
	1990	2.63	2.31	3.01	1170
	1991	3.23	2.81	3.72	1016
	1992	5.27	4.83	5.75	1451
	1993	5.68	5.11	6.31	1027
	1994	5.73	5.17	6.35	1149
	1995	3.78	3.38	4.23	947
	1996	3.24	2.76	3.81	402
	1997	3.10	2.54	3.79	267
	1998	4.81	3.88	5.95	219
	1999	6.72	4.82	9.36	85
	2000	3.01	1.76	5.14	34
	2001	2.91	1.67	5.07	31
Keys	1981	22.38	20.13	24.87	699
	1982	26.70	24.19	29.47	831
	1983	18.35	16.68	20.19	915
	1984	16.45	14.98	18.07	903
	1985	18.54	16.61	20.68	625
	1986	19.49	17.51	21.69	660
	1987	28.14	25.58	30.96	837
	1988	37.13	33.08	41.68	562
	1989	34.20	30.61	38.21	601
	1990	46.76	42.53	51.41	824
	1991	59.38	53.55	65.84	707
	1992	40.92	38.59	43.38	1233
	1993	40.57	38.38	42.89	1335
	1994	40.92	38.82	43.14	1460
	1995	35.79	33.83	37.86	1260
	1996	34.29	32.32	36.37	1166
	1997	38.38	35.76	41.20	834
	1998	37.18	34.76	39.77	893
	1999	36.03	33.60	38.64	819
	2000	42.58	39.58	45.80	742
	2001	40.60	37.37	44.11	575

Table 5.2.a. Bag limit analysis of yellowtail snapper interviews from 1981-1986 and 1993-2001 using MRFSS recreational interview data.

Region Atlantic

Period: 1981 1986

				Fish	Fish	Weighted by years		
Num Fish	Num Years	Trips	Anglers	Caught	Kept	Trips	Anglers	Kept
0	6	150	186	229	8	900	1116	48
1	6	153	195	196	180	918	1170	1080
2	6	57	63	134	125	342	378	750
3	5	25	28	85	84	125	140	420
4	4	13	16	66	62	52	64	248
5	4	9	12	60	60	36	48	240
6	3	6	8	47	47	18	24	141
7	2	3	5	41	35	6	10	70
8	2	2	2	22	16	4	4	32
10	2	3	3	40	30	6	6	60
12	1	1	1	12	12	1	1	12
17	2	2	7	117	117	4	14	234
20	1	5	5	100	100	5	5	100
	Totals	429	531	1149	876	2417	2980	3435
Percent > 10		2%	2%		11%	0.4%	0.7%	10.1%

Period: 1993 2001

				Fish	Fish	Weighted by years		
Num Fish	Num Years	Trips	Anglers	Caught	Kept	Trips	Anglers	Kept
0	9	741	1100	1949	59	6669	9900	531
1	9	246	401	540	339	2214	3609	3051
2	9	112	163	497	310	1008	1467	2790
3	9	49	75	299	220	441	675	1980
4	8	22	38	184	150	176	304	1200
5	8	29	51	338	248	232	408	1984
6	6	23	31	276	185	138	186	1110
7	4	14	22	167	151	56	88	604
8	6	14	21	178	159	84	126	954
9	3	10	15	167	137	30	45	411
10	6	9	9	110	90	54	54	540
11	1	1	1	11	11	1	1	11
12	4	5	7	120	83	20	28	332
15	2	2	2	45	30	4	4	60
	Totals	1277	1936	4881	2172	11127	16895	15558
Percent > 10		1%	1%		1%	0.2%	0.2%	2.6%

Table 5.2.b. Bag limit analysis of yellowtail snapper interviews from 1981-1986 and 1993-2001 using MRFSS recreational interview data.

Region Keys
Period: 1981 1986

Num Fish	Num Years	Trips	Anglers	Fish Caught	Fish Kept	Weighted by years Trips	Anglers	Kept
0	6	121	220	323	30	726	1320	180
1	6	122	218	271	182	732	1308	1092
2	6	51	96	224	180	306	576	1080
3	5	34	70	240	200	170	350	1000
4	6	20	31	168	123	120	186	738
5	6	17	25	138	122	102	150	732
6	6	19	30	206	180	114	180	1080
7	3	3	5	36	36	9	15	108
8	5	9	18	169	137	45	90	685
9	2	2	2	18	18	4	4	36
10	2	2	2	20	20	4	4	40
11	2	2	2	30	22	4	4	44
12	3	9	10	123	119	27	30	357
13	2	2	5	70	63	4	10	126
14	1	1	1	14	14	1	1	14
15	4	4	5	79	75	16	20	300
16	1	1	1	16	16	1	1	16
18	1	1	2	43	35	1	2	35
20	3	5	8	161	161	15	24	483
21	1	2	4	83	83	2	4	83
23	1	1	5	116	116	1	5	116
24	1	1	4	97	97	1	4	97
25	1	2	5	125	125	2	5	125
30	2	3	5	159	149	6	10	298
32	1	1	2	64	64	1	2	64
36	1	1	1	36	36	1	1	36
38	1	1	2	75	75	1	2	75
40	1	1	1	40	40	1	1	40
60	1	1	1	60	60	1	1	60
	Totals	439	781	3204	2578	2418	4310	9140
Percent > 10 fish		9%	8%		52%	4%	2.9%	26%

Table 5.2.b (Continued). Bag limit analysis of yellowtail snapper interviews from 1981-1986 and 1993-2001 using MRFSS recreational interview data.

Region: Keys

Period: 1993 2001

				Fish	Fish	Weighted by years		
Num Fish	Num Years	Trips	Anglers	Caught	Kept	Trips	Anglers	Kept
0	9	1187	1976	5171	116	10683	17784	1044
1	9	316	791	1404	672	2844	7119	6048
2	9	152	432	1353	830	1368	3888	7470
3	9	118	338	1491	977	1062	3042	8793
4	9	82	267	1473	1030	738	2403	9270
5	9	62	206	1281	1014	558	1854	9126
6	9	47	124	1029	740	423	1116	6660
7	8	21	57	517	391	168	456	3128
8	8	33	80	776	626	264	640	5008
9	8	16	36	373	321	128	288	2568
10	9	35	66	886	655	315	594	5895
11	3	7	24	292	263	21	72	789
12	5	8	21	286	251	40	105	1255
13	3	5	18	250	235	15	54	705
14	1	1	1	14	14	1	1	14
15	6	11	24	421	360	66	144	2160
16	4	6	8	172	128	24	32	512
18	2	2	4	86	71	4	8	142
19	2	2	5	94	94	4	10	188
20	5	7	13	293	260	35	65	1300
24	2	2	4	134	96	4	8	192
50	1	1	3	149	149	1	3	149
	Totals	2121	4498	17945	9293	18766	39686	72416
Percent > 10		2%	3%		7%	1.1%	1.3%	3.3%

List of Figures

List of Figures (Continued)

List of Figures (Continued)

List of Figures (Continued)

List of Figures (Continued)

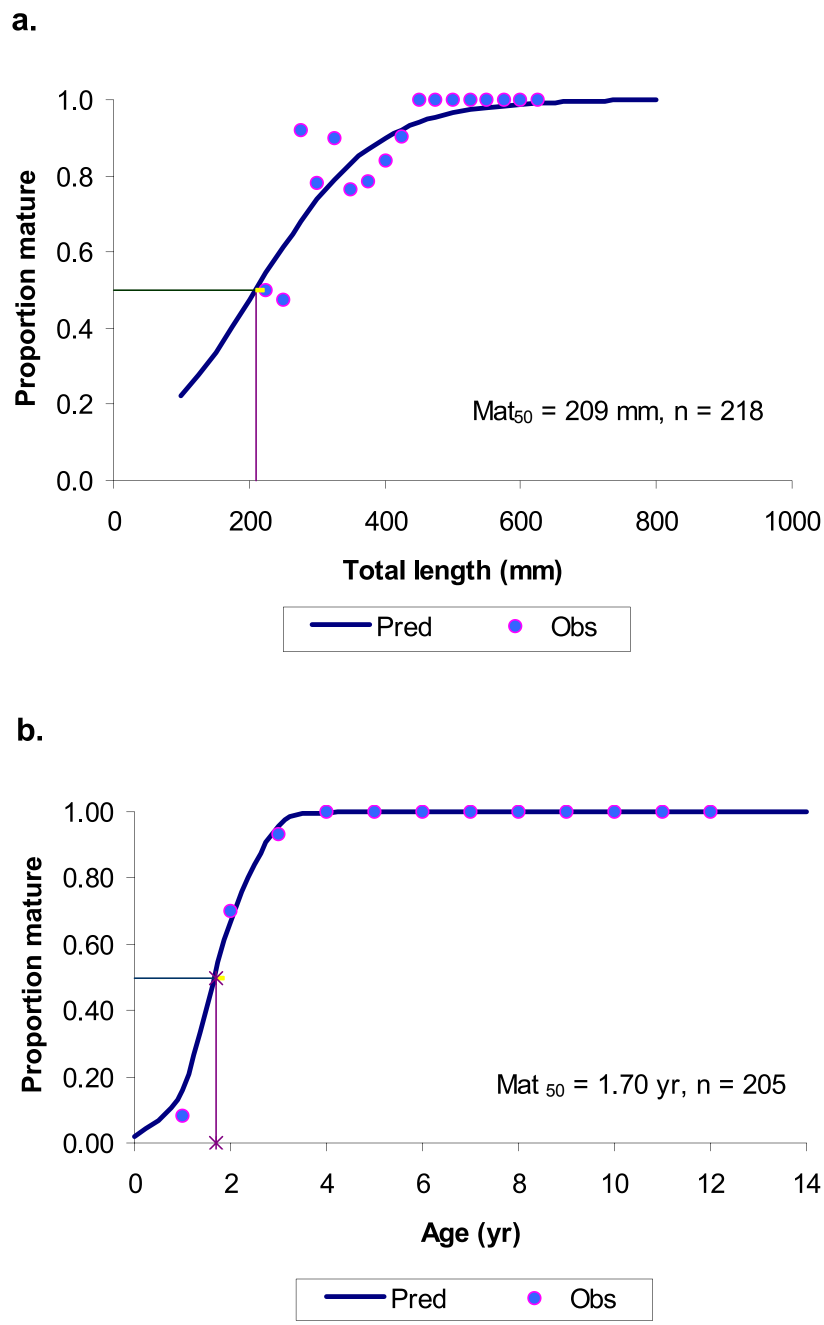
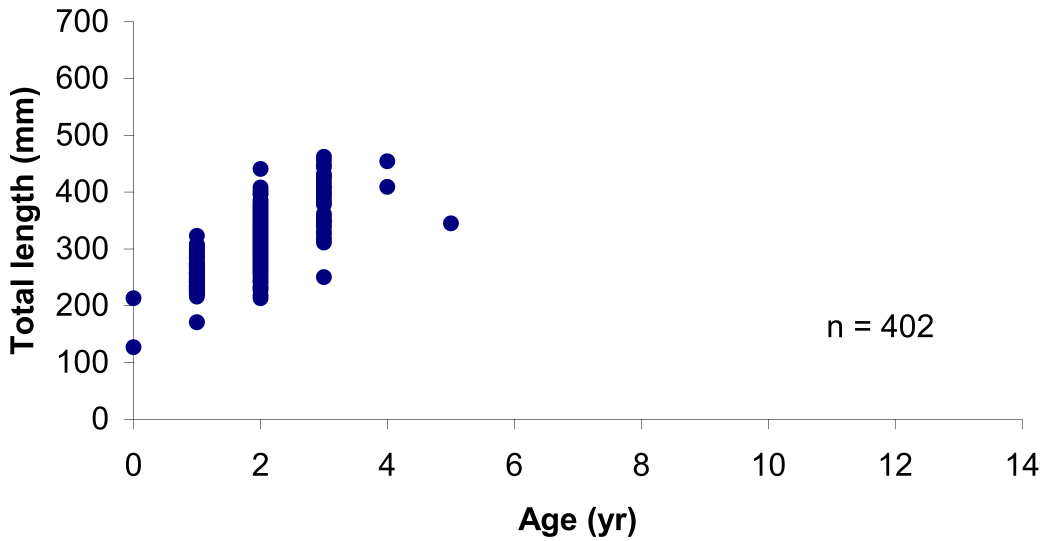


Figure 2.5 Proportion of mature fish based upon histological examination by total length in mm (a) and by age in years (b).

a.



b.

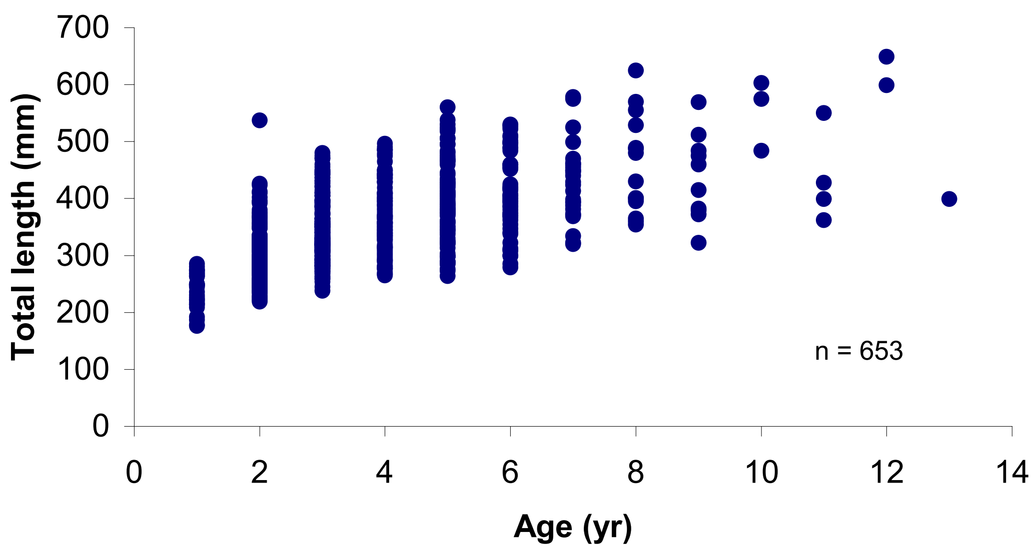


Figure 2.6 Total lengths and ages from sectioned otoliths using fish collected by fishery independent sampling 1999-2001 in the Atlantic (a) and Keys (b) regions.

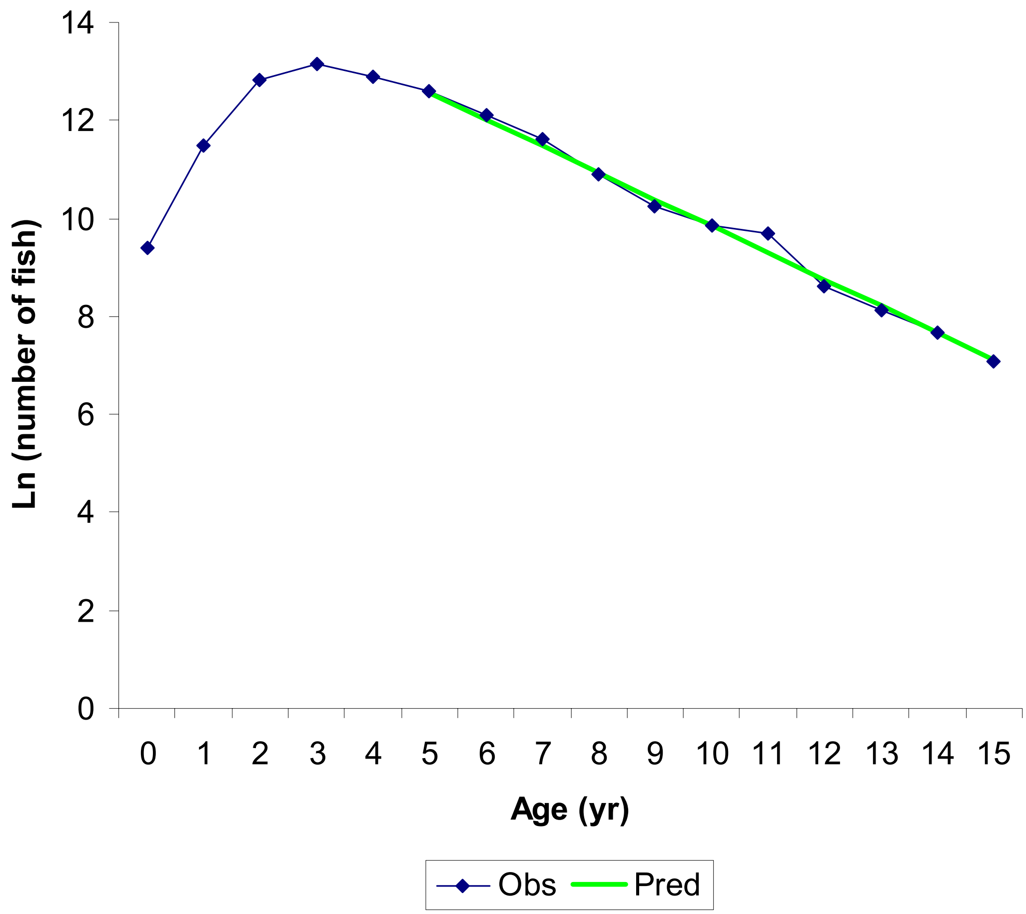


Figure 2.7. Catch curve based on the average numbers of fish by age from 1997-2001 from the combined fisheries. The predicted line corresponds to a total mortality rate of 0.54 per year.

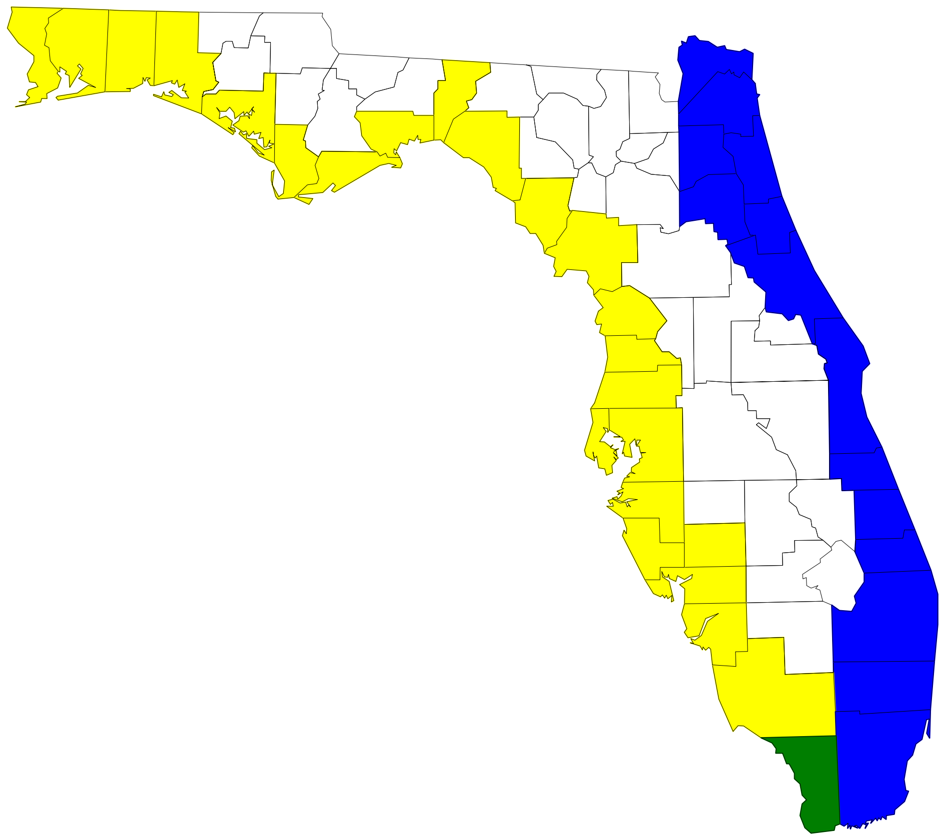


Figure 3.1. Geographic designations of Atlantic (Monroe-Dade county line and north, dark color) and Keys (Monroe county, intermediate color, and areas to the west, lighter color).

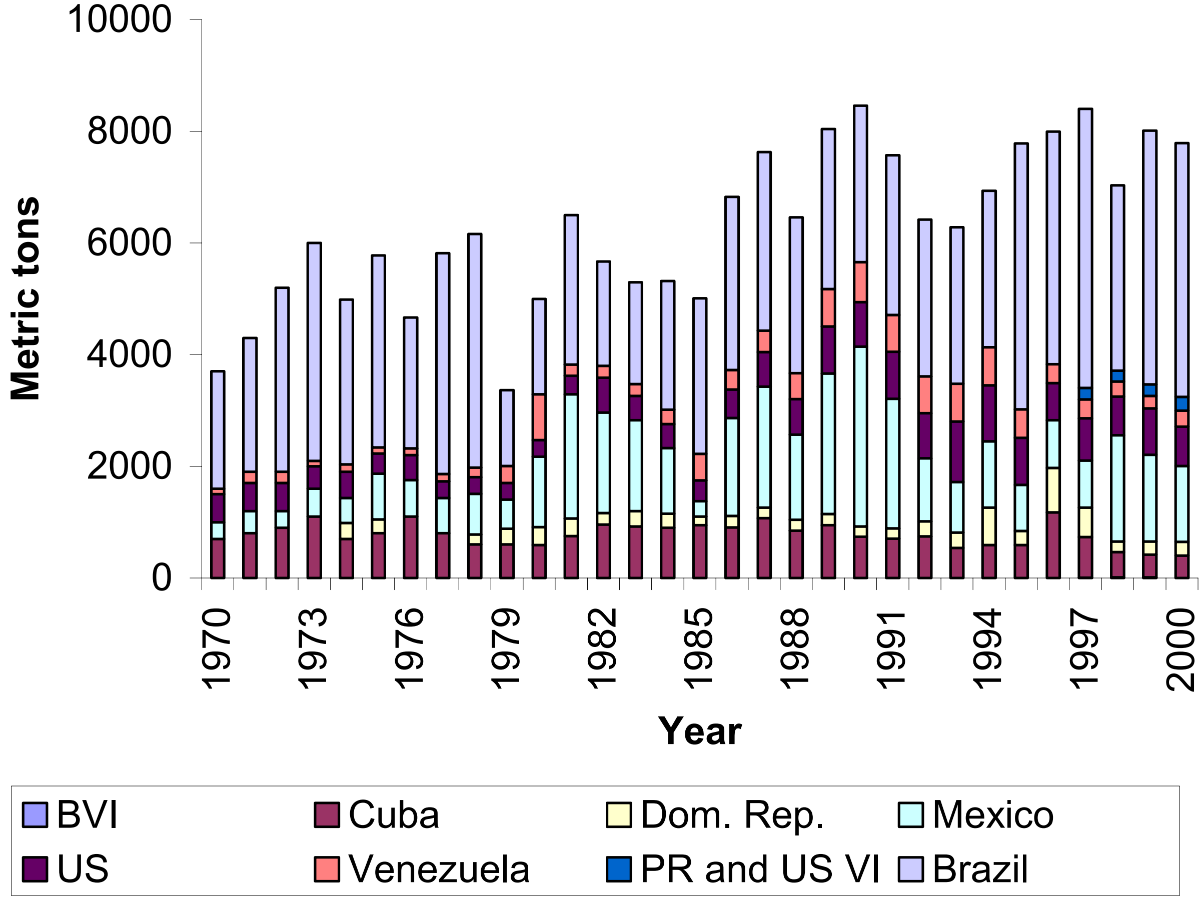


Figure 3.2.1 Western Atlantic landings (mt) of yellowtail snapper by country. Data are a composite of information from United Nations, Food and Agriculture Organization, Data and Statistics Unit and the National Marine Fisheries Service.

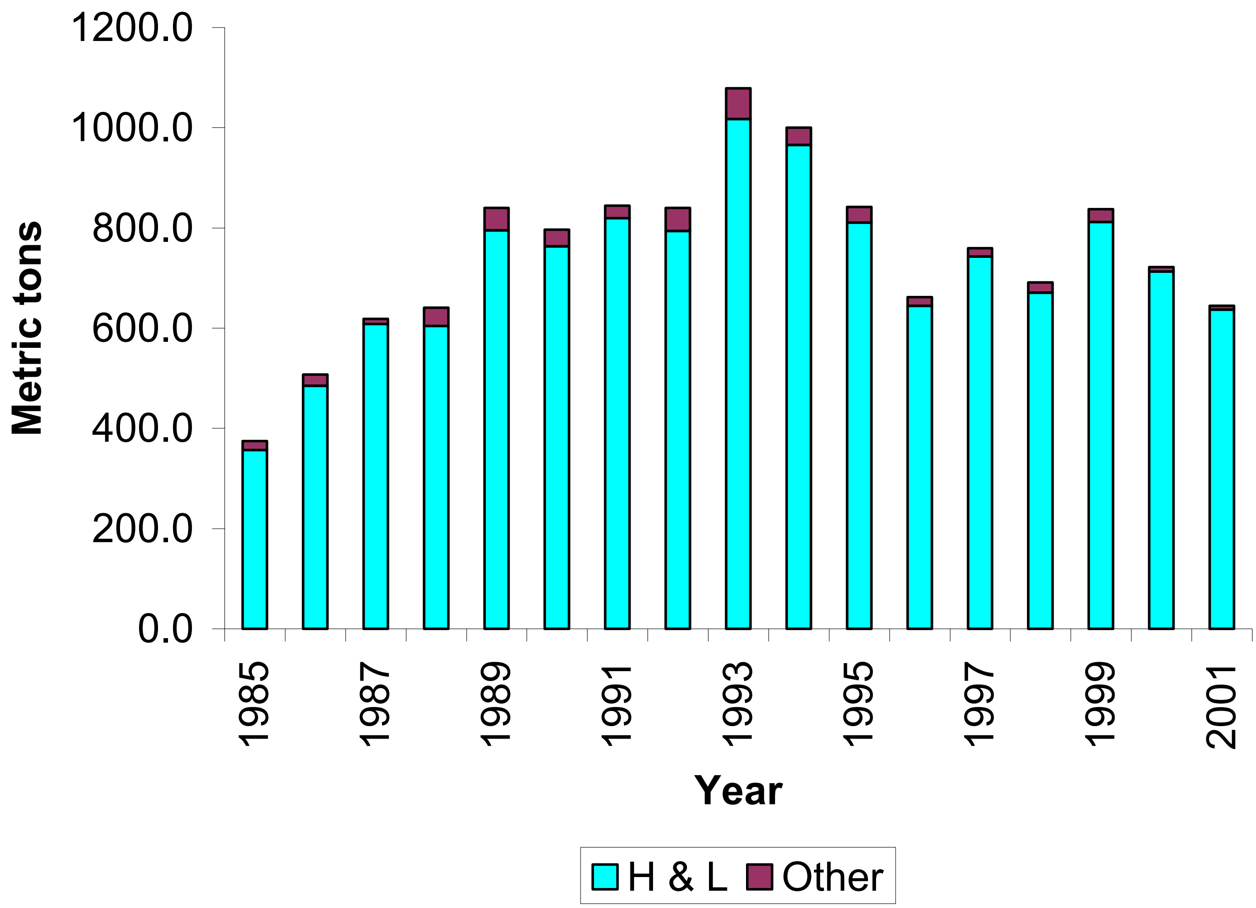


Figure 3.2.2. Commercial landings by year and gear (HL – hook-and-line and other gears.

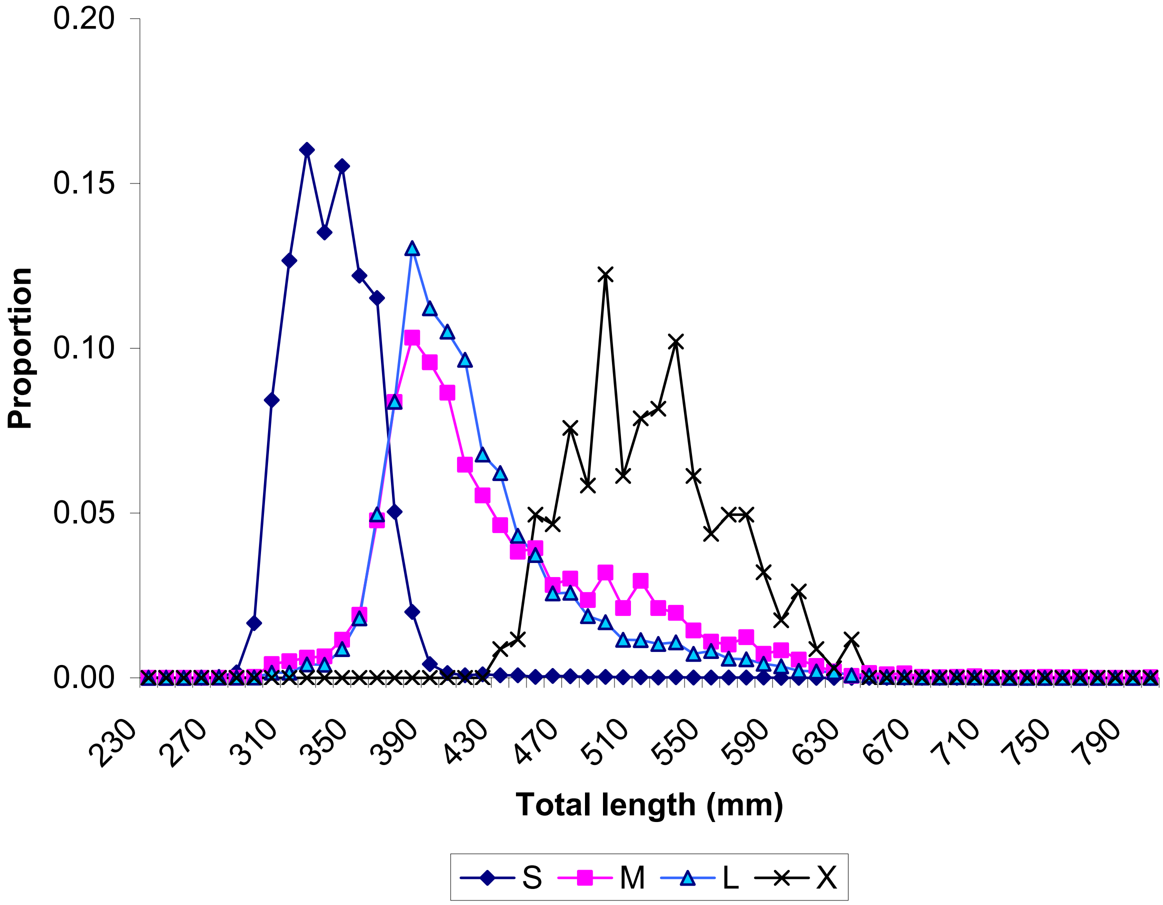
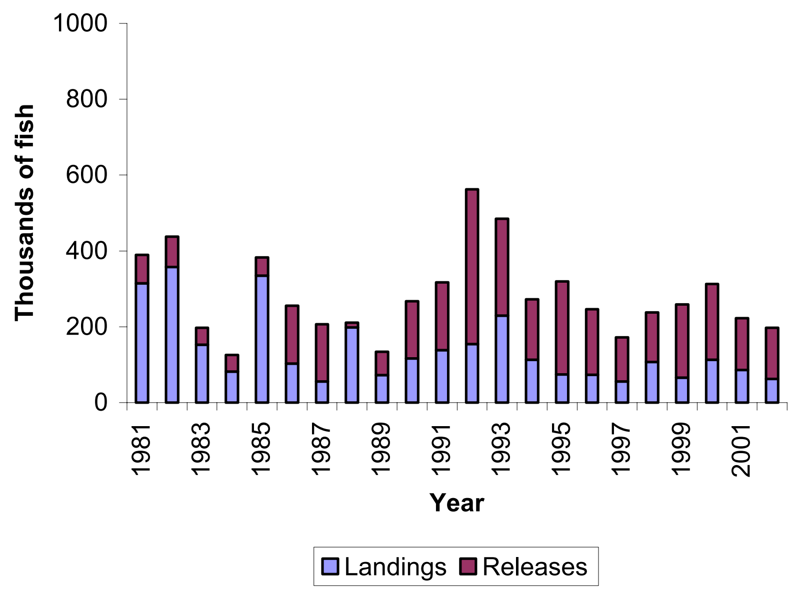


Figure 3.2.5. The proportion of commercial lengths from the Trip Interview Program by dealer size categories: S – small, M – medium, L – large, X – extra large. For subsequent analyses, the medium and large categories were pooled because of the extensive overlap.

a.



b.

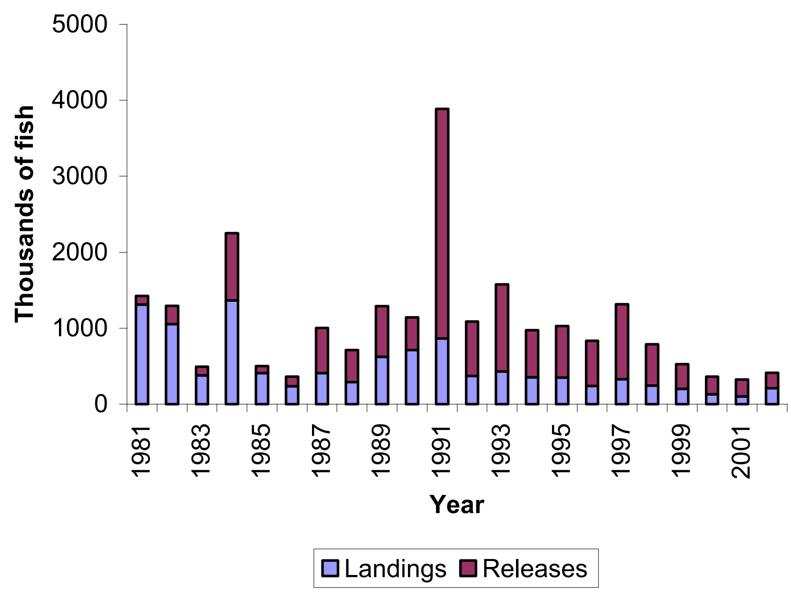
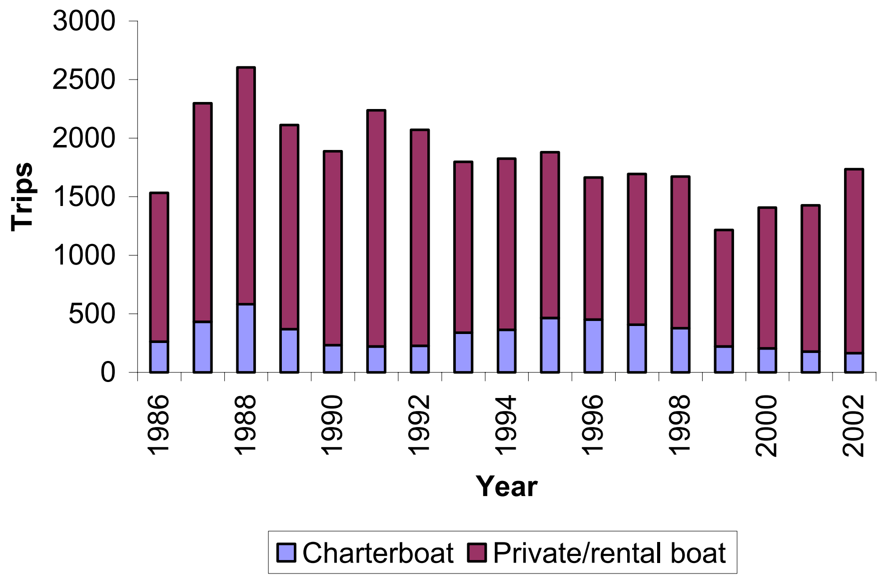


Figure 3.3.1. Estimated numbers of yellowtail snapper landed and released alive by MRFSS anglers by region (a -– Atlantic and b -– Keys) and year.

a.



b.

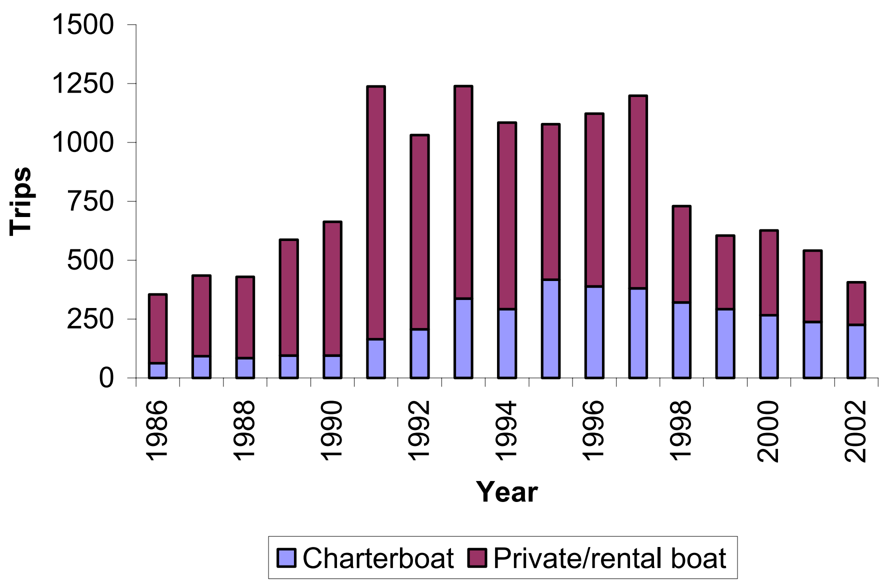
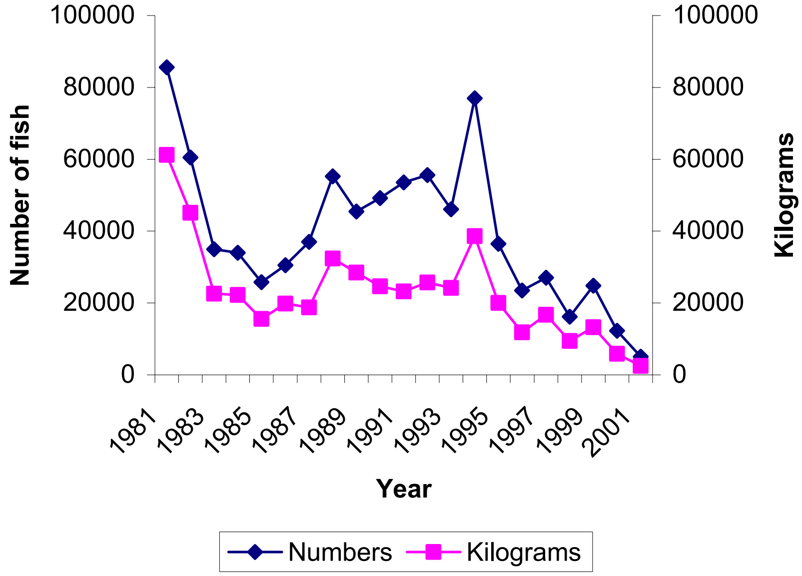


Figure 3.3.2. Estimated numbers of recreational trips by MRFSS for charterboat and private/rental boats in Southeast Florida (a – Palm Beach-Dade counties) and the Keys (b – Monroe county only).

a.



b.

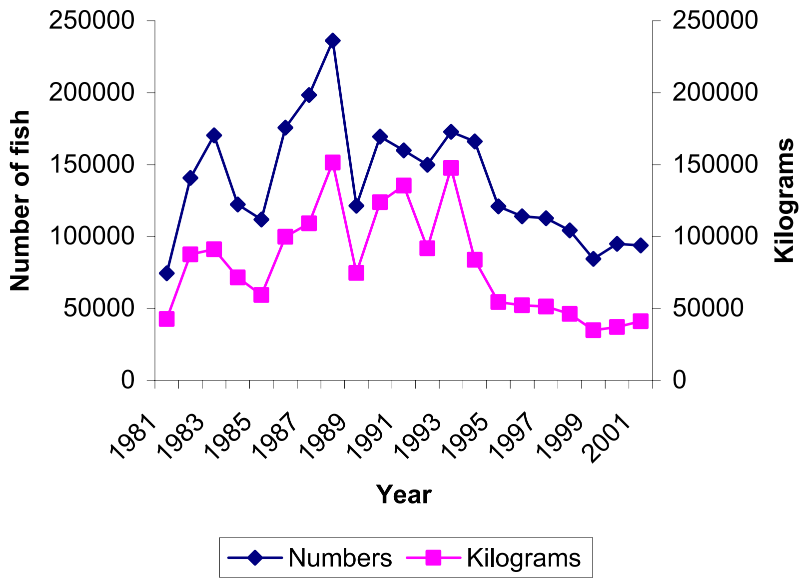


Figure 3.4.1. Headboat landings of yellowtail snapper in numbers and weight from Atlantic (a.) and the Keys (b).

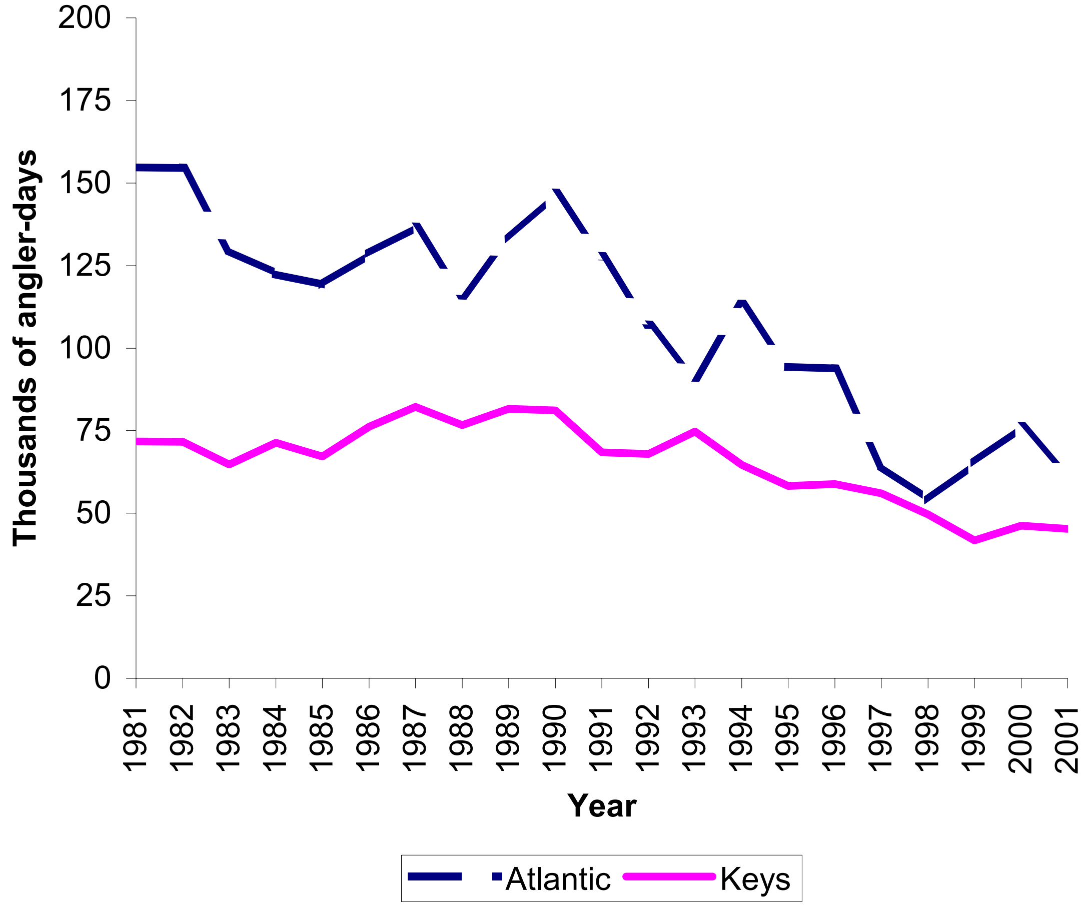


Figure 3.4.2. Headboat effort in thousands of angler-days by region. Atlantic (a) is Area 11 and the Keys (b) is the sum of Areas 12,17,and 18.

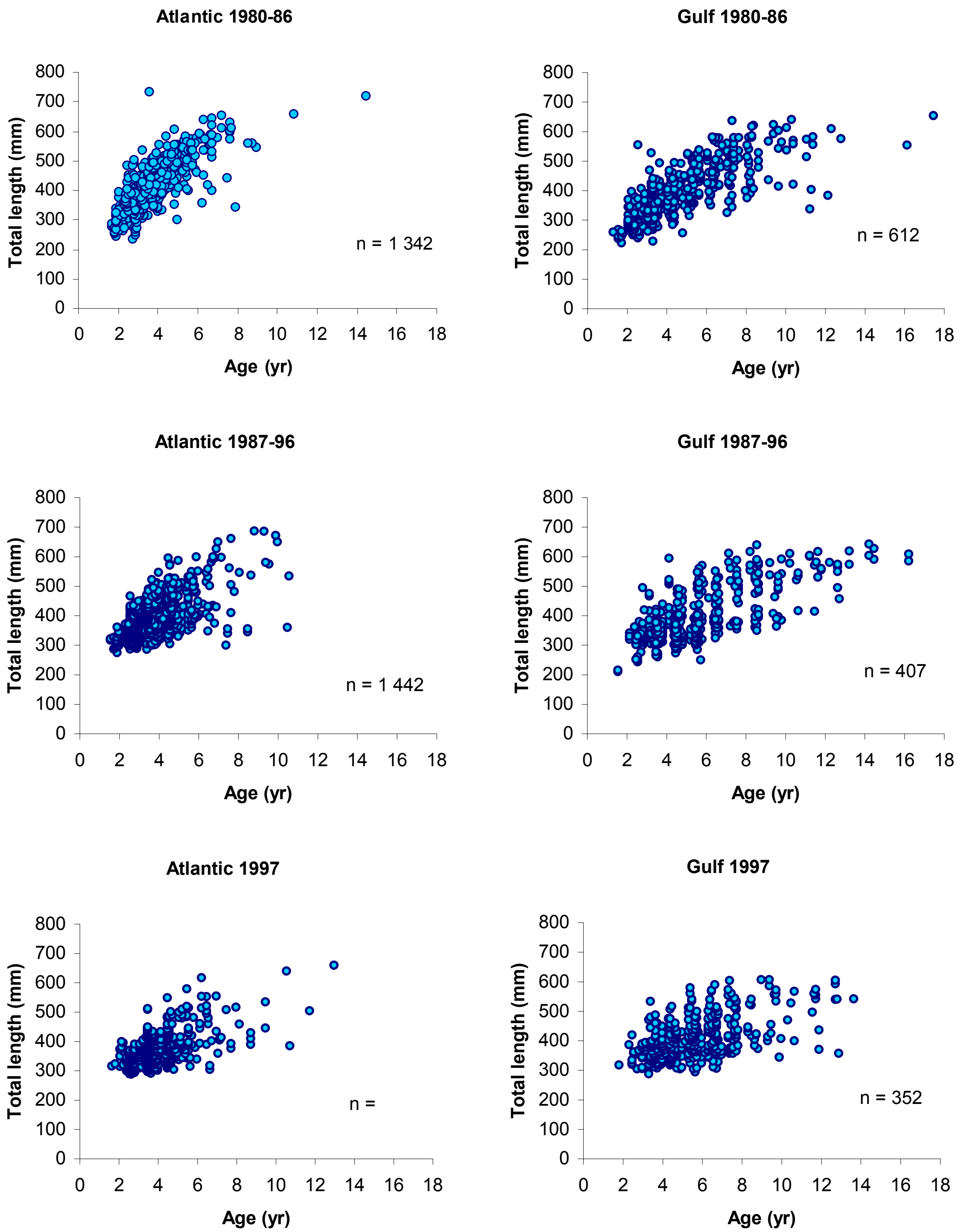


Figure 3.6 Fishery dependent lengths and ages used to create age-length keys by time period and region. The ages based on the fraction of year between January 1 and the middle of the month of collection.

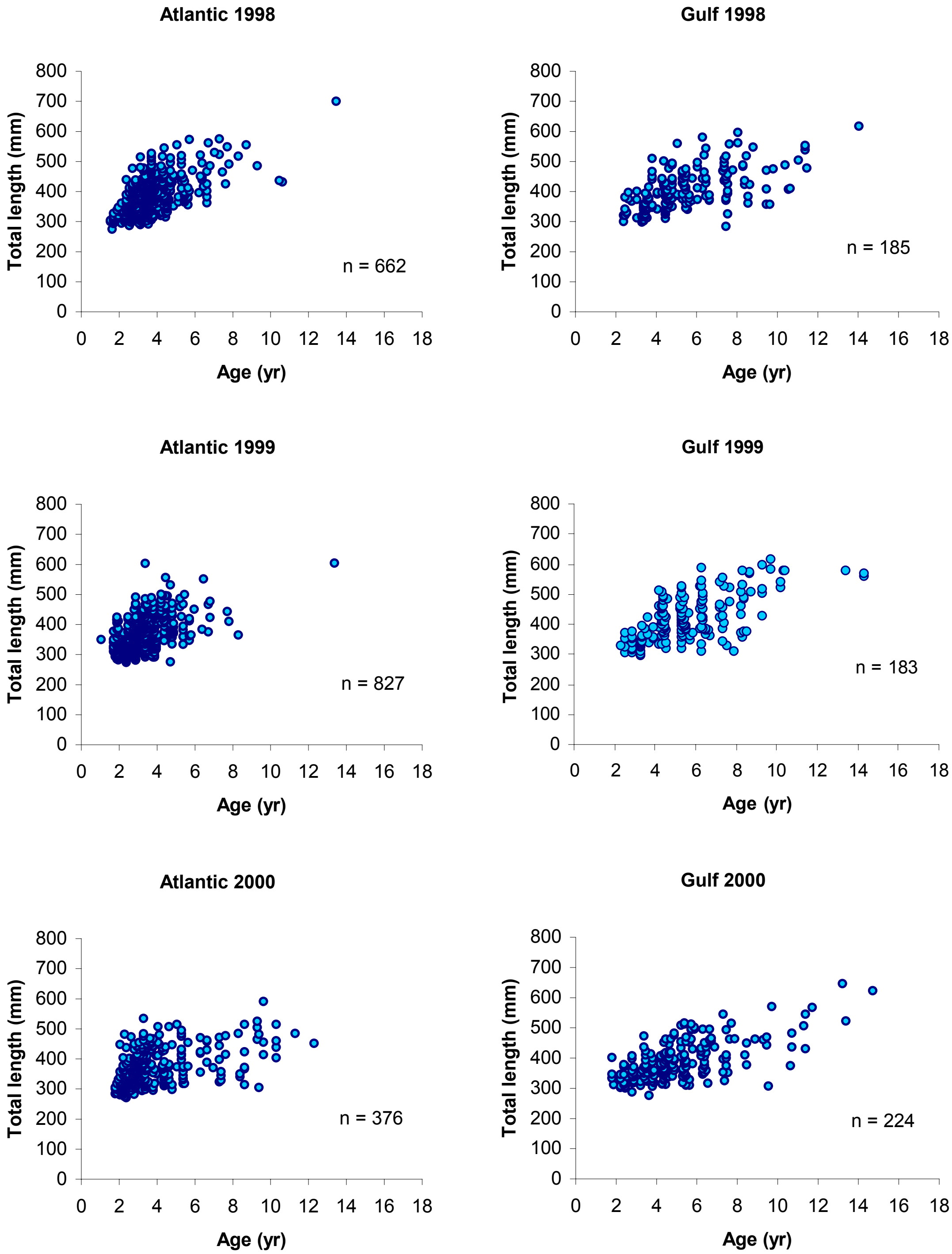


Figure 3.6 (Continued). Fishery dependent lengths and ages used to create age-length keys by time period and region. The ages based on the fraction of year between January 1 and the middle of the month of collection.

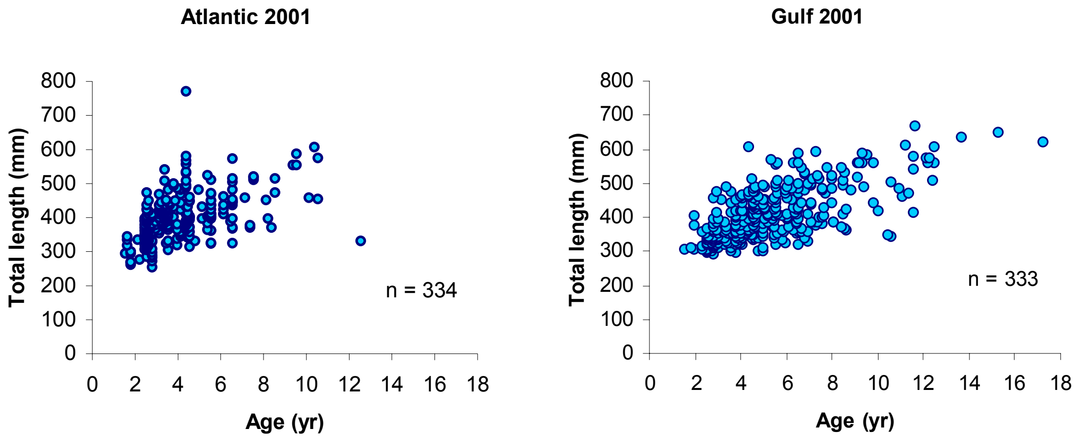
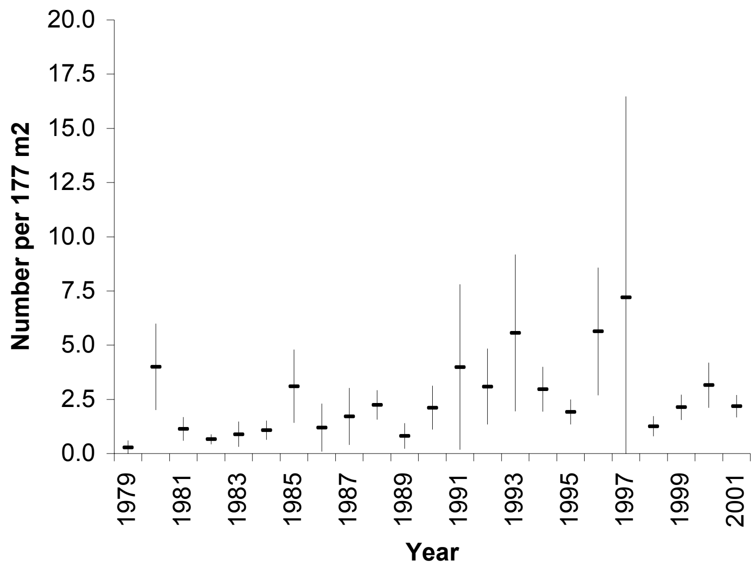


Figure 3.6 (Continued). Fishery dependent lengths and ages used to create age-length keys by time period and region. The ages based on the fraction of year between January 1 and the middle of the month of collection.

a.



b.

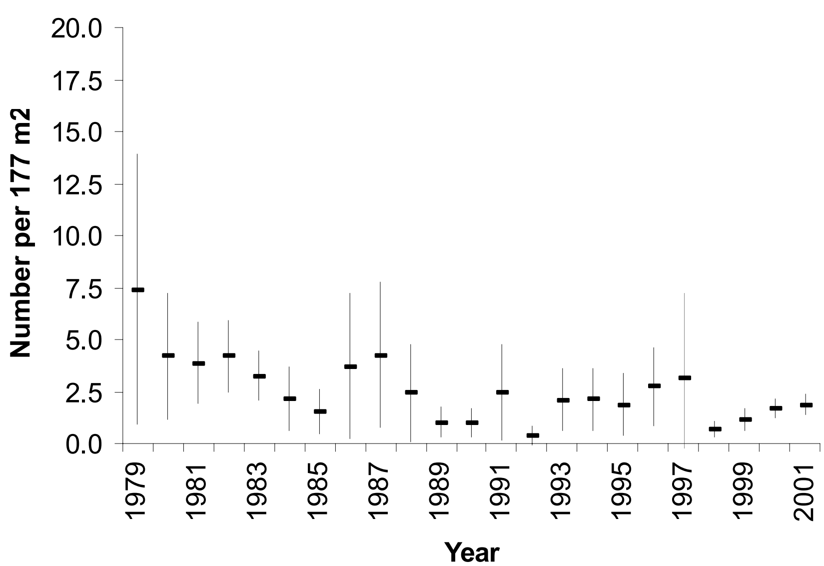


Figure 4.1.1.1. Annual densities in numbers per 177 m^2 of yellowtail snapper from the National Marine Fisheries Service and University of Miami's Reef Visual Census. The vertical line represents the 95% confidence limits and the horizontal line is the mean.

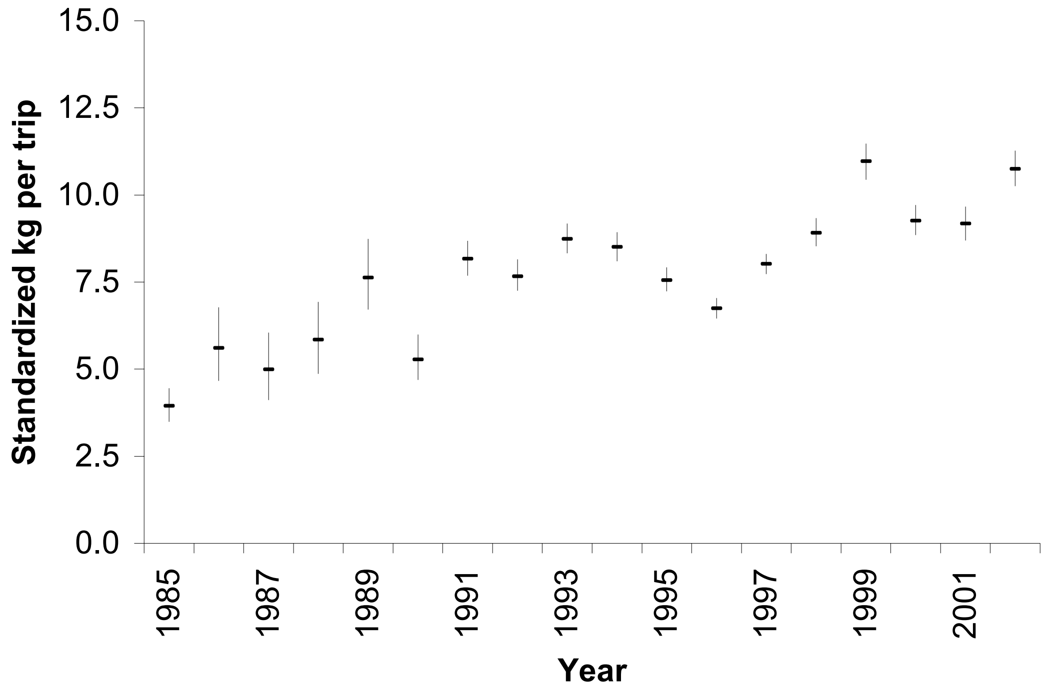


Figure 4.1.2.1.1 Annual kilograms landed per trip by the commercial fishery for combined gears standardized with the delta-lognormal method. The vertical lines are 95% confidence intervals and the horizontal line is the mean.

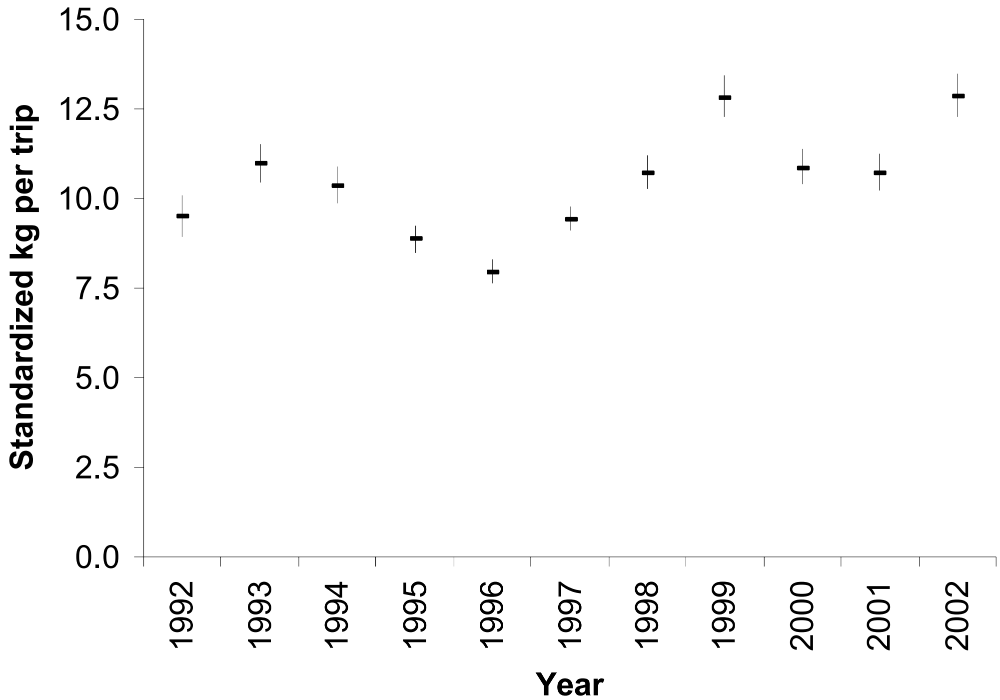


Figure 4.1.2.1.2 Annual kilograms landed per trip by the commercial fishery for hook-and-line gear standardized with the delta-lognormal method. The vertical lines are 95% confidence intervals and the horizontal line is the mean.

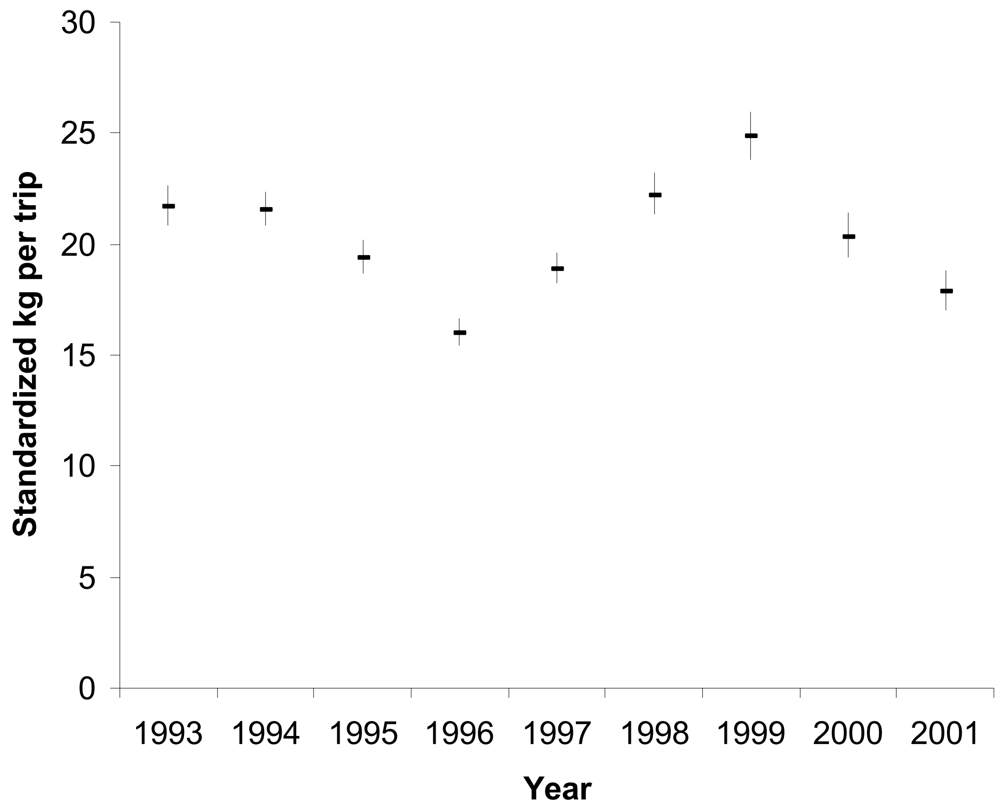


Figure 4.1.2.1.3 Annual kilograms landed per trip by the commercial fishery from Reef Fish logbook holders using hook-and-line gear standardized with the delta-lognormal method. The vertical lines are 95% confidence intervals and the horizontal line is the mean.

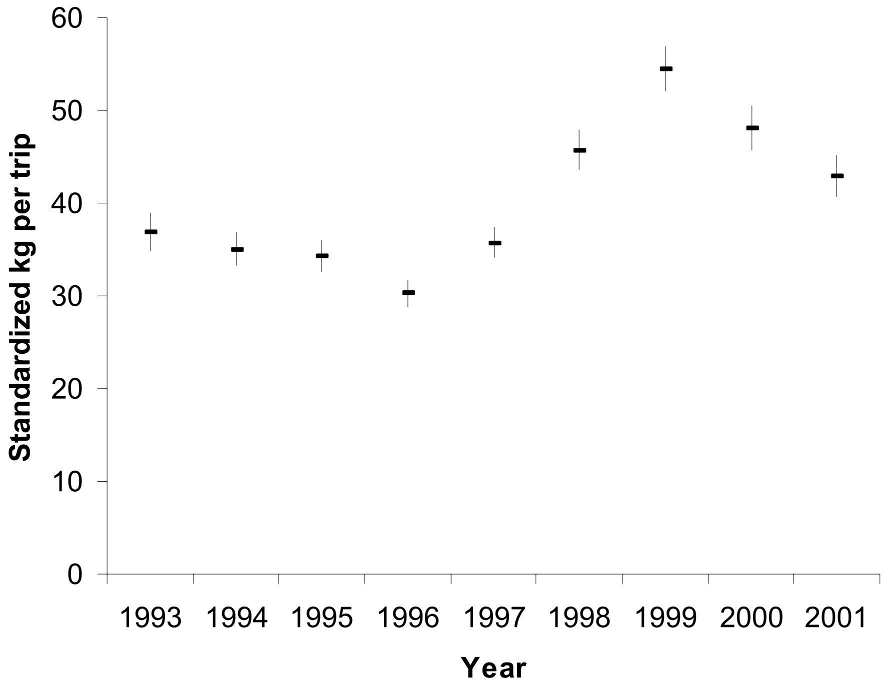
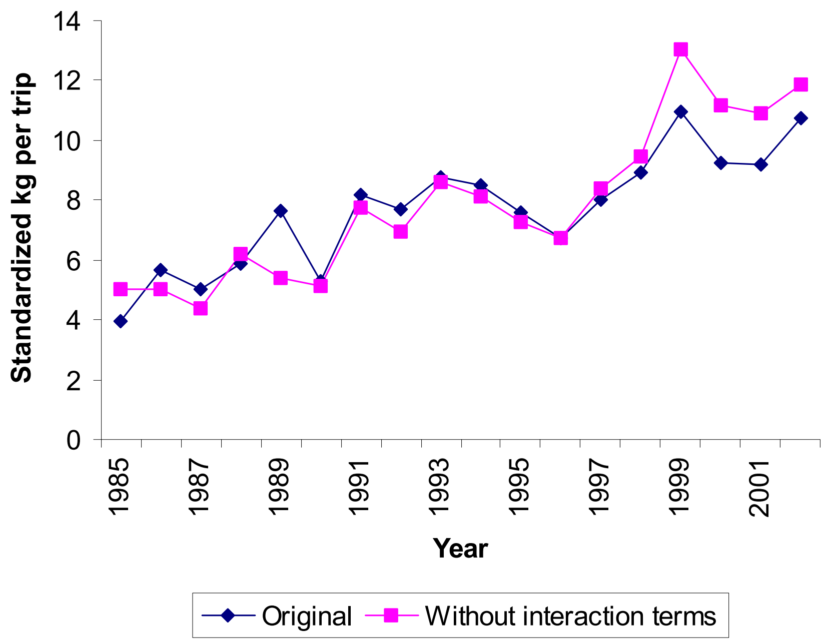


Figure 4.1.2.1.4 Annual kilograms landed per trip by the commercial fishery from Reef Fish logbook holders that target yellowtail snapper using hook-and-line gear standardized with the delta-lognormal method. The vertical lines are 95% confidence intervals and the horizontal line is the mean.

a.



b.

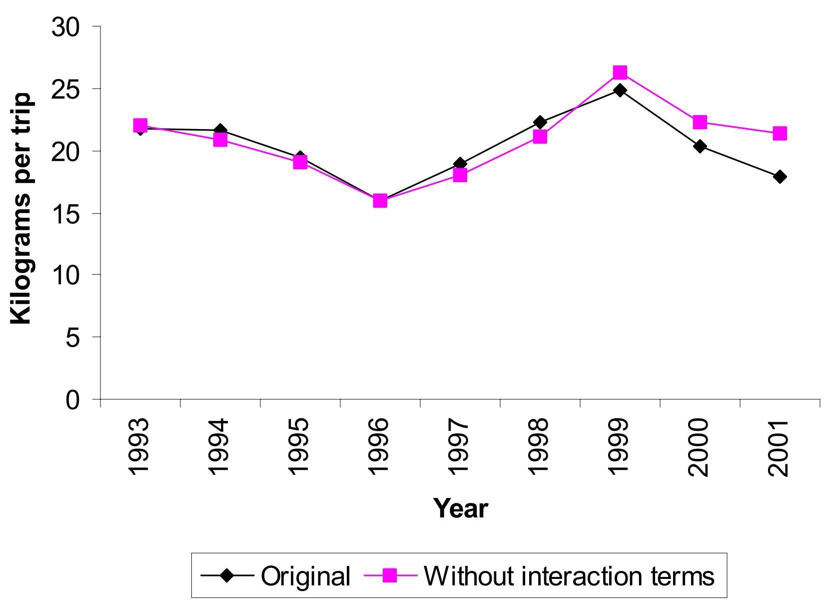


Figure 4.1.2.1.5. Comparison of the original commercial indices with the recalculated indices that did not include interaction terms. a) is for combined gears and b) is the Reef Fish Permit logbook index.

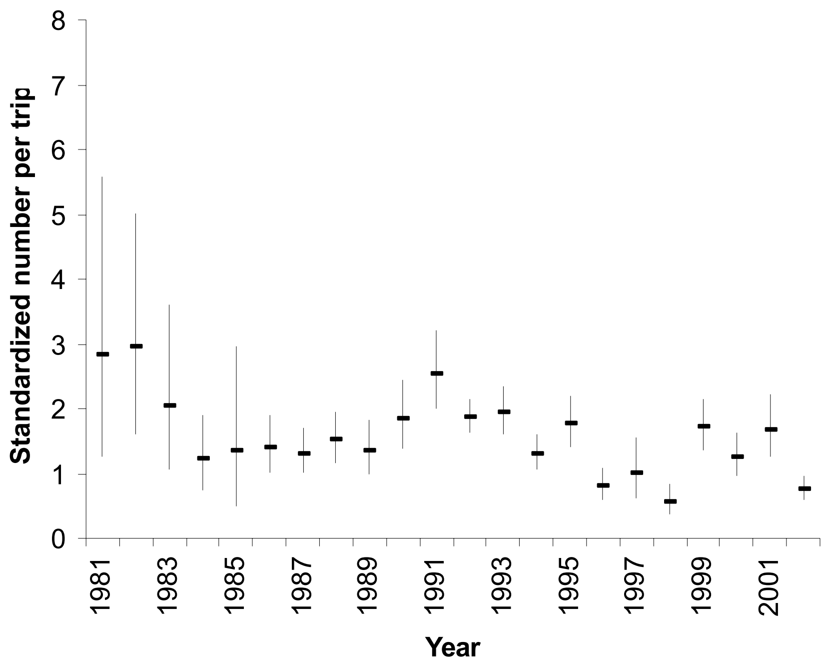


Figure 4.1.2.2.1 Annual number of fish caught per trip by MRFSS recreational anglers standardized with a generalized linear model using a negative binomial distribution. The vertical lines are 95% confidence intervals and the horizontal line is the mean.

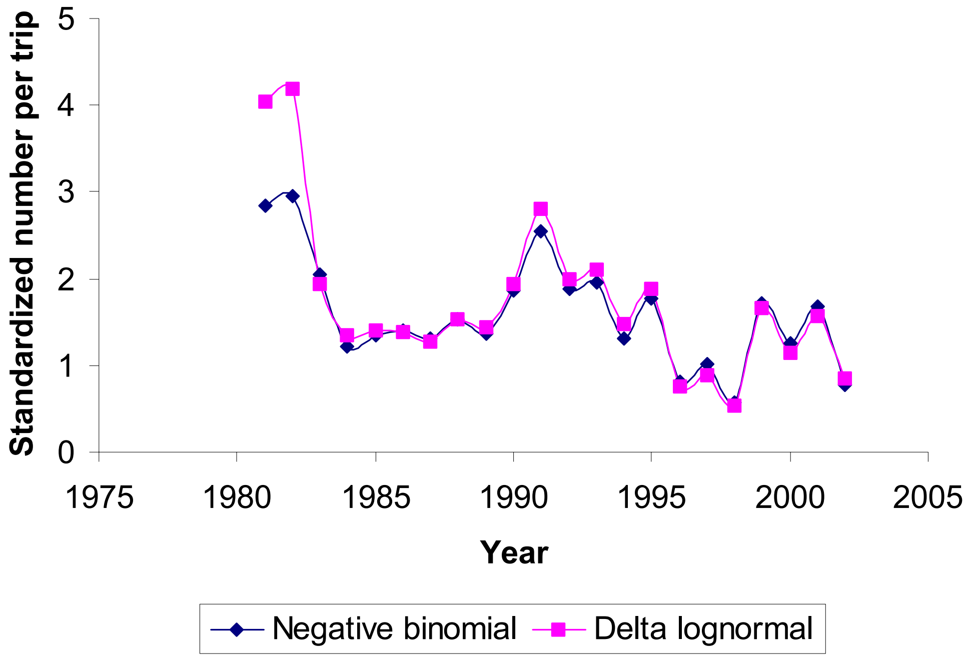


Figure 4.1.2.2.2 Comparison of the MRFSS recreational catch rates calculated with the negative binomial distribution and the delta-lognormal distribution.

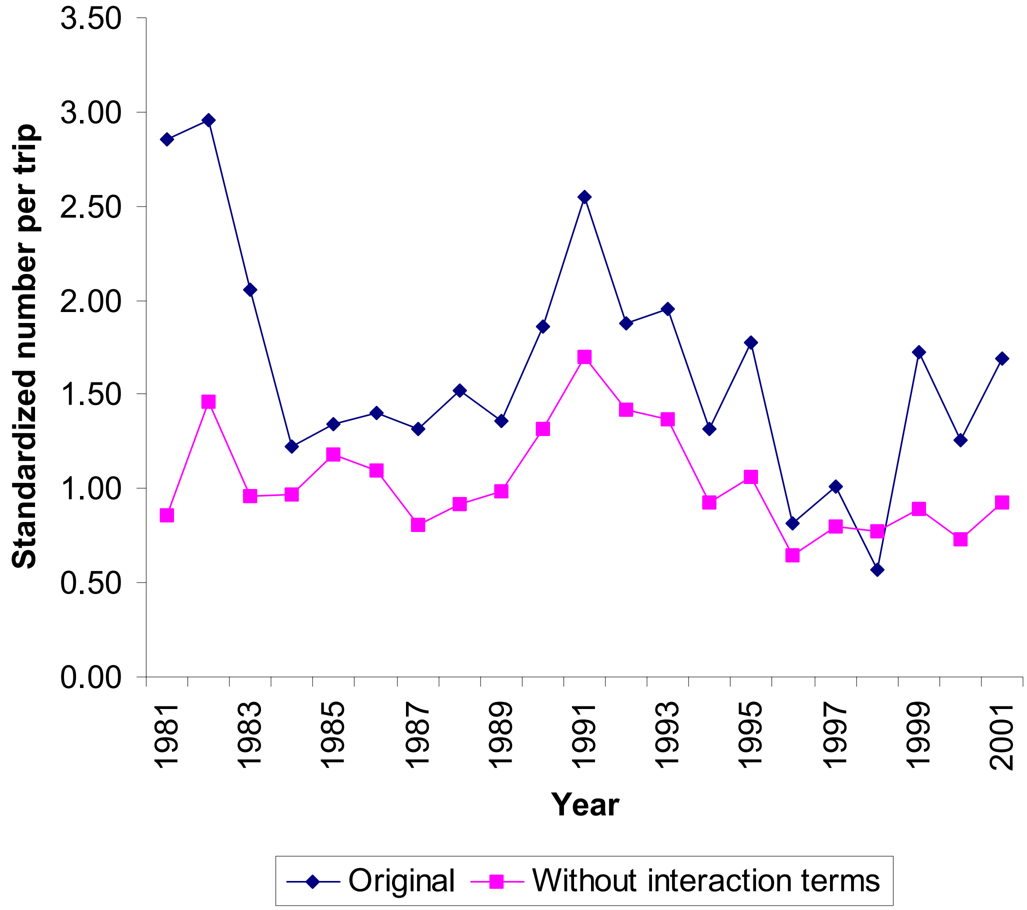
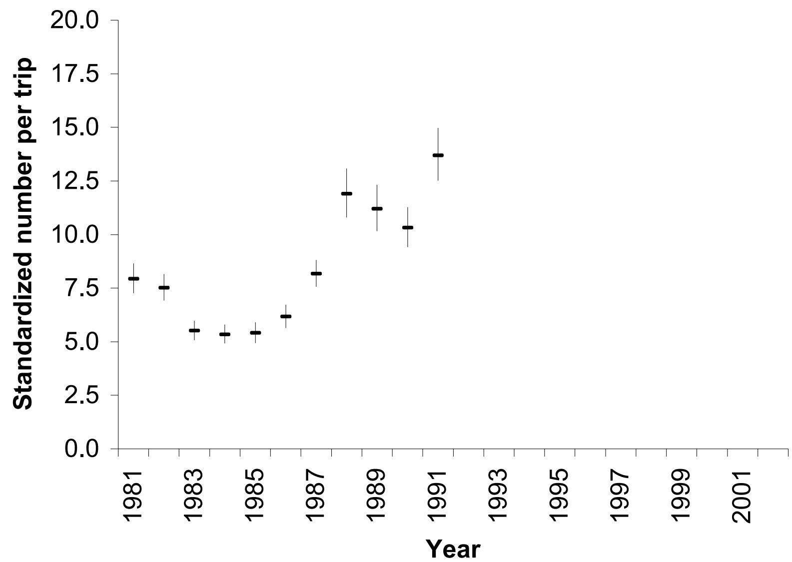


Figure 4.1.2.2.3. Comparison of the original MRFSS recreational index with the recalculated index using a delta-lognormal distribution that did not include interaction terms.

a.



b.

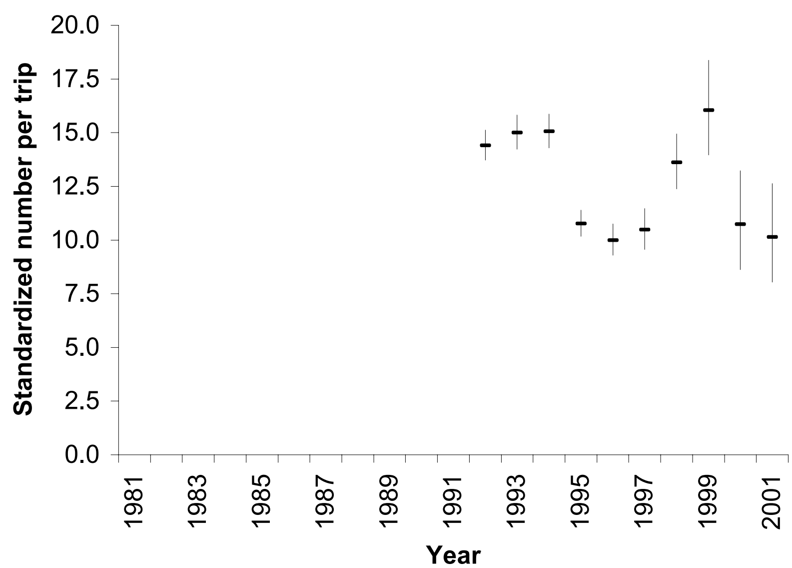
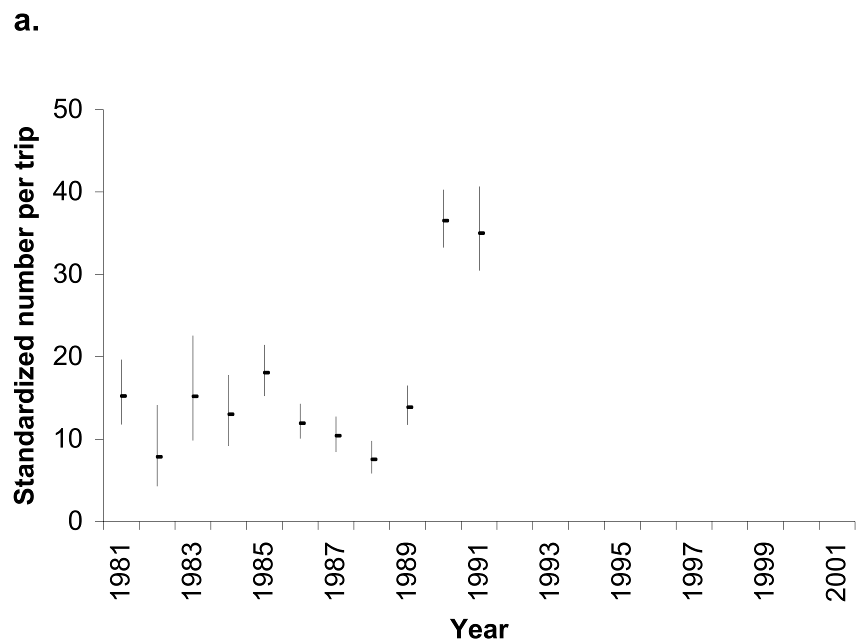


Figure 4.1.2.3.1 Annual number of fish landed per trip by headboat anglers standardized with a generalized linear model using a negative binomial distribution. Areas 11 and 12 only. Because of the aggregate bag limit, the headboat data were fit by time period: a) 1981-1991 and b) 1992-2001. The vertical lines are 95% confidence intervals and the horizontal line is the mean.



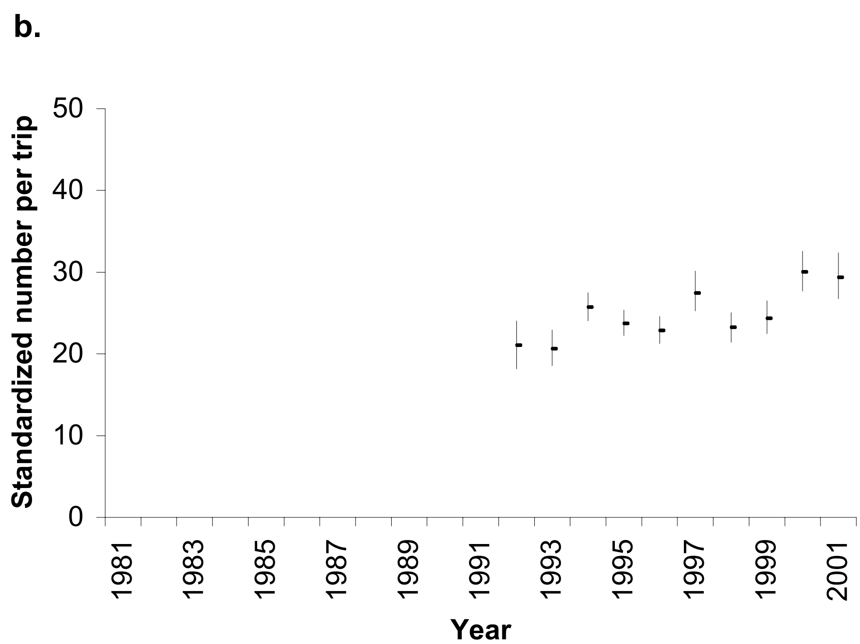


Figure 4.1.2.3.2 Annual number of fish landed per trip by headboat anglers on headboats "targeting" yellowtail snapper standardized with a generalized linear model using a negative binomial distribution. Areas 11 and 12 only. Because of the aggregate bag limit, the headboat data were fit by time period: a) 1981-1991 and b) 1992-2001. The vertical lines are 95% confidence intervals and the horizontal line is the mean.

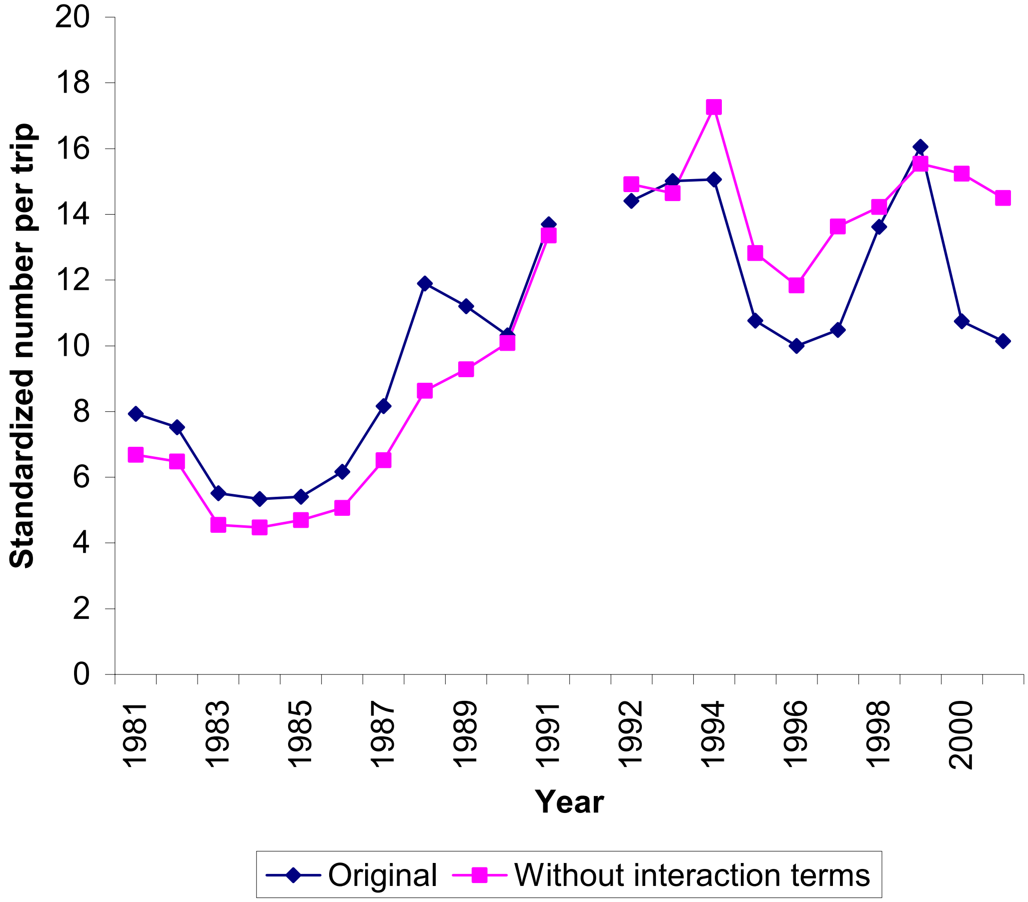


Figure 4.1.2.3.3. Comparison of the original headboat index with the recalculated index using a delta-lognormal distribution without interaction terms.

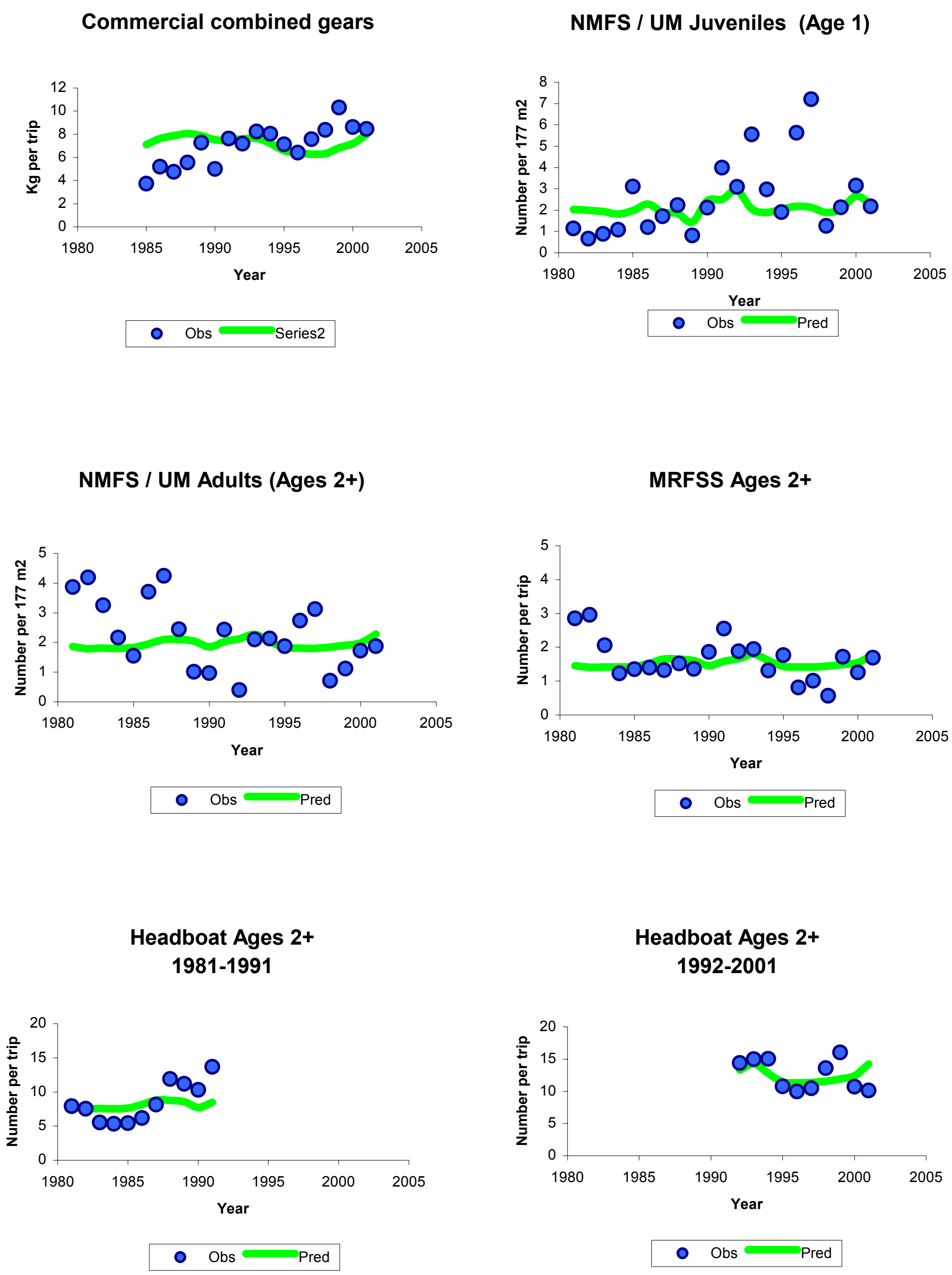


Figure 4.2.2.1.1 Observed and predicted values for the tuning indices used in the base run.

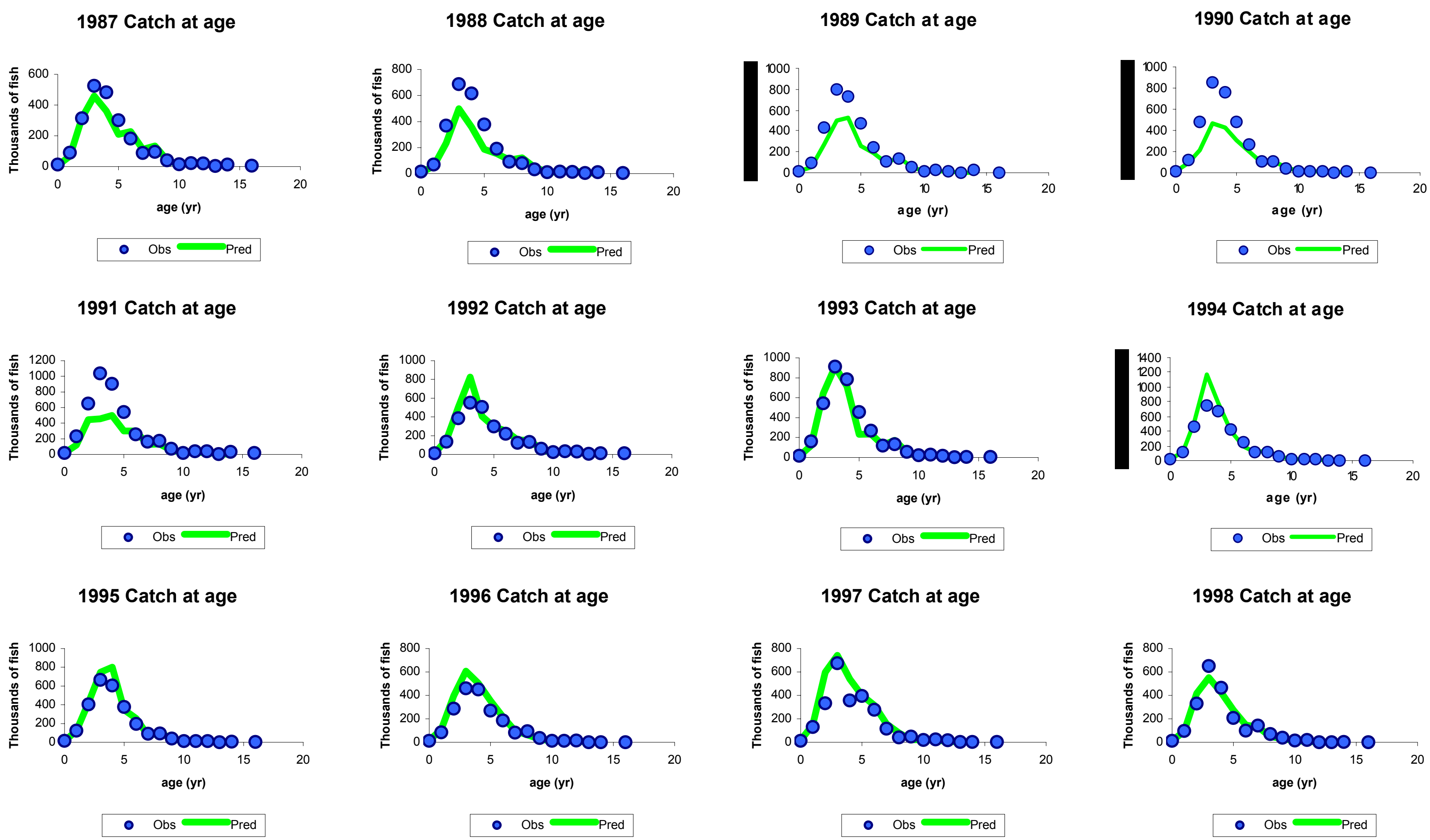


Figure 4.2.2.1.2 Comparison of observed versus predicted numbers of fish by age and year. Years 1987-1996 were down-weighted relative to the 1997-2001 because of their composite age-length keys.

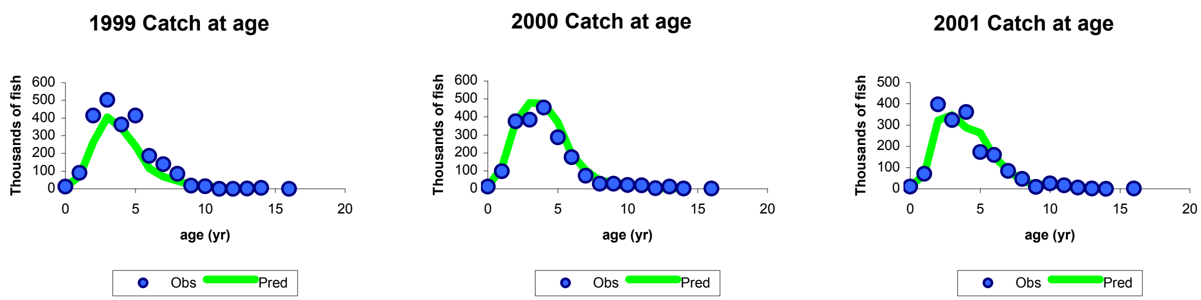


Figure 4.2.2.1.2 (Continued) Comparison of observed versus predicted numbers of fish by age and year. Years 1987-1996 were down-weighted relative to the 1997-2001 because of their composite age-length keys.

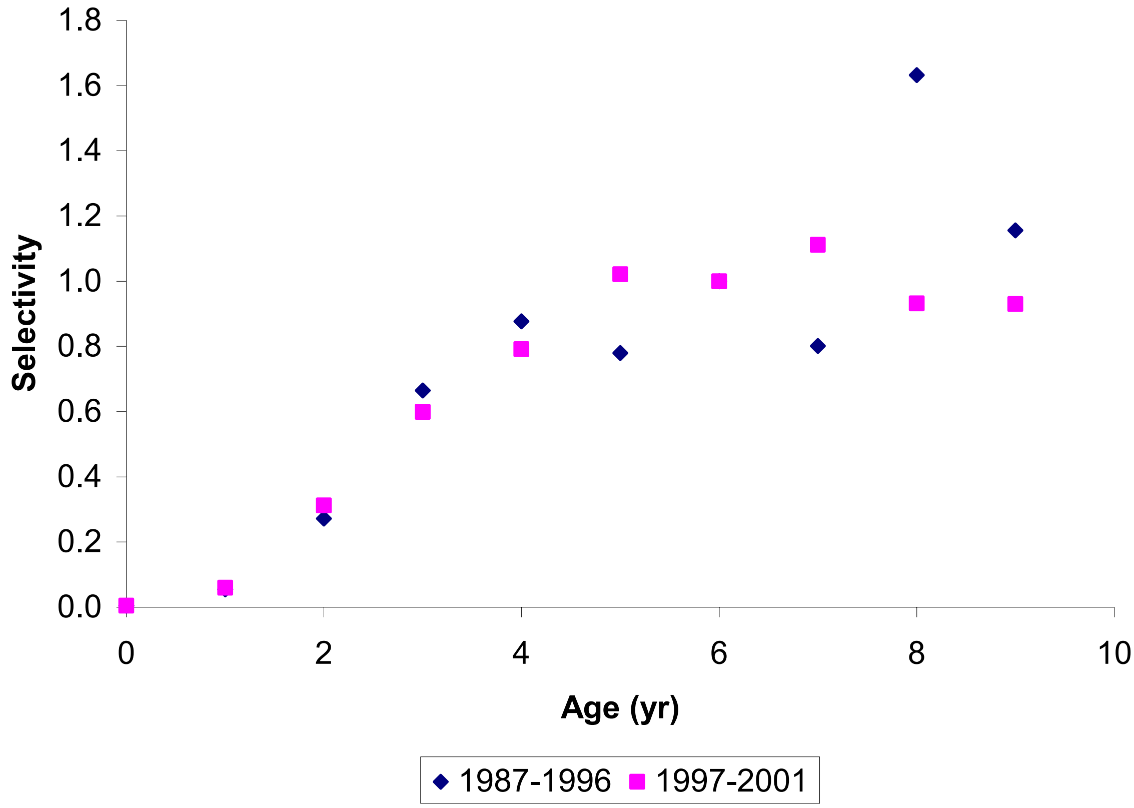


Figure 4.2.2.1.3 Selectivities by age for two time periods: 1987-1996 and 1997 and 2001.

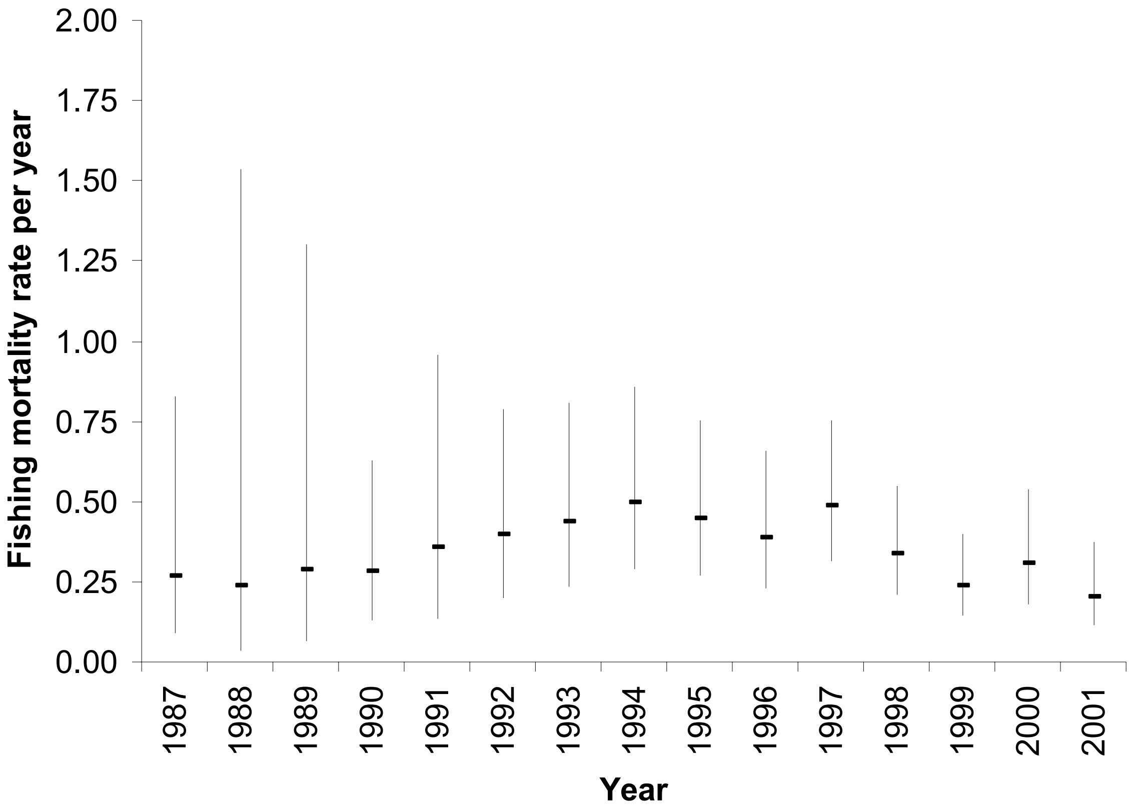


Figure 4.2.2.1.4 Annual fishing mortality rates on age-6 fish, the earliest age that is believed to be fully recruited. The vertical lines are 95% confidence intervals surrounding the mean mortality rates.

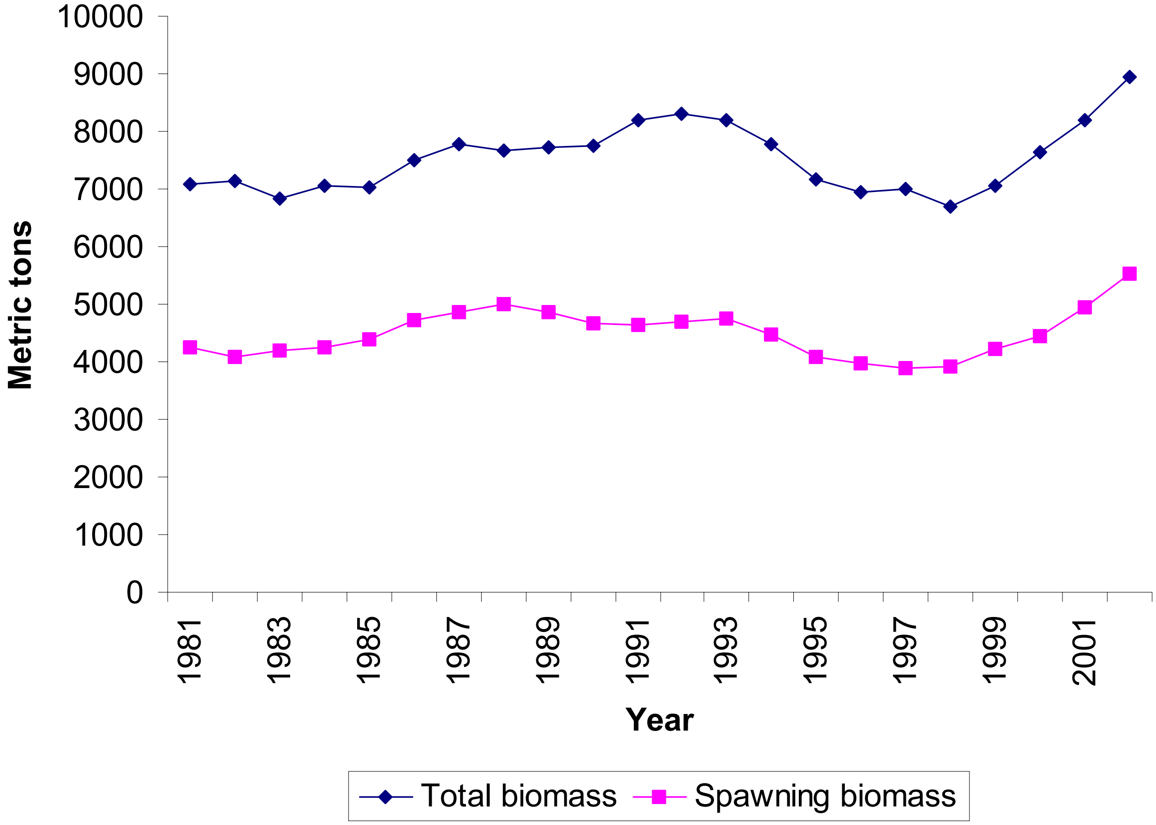


Figure 4.2.2.1.5 Estimated total biomass ad spawning biomass in metric tons by year.

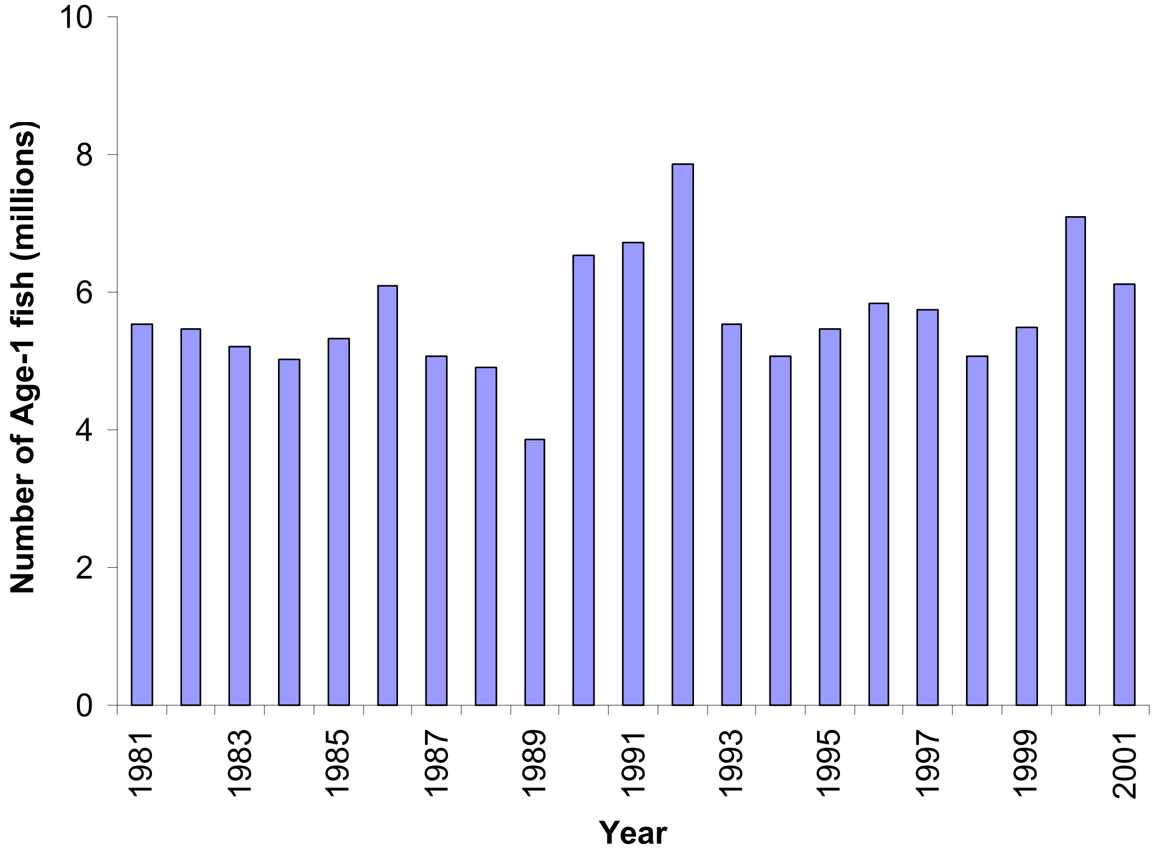


Figure 4.2.2.1.6 Recruitment of age-1 fish by year.

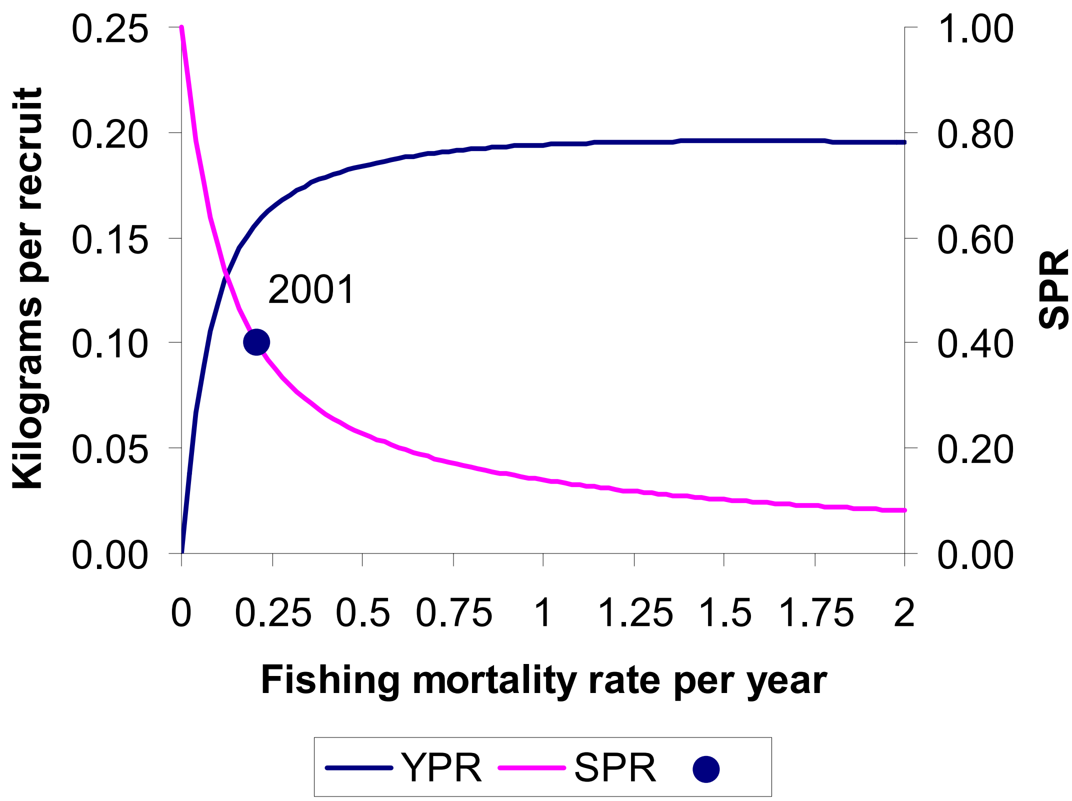


Figure 4.2.2.1.7 Yield per recruit and static spawning potential ratios with the 2001 value of SPR superimposed.

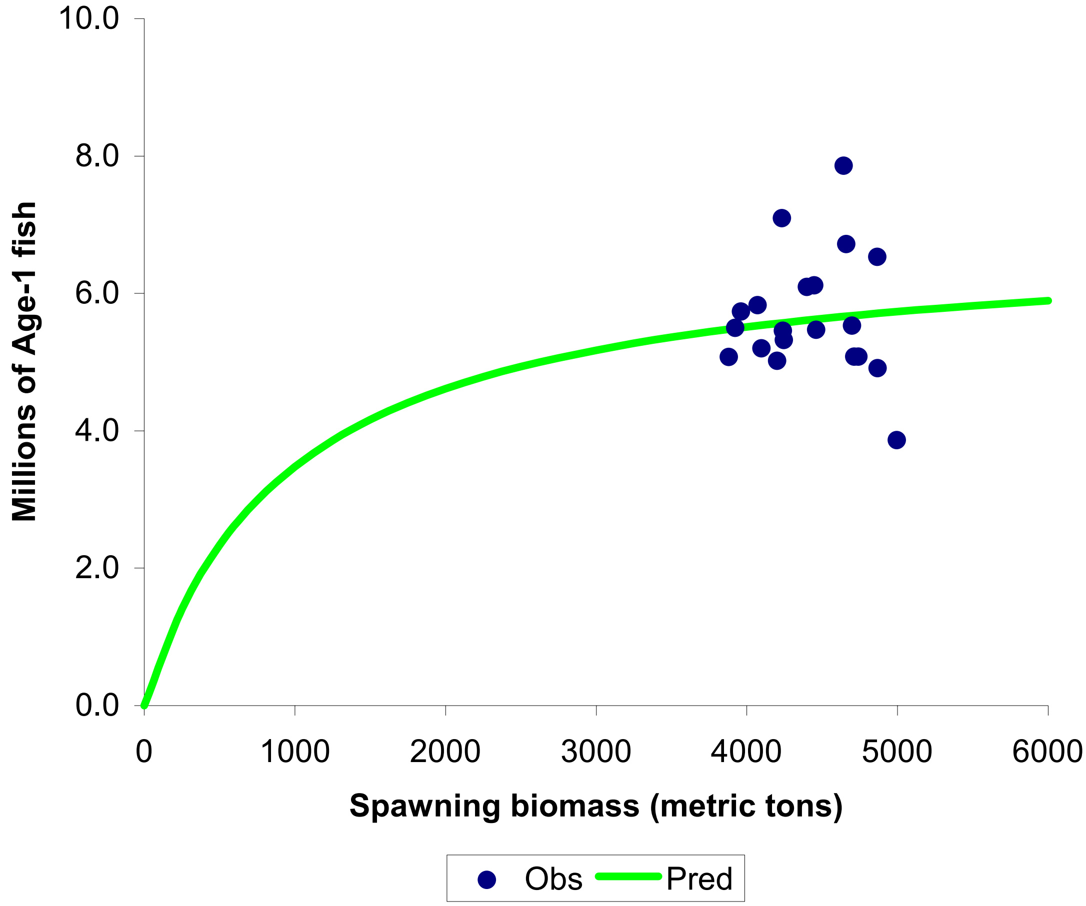


Figure 4.2.2.1.8 Spawning biomass and subsequent number of age-1 fish. The line is the predicted number of recruits given a steepness of 0.8.

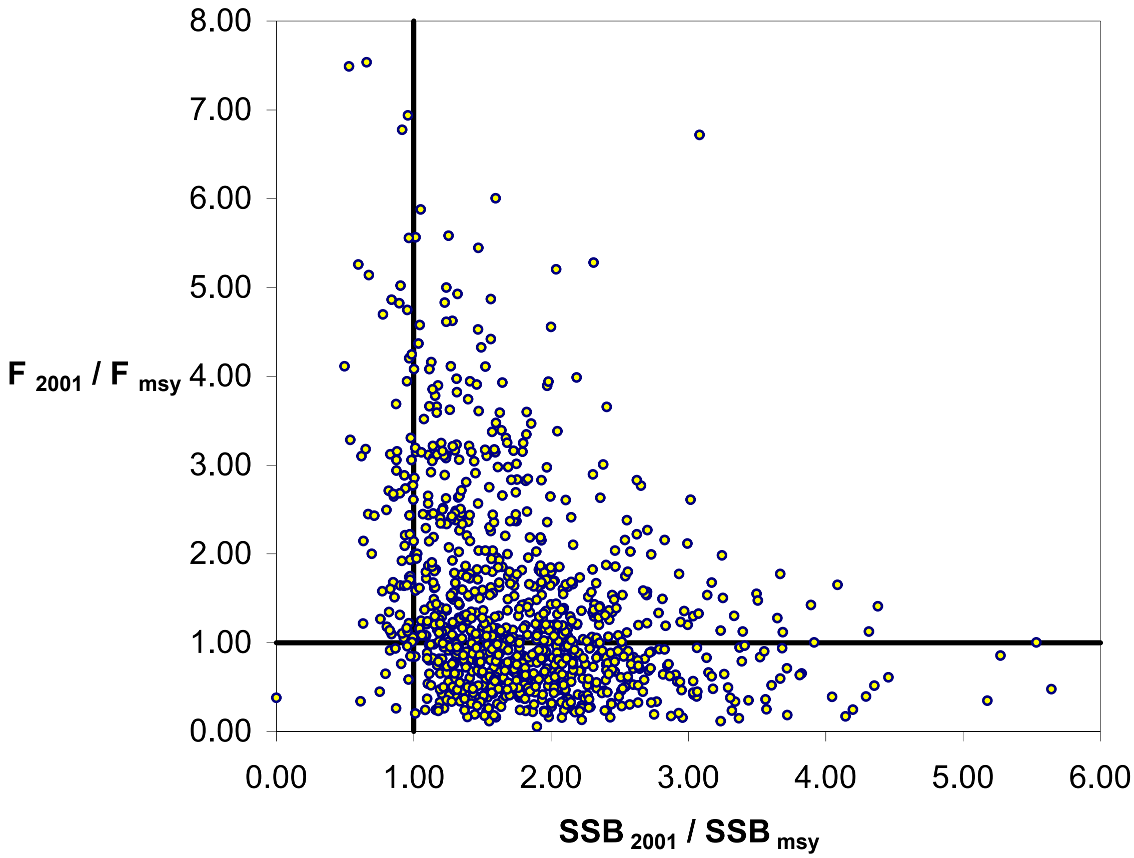


Figure 4.2.2.1.9 Phase plot of the ratios of F_{2001} / F_{msy} and SSB_{2001} / SSB_{msy}

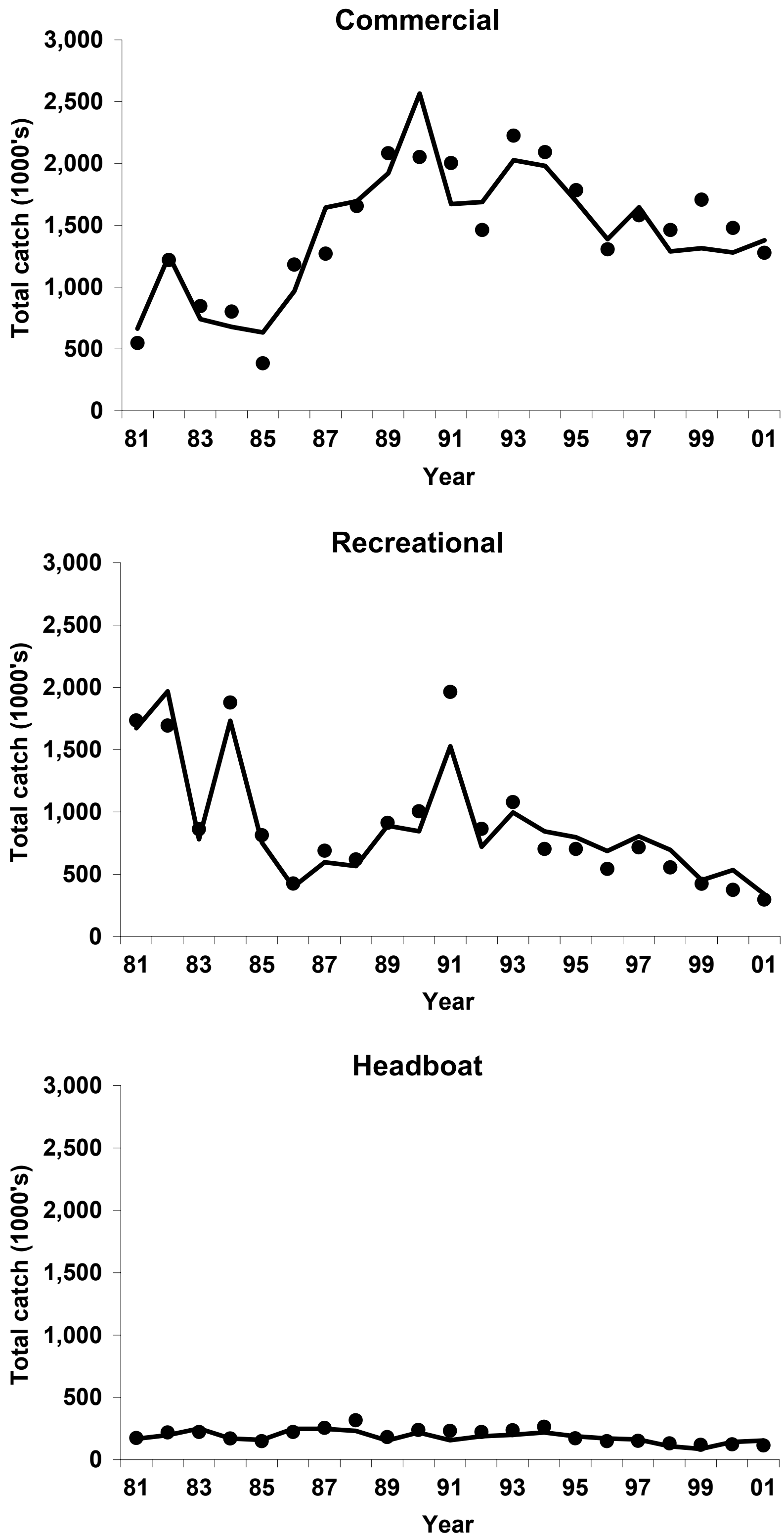


Figure 4.2.2.2.1. Observed (solid circle) and predicted (line) total catch (in thousands of fish) for the commercial, recreational, and headboat sectors of the yellowtail snapper fishery during 1981-2001.

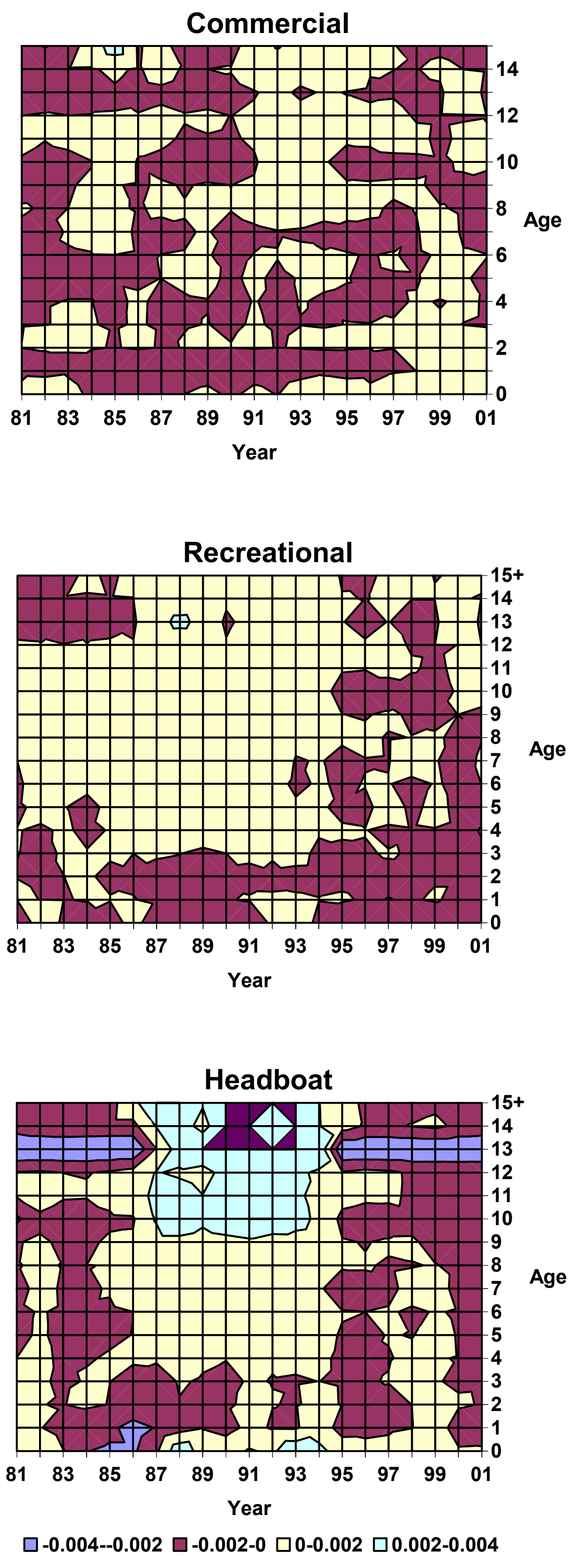


Figure 4.2.2.2.2. Model deviations from the observed catch at age for the commercial, recreational, and headboat sectors of the yellowtail snapper fishery during 1981-2001. In black-and-white, darker colors indicate underestimates and lighter colors indicate overestimates.

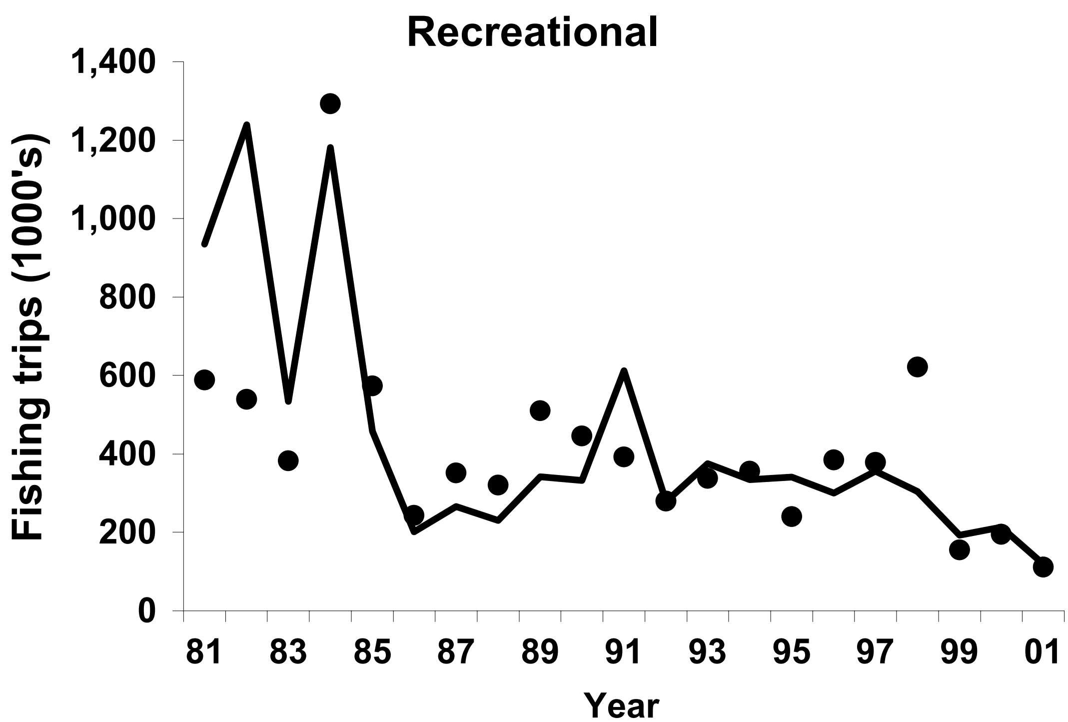
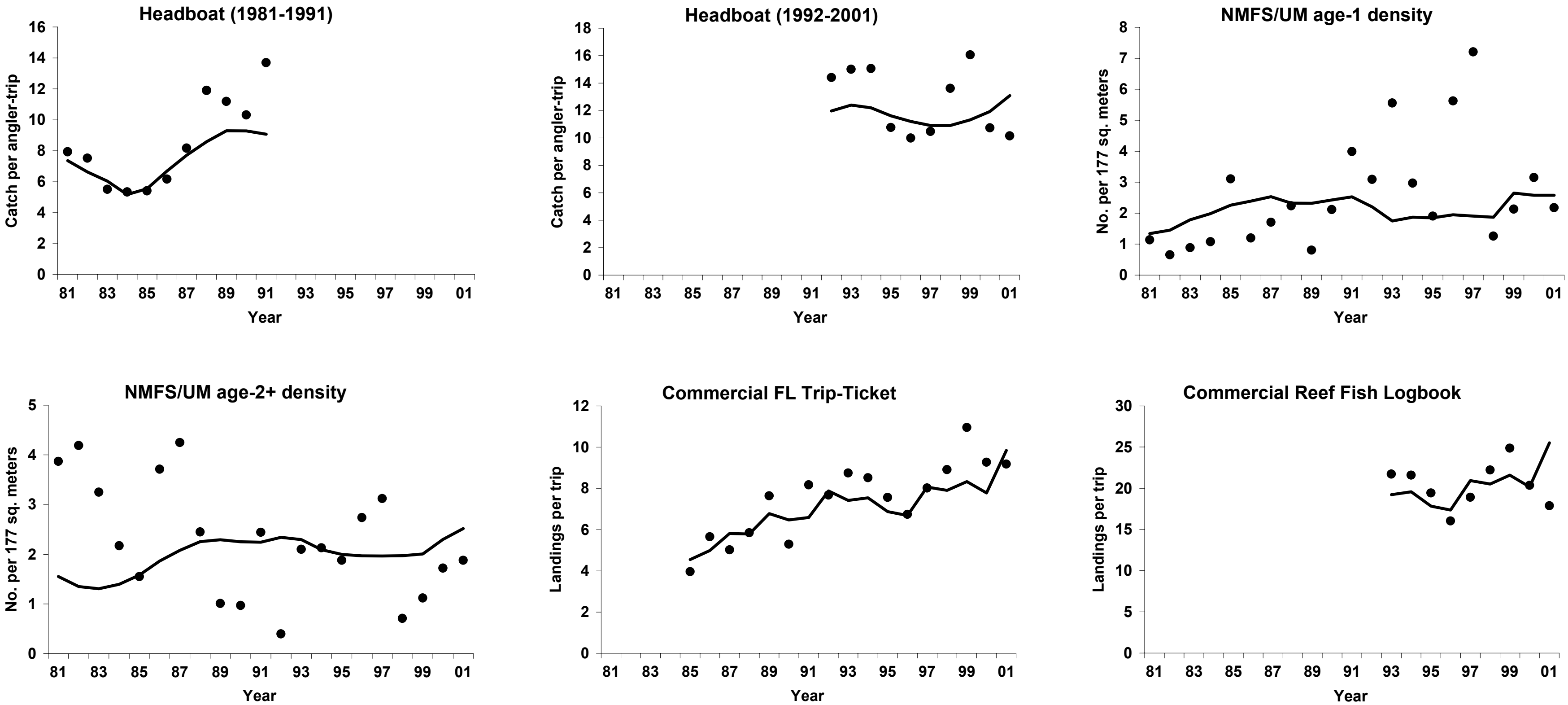


Figure 4.2.2.2.3. Observed (solid circle) and predicted (line) number of recreational fishing trips (in thousands of trips) directed at capturing yellowtail snapper during 1981-2001.



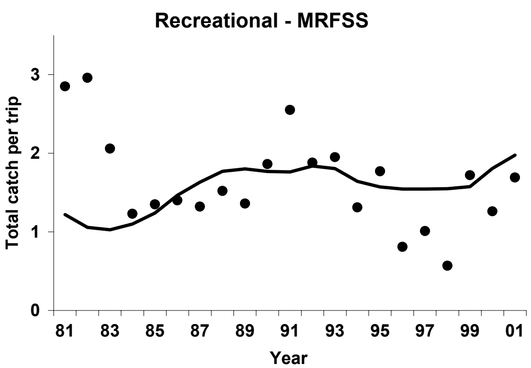


Figure 4.2.2.2.4. Observed (solid circle) and predicted (line) indices of abundance for yellowtail snapper during 1981-2001. See a description of the development of each index in the text above.

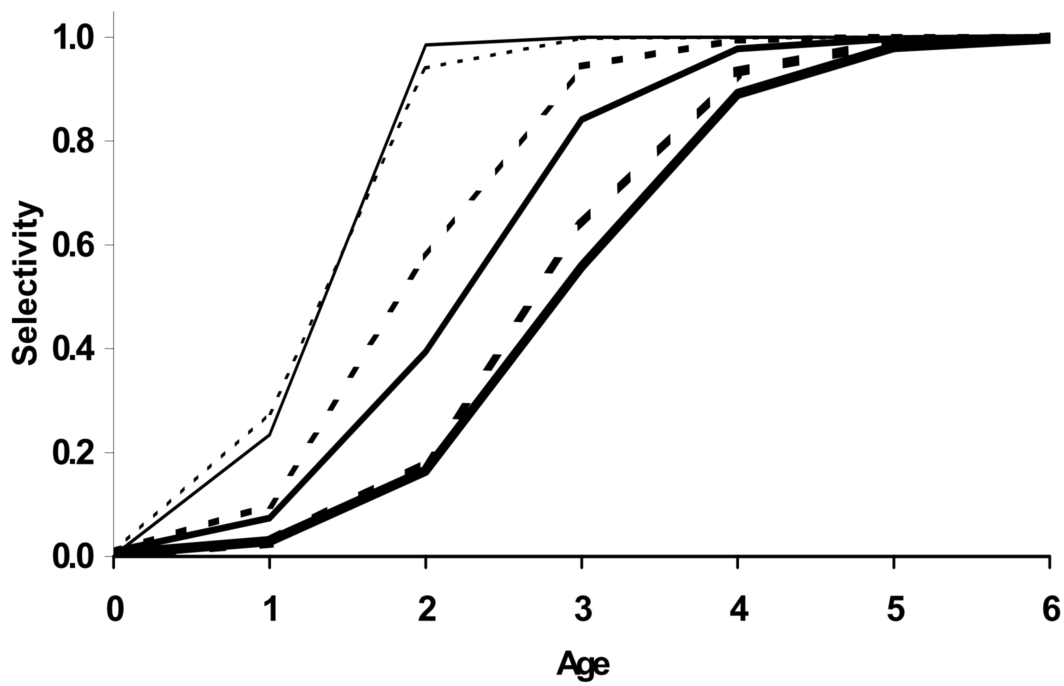


Figure 4.2.2.2.5. Vulnerability-at-age or selectivity curves for recreational (light lines), headboat (medium lines), and commercial (heavy lines) sectors of the yellowtail snapper fishery during each of two periods, 1981-1983 and 1984-2001. The dashed lines indicated selectivity curves for the 1981-1983 period and solid lines indicated selectivity curves for the more recent 1984-2001 period.

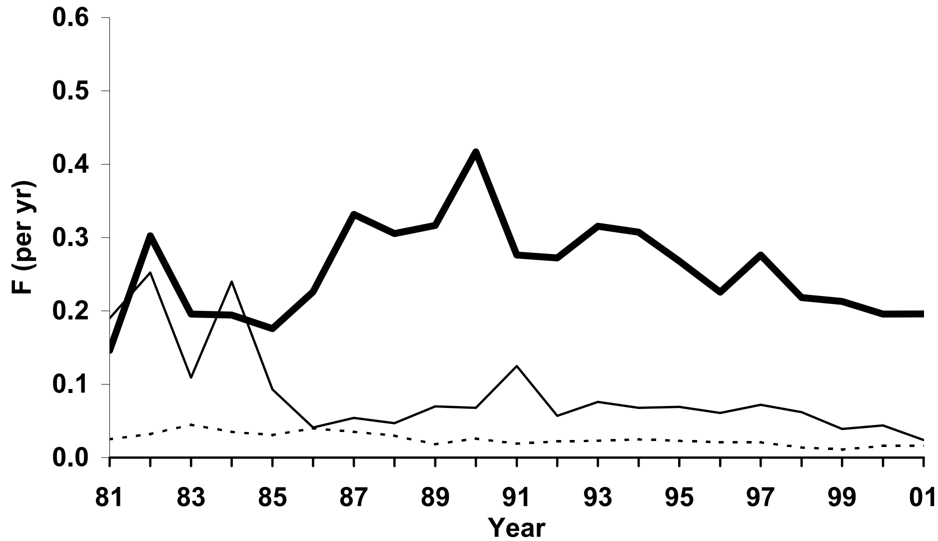


Figure 4.2.2.2.6. Estimated instantaneous fishing mortality rate (yr^{-1}) on yellowtail snapper attributed to each sector of the fishery during the period 1981-2001. Annual rates are given for the commercial sector (heavy line), the recreational sector (thin line), and the headboat sector (dashed line).

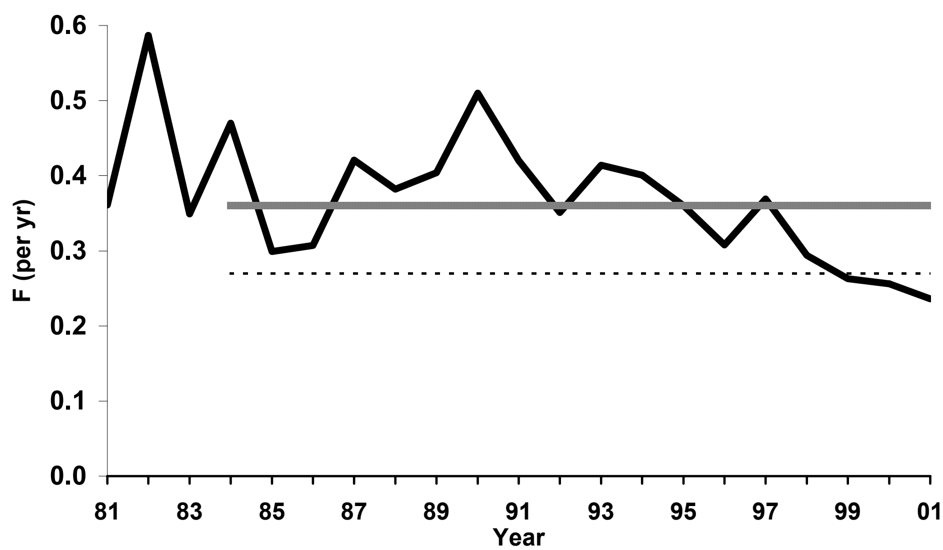


Figure 4.2.2.2.6a. Estimated total instantaneous fishing mortality rate (yr^{-1}) on yellowtail snapper during the period 1981-2001. The horizontal lines indicate the target fishing mortality at maximum sustainable yield (F_{msy}, thick stippled line) and the threshold fishing mortality at $0.75F_{msy}$ (dashed line)

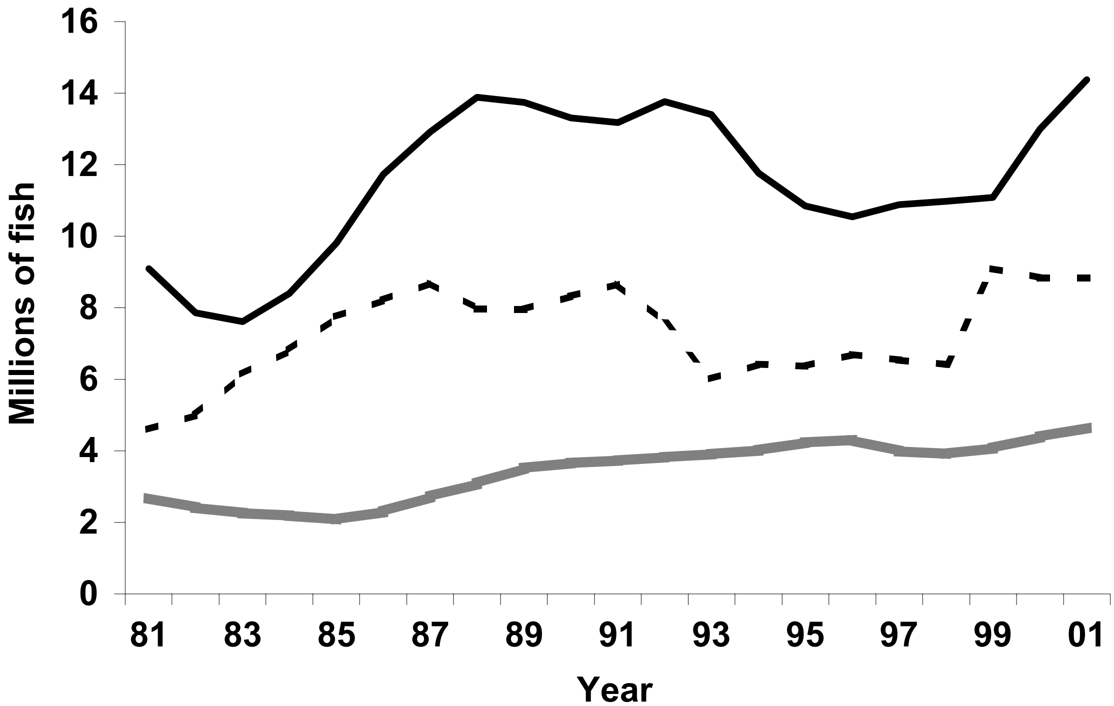


Figure 4.2.2.2.7. Estimated average annual abundance of age-0 (dashed line) and ages-1 (solid line), and ages 4+ (heavy stippled line) yellowtail snapper during 1981-2001.

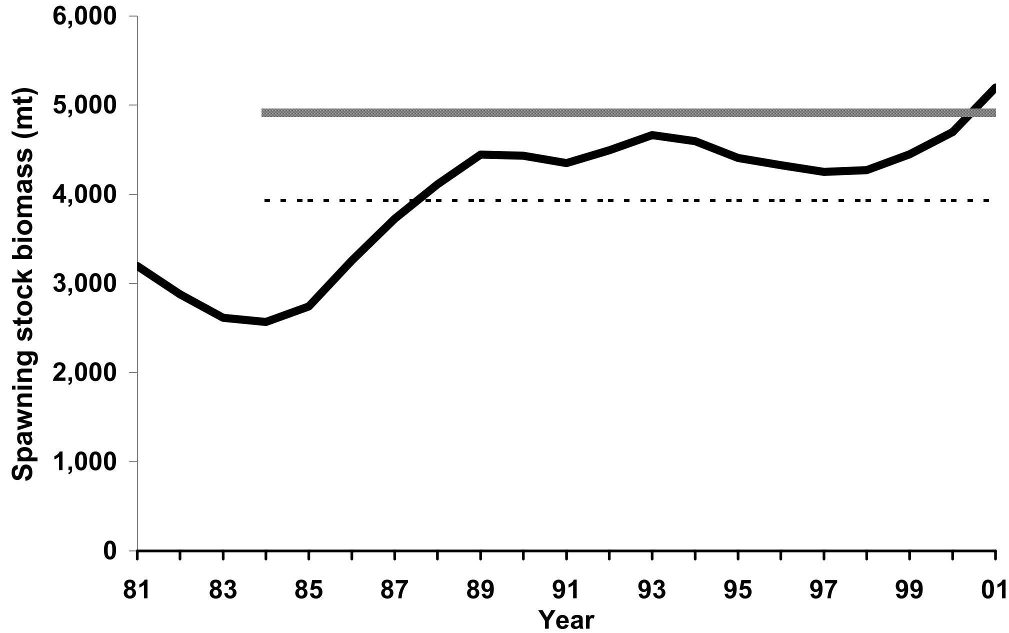


Figure 4.2.2.2.8. Estimated average spawning stock biomass of yellowtail snapper each year during 1981-2001. The horizontal lines indicate the target spawning stock biomass at maximum sustainable yield (SSB_{msy}, thick stippled line) and the threshold spawning stock biomass at 1-M (or 0.80 in this base model case) of SSB_{msy} (dashed line).

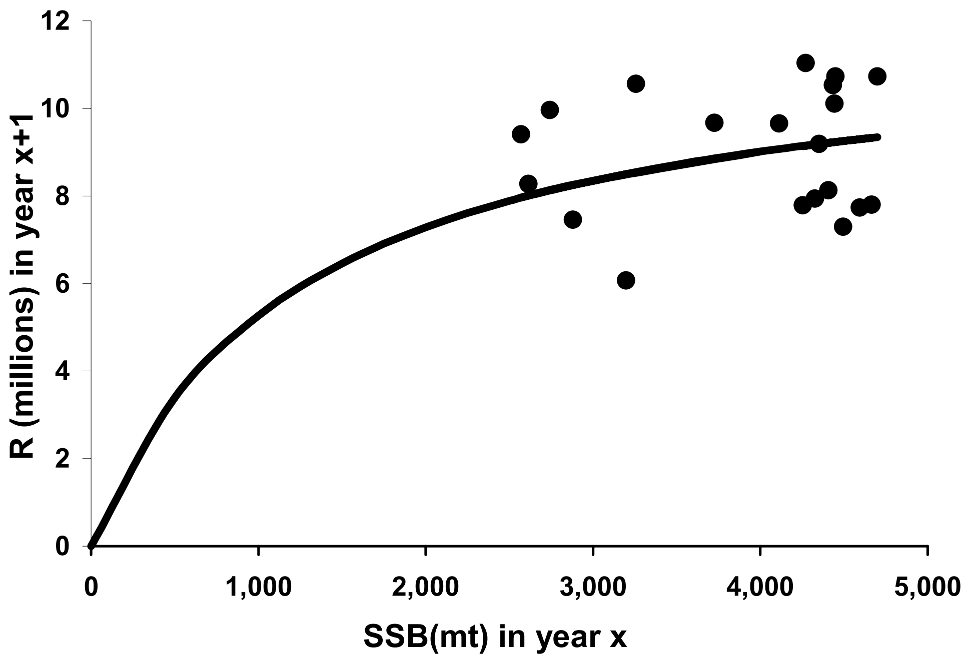


Figure 4.2.2.2.9. Base-model assumption of the relationship between average spawning stock biomass of female yellowtail snapper and the subsequent year's number of recruits (solid line). The "observed" data (solid circles) are based on model estimates of recruitment (year+1) and spawning stock biomass (year) where year equals 1981-2000.

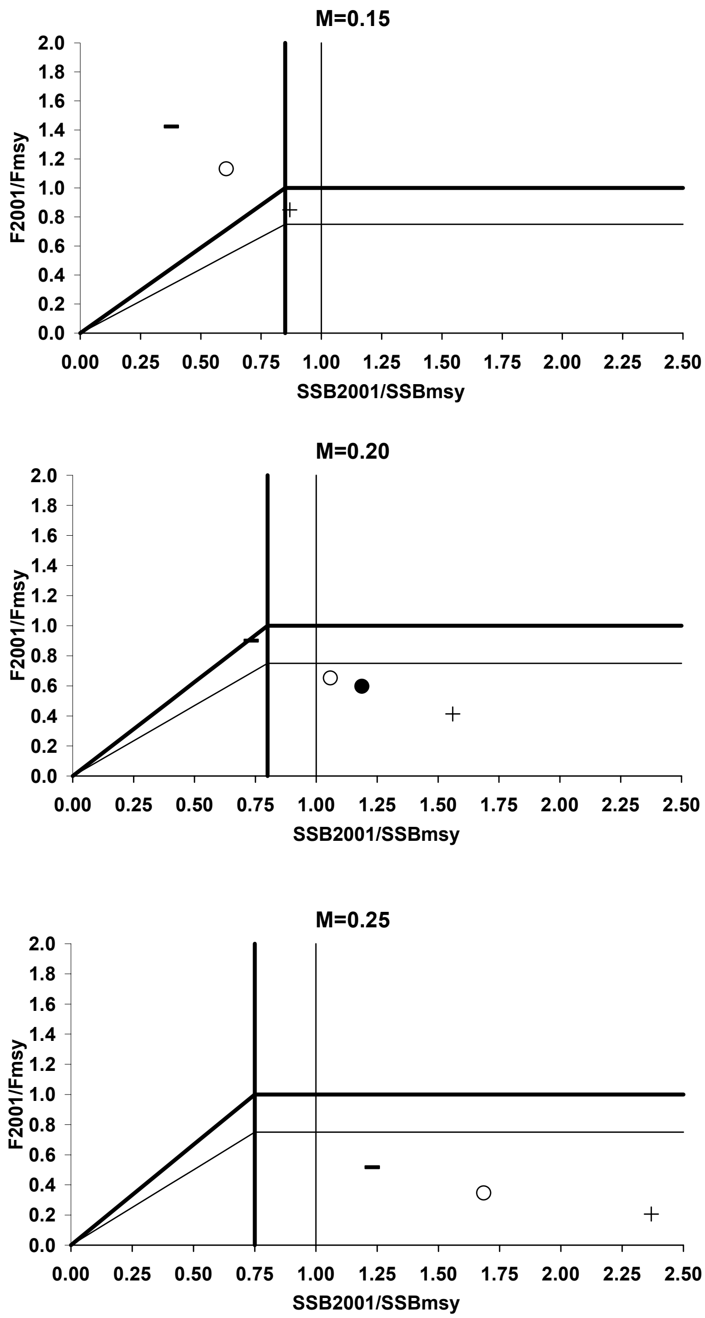
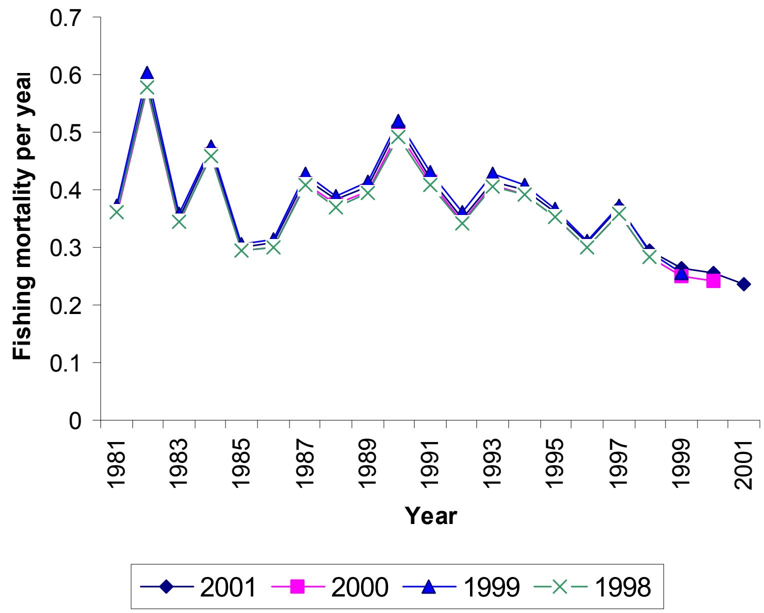


Figure 4.2.2.2.10. Control rule plots for yellowtail snapper modeled under assumptions about the value of natural mortality (M=0.15, M=0.20, and M=0.25 yr^{-1}) and value of steepness [h=0.7('-' symbol), h=0.8 ('o' symbol), and h=0.9 ('+' symbol)]. An additional model run at M=0.20/h=0.8 utilizing 'targeted' catch per unit effort data to develop the headboat and commercial logbook indices. Heavy lines indicate threshold level boundaries and light lines indicate target level boundaries

a.



b.

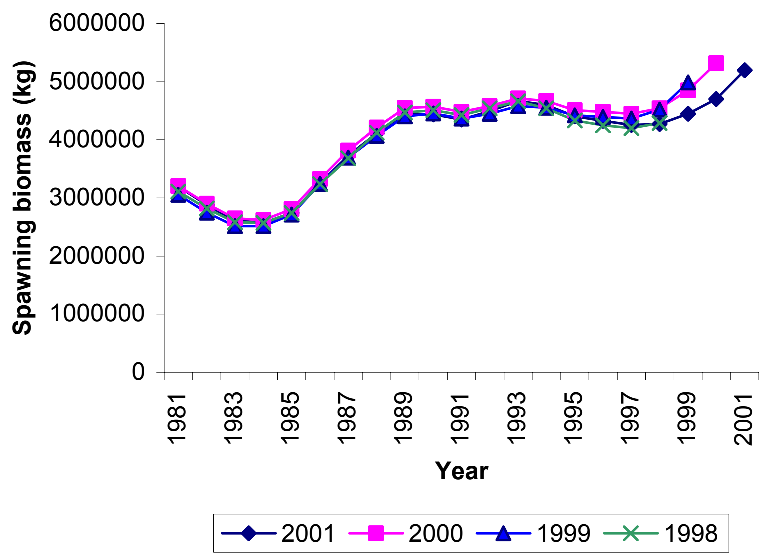


Figure 4.2.3. Retrospective analyses using terminal years of 1998 through 2001 with the fleet-specific model for fishing mortality rates (a) and spawning biomass (b).

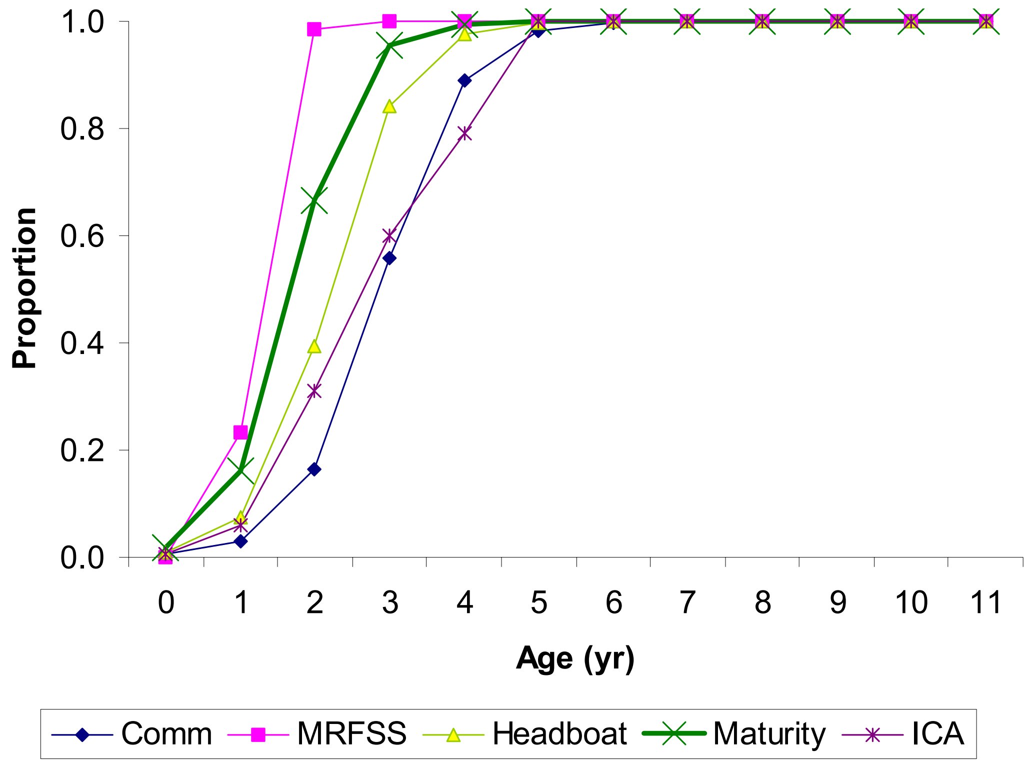


Figure 4.3. Comparison of selectivity by fishery from the fleet-specific model and from the ICA model together with proportion mature by age.

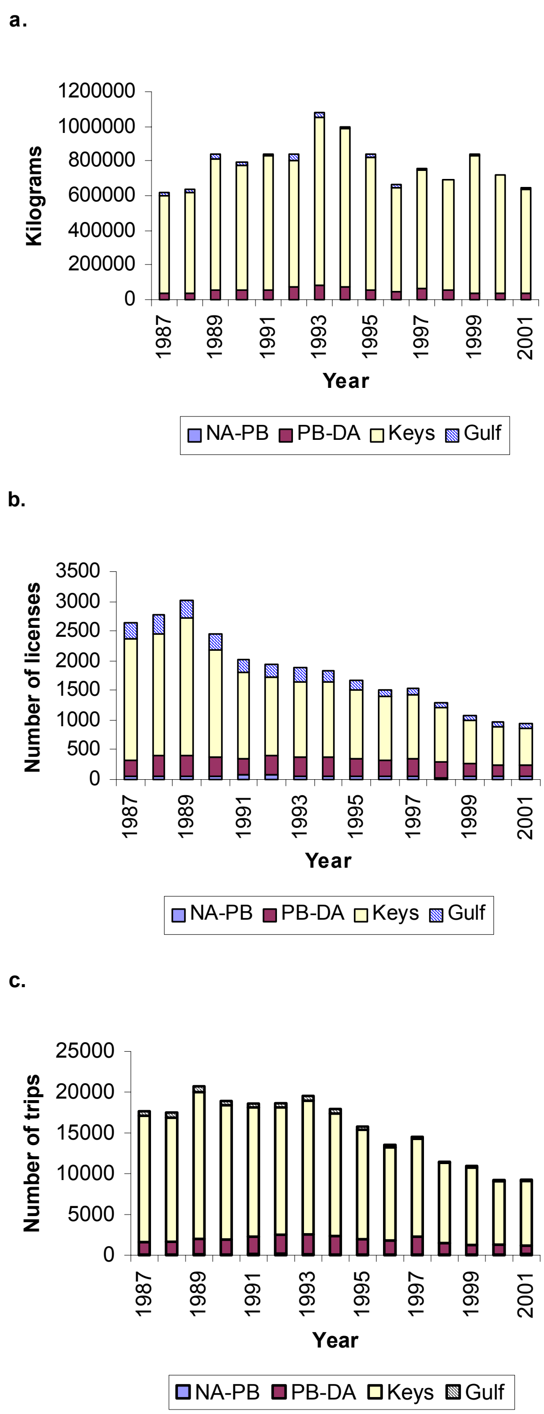


Figure 4.5.1. Yellowtail snapper commercial landings (a), numbers of Saltwater Products licenses (b), and commercial trips (c) by subregion. NA-PB -- counties between Georgia border and Palm Beach county, PB-DA -- Palm Beach through Miami-Dade counties, Keys -- Monroe county, and Gulf of Mexico -- North and west of the Keys.

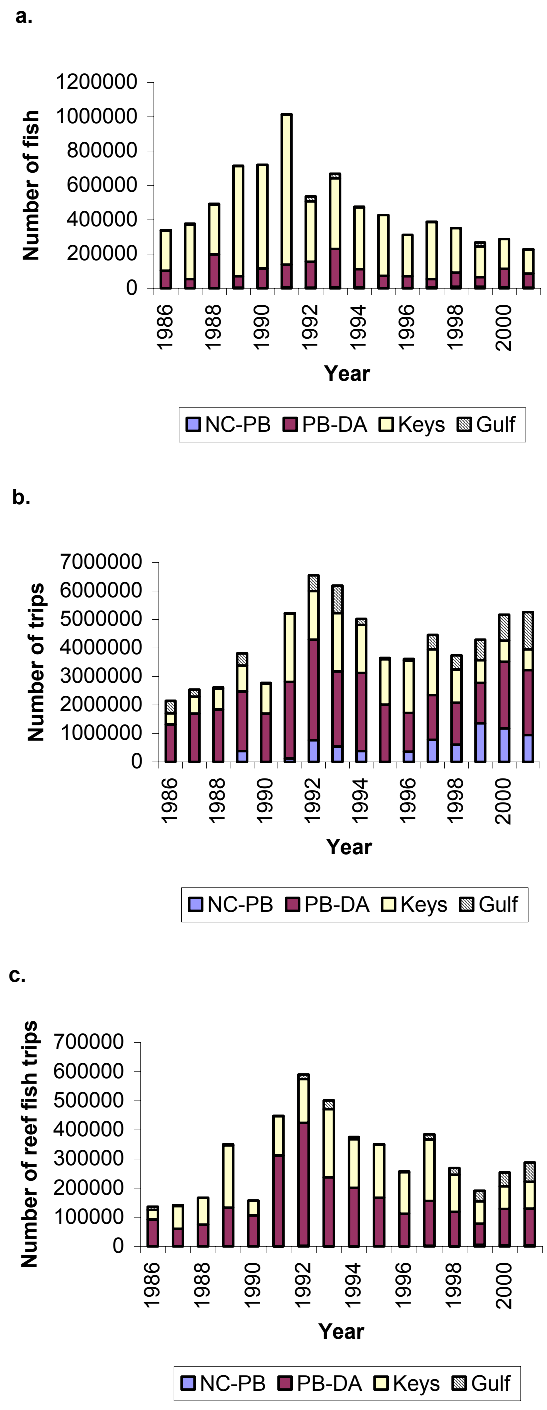
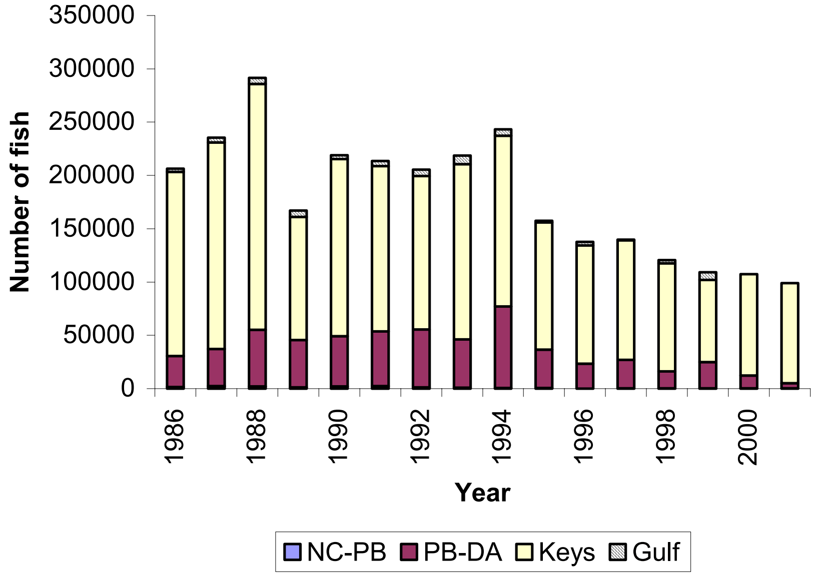


Figure 4.5.2. Yellowtail snapper recreational (MRFSS) landings (a), numbers of trips from telephone survey (b), and the estimated number of reef fish trips (c) by subregion. NA-PB -- counties between Georgia border and Palm Beach county, PB-DA -- Palm Beach through Miami-Dade counties, Keys -- Monroe county, and Gulf of Mexico -- North and west of the Keys.

a.



b.

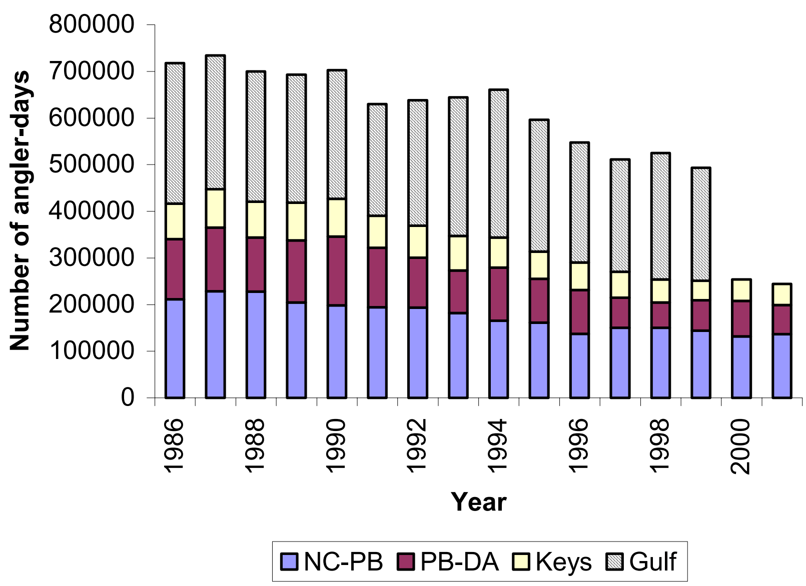


Figure 4.5.3. Yellowtail snapper headboat landings (a) and the number of headboat (b). NA-PB -- counties between Georgia border and Palm Beach county, PB-DA -- Palm Beach through Miami-Dade counties, Keys -- Monroe county, and Gulf of Mexico -- North and west of the Keys.

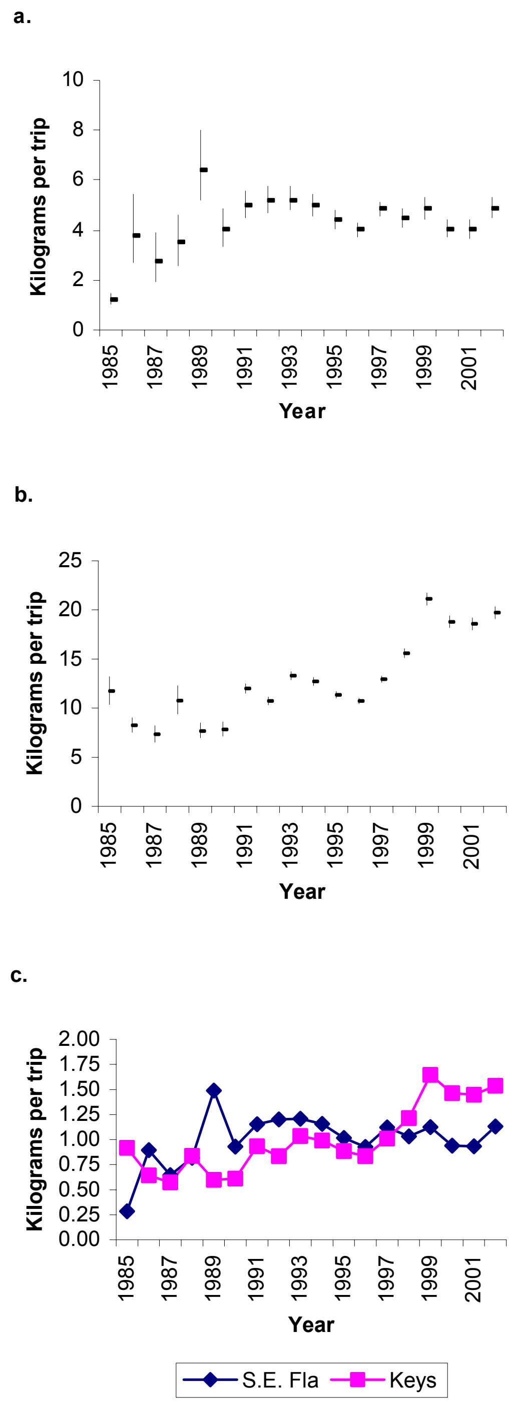


Figure 4.5.4. Standardized commercial catch rates (kilograms per trip) with combined gears from Southeast Florida (a) and Keys (b). The vertical lines are the 95% confidence intervals. Also included is a plot of the two series scaled to their respective means (c).

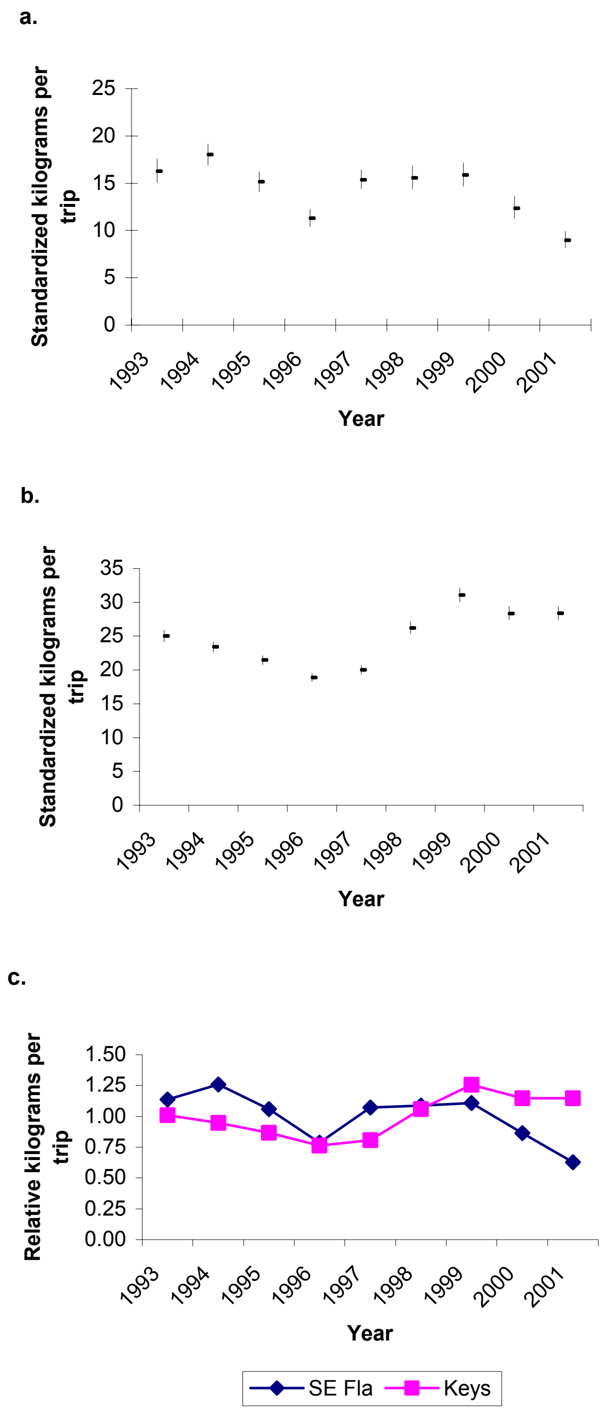
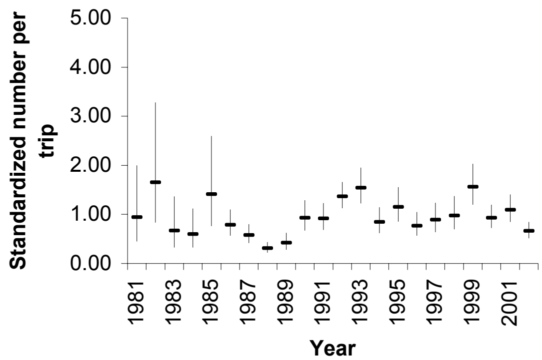
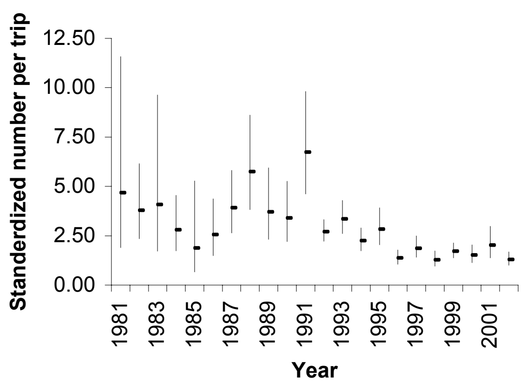


Figure 4.5.5. Standardized commercial catch rates (kilograms per trip) from logbooks using hook-and-line gear from Southeast Florida (a) and Keys (b). The vertical lines are the 95% confidence intervals. Also included is a plot of the two series scaled to their respective means (c).

a.



b.



c.

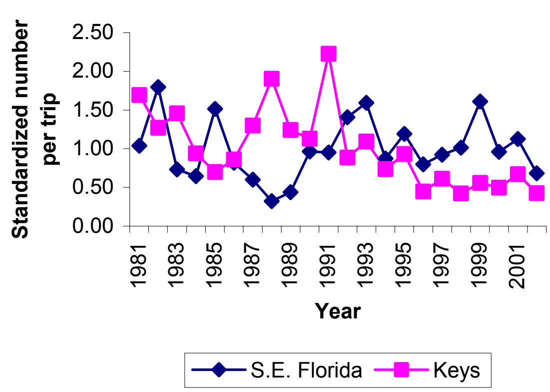


Figure 4.5.6. Standardized recreational (MRFSS) catch rates (total number of fish per trip) using hook-and-line gear from Southeast Florida (a) and Keys (b). The vertical lines are the 95% confidence intervals. Also included is a plot of the two series scaled to their respective means (c).

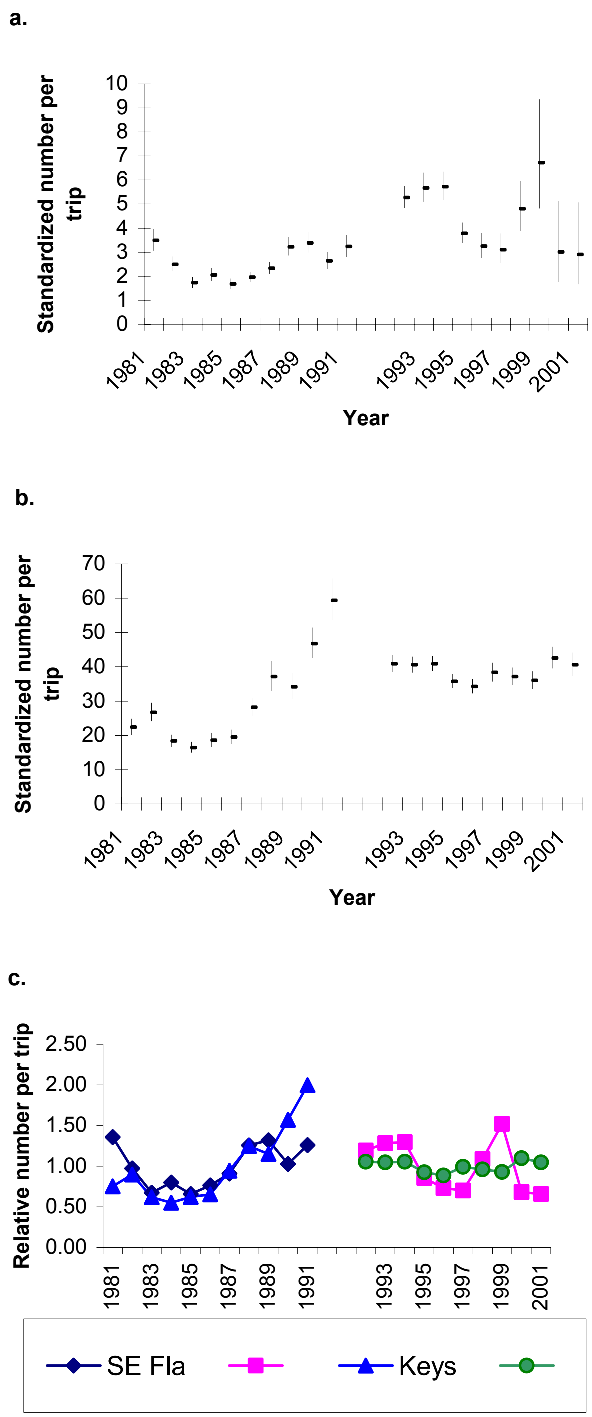


Figure 4.5.7. Standardized headboat catch rates (reported number of fish per trip) using hook-and-line gear from Southeast Florida (a) and Keys (b). The vertical lines are the 95% confidence intervals. Also included is a plot of the two series scaled to their respective means (c).

SEDAR

SouthEast Data, Assessment, and Review

Stock Assessment Consensus Summary

Yellowtail Snapper
in the
Southeast United States

Prepared by the SEDAR 3
Stock Assessment Review Workshop

SEDAR Peer Review of Yellowtail Snapper Assessment, with comments on Goliath Grouper

Tampa, Florida

July 28-31, 2003

I General

The SEDAR Review Panel (Annex 1) accepted its terms of reference as listed (Annex 2). At the suggestion of the Fishery Management Councils and after discussion, the Panel decided to include some discussion on goliath grouper in addition to its in-depth discussion on the yellowtail snapper assessment and stock status. This is the first stock assessment that has been carried out on yellowtail snapper. Following the recommendation of the SEDAR Data Workshop, yellowtail snapper in the Gulf of Mexico, South Atlantic, and Florida state waters were considered to be a single stock that crosses jurisdictional boundaries. Yellowtail snapper in the Caribbean were considered to be a separate stock for purposes of the current assessment and were therefore excluded. However, research into the genetic relationships among yellowtail snapper from various areas is continuing, and the definition of the stock may change in future.

The Panel was satisfied with how the data were used in the stock assessment of yellowtail snapper and with the choice of models for stock assessment. However, the Panel noted a number of issues that might improve the quality of the next assessment. These are addressed under Section II. The Panel included stakeholders (fishers and environmental representatives) among its members, and felt that information on the stock from their perspective may be germane to the conclusions. Inputs from the stakeholders, specifically those related to the quality of the data used and decisions on stock status now against historical levels, are summarized in Section III.

This report forms part of a suite of documents relating to this particular SEDAR process (the third). Reports from the Data Workshop and from the Stock Assessment Workshop, which preceded this review, were made available on a website and CD, and were made available to all Panel members before or during the meeting. This report, and the summary stock status and management considerations report, are targeted for submission to the Councils by 15 August 2003, as are the two external evaluators' reports (chair, Payne; technical reviewer, Francis), which will be submitted to the CIE.

II Assessment Issues Relating to Yellowtail Snapper

A presentation of the draft yellowtail snapper assessment[1] was made by Dr Robert Muller, one of the assessment's co-authors. Based on the presentation, the following issues were noted for discussion and resolution:

[1] Muller, R. G., Murphy, M. D., de Silva, J., and Barbieri, L. R. 2003. A stock assessment of yellowtail snapper, *Ocyurus chrysurus*, in the Southeast United States. Draft Report submitted to the National Marine Fisheries Service and the Gulf of Mexico Fishery Management Council as part of the Southeast Data, Assessment, and Review (SEDAR) III. St Petersburg, FL; Florida Marine Research Institute: 182 pp.

1. **Discard mortality rate.** Discard mortality rates of 28% for the commercial fishery and 30% for the recreational fishery were used in the assessment. The former figure was derived from data from logbooks from just 24 commercial fishers during the period 2001-2002, and the latter figure was simply assumed. The Panel felt that the paucity of data on this issue was unsatisfactory. Fishers on the Panel indicated that, based on their own experiences and observations, these mortality rates were too high.

The Panel also noted that the use of incorrect discard rates would have an unknown effect on point estimates of biomass and fishing mortality, However, as long as there had been no trend in discard mortality over time, there would be relatively little effect on ratios such as F/F_{MSY} and B/B_{MSY}, which are used to judge relative stock status.

2. **General Linear Model (GLM).** The CPUE indices used in the assessment were produced using GLM analyses. Some of those analyses included interaction terms between year and other factors (e.g. region and month). This means that each GLM produced many time trends in CPUE (e.g. one for each region, or for each month) rather than just one. If only one time trend is to be used in the assessment, then it should be a data-weighted average of these. However, it appears that the software used in the GLM analyses presented either just one of these trends or the simple average of them. The Panel asked that the GLM analyses be redone without any year interactions. This produced a markedly different MRFSS index, and a slightly steeper trend for the commercial CPUE. The Panel felt that this produced more representative indices, and these were then used in the new model runs.

3. **Model choice.** The Panel agreed with the assessment team's decision to use two age-structured models, integrated catch-at-age (ICA) and fleet-specific. These models are described in the Executive Summary of the stock assessment. It was noted that each had some advantages and some disadvantages. Given the lack of age data for the early years, the Panel recommended that consideration be given to the use of a length-based model for future assessment.

4. **Recruitment variability.** The Panel was concerned that both assessment models estimated levels of recruitment variability that were very low compared to most marine species (a coefficient of variation of about 15%, compared to more typical values of 40–80%). It was pointed out that the use of the same age/length key across many years (which is unavoidable because of the paucity of age data in early years) would be likely to cause an underestimate of recruitment variability. However, the view was expressed that recruitment variability may be low for this species because of the generally stable environment in the Keys. Further, an opinion was expressed that this species also appears to exhibit a faster growth rate and earlier maturity than typical for species with similar longevity, which could result in higher egg production for the early age-classes, allowing for more constant recruitment.

5. Retrospective bias. There was little or no evidence for "retrospective bias" in biomass and fishing mortality estimates for recent years from either assessment model. Retrospective bias is here defined as the deviation from the true stock trajectory caused by successively removing annual data points retrospectively. However, to fully investigate this issue would require much more extensive analyses (involving simulated data) than were possible in the time available.

6. Weighting of input data sets in both models. The Panel asked that there be an evaluation of the weights assigned to the different data sets in the assessment. In some cases, changing these weights can have a substantial effect on model outputs. Both assessment models down-weighted the early catch-at-age data (see Table 4.2.2.1.3 in the Assessment). However, the two models differed in their weighting of the biomass indices. Equal weighting was used for the ICA model; a regression-based approach was used for the fleet-specific model. An examination of the residuals from the ICA main run (specifically, calculation of the standard deviation of the standardized residuals for each dataset) suggested that the two NMFS/UM biomass indices were overweighted (compared with the other indices). When the iterative re-weighting facility of ICA was used, the overweighting made little difference to the assessment outputs. Another run was requested in which the early catch-at-age data were very strongly down-weighted. This run produced unsatisfactory fits because it denied the model information about the total catches and selectivity in the early years.

7. Inconsistent trends in biomass indices. The commercial CPUE index showed a clear increase in biomass, whereas all other indices showed no trend, or possibly a slightly decreasing trend. Some Panel members felt that the commercial CPUE trend could have been influenced by an increase in fishing power rather than an increase in abundance. The fishers on the Panel expressed the view that the biomass could be increasing. When the commercial CPUE was excluded from an ICA model run, there was little change in the model outputs. Thus, while inconsistencies in biomass indices clearly contributed to the lack of model fit, the results on stock status were not sensitive to it.

Concern was also expressed about the appropriateness of the fishery-independent reef visual census indices. The Panel strongly suggested reviewing the sampling and estimation procedures underpinning these indices for their utility in stock assessments.

8. Double-weighting of total catch in the model. Concern was expressed that the fleet-specific model was double-weighting the catch data by including both total catch and catch-at-age in the fitting criteria. However, an additional model run in which the total catch data were omitted made little difference to the assessment outputs.

9. Natural mortality (M). There was considerable discussion about the appropriateness of the range of M values used in the assessment. The logic underlying the choice of M values, as expressed in Section 2.7 of the assessment seemed questionable, because the mortalities calculated from the maximum age of 17 (0.18-0.25) are really estimates of total mortality (Z), rather than M. Z is the sum of fishing mortality and natural mortality (F + M). This suggested that the range of M values used in the assessment (0.15-0.25) was too high. However, when a catch-curve estimate of Z was calculated at the request of the Panel, this gave the much higher value of Z = 0.54. After much discussion and careful review of the biological characteristics of yellowtail snapper and other species, the Panel agreed that there was very little information on M for yellowtail snapper and that there were no grounds to change the assessment team's use of 0.15-0.25 as an estimate for the range of M.

10. Steepness of the spawner-recruit relationship. Steepness is an important parameter that determines the productivity of a stock. If steepness is high, the stock is resilient because recruitment remains high at low levels of SSB. The value of 0.8 used as best point estimate in the assessment (with alternatives of 0.7 and 0.9) means that, if the stock were to be reduced to 20% of its pre-fishery biomass, the average recruitment would be reduced to 80% of its pre-fishery level. The Panel felt that there was no basis upon which to make any choice or provide any advice concerning a choice for the parameter. This is a point of concern because choice of its value has a large impact on stock status.

11. Fishing power and CPUE. There is reason to believe that fishing power (fishing mortality per unit of fishing effort) in commercial and recreational fisheries for yellowtail snapper has changed over time owing to changes in fishing methods and technology, regulations, and in the experience level of fishers. This needs consideration before the next stock assessment. CPUE is a valid measure of trends in fish abundance over time if fishing power remains constant or if CPUE can be adjusted for changes in fishing power. Fishers on the Panel described a number of changes in the fishery that likely affected fishing power in both commercial and recreational fisheries. First, fishing, originally at night, is now carried out also during the day, when yellowtail snapper may be harder to catch. Second, "power chumming" (use of large amounts of bait to attract fish) and the use of sand, oats, corn and other material to cloud the water, may have increased the fishing power, as may have the increased availability and decreased price of marine electronics (e.g. GPS, depth finders, digital charts). Further, fishing effort has declined in recent years as a consequence of regulations that discouraged part-time and other participants who were likely less efficient fishers than those that remained. Finally, recent regulations (e.g. closed areas) probably also decreased effective fishing power. Therefore, the relatively steep increase in commercial CPUE relative to fishery-independent and recreational abundance indices may simply be a reflection of the increased fishing power.

III Stakeholder Statements on Yellowtail Snapper

Fisher community

The general impression from the fisher community was that the yellowtail snapper, a prolific batch-spawner, has benefitted from some luck and well founded management in the past decade or so. For instance:

- the establishment of no-take zones on the Florida Keys affords spawning fish (yellowtail snapper and other species) protection in a critical part of their geographical area,

- a minimum size limit protects fish until well after their length at 50% maturity and clearly has a positive influence on spawning production,
- the removal of some effort from the fishery (e.g. "bucket fishers", fish traps on the Atlantic side, and netters) takes out what some regard as major sources of fishing mortality.

The result is that yellowtail snapper are now caught mainly by hook and line; fishers believe that the population has burgeoned and that there are now more large fish around than before the management interventions. In fishers' terms, the stock is healthy, has stayed healthy, and has a healthy prognosis for the future. Production appears to be constant and largely driven by economic considerations (markets and price). "Power chumming" (delivery of large quantities of chum, including land-based protein, to attract the species up in the water column) has enhanced catch rates even further, with no apparent detrimental affect on the stock.

The fishers on the Panel seriously questioned some of the data relating to the rate of discard mortality as well as the accuracy of some of the fishery-independent survey results presented, which were felt to be based on too few and possibly unrepresentative data. They also noted that there had been a move from predominantly night fishing to more daylight fishing. Some strictly commercial operators ("good fishers") had been displaced by tourism-based effort, which was likely not so effective and therefore also afforded the stocks some relief in the form of reduced effective effort.

Environmental representative
The environmental representative focused attention on the process rather than on the detail of stock status, which she acknowledged seemed to be healthy in terms of yellowtail snapper, though not necessarily so for other associated members of the reef fish community. She advocated broad representation in the process, as on this occasion, and that the report be written clearly to facilitate decision-making. She supported the spirit of the conservation-minded management measures made in the past and urged management to follow the same route in future. However, she expressed concern about the sparseness of data for some sectors of the fishery and encouraged efforts to improve the situation (for instance the use of independent observers).

IV Conclusions in respect of Terms of Reference: yellowtail snapper

1. Adequacy and appropriateness of the fishery dependent and fishery independent data

(a) The Panel accepted that the data used for the assessment were the best of those available and were adequate for conducting the assessments provided.
(b) Appropriate weighting of the different data sets is addressed in Section II(6).

2. Adequacy and appropriateness of the models

(a) The Panel acknowledged that, based on the available information, implementation of the models (ICA and fleet-specific) was sound and endorsed the decision to use two age-

structured, statistical models for this assessment and benchmark estimation of yellowtail snapper.
(b) The Panel acknowledged that, because there was little contrast in the information on historical abundance, a production model was inappropriate.
(c) The Panel noted the dependence of the assessments on the values of M (natural mortality) and h (steepness), but felt that the range of those parameters used was appropriate, given the information available.
(d) The Panel suggested that a length-based model be considered in future, but did not necessarily feel that it would be better than those used this time.

3. Adequacy and appropriateness of the models for rebuilding purposes
The Panel felt that this was an inappropriate question to address given the conclusion that the stock was currently seen as currently not overfished (biomass too low) or subject to overfishing (fishing mortality too high).

V Research and data collection recommendations: yellowtail snapper

Yellowtail snapper specifically
Following the discussions and conclusions above, the Panel recommended that certain areas be subject to increased research effort and monitoring, before the next assessment of the stock. These are listed below.

1. Determine the release mortality rate for fish in the commercial, charterboat, headboat, and private/rental boat fisheries.
2. Collect discard data (quantity, size, condition, etc.) from the headboat fishery. This could include modification to the current logbook used by headboats or employing observers; if observers are used, they could also collect biological data. Collection of discard data from the commercial fishery should continue. It is critical that a total (accurate) estimate of discards by sector (commercial, headboat, charter boat and private/rental boat) be available for the next assessment.
3. Thoroughly evaluate the reef visual census CPUE index prior to use in future assessments.
4. Examine alternative methods to incorporate recent increases in catching efficiency ("power-chumming", smaller hooks, fluorocarbon leaders, GPS, etc.) into the commercial and recreational CPUE indices. This effort should lead to alternative methods to refine CPUE indices (electronic logbooks, observers, etc.), or alternative indices.
5. Continue the use of annual age/length keys, and move to direct age estimation where possible. Cognizance should also be taken of the temporal and geographic effects on such collections.
6. Seek better validation of age estimates.
7. Continue research into stock structure, e.g. genetics.

Yellowtail snapper and associated species

1. Thoroughly examine estimates of natural mortality (M) and steepness (h) in a workshop setting. Such a workshop should not be limited to yellowtail snapper, but should make comparisons with other species.
2. Examine the following issues with the MRFSS program:
   (a) The contractor changed in the mid-1990s. Whether or not this affected CPUE trends should be examined.
   (b) The level of intercepts increased after 1992, and from 1998/99 onwards, representatives of the State of Florida conducted the intercepts. What impact did this have on estimates and how should this CPUE index be incorporated into future assessments (as a continuous time-series or subdivided into one or more separate time-series)?
   (c) Private vessel owners leaving from their own private facilities are not currently sampled adequately. Is an adjustment factor used to account for this sector? Is this an important issue in Keys fisheries, given the large number of canals and private docks?
   (d) Given the concerns about the MRFSS data, potential new methodologies to collect these data should be evaluated.
3. Examine predator/prey interactions (and other ecosystem considerations).
4. Develop methods to incorporate the effects of spatial variability into assessments.
5. Put effort into developing better fishery-independent survey indices to assess fish stock status.

VI Overview of data and information on goliath grouper

The Panel received a brief presentation on goliath grouper. Data from a workshop on the species had only recently been made available to Panel members via a web site and on CD; some members had not had sufficient time to examine the data. There was also the report from the workshop available[2]. However, it was noted that information could be examined and conclusions reached about stock status without the use of elaborate models. The different management goals of the South Atlantic Council (non-consumptive use and stock status) and Gulf Council (stock status) were noted, as was the need to consider ecosystem considerations in management. It was agreed that, although ecosystem management could not be addressed during the current workshop (and aspects of it are covered in the research requirements listed below), the Councils would do well to begin considering it seriously in future fora.

Time ruled out anything other than brief conclusions on future research and data needs (as per Term of Reference 4 for yellowtail snapper), listed below, and some discussion on future management and assessment possibilities.

1. *Estimation of population size.* Estimates of population size were considered to be crucial for future management. It was noted that, because of the apparently narrow home ranges and site fidelity, sampling throughout the geographic range would

[2] Anon. (2003). Goliath Grouper Data Workshop Report, March 2003. 11 pp.

probably be important. Tag/recapture research and studies with data storage tags were mentioned as potential monitoring tools.
2. *Demographics.* Monitoring the demographics of the population, particularly age composition, could provide valuable information. Noting that age determination of the species was difficult, the Panel suggested that effort be channeled into improving it.
3. *Reproductive biology.* Developing further understanding of the reproductive biology of goliath grouper was considered important. Identifying spawning locations, duration and periodicity, and identifying whether there were spawning migrations, could be useful in identifying sites to conduct population surveys. Further, there would be value in obtaining more information on early life history (eggs and larvae). It appeared that the survival rate of juveniles in mangroves and estuaries was good.
4. *Historical abundance.* Obtaining information on historical abundance, perhaps via old logbooks, was considered a possibility as such information could enhance assessments.

Other research material and topics considered as of less immediate importance or of questionable feasibility (in terms of collection of data) were:

- estimating unrecorded mortality from accidental or intentional sources;
- information on stock structure;
- bioenergetics and trophic relationships (though note the comment above on the need for ecosystem management);
- information identifying changes in mangrove abundance and distribution, and hence changing available nursery habitat (goliath grouper spend their first 6-7 years in mangrove areas, sometimes attaining as much as 50 lbs).

Noting that exploitation of goliath grouper had been stopped in 1990 after at least a decade of very heavy exploitation, mainly for the direct restaurant trade, that it was a vulnerable species (to both spear and hook and line) and seemingly highly gregarious, that consideration had already been given to placing it on the IUCN Red List of Threatened Species, and that catch-and release activities had burgeoned since 2000 (though often through repeatedly sampling the same individual fish), the Panel were of the opinion that not conducting an assessment on this occasion had likely been an incorrect decision. It was suggested that the assessment option for goliath grouper be revisited at an early opportunity, initially looking specifically at assessment models that could operate in a data-poor arena. It was also suggested that debate be opened by both management councils on the real objectives of managing the species successfully – e.g. non-consumptive use, or a sustainable fishery. Only when that decision had been made could scientific advice be sought on when (or if) the fishery could be opened.

VII General recommendations for future SEDAR workshops

1. Provide hard copies of materials for participants. Not everyone can access material via the Internet and download/print large quantities of material.
2. The category "recreational catch" should include charterboat catches, private/rental boat catches, headboat catches and shore-mode catches (if appropriate).

3. Review and evaluation of data during Data Workshops should be much more rigorous. All data should be plotted and the trends examined, and detailed recommendations should be documented and provided on the use of the various datasets. Assessment scientists should attend along with representatives of all major data collection programs (MRFSS, commercial logbook, TIP, etc.). Consensus needs to be reached on the use of specific datasets or estimates for incorporation in the assessments.
4. The next assessments should use simple stock assessment techniques in addition to relatively complex stock assessment models, because simple techniques are easier to understand and describe, as well as being useful in confirming the results from the more complicated models. In particular, simple exploitation indices (total catch divided by abundance indices) should be examined to detect trends in fishing mortality. The simple trends in survey, CPUE, and catch data should be examined and described, and trends in survey and CPUE data compared. Trends in mean length or mean weight also provide information on exploitation and recruitment levels, and are worthy of presentation.

Annex 1

SEDAR Assessment Review Panel Workshop
Hilton Tampa Airport Hotel
Tampa, Florida
July 28-31, 2003

Panel

PANEL CHAIR:	Dr Andrew Payne
REVIEW PANELIST:	Mr Chris Francis
SAFMC:	Mr Gregg Waugh
GMFMC:	Mr Steve Atran
NMFS SEFSC:	Dr Joseph Powers
NMFS NEFSC:	Dr Larry Jacobson
FISHERS:	Mr William Kelly Mr Robert Zales Mr Peter Gladding
NGO REPRESENTATIVE:	Ms Nadiera Sukhraj
SSC REPRESENTATIVES:	Mr Doug Gregory Mr Billy Fuls Dr Al Jones Ms Carolyn Belcher Dr Robert Trumble Dr Rocky Ward

Non-Panel

PRESENTERS:

AW Coordinator	*Dr Luiz Barbieri*
Lead Analysts	*Dr Robert Muller* *Mr Michael Murphy*
Goliath grouper	*Dr Anne-Marie Eklund*

AW/RPanel SUPPORT STAFF:

Dr John Merriner
Dr Janaka de Silva

MEETING SUPPORT STAFF & OTHER ATTENDEES

Mr Roy Williams
Dr Tom McIlwain
Dr Joe Kimmel
Mr Mark Robson
Mr Stu Kennedy
Dr Roy Crabtree
Dr Behzad Mahmoudi

Participant contact details

Steven Atran	GMFMC staff	steven.atran@gulfcouncil.org
Luiz Barbieri	FFWCC/FMRI	luiz.barbieri@fwc.state.fl.us
Carolyn Belcher	SAFMC SSC	cbelcher@uga.edu
Roy Crabtree	NMFS/SERO	roy.crabtree@noaa.gov
Janaka de Silva	FFWCC/FMRI	janaka.desilva@fwc.state.fl.us
Anne-Marie Ecklund	NMFS/SEFSC	anne.marie.eklund@noaa.gov
Chris Francis	NIWA/CIE	c.francis@niwa.co.nz
Billy Fuls	GMFMC SSC	billy.fuls@tpwd.state.tx.us
Peter Gladding	Commercial fisher	dondemaria@aol.com
Douglas Gregory	GMFMC SSC, UF Sea Grant	drg@ufl.edu
Larry Jacobson	NMFS/NEFSC	larry.jacobson@noaa.gov
Albert Jones	GMFMC SSC	albertcljones@juno.com
Bill Kelly	SAFMC AP	keyskelly@aol.com
Stu Kennedy	GMFMC staff	stu.kennedy@gulfcouncil.org
Joe Kimmel	NMFS/SERO	joe.kimmel@noaa.gov
Behzad Mahmoudi	FFWCC/FMRI	behzad.mahmoudi@fwc.state.fl.us
Tom McIlwain	NMFS/SEFSC	tom.mcilwain@noaa.gov
John Merriner	NMFS/SEFSC	john.merriner@noaa.gov
Bob Muller	FFWCC/FMRI	robert.muller@fwc.state.fl.us
Mike Murphy	FFWCC/FMRI	mike.murphy@fwc.state.fl.us
Andrew Payne	CEFAS/CIE	a.i.l.payne@cefas.co.uk
Joseph Powers	NMFS/SEFSC	joseph.powers@noaa.gov
Mark Robson	FFWCC/DMF	mark.robson@fwc.state.fl.us
Nadiera Sukhraj	ReefKeeper International	n_sukhraj@reefkeeper.org
Bob Trumble	SAFMC SSC	bob.trumble@mragamericas.com
Rocky Ward	GMFMC SSC, TPWD	rocky.ward@tpwd.state.tx.us
Gregg Waugh	SAFMC staff	gregg.waugh@safmc.net
Roy Williams	FFWCC/DMF, GMFMC	roy.williams@fwc.state.fl.us
Bob Zales, II	GMFMC AP, PCBA	bobzales@fishpc.com

Annex 2: Terms of Reference

The task of this SEDAR Assessment Review Panel is to review the yellowtail snapper stock assessment as to completeness, correctness, and adequacy under the Sustainable Fisheries Act. Do the assessments use the best available data and scientific techniques, both within the constraints of available time and manpower provided for the assessment? The Panel should also make recommendations for improvements in future data collection and assessment. The Review Panel will provide a final brief peer review report (items 1-4 below) that includes its peer review comments on the assessment, the Panel's findings on stock and fishery status, and recommendations for management under SFA guidelines.

1. Evaluate adequacy and appropriateness of fishery-dependent and fishery-independent data used in the assessment (i.e. were the best available data used in the assessment).
2. Evaluate adequacy, appropriateness, and application of models used to assess yellowtail snapper and to estimate population benchmarks (MSY, F_{msy}, B_{msy}, and MSST, i.e. Sustainable Fisheries Act items).
3. Evaluate adequacy, appropriateness, and application of models used for rebuilding analyses.
4. Develop recommendations for future research for improving data collection and the assessment.
5. Prepare a report summarizing the peer review panel's evaluation of the yellowtail snapper stock assessment (to be drafted during the Review Workshop; final report due two weeks after the workshop - August 15)
6. Prepare a summary stock status report including management recommendations (to be drafted during the Review Workshop; final report due two weeks later - August 15)

Each individual panelist will receive the Stock Assessment Workshop Report and other appropriate documents on these species for review approximately 10 days before the panel meets.

It is emphasized that the Panel's primary duty is to review the existing assessment. In the course of this review, the Chair may request a reasonable number of sensitivity runs, additional details of the existing assessment, or similar items from technical staff. However, the review panel is not authorized to conduct an alternative assessment, nor request an alternative assessment from the technical staff present. To do so would invalidate the transparency of the SEDAR process. If the review panel finds that the assessment does not meet the standards outlined in points 1 through 4 above, the panel shall outline in its report the remedial measures it proposes to rectify those shortcomings.

SEDAR

SouthEast Data, Assessment, and Review

Advisory Report

Yellowtail Snapper
in the
Southeastern United States

Prepared by the SEDAR 3
Stock Assessment Review Workshop

SEDAR Stock Status Report for Yellowtail Snapper

Tampa, Florida
July 28-31, 2003

Stock Status

According to basecase results from two stock assessment models that assumed recruitment steepness, h = 0.8[1] and natural mortality M = 0.2, yellowtail snapper are not overfished and overfishing is not occurring (Table 1). Spawning stock biomass during 2001 (SSB_{2001}) was above the minimum stock size threshold $B_{MSST} = (1–M) \times SSB_{MSY} = 0.8\ SSB_{MSY}$ used to identify overfished stock conditions. Fishing mortality during 2001 (F_{2001}) was below the maximum fishing mortality threshold F_{MFMT} level used to identify overfishing[2].

Stock status conclusions are sensitive to assumptions about h and M (Table 1). Base-case values of these parameters are the best available information, but were not estimated precisely. Some combinations of lower (but still plausible) values of h and M lead to the conclusion that the stock is overfished or that overfishing is occurring.

Table 1. Stock status calculations for yellowtail snapper (italicized values indicate potential overfishing and overfished stock conditions)

	Steepness					
Natural	h = 0.7		h = 0.8		h = 0.9	
mortality (M)	F_{2001}/F_{MFMT}	SSB_{2001}/B_{MSST}	F_{2001}/F_{MFMT}	SSB_{2001}/B_{MSST}	F_{2001}/F_{MFMT}	SSB_{2001}/B_{MSST}
Integrated Catch-At-Age (ICA) model						
0.15	*1.2*	*0.6*	0.9	*0.8*	0.7	1.1
0.20	0.7	1.3	**0.5**[A]	**1.8**[A]	0.3	2.6
0.25	0.4	2.4	0.3	3.2	0.2	4.3
Fleet-specific model						
0.15	*1.7*	*0.3*	*1.3*	*0.6*	1.0	*0.9*
0.20	1.0	*0.8*	**0.7**[A]	**1.2**[A]	0.4	1.9
0.25	0.5	1.6	0.4	2.2	0.2	2.2

[A] Base-case model results

[1] Steepness (h) is a measure of recruitment when SSB is reduced to a low level. For example, h = 0.8 means that recruitment is reduced to 80% of the level in an unfished stock when SSB is reduced to 20% of the unfished stock level. Steepness measures the ability of a fish stock to withstand high fishing mortality rates. If steepness is high, the stock is resilient because recruitment remains high at low levels of SSB.

[2] For yellowtail snapper, $F_{MFMT} = F_{MSY}$, which is the fishing mortality rate for maximum sustainable yield.

APPENDIX 2
SEDAR Stock Status Report for Yellowtail Snapper

Considerations for Management

Current management measures appear to be maintaining a healthy and productive yellowtail snapper stock. SSB was relatively stable during the period 1991–2001, while catch and fishing mortality declined. The stock is near or exceeds management targets because SSB_{2001} was near or above B_{MSST} and F_{2001} was near optimum yield F_{OY} levels (Table 2). Catch was 802 metric tons during 2001 and below catch levels of optimum yield (OY) and maximum sustainable yield (MSY). F, OY and catch figures refer to total removals (landings plus dead discards). OY estimates are not intended as estimates of long-term potential yield.

Table 2. Reference points, F and SSB levels for yellowtail snapper

Reference point or status measure[a,b,c]	ICA model	Fleet-specific model
SSB_{2001}	4,481 (9,879)	5,280 (11,640)
$SSB_{MSST} = SSB_{MSY}$	3,567 (7,864)	5,338 (11,768)
SSB_{2001} / SSB_{MSY}	1.44	0.99
SSB_{MSST}	2,854 (6,291)	4,270 (9,415)
SSB_{2001} / SSB_{MSST}	1.57	1.24
F_{2001}	0.17	0.23
F_{MSY}	0.34	0.33
F_{OY} (definition 1)[d]	0.21	0.21
F_{2001}/F_{OY} (definition 1)	0.81	1.10
F_{OY} (definition 2)[e]	0.26	0.27
F_{2001} / F_{OY} (definition 2)	0.66	0.89
F_{OY} (definition 1) x SSB_{2001}[d,f]	941 (2,075)	1,109 (2,445)
F_{OY} (definition 2) x SSB_{2001}[e,f]	1,165 (2,568)	1,426 (3,142)
MSY	920 (2,028)	1,382 (3,047)

[a] SSB and F levels from base-case model runs with steepness h = 0.8 and natural mortality M = 0.2.
[b] F levels (annual rates for mortality due to landings and discards) are for six-year-old snapper, which are assumed fully recruited to the fishery.
[c] SSB, catch, MSY and OY catch levels are in metric tons (and 1,000 lbs). OY catch levels include discard mortality.
[d] Definition 1: As specified in the Gulf Reef Fish FMP and South Atlantic Snapper–Grouper FMP, $F_{OY} = F_{40\%}$.
[e] Definition 2: $F_{OY} = 75\%F_{MSY}$ based on Restrepo *et al*. (1998). Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson–Stevens Fishery Management and Conservation Act. NOAA Technical Memorandum NMFS–F/SPO–31.
[f] For the South Atlantic Fishery Management Council, $OY = F_{OY} \times B_{2001}$; the Gulf of Mexico Fishery Management Council has not yet adopted an OY level.

APPENDIX 3.

Revised tables corresponding to the tables in the SEDAR Stock Status report. These tables show the results of runs that used fishery dependent indices without interaction terms and were assembled from entries in the final report Table 4.2.2.1.8 (ICA runs 10-12) and Table 4.2.2.2.6 (Fleet-specific).

Table 1. Stock status calculations for yellowtail snapper (italicized values indicate potential overfishing and overfished stock conditions)

	Steepness					
	h = 0.7		h = 0.8		h = 0.9	
Natural Mortality (M)	F_{2001}/F_{MFMT}	SSB_{2001}/B_{MSST}	F_{2001}/F_{MFMT}	SSB_{2001}/B_{MSST}	F_{2001}/F_{MFMT}	SSB_{2001}/B_{MSST}
Integrated Catch-at-Age (ICA) model						
0.15	*1.4*	*0.6*	*1.1*	*0.8*	0.8	1.2
0.20	0.8	1.1	0.6[A]	1.5[A]	0.3	2.2
0.25	0.4	1.8	0.3	2.2	0.2	3.0
Fleet-specific model						
0.15	*1.7*	*0.3*	*1.3*	*0.6*	1.0	*0.9*
0.20	1.0	*0.8*	0.7[A]	1.2[A]	0.4	1.9
0.25	0.5	1.6	0.4	2.2	0.2	3.2

[A] Base-case model results

Table 2. Reference points, F and SSB levels for yellowtail snapper

Reference point or status measure[a,b,c]	ICA model	Fleet-specific model
SSB_{2001}	5,251 (11,577)	5,297 (11,678)
SSB_{MSY}	3,684 (8,122)	5,360 (11,817)
SSB_{2001} / SSB_{MSY}	1.43	0.99
SSB_{MSST}	2,947 (6,498)	4,288 (9,453)
SSB_{2001} / SSB_{MSST}	1.78	1.24
F_{2001}	0.19	0.24
F_{MSY}	0.33	0.33
F_{OY} (definition 1)[d]	0.21	0.21
F_{2001}/F_{OY} (definition 1)	0.92	1.13
F_{OY} (definition 2)[e]	0.25	0.25
F_{2001} / F_{OY} (definition 2)	0.77	0.95
F_{OY} (definition 1) x SSB_{2001}[d,f]	1,085 (2,392)	1,123 (2,477)
F_{OY} (definition 2) x SSB_{2001}[e,f]	1,299 (2,865)	1,330 (2,932)
MSY	946 (2,085)	1,388 (3,060)

SEDAR

SouthEast Data, Assessment, and Review

Data Workshop Reports

SEDAR 3

Prepared by the SEDAR 3
Data Workshop

Goliath Grouper Data Workshop Report

Introduction

The goliath grouper SEDAR Data Workshop was held from 8:30 AM March 5 through 11AM March 6, 2003. Stu Kennedy of Florida Fish and Wildlife Commission's Florida Marine Research Institute (FWC-FMRI) was the convener; the participants are listed in Appendix 1. Stephania Bolden and Anne-Marie Eklund served as rapporteurs for the first and second days respectively.

The terms of reference for the workshop were to determine the quality and appropriateness of data available for an assessment. The participants agreed to place all data needed for an assessment on a CD, which would be provided to the Gulf of Mexico, South Atlantic, and Caribbean Fishery Management Councils and to the NOAA-Fisheries stock assessment team at the Southeast Fisheries Science Center in Miami. Anne-Marie Eklund agreed to collect the data files and reports for that CD.

The working group reviewed the available data and concluded that they were not adequate for an assessment; although since the meeting, a new data-source has been identified that may be useful for assessment purposes (see section E). In general, goliath grouper data are limited as all harvest for goliath grouper has been prohibited since 30 August 1990. In addition, the working group found several problems with the historical fishery-dependent data. The working group developed a prioritized list of information that it believed would be required to develop adequate estimates of stock status.

A. Biology and Life History

Felicia Coleman made a general presentation on life history based on multiple years of research conducted by herself, Anne-Marie Eklund, Chris Koenig, Jennifer Schull and other colleagues. That presentation will be placed on the CD with explanations of the information on each slide. Subsequent discussion reviewed the various research topics in greater detail.

Stock structure

Coleman reported on preliminary results of genetic analyses of goliath grouper from Belize and southwest Florida (conducted by Bob Chapman of South Carolina Department of Natural Resources) which indicate that the fish in those two areas are discrete stocks. Coleman and Chapman are working on size/age of fish from which genetic samples were taken. It was stated that the fish from Florida were small (juveniles) but the size of the fish from Belize was not known.

Age and Growth

Bullock *et al.* (1992) published information on goliath grouper age and growth.

More than 1000 dorsal spines and a small number of otoliths from juvenile goliath grouper in mangrove habitat have been examined (John Brusher and Jennifer Schull from SEFSC). Edge analysis indicates that the observed annuli in spines are formed once a year between July and December (with peak annulus formation from August-November). A comparison of spine and otolith ages from a small number of fish indicates that there are differences of up to one year between the two hard parts. These differences are thought to be due to the different times of year that the two hard parts appear to lay down annuli. Schull and Brusher are currently analyzing the data and adjusting the ageing for date and time of annulus formation.

Study of goliath grouper in mangrove creeks and tidal passes indicates that those caught by crab traps and fish traps and by hooks were primarily ages 1-6 years old (having 1-6 annuli present on otoliths and fin spines). Most of those fish were less than 100 cm TL, while fish from wrecks and reef habitats were greater than 150 cm TL. It was therefore assumed that most of the fish on wrecks and reefs were at least 6 years old. These data on individual fish and comparisons between age readers will be put on the CD.

The panel recommended continued work on ageing. Ages should be standardized to a calendar year, so that information on a year class is treated consistently throughout the year. Corroborative studies between the current research group (Schull and Brusher) and those with previously published age and growth work (Lew Bullock - FMRI) should be continued.

Reproduction

Bullock *et al.* (1992) published information on goliath grouper reproductive biology. They collected ripe fish between July-September and found no indication of sex change in any of the fish collected. Fish were mature between the ages 4 to 7.

Habitat

Felicia Coleman and colleagues (Anne-Marie Eklund, Chris Koenig, Jennifer Schull at meeting) reported that goliath grouper found in mangrove creeks and tidal passes are immature, and mature goliath grouper were thought to be associated with both artificial and natural reef structure, including piers, bridges, artificial reefs, wrecks and natural reefs. They have caught goliath grouper from about 2-100 cm TL (from young-of-the-year to age 6) in mangrove habitat. Those researchers and fishermen (Don DeMaria, Eddie Toomer) reported that fish of about 150 cm TL and larger are usually found around structure such as wrecks, artificial reefs and natural habitat with relief and overhangs. Another fisherman (Peter Gladding) reported that large goliath grouper have been observed on sand bottom in shallow water, beneath vessels.

Felicia Coleman further reported that there are indications that the amount of mangrove habitat in Florida has declined over time, thereby potentially reducing nursery habitat. There is a student at FSU working on a project to compare historical coastal mangrove coverage to present-day coverage. A student at the University of Florida is evaluating the relative impact of sea-level rise on mangrove distribution. It was noted that black mangrove habitat is newly developing along the Louisiana coast. Although our studies indicate that goliath grouper use primarily red mangrove habitat, goliath grouper occur and have historically occurred along the coasts of Louisiana and Texas; what habitat is used by juvenile goliath grouper in those areas is not known. (NB – during the last day of the workshop, two Texas Fishermen, Matt Murphy and Mike Nugent, reported that goliath grouper are frequently seen under docks off central Texas).

In the southeastern Gulf of Mexico, adult goliath grouper are often observed on offshore wrecks. Information on their distribution and abundance on natural habitat is more limited, possibly because these sites are visited less frequently by many of the dive groups that make and report observations. Goliath grouper may be concentrated around wrecks (isolated areas of high relief) and more spread out on low-relief natural habitat. The number of offshore wrecks has increased over time, thereby potentially increasing the amount of available offshore habitat available for the fish, or simply concentrating the fish on isolated structures. Eddie Toomer presented some interesting footage of goliath grouper on shallow, inshore sites and has offered to take the goliath grouper research team to visit these sites in summer 2003.

Distribution

Most of the current observations of goliath grouper are on wrecks off Charlotte and Lee Counties in southwest Florida. Don DeMaria pointed out that there were aggregations of goliath grouper off the southeast coast of Florida, near Jupiter, in the 1950s. These aggregations were fished-out soon after discovery, and the goliath grouper had not been reported from that area for several decades. However, in 2002, an apparent aggregation of 50 individuals was observed in that same area. Reports of fish in the northeastern Gulf of Mexico and northeast coast of Florida are beginning to come in through the FWC tagging hotline. No spawning aggregations from these northern sites are known.

Movement

Tagging of juvenile goliath grouper in southwest Florida mangrove habitat (mainly in the Ten Thousand Islands) indicates limited movement. Tagging of adults (Koenig *et al.* unpublished data) primarily during the spawning months on presumed spawning sites has shown that a high proportion (>40%) of recaptures occurred at the original tagging site. Analysis of acoustic tagging information at four sites in the Gulf of Mexico (Eklund *et al.* unpublished data) might provide additional quantitative information, but the analyses have not yet been conducted. Information gathered from that study might provide some indication of motility and site fidelity. The acoustic data from the juvenile tagging study in the Ten Thousand Islands area and from offshore tagging will be put on the CD.

Concern was expressed that if the fish do not move much, then the estimates of abundance would be only estimates of a local population and would, therefore, have only limited value in estimating the size of the population at large. Don DeMaria reported that he observed new fish on wrecks within months after removal of fish via spear fishing. This observation was true earlier in his fishing experience, but later, as the overall population was thought to have declined, replacement of removed fish occurred much more slowly. Jim Cowan suggested that it was possible that motility could be directly related to fish density, and as the overall population declined and density decreased, the motility of the fish might also have declined.

Predation

Sharks are the only known natural predator on adult or larger juvenile goliath grouper.

Natural Mortality

It was noted that the estimates of mortality provided from Jolly-Seber analyses of mark/recapture of juveniles (see power point presentation by Felicia Coleman on the CD) are confounded with emigration and gear selectivity. The investigators did not use those estimates of mortality and do not recommend using them. Jim Cowan recommended that alternative analytical methods (MARK software) be considered for use in estimating abundance and particularly the natural mortality rate.

B. Catch

Landings

Landings data from NOAA Fisheries were presented for 1950-1990; the moratorium on goliath grouper landings was imposed on August 30, 1990 [55 FR 25310]. The reliability of the landings data was discussed.

FWC reported that landings prior to 1985 or 1986 from a dealer on the west coast of Florida were substantially inflated for all species. With the advent of the Florida trip ticket system in 1986 this problem was identified, and FWC personnel developed revised catch statistics. It is possible that the NOAA Fisheries data are not corrected for that problem; a noted decrease in the goliath grouper landings in the mid-1980s could be associated with a transition from inflated to actual landings statistics. Josh Bennett will work with Stu Kennedy and Joe O'Hop to determine whether NOAA Fisheries landings data have been corrected or need revision.

Several fishermen reported that goliath grouper catches frequently were not sold through dealers. Prior to the early to mid-1980s, prices were very low (on the order of $0.10 / lb) and a substantial fraction of the catch was thought to have been sold directly to restaurants rather than to dealers. Apparently, in about 1984, prices began to increase and the proportion of the landings sold through fish houses increased. Some goliath grouper continued to be sold directly to restaurants, even after the imposition of the Florida trip ticket system in 1986. One fisherman from Key West reported that he had caught one to five goliath grouper per trip over many years but had never sold them to a dealer, whereas another Key's fisherman reported that he had always sold fish through dealers. If the proportion of sales of goliath grouper to fish houses increased in the mid-1980's, then the decline in reported landings may actually be an underestimate of the actual decline in catch. It was recommended that estimates of the proportions of sales of goliath grouper to restaurants be made from Florida trip ticket data if possible.

Another concern was that goliath grouper larger than about 150 lbs. were sold without the head. Because NOAA Fisheries landings records historically record whole weight, landings of headed and gutted fish would have been converted to whole weight using a standard set of conversion factors.

One fisherman (Eric Schmidt) estimated that in the Fort Myers, FL area, about 75% of the goliath grouper landings were made by recreational fishermen.

Current (catch and release) mortality

Several fishermen reported that they thought fishing mortality was currently occurring when goliath grouper are caught (when other species are targeted) and when fishermen target (some repeatedly) goliath grouper for catch-and-release. Generally, the goliath grouper population is thought to have increased, but mortality continues as a result of probable release mortality (especially adult specimens brought from depth) and unreported illegal catch.

C. Size and Age Composition

A small number of individual sizes were recorded for goliath grouper in the NOAA Fisheries TIP database (n = 102 total, 28 from the Caribbean area and 74 for mainland US). Investigation of the mainland US records after the Data Workshop revealed that at least 66 of the records were mis-identified gag and snowy grouper (Josh Bennett), thus at most 8 size observations are available in the TIP data base.

Fishery-independent sampling for age and size composition is continuing (1997-present) (Schull and Brusher and other colleagues). Bullock and Smith (1991) and Bullock et al. (1992) also present data on age and size composition from opportunistic sampling during the late 1980s.

D. Effort

Effort directed at goliath grouper reportedly increased during the 1980s (see Amendment 2 to the Gulf of Mexico Reef Fish Fishery Management Plan).

E. Indices of Abundance

Everglades National Park has conducted a survey of recreational fishermen since 1974 (or possibly before), and goliath grouper is likely to have been recorded in the data set. Apparently the survey collects information not only on landings, but also releases, and should be useful for developing an index of abundance. Anne-Marie Eklund will review that data to determine if goliath grouper landings are recorded with sufficient frequency to develop an index.

A relatively short time-series of catch and effort information exists in the Florida trip ticket data for the mid-1980s to August 1990 when the prohibition of harvesting was imposed. These data would be available for analysis if required.

Catch rates have been recorded from 1997-present in the juvenile tagging study conducted in the Ten Thousand Island/ Florida Bay area. The low motility of some of those fish (approx. 40% recaptured, many fish several times) was thought to limit the usefulness of that data as an index for the entire population. These data will be put on the CD.

The Florida Marine Research Institute conducted a trap survey in 2000-2002 along the Southeast Coast; no goliath grouper were caught.

Scott Nichols reported that SEAMAP had recorded only one goliath grouper in many years of sampling with multiple gears.

<u>Diver observations</u>

A series of observations by one diver (Don DeMaria) from 1981 to present at four wrecks from depths of 100-130 feet in the eastern Gulf of Mexico was presented as a possible index of abundance. Don DeMaria was a spear fisherman in the 1970s and 1980s. His written log lists the number of goliath grouper observed on each dive. DeMaria noted that during the earlier part of his log he probably underestimated numbers, because it was difficult to see all of the fish present when there were so many of them. Thus, his earlier numbers would be less precise; the counts in the mid to late 1980s likely included all of the fish observed because far fewer fish were present. It was noted that the pattern in the observations was similar to the pattern of commercial landings. The data and a description of the sampling protocol are provided on the CD.

Several questions were raised about the utility of the time-series for use as an index of abundance. In response to a question about the consistency of the effort, Don DeMaria reported that he thought it was consistent due to limits on dive time at such depths. In response to a question about whether the high number of goliath grouper recorded when a site was first visited (1982 for three of the sites) was accurately representing the number of fish on the wrecks, Don DeMaria responded that he thought the wrecks had not been exploited before he first visited them (they were in deep water and spear fishing had been limited to the shallower inshore wrecks) and that the observations did represent the number of fish present. It was noted that the wrecks might deteriorate over time and their suitability as habitat for goliath grouper might diminish. One wreck was small and deteriorating; another was a large shipwreck from WWII and was not visibly changing.

The group discussed whether the data from these four small areas could reflect total population trends. Don Demaria noted that inshore wrecks generally were not repopulated after being fished-out while offshore wrecks appeared to repopulate. However, tagging data from 1998-present indicate that fish often continue to be observed at their tagging locale. It was recommended that the tagging data be further examined for indications of site fidelity. There was some discussion that these offshore wrecks might be associated with spawning sites. If they were spawning sites and goliath grouper actually migrate to them, then they might be more reflective of the population in a broader area. There are no data on spawning migrations, however; and acoustic data from Eklund suggest that the majority of the acoustically-tagged fish remain on-site for several months after tagging.

The Florida Marine Research Institute has conducted an underwater visual survey on selected reef tracts in the Florida Keys since 1999. One goliath grouper was seen in 1999, two in 2000, none in 2001, and three in 2002.

The Reef Fish Visual Census information collected by NOAA Fisheries in Miami (and in recent years in cooperation with the University of Miami) consists of replicated observations by pairs of divers in the Florida Keys and extends from 1978 to present. A total of 8 goliath grouper are noted in the data set through 2001. However, there are several more observations in the 2002 data (not analyzed yet). The panel decided that the limited number of goliath observations would likely be of little value so this data will not be included on the CD.

Some time series of observations by recreational divers might be considered for developing indices of abundance. The Reef Educational and Environmental Foundation (REEF) has collected information from recreational divers from 1993-present from sites in Florida and in the Caribbean. Abundance is recorded in the following categories: one, few, several and many. Size of fish is not recorded. Anne-Marie Eklund will request the data from REEF and if obtained will include it on the CD unless the numbers of goliath grouper observations are very low. A time series of observations from dive clubs diving artificial reefs in Florida has been collected by Bill Horn (Florida Fish and Wildlife Conservation Commission, Marine Fisheries Division). Felicia Coleman and Chris Koenig have that data and will attempt to determine whether the data set contains useful effort measures. Without a good measure of effort, the increase in the number of goliath grouper observations is confounded with increases in diving effort and number of artificial reefs placed in Florida waters over time.

F. Estimates of Abundance

Estimates of abundance have been made from juvenile mark-recapture data in the inshore mangrove areas of the Ten Thousand Islands and Florida Bay (Coleman, Koenig and Eklund, in review). Jolly-Seber methods were utilized to estimate population size. It was recognized that these would be estimates of local abundance because of the limited geographic range of the tagging and the low movement rates exhibited (gear selectivity also confounds information on age-class abundance). These data will be included on the CD. Mark-recapture abundance estimates of adult abundance throughout the Florida shelf (east and west coast) have not yet been finalized (Koenig et al.).

G. Estimates of abundance relative to the unexploited condition

Steve Turner (SEFSC) presented a paper by Porch and Scott (2001) detailing a method of estimating time of stock recovery given information or assumptions on the status of spawning stocks relative to the unexploited condition. The group discussed the possibility of using information from fishermen who had fished for goliath grouper in the 1950s or 1960s through the 1980s to provide perspectives on stock biomass decline between a relatively lightly exploited period and the time of the closure of the fishery. The group expressed concern that the results would be so highly variable that they would be unreliable for producing meaningful estimates. Steve Atran reported that the Gulf Council had conducted surveys of opinions about the relative status of goliath grouper in the early 1990s. Anne-Marie Eklund has that information from the Council and will include it on the CD. Several people recommended that log books would provide more reliable estimates than oral history.

H. Population information which might be useful in monitoring future stock status

The group expressed concern that the existing information available for estimating stock status might not be sufficient. The group discussed the types of information which might be useful for monitoring stock rebuilding. Research issues were discussed and categorized into eight research topics. They were then prioritized based on their short term value for assessing goliath grouper stocks Gulf-wide. There was also a request to the Gulf Council and NMFS (Tom McIlwain) to include this research in the next round of grant RFPs.

The top four research topics were:

1. **Estimation of population size** - Estimates of population size were considered to be of highest importance for future management. It was noted that because of the apparent restricted home ranges and high site fidelity, sampling throughout the geographic range would probably be important. Tag/recapture studies were mentioned as a potential monitoring tool. (NB – to better define their geographic distribution, the State of Alabama (http://www.dcnr.state.al.us/mr/goliath_grouper.htm) and the State of Mississippi (http://www.dmr.state.ms.us/Misc/Species-of-concern/) recently put up hotline

notices on their websites. Louisiana plans to add a link to their site, and Texas should follow suit).

2. **Demographics** - Monitoring the demographics of the population, particularly age composition, could provide valuable information (as it has for red drum in the Gulf of Mexico).

3. **Reproductive Biology** - Developing further understanding of the reproductive biology of goliath grouper was considered quite important. Identifying spawning locations, duration and periodicity could be very useful for identifying sites to conduct population surveys.

4. **Historical Abundance** - Obtaining information on historical abundance, perhaps via old logbooks, was also considered important.

Four other research topics were also considered, but it was thought that they were either less important, or less likely to be completed:

1. It could be very useful to have estimates of unrecorded mortality from accidental or intentional sources, but obtaining such information would be very difficult.

2. Additional information on stock structure was considered important.

3. Some thought that it would be useful to have a greater understanding of goliath grouper bioenergetics and trophic relationships. Others asked how that information would assist in a stock assessment.

4. Information identifying the changes in mangrove abundance and distribution, thereby changing available nursery habitat, could assist in developing predictions of future abundance.

Literature Cited

Bullock, L.H and G.B.Smith 1991. Seabassess (Pisces:Serranidade).Florida Mar. Res. Inst. Memoirs of the Hourglass Cruises. 8(2), 243p.

Bullock, L.H., M.D.Murphy, M.F. Godcharles and M.E.Mitchell. 1992. Age, growth and reproduction of jewfish, *Epinephelus itajara*, in the eastern Gulf of Mexico. Fish. Bull. 90: 243-249.

Coleman, FC, CC Koenig, and AM Eklund. In review. Density, survival and movement patterns of juvenile goliath grouper (Epinephelus itajara) in mangroves. Ecological Applications.

Porch, C.E. and G.P. Scott. 2001. Rebuilding times for Nassau and goliath grouper. NOAA Fisheries, Miami, manuscript 6p.

SEDAR Data Workshop for yellowtail snapper, *Ocyurus chrysurus*

The SEDAR (SouthEast Data, Assessment, and Review) Data Workshop for yellowtail snapper was held from 1 p.m., March 3 until 5 p.m., March 4, 2003 in St. Petersburg, Florida, at the Florida Fish and Wildlife Conservation Commission's Florida Marine Research Institute (FWC-FMRI, see Yellowtail SEDAR Data Workshop Agenda). Stu Kennedy, FWC-FMRI, was the convener and representatives were present from the FWC-FMRI, the National Marine Fisheries Service (NMFS), non-governmental organizations, the commercial and headboat industries, and the Gulf of Mexico and Caribbean Fishery Management Councils (see List of Participants). Panelists agreed to summarize the discussion in this report and to produce a CD containing all of the data discussed at the Workshop. This would then be provided to the Gulf, South Atlantic, and Caribbean Fishery Management Councils and to participants of the SEDAR Stock Assessment Workshop for yellowtail snapper.

This report is the summary of discussions held at the meeting convened for the purposes of identifying any pertinent information or datasets for yellowtail snapper that would be useful in conducting an assessment(s) of the stock(s). Major focus was in discussions of the validity and limitations of the available data. The Panel decided that FWC-FMRI analysts would conduct the assessment only for the stock of yellowtail snapper found in South Florida (see Stock Structure section below). NMFS representatives indicated that during this workshop they would be evaluating whether an assessment could be conducted for two separate yellowtail snapper stocks found in the Caribbean near Puerto Rico and the U.S. Virgin Islands.

A. Life History

<u>Stock Structure</u>

Theresa Bert, FWC-FMRI, gave a summary of the value of genetics to the identification of stock structure of marine fishes and an overview of the preliminary findings for a yellowtail snapper study (Wallace et al. 2003). She described several limitations to the study including low sample sizes, restricted geographic coverage, and the use of only one genetic technique (a second microsatellite analysis is underway). Results of yellowtail snapper mtDNA analyses indicated that there was little population structuring between the Florida Keys, Southeast Florida, and Puerto Rico groups of yellowtail snapper. However, there was some evidence for isolation-by-distance between South Florida and the Puerto Rico samples. It was pointed out that additional samples should be obtained from yellowtail snapper collected in the western and southern Gulf of Mexico, Bermuda, Azores, Central American coast, and in other areas of the Caribbean, especially the Bahamian banks where the population was thought to be very large. The Panel recognized that yellowtail snapper larvae may be exchanged between assessment areas but assumed that the majority of recruits to each stock assessment area probably came from adults occupying that area. Panelists felt that adult movement between assessment areas was probably very limited.

DECISIONS:

1. *Separate assessments should be conducted, if possible, for three separate yellowtail snapper populations in waters adjacent to: a.) South Florida, b.) the Puerto Rican platform area, including St. John, St. Thomas, and the British Virgin Islands, and c.) St. Croix.*

<u>Age, growth, maturity, and sex ratios</u>

Data are available from yellowtail snapper life history studies conducted off the Tequesta area of Southeast Florida (FWC-FMRI, 2000-2002), the Middle Florida Keys (FWC-FMRI, 1999-2002), Puerto Rico (Dennis 1991; Figuerola 1998), and the U.S. Virgin Islands (Manooch and Drennon 1987). In addition, the NMFS-Beaufort Headboat Survey Program (1980-2002) and NMFS-Panama City Bioprofile Sampling Program (1980-1981; 1992-2001) have been routinely collecting biostatistics from the southeastern U.S. headboat and commercial yellowtail snapper landings. The FWC-FMRI studies provide data on lengths, age, individual body weights, gonad weight, sex, and maturity state of yellowtail snapper collected by researchers using a stratified random sampling design employing primarily fish traps off Tequesta and primarily hook-and-line gear off the Middle Florida Keys. The NMFS-Beaufort Headboat Survey intercepts headboats at landing docks and samples landed fish for otoliths, lengths, sex, and individual weight. The NMFS-Panama City program collects individual lengths, otoliths, and sex from commercial landings of yellowtail snapper. Panelists also mentioned other available data sets for yellowtail snapper length and age. NMFS-Beaufort should have the otoliths or ages from a study conducted off the U.S. Virgin Islands during the 1983-1984. Nancie Cummings, NMFS-Miami, will contact NMFS-Beaufort about the disposition of the samples analyzed by Manooch and Drennon (1987). Ages, lengths, and gonad weights were determined for yellowtail snapper by Allyn Johnson and John Finucane (NMFS-Panama City, Johnson 1983) during the late 1970s-early 1980s. Another study of yellowtail snapper growth was mentioned as being conducted by the U.S. Virgin Islands Department of Natural Resources during 1996-1997. There were approximately 1,500 otoliths from yellowtail snapper collected during 1994-1999 by an East Carolina University Masters student that were re-aged by NMFS-Beaufort staff (Garcia, et al., In press). Many of these otoliths have deteriorated during years of being stored in clove oil and are unreadable. Since the ageing methods of this study may not be consistent with those of FWC-FMRI and NMFS-Panama City researchers, the Panel suggested that NMFS-Beaufort staff read a test sample of otoliths read by FWC-FMRI and NMFS-Panama City researchers to verify that age determination methods are consistent. If these results are similar, then the growth information generated from the re-aged 1994-1999 otoliths need to be compared with comparable data developed from well-kept otoliths collected from the same fishery during 1994-1999 to verify correct age determination for the re-aged otoliths.

Age determination of yellowtail snapper has been made using banding patterns seen on the surface of sagittae sections, with excellent agreement between FWC-FMRI and NMFS-Panama City readers (average percentage errors <1%, Robert Allman, NMFS-Panama City personal communication). Marginal increment analysis provides evidence that the opaque bands seen on otoliths form once each year, mostly during April-June. All available age data from FWC-FMRI and NMFS-Panama City are based on calendar year, i.e., otoliths were advanced a year in age after January 1st if their edge-type was a nearly complete translucent zone. For yellowtail snapper this means that most fish begin the calendar-year-based age 1 at about 6-9 months chronological age (peak spawning occurs April through June). All other age data need to be assigned using a January 1st hatch date or needs to be accompanied by careful documentation of the age assignment definition.

In these studies, the ages of sampled yellowtail snapper ranged from 1 to 17 years. Individual databases had fish ranging from 1-8 years off Tequesta (FWC-FMRI fishery-independent fish trap survey), 1 to 13 years old off the Middle Florida Keys (FWC-FMRI fishery-independent hook-and-line survey), 1-17 years old in the Southeast U.S. region (NMFS-Beaufort Headboat Survey Program, NMFS-Panama City Bioprofile Sampling Program). In all studies most yellowtail snapper sampled were less than age 5. Fishermen on the Panel noted that the old fish that appeared in the relatively small samples taken from the Marathon/Key West/Islamorada commercial fishery prior to 1983 could have been captured in the Bahamas and landed in the U.S., a practice that continues to a lesser extent today.

Sizes of yellowtail snapper sampled for ages were mostly 225-450 mm TL in the FWC-FMRI hook-and-line and trap studies, 300-550 mm TL in the NMFS-Beaufort Headboat Survey hook-and-line samples, and 214-680 mm FL (mostly 300-435 mm TL) in the commercial TIP samples (NMFS-Panama City Bioprofile Sampling Program). The commercial TIP data appeared to show evidence of a strong, 1994 year-class moving through the fishery during 1996-1998.

Sexual maturity ogives (a schedule of the proportion of fish in the population that are mature at each age) for yellowtail snapper collected off the Florida Keys indicated that about 35% of age-1 yellowtail snapper were mature and nearly all of age-2 fish and older were sexually mature. Spawning occurs over a long time period in the Florida Keys, February-November, with a peak in April-June. There was no evidence for yellowtail snapper spawning off Tequesta in Southeast Florida but some researchers believed that these fish did spawn each year but in other areas. Yellowtail snapper are gonochorists and indeterminate spawners; no valid fecundity data are available.

Natural mortality rates

Using data from studies conducted in the Caribbean, estimates of natural mortality (instantaneous rate M) calculated using a Pauly relationship (Pauly 1980) ranged from 0.32 to 0.44 per year. However, yellowtail snapper as old as 17 years have been found in the heavily fished South Florida stock, supporting an argument for a relatively low M. As a rule of thumb for exploited stocks, Gabriel et al. (1989) suggested that M=3.0/maximum observed age and for yellowtail snapper M=3.0/17=0.18 per year. There were no data suggesting other than a constant natural mortality with age.

DECISIONS:

1. *Life history information for the South Florida assessment should come from the FWC-FMRI fishery-independent life history study.*
2. *Male and female growth and mortality will be assumed equal in the analyses.*

3. *Gonad weight-age relation will be used to generate a proxy for spawning stock.*
4. *All ages used in the assessment should be referenced to a January 1 hatch date.*
5. *The instantaneous natural mortality rate, M, used in the assessment of the South Florida resource should range from 0.2 to 0.4 per year.*
6. *Constant natural mortality across ages should be assumed.*

B. Sources of Removals

Commercial Fisheries

Even given the lack of genetic stock structure, the South Florida fishery could be broken up into logical spatial components: eastern Gulf waters (including Monroe and Atlantic side of Keys) and southeast Florida Atlantic waters (Dade county north). Outside these regions there are fisheries throughout the Caribbean, portions of Mexico, Cuba, and Venezuela, all with substantial landings according to FAO documents (western Central Atlantic landings, 1970-2001). Puerto Rico commercial landings have been estimated or recorded by species since 1969. However, landings data prior to 1983 are not yet available (Nancie Cummings, NMFS-Miami, has requested the earlier landings data). Only aggregate species groups are reported in U.S. Virgin Islands commercial landings and will need to be apportioned to species using samples taken from the landings where species have been identified (NMFS-TIP data from biostatistical sampling). Additionally, U.S. Virgin Islands landings records are still being computerized and verified; with 1975-1985 data may be available by September 2003. The date that more recent data will become available is not known. Landings for U.S. waters are available from the NMFS Statistical Bulletins (1950-1961), NMFS General Canvass of Dealers (1962-2001) and from the FWC-Marine Fisheries Information System (Trip ticket, 1985-2001). Landings of yellowtail snapper recorded in the NMFS Federal Logbook System for reef fish fishermen shows generally good agreement with landings reported in the Florida trip-ticket system.

Commercial fishermen participating in the Data Workshop indicated that they felt the accuracy of reported commercial landings was quite low. They believed that beginning with 1985 Florida trip tickets, an increasing portion of the actual yellowtail snapper landings in South Florida has gone unreported or has been reported as other species, increasing to 30-40% of the total landings by 2003. If annual numbers of Florida fishery landings violations are available, they should be checked to see if an increasing trend in violations is seen that supports these assertions that under-reporting has increased. In Puerto Rico, reported commercial landings have increased from 50,000 pounds in 1983 to 300,000 pounds in 2001, but this is in large part because fishermen have increased their reporting rate due to financial incentives (e.g., landings records help qualify for disaster relief eligibility) and newer licensing requirements. Corrections in landings to account for changes in compliance with landings laws have been estimated using information from fishermen surveys conducted every five years. Also, dealers in Puerto Rico may keep separate records of landings and these may be more accurate. NMFS-Miami personnel are working with Puerto Rico staff to obtain the needed compliance data.

The Florida trip-ticket data indicate that the number of trips reporting yellowtail snapper landings declined beginning in 1992-1993 (concurrent with, and possibly due to, implementation of the regulations for the snapper/grouper complex). The gear used in the commercial fishery is mostly hook-and-line, with some trap landings from the eastern Gulf/Florida Keys region. Most commercial catch and effort occurs in waters 40-100 feet deep.

Data on commercial fishing trips in Puerto Rico, collected in 1983 and then 1985 to the present, is available from the NMFS TIP Sampling Program database. Information includes complete trip records for species-specific catch, length structure, individual weights, and sex ratios. Most of the landings are with “bottom lines”, which is a hook-and-line gear that is fished initially on the bottom then higher and higher in the water column to chum the fish toward the surface. All “bottom line” fishing is considered to be for yellowtail snapper, mostly occurring at night with lights. There were NMFS-TIP interviews made for the U.S. Virgin Islands fisheries off north St. Thomas and St. John during 1993 then again in 2003, but these were discontinued in March 2003. Interviews under the NMFS-TIP Sampling Program have been conducted in St. Croix since about 1986 with a total of 10,000-12,000 records available.

The size distributions of commercially landed yellowtail snapper were similar among gears in South Florida, except for the larger-sized fish caught in a stab-net fishery that operated for short time during the mid 1980s in the Florida Keys. Otherwise, there has been little change over time in the lengths of yellowtail snapper landed by the U.S. commercial fishery.

Some information on the quantity of commercial discards was collected by the NMFS-Southeast Fisheries Science Centers during August 2001-July 2002 but these data are still very preliminary. Many yellowtail snapper are released alive and most are noted as regulatory discards (probably too small but no measurements were taken). NMFS-Miami analysts are still working on some more sophisticated analytical techniques to estimate the number of discarded yellowtail snapper, but current estimates indicate that discard rates are relatively low (Poffenberger 2003). A non governemental organization representative stated that low rates could be expected from a self-administered bycatch logbook program. This opinion was supported by a wholesale dealer’s observation that many fishermen disliked filling out the bycatch logbook. There was a feeling that it was to a commercial fisherman’s advantage to report little or no discards rather than to report accurately. However, there was also an opinion by a commercial fisherman that fishers would not be waste time catching undersized fish so discards from the commercial fishery may be low. There was little information from a NMFS bycatch characterization study for fisheries in the eastern Gulf of Mexico (Galveston and Miami Laboratories 1995), with only one dead release out of 11 discards from a catch of 21 yellowtail snapper in fish traps. The release mortality of yellowtail snapper has not been studied but fishermen at the workshop believed it was relatively low, 8-10%. Also, fishermen indicated that there has been an increase in the use of small yellowtail snapper as live bait for black grouper. In their opinion this was getting to be a big problem with the large charterboats that operated occasionally under commercial licenses.

Commercial fishermen participating in the workshop indicated several factors that affect the observed landing made by fishermen. There are strong interactions among the fisheries for different fishes in South Florida where fishermen regularly switch from kingfish or dolphin to yellowtail snapper and other snappers and groupers. The South Atlantic Fishery Management Council's licensing requirement are less strict than the Gulf of Mexico Fishery Management Council's so some fish caught in the Atlantic are reported as caught in the Gulf to build up sufficient landings record from the Gulf to qualify for license renewals. Some landings of yellowtail snapper may sometimes be reported as other species to maintain eligibility requirements for license renewals. With the advent of a restricted species requirement in Florida in February 1990 many fishermen fished closer to shore because there was no commercial bag limit in state waters until ????. Conversely there were monetary incentives for reporting landings from Federal waters even if they are taken in State waters.

DECISIONS:

1. *A sensitivity analysis should be run using commercial landings estimates for South Florida calculated under assumption that there was a linear increase in unreported commercial landings from 0% in 1985 to 35% in 2001.*
2. *The time frame of the South Florida assessment should be 1981-2001.*
3. *A report is needed describing the levels of compliance to catch reporting requirements in Puerto Rico and the U.S. Virgin Islands. NMFS-Miami staff are working with Puerto Rico Department of Natural Resources staff on this.*
4. *Assume a release mortality rate of 10% for the commercial fishery.*
5. *Collate any fishery law enforcement data to test whether landings violations have increased.*

Recreational fisheries

The U.S. recreational fishery is monitored by the NMFS-Marine Recreational Fishery Statistics Survey (NMFS-MRFSS) for shore-based, private/rental boat, and charterboat fishermen. Data are available since 1979, but generally considered valid only since 1981. The NMFS-Beaufort Headboat Survey estimates the landings made by anglers fishing from headboats operating from North Carolina to Texas (1982-present for Atlantic, 1986-present for the Gulf) using logbooks collected from headboat captains. Both of these surveys indicate a decline in the landings of yellowtail snapper since at least the mid 1990s. It was noted that there was a change in how charterboat catches were estimated by the NMFS-MRFSS beginning in 2000. For comparability, the Panel felt that charterboat catch estimates made using the old estimation procedure should be used in the assessment. In general, it was noted that there are relatively few intercepts of fishermen who had caught or sought yellowtail snapper each year in the NMFS-MRFSS.

In the Caribbean, the NMFS-MRFSS has estimated the recreational catch for Puerto Rico in 1981 and during each year from 1999 to the present. In the U.S. Virgin Islands, recreational tournaments are monitored for catch and biostatistics, although these tournaments mostly target billfishes. Occasional studies using volunteer logbooks recorded by charterboats and telephone surveys provided estimates of recreational catch and effort. However, this was terminated at the end of FY02. In general the recreational landings for yellowtail snapper is believed to be very small in this region compared to the commercial landings.

Both the NMFS-MRFSS and the NMFS-Headboat Survey examine and measure fish in the landings. NMFS-MRFSS data indicated the presence of very small yellowtail snapper in shore-based angler creels in some years. The Panel members agreed that it was plausible that small yellowtail snapper were caught near shore. Otherwise lengths of MRFSS and the Headboat Survey showed no consistent differences in lengths of fish landed between seasons or years. Larger yellowtail snapper were seen in the angler landings in 1985-1987 and unusually small fish (125-300 mm TL, shore mode catch) were seen in 1999-2001. Fishermen suggested that when recreational size and bag limits were put in place, there was an increase in high grading so that only larger killed fish will be seen in the samples taken from the landings.

While discard estimates (NMFS-MRFSS Type B2 catch or fish released alive) are available from NMFS-MRFSS, there are no data on the quantity of discards from headboats. Fishermen on the Panel believed that the proportion of the catch discarded by the headboat fishery would be higher than that estimated for the commercial fishery but did not give a clear indication as to how much higher. FWC-FMRI analysts will attempt to find any discard data that might be available from scientific studies on headboats, e.g., Mote Marine Lab's reef fish tagging or Biscayne Bay fishery surveys. Otherwise the length distribution of yellowtail caught by scientific surveys will be compared to the lengths of landed fish to determine the likely release estimates.

Mortality rates for yellowtail snapper released alive by anglers were thought to be less than 50%, some panel participants thought much less. The release mortality rate of yellowtail released by anglers fishing from headboats was thought to be lower than for the recreational fishery, probably averaging 30% because headboats fish in shallower depths (when fishing is on schools of yellowtail snapper and they are chummed to the surface even lower release mortality rates are likely). The mortality of yellowtail released by headboat fishermen fishing north of Miami may be as high as that for recreational fishermen since fishing there occurs in 50-120' water depths.

DECISIONS:

1. *Assume the size distribution of the Type B1(killed but not available to the creel clerk) landings is the same as Type A (killed and available to the creel clerk).*
2. *Nancie Cummings (NMFS-Miami) suggested adjusting the Types B1 and B2 catch estimates by the non-interviewed catch.*
3. *Recreational release mortality advice was vague. Recommend using the range of 20-40% in a sensitivity analysis. Robert Dixon, NMFS-Beaufort, will provide additional guidance on the release mortality rate from headboats. The size structure of releases will be obtained from the difference between scientific hook-and-line survey yellowtail snapper lengths and Type A yellowtail snapper lengths*

C. Indices of Abundance

A number of fishery-independent surveys capture or observe yellowtail snapper in South Florida. Visual census information has been gathered under the NMFS Visual Census Survey Program (1979-present), the Reef Environmental Education Program (REEF) Reef Fish Survey Project (1993-present), the FWC-FMRI Fishery Independent Monitoring Program's Visual Survey (1999-present), and SEAMAP Reef Fish Survey. The latter two surveys were considered to be too short a time series (FWC-FMRI) or to have occupied too few stations in a limited area (SEAMAP) to be used as indices in this assessment. The NMFS Visual Census Survey has been conducted since the 1970s along most of the Florida reef track from the southern Keys to off Biscayne Bay. Concern was raised by the Panel as to the consistency of the geographic coverage of the survey over time. Standardized annual relative abundance estimates were provided to FWC-FMRI analysts by Steve Smith, University of Miami-RSMAS, for juveniles (< 190 mm TL), adults (>=190 mm TL), and exploited phase fish (>305 mm TL). There was a high degree of variability and some inconsistency between juvenile and adult indices. Concern was expressed that the recent prohibition of fishing in some of the survey area could have resulted in an increase in the index that may not have been reflective of the abundance of yellowtail snapper throughout their range. The Panel requested that further information about the survey and estimation procedures be gathered. The REEF Fish Survey Project is an opportunistic survey conducted by trained volunteer divers during their normal recreational activities. Survey sites range throughout South Florida.

NMFS-commercial logbook reports (1993-2001) were analyzed by FWC-FMRI staff to identify the species complex associated with yellowtail so that a subset of the data could be designated as potential yellowtail snapper fishing trips. Identifying yellowtail snapper trips was somewhat problematic since, even on trips where yellowtail snapper occur, they make up less than 40% of the catch. Steve Turner, NMFS-Miami suggested that the system used to define associated species developed by Dennis Heineman and Shannon Cass-Calay, NMFS-Miami, be considered. Logbook catch rates showed a decline on the Atlantic coast and a flat trend on the Gulf coast, trends which the fishermen on the Panel seemed to agree with.

Conversely, trip-ticket catch rates for South Florida showed a general increase between 1987 and 2001. Fishermen suggested that the jump in catch rates seen in 1999 is possibly due to a series of earlier regulations (restricted species endorsement in February 1990 and Federal licensing requirements) that caused all but professional fishermen to drop out of the fishery. If vessels could be identified as staying under the control of the same captain then the effect of this change in fishing-ability could be incorporated into a standardization model, although NMFS-Miami analyst Mauricio Ortiz has had little success performing such analyses.

Catch-and-effort data from the recreational fisheries was used to develop fisheries-dependent indices of abundance by FWC-FMRI staff. For NMFS-MRFSS data, fishing effort expended for yellowtail snapper was defined as all fishing trips that caught (landed or released) yellowtail snapper and all trips where anglers interviewed after the fishing trip indicated that they had been fishing for yellowtail snapper. The total-catch-per-trip data were used in a general linear model standardization to estimate standardized annual total-catch rates. Independent variables used as model effects were: number of anglers, wave, mode of fishing, area fished, and targeting. For Headboat Survey data, fishing effort for yellowtail was defined as all headboat trips fishing in South Florida. The landings-per-trip data were used in a general linear model standardization to estimate annual landings rates. Variables used as effects in the model were: year, month, region, time fished, and number of anglers. Since the Headboat Survey landings rates may have been affected by changes in regulations -- in 1990, a ten snapper aggregate bag-limit in was implemented in Gulf Federal waters; on 11 December 1987 a ten snapper aggregate bag-limit was implemented for anglers fishing in Florida state waters -- it was recommended that the data be divided into two time series (before and after regulations) and re-standardized.

The Panel tried to determine if any indices should not be used in the South Florida yellowtail snapper assessment model or if any should be modified. The Panel suggested that the Headboat index series be broken into two survey periods before and after the federal aggregate bag-limit was implemented (1990). Dr. Bob Dixon, NMFS-SEFSC-Beaufort, also suggested that the 1978-1980 data should not be used because sampling and estimation methods were somewhat inconsistent with the rest of the data series. Without consensus as to the validity of each survey, the Panel agreed that all surveys could be used and that sensitivity analyses should be conducted such that one assessment be conducted using all indices, another assessment be conducted using only fishery-independent indices, and yet another assessment be conducted using only fishery-catch rate indices. In addition, reports should be written that would explain in detail how each index was developed from the data. Ideally only fishery-independent indices should be used in the assessment to avoid the confounding effect of changes in fishermen behavior. However, the fishery-dependent catch rates were estimated across a much larger geographic range, which could be a deficiency of the fishery-independent survey if they measure only local and not global stock abundance. Also, Don DeMaria, an experienced diver, felt that yellowtail snapper might avoid divers so that there may be behavioral difficulties in visually surveying this species. Thought should be given to identifying common criteria for the definition of a yellowtail snapper fishing trip in the three main fisheries. It is possible that different definitions cause the differences seen in the fishery-dependent indices of abundance.

Several fishery independent surveys are conducted in the Caribbean region, including a handline and trap (1988-89, 1998-2001) finfish survey conducted off Mayaguez, Puerto Rico, SEAMAP Puerto Rico (1990-1991,1994-2000?), SEAMAP U.S. Virgin Islands St. Croix (1993-1994, Dixon and Maidment 1994), St. Croix (2000-2002, Tobias et al 2002), St. Thomas (1999-2000, Gomez 2000), and St. Thomas (1993-1994, Dixon and Maidment 1994), Department of the Interior Visual Survey in U.S. Virgin Islands (such as Mateo 2001 and 2002), East Coast Puerto Rico study off Collebra (1996-1997), and Turromote - SW Puerto Rico survey (1995- present?).

DECISIONS:

1. *All fishery-dependent indices (Headboat, Logbook, and MRFSS) need to be based on a consistently defined "yellowtail snapper trip", e.g. a common species catch composition)*
2. *Split the Headboat Survey landings-rate series into pre-1991 and 1991-onward series to account for the potential effect of implementing the aggregate bag limit.*
3. *Generate reports to be presented at the Stock Assessment Workshop describing the standardization procedure used to estimate fishery-dependent catch rates. It may be important to settle on a common method for determining which fishing trips qualify as yellowtail snapper trips.*
4. *Sensitivity analyses should be conducted such that one assessment be conducted using all indices, another assessment be conducted using only fishery-independent indices, and yet another assessment be conducted using only fishery-catch rate indices.*

D. Stock Assessment Analyses

The Panel felt that given the poor relationship of length to age, there was little age structure information imbedded in the length samples available for yellowtail snapper. Although still requiring an estimate of growth rate, the Panel felt that the primary stock assessment method employed in South Florida should be an Age-Structured Biomass Dynamic model. In addition, attempts should be made to construct an age-structured sequential population analysis in parallel to any biomass-based model.

In the Caribbean, data on yellowtail snapper landings, fishing effort, and relative abundance information appear to be substantially limited. There is on-going work to recover and computerize some historical data. At this point the Panel recommends development of valid fishery-dependent and fishery-independent catch rate trends to assess the relative condition of the population. Also, the gathering of and adjustments to the landings data should continue to move forward in this region.

DECISIONS:

1. *Develop an Age-Structured Biomass Dynamic model as a primary assessment tool for yellowtail snapper populations in South Florida. Also, attempt to integrate available data within an age-structured assessment as a additional investigative method.*
2. *For the Caribbean population of yellowtail, develop valid catch rate estimates for the fishery and for fishery independent surveys.*

<u>Environmental effects on catch rates</u>

There are strong indications that environmental factors affect the availability of yellowtail snapper to fishermen. Catch rates off the Southeast Florida coast are depressed during periods of cold water intrusions from upwelling events caused by a sudden offshore displacement of the Gulf stream, the duration of the typical intrusion is perhaps two weeks or more. Fishermen also suggested that rapid releases of large amounts of freshwater from the storm-water control structures in Southeast Florida depresses catch rates or changes the distribution of yellowtail snapper and other fishes in Southeast Florida waters. There was an opinion among Panel fishermen that increasingly poor water quality off Southeast Florida has reduced recruitment of yellowtail snapper to that area. After severe storms off the Southeastern U.S. coast there are usually 4-5 days of extremely high catch rates of yellowtail snapper, especially with winds out of the northeast. This has been observed after the passage of hurricanes.

List of Participants

Allman, Robert
National Marine Fisheries Service/Panama City
Tel. 850-234-6541
e-mail: bob.allman@noaa.gov

Atran, Steven
Gulf of Mexico Fishery Management Council
Tel. 813-228-2815
e-mail: steven.atran@gulfcouncil.org

Barbieri, Luiz
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: luiz.barbieri@fwc,state,fl,us

Bennett, Josh
National Marine Fisheries Service
Tel. 305-361-4485
e-mail: joshua.bennett@noaa.gov

Bert, Theresa
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: theresa.bert@fwc.state.fl.us

Cass-Calay, Shannon
National Marine Fisheries Service/Miami
Tel. 305-361-4231
e-mail: shannon.calay@noaa.gov

Chih, Ching-ping
Southeast Fisheries Science Center
Tel. 305-361-4489
e-mail: ching-ping.chih@noaa.gov

Cufone, Marianne
The Ocean Conservancy
Tel. 727-895-2188
e-mail: mcufone@oceanconservancyFL.org

Cummings, Nancie
National Marine Fisheries Service/
Southeast Fisheries Science Center/SFD
Tel. 305-361-4234
e-mail: nancie.cummings@noaa.gov

Davis, Jim
Commercial Fisherman
Tel. 305-664-8690
e-mail: CaptJamesDavis@direcway.com

De Silva, Janaka
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: janaka.desilva@fwc.state.fl.us

Dixon, Robert
National Marine Fisheries Service /Beaufort, NC
Tel. 252-728-8719
e-mail: robert.dixon@noaa.gov

Garcia-Moliner, Graciela
Caribbean Fishery Management Council
Tel. 787-766-5926
e-mail: graciela@coqui.net

Gladding, Peter
Commercial Fisherman
Tel. 305-296-2821
P.O. Box 5325, Key West, FL 33045

Goode,Tim
Gulf of Mexico Fishery Management Council
Tel. 813-228-2815
e-mail: tim.goode@gulfcouncil.org

Holiman, Stephen
National Marine Fisheries Service/SERO
Tel. 727-570-5335
e-mail: stephen.holiman@noaa.gov

Hood, Peter
Gulf Council, National Marine Fisheries Service
Tel. 727-530-5305 or 813-228-2815
e-mail: phood1@tampabay.rr.com

Kennedy, Frank S.
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: stu.kennedy@fwc.state.fl.us

Laks, Ira
Charter/Commercial
Tel. 561-575-4198

Muller, Robert G.
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: bob.muller@fwc.state.fl.us

Murphy, Michael D.
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: mike.murphy@fwc.state.fl.us

Nagel, Richard
Head Boat Fishery
Tel. 561-844-3523

Nichols, Scott
National Marine Fisheries Service/PASC
Tel. 228-762-4591
e-mail: scott.nichols@noaa.gov

O'Hop, Joe
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: joe.ohop@fwc.state.fl.us

Poffenberger, John
National Marine Fisheries Service/Miami
Tel. 305-361-4263
e-mail: john.poffenberger@noaa.gov

Rosario, Aida
Puerto Rico Department of Natural Resources
Tel. 787-833-2025
e-mail: lipdrna@coqui.net

Skov, Jens & Patricia
Caribbean Fishery Management Council
Tel. 340-773-4571

Steele, Phil
National Marine Fisheries Service/SERO
Tel. 727-570-5305
e-mail: phil.steele@noaa.gov

Strelcheck, Andy
Florida Fish & Wildlife
Division of Marine Fisheries
Tel. 850-487-0554 x 214
e-mail: andy.strelcheck@fwc.state.fl.us

Thomas, Paul
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel. 561-575-5407
e-mail: paule.thomas@fwc.state.fl.us

Tunnell, Janet
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel. 727-896-8626
e-mail: janet.tunnell@fwc.state.fl.us

Turner, Steve
National Marine Fisheries Service/Miami
Tel. 305-361-4482
e-mail: steve.turner@noaa.gov

Uwate, Roger
Fish & Wildlife, US Virgin Islands
Tel. 340-775-6762
e-mail: ruwate@vitelcom.net

Wallace, Liz
Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
Tel: 727/896-8626
e-mail: liz.wallace@fwc.state.fl.us

Williams, Kay
Gulf of Mexico Fishery Management Council
Tel. 228-826-2160
e-mail: hkaywilliams@hotmail.com

References (* indicates documents received at Data Workshop)

Dennis, G.D. 1991. The validity of length-frequency derived parameters from commercial catch data and their application to stock assessment of the yellowtail snapper (*Ocyurus chrysurus*). Proceedings of the Gulf and Caribbean Fisheries Institute 40:126-138.

Dixon, H. and S. Maidment. 1994. Annual summary report, April 1993-March 1994, Caribbean/NMFS Cooperative SEAMAP Program NA27FS107-01. 6 pp.

Figuerola 1998.

Gabriel, W.L., M.P. Sissenwine, and W.J. Overholtz. 1989. Analysis of spawning stock biomass per recruit. North American Journal of Fisheries Management 9:383-391.

*Galveston and Miami Laboratories. 1995.
Characterization of the reef fish fishery in the eastern U.S. Gulf of Mexico. Report to the Gulf of Mexico Fishery Management Council Reef Fish Management Committee.

Garcia, E.R., J.C. Potts, R.A. Rulifson and C.S. Manooch, III. In press. Age and growth of yellowtail snapper, *Ocyurus chrysurus*, from the southeastern United States. Bull. Mar. Sci.

Gomez, R.M. 2000. Fisheries independent sampling of the shallow water reef resources in the U.S. Virgin Islands. Caribbean/NMFS Cooperative SEAMAP Program. Bureau of Fisheries, Division of Fish & Wildlife, Department of Planning and Natural Resources. 7 pp.

*Harper, D. NMFS-SEFSC-Miami memo to J. Powers, NMFS-SEFSC Miami. Addendum to the report "Characterization of the reef fish fishery in the eastern U.S. Gulf of Mexico". NOAA NMFS-SEFSC, Miami, FL.

*Wallace, E.M. et al. 2003.
Genetic stock structure assessment of yellowtail snapper (*Ocyurus chrysurus*) in southern Florida, estimated by mtDNA D-loop sequencing. Special Report to the Fish and Wildlife Conservation Commission (preliminary draft, not for distribution or citation).

Johnson, A.G. 1983. Age and growth of yellowtail snapper from South Florida. Trans. Amer. Fish. Soc. 112:173-177.

Manooch, C.S. III and C.L. Drennon. 1987. Age and growth of the yellowtail snapper and queen triggerfish collected from the U.S. Virgin Islands and Puerto Rico. Fish. Res. 6:53-68.

Mateo, I. 2001. Nearshore habitats as nursery grounds for recreational important fishes. U.S. Fish and Wildlife Service, Sport Fish Restoration Program. 72 pp.

Mateo, I. 2002. Nearshore habitats as nursery grounds for recreationally important fishes, St. Croix, U.S. Virgin Islands. U.S. Fish and Wildlife Service, Sport Fish Restoration Program. 56 pp.

*Poffenberger, J. 2003.
Yellowtail snapper discards. NMFS-SEFSC Sustainable Fisheries Division.

*Scott-Denton, E. 2003.
Characterization of the reef fish fishery in the eastern U.S. Gulf of Mexico, MARFIN Grant No. 95MF1H07. Supplement to the Final MARFIN Report, NMFS-SEFSC Galveston, Tx.

Tobias, W., W. Toller, W. Ventura, H. Rivera. 2002. St. Croix fisheries independent trap and line survey. SEMAP-C USVI. Division of Fish & Wildlife, Department of Planning and Natural Resources, U.S. Virgin Islands. 27 pp.

List of Datasets

1. Results of yellowtail snapper mtDNA analyses (FWC-FMRI, 1998-2002).

2. Data from a life history study conducted off the Tequesta area of Florida (FWC-FMRI, 2000-2002).

3. Data from a life history study conducted off the Middle Florida Keys (FWC-FMRI, 1999-2002).

4. Data from a life history study conducted off Puerto Rico (Dennis 1991; Figuerola 1998).

5. Data from a life history study conducted off theU.S. Virgin Islands (Manooch and Drennon 1987).

6. Landings, landings rates, and bioprofile data from the NMFS-Beaufort Headboat Survey Program (1980-2002).

7. Bioprofile data from the NMFS-Panama City Bioprofile Sampling Program (1980-1981; 1992-2001).

8. Data from a life history study conducted off the U.S. Virgin Islands during the 1983-1984 (Manooch and Drennon 1987).

9. Ages, lengths, and gonad weights of yellowtail were determined for yellowtail snapper by Allyn Johnson and John Finucane (NMFS-Panama City, Johnson 1983) during the late 1970s-early 1980s.

10. A life history study from the USVI Department of Natural Resources 1996-1997, GCFI publication????

11. Data from about 1,500 yellowtail snapper sampled for otoliths 1994-1999 by an East Carolina University Masters student (Garcia et al. In Press).

12. Yellowtail landings from FAO documents (western Central Atlantic landings, 1970-2001).

13. Puerto Rico commercial landings estimated or recorded by species since 1969. However, landings data prior to 1983 are not yet available (Nancie Cummings has requested the earlier landings data).

14. U.S. Virgin Islands commercial landings (as available).

15. Commercial landings for U.S. waters are available from the NMFS Statistical Bulletins (1950-1961)

16. Commercial landings from the NMFS General Canvass of Dealers (1962-2001)

17. Commercial landings and trip ticket data from the FWC-Marine Fisheries Information System (Trip ticket, 1985-2001).

18. Trip landings and characteristics recorded in the NMFS Federal Logbook System for reef fish fishermen or NMFS-commercial logbook reports (1993-2001.

19. NMFS-Marine Recreational Fishery Statistics Survey (MRFSS) for shore-based, private/rental boat, and charterboat fishermen, 1982-2001.

20. NMFS-Beaufort Headboat Survey estimates the landings made by anglers fishing from headboats operating from North Carolina to Texas (1982-present for Atlantic, 1986-present for the Gulf).

21. Quantity of commercial discards collected by the NMFS during Aug 2001-July 2002.

22. The NMFS Visual Census Survey Program (1979-present).

23. The Reef Environmental Education Program (REEF) Reef Fish Survey Project (1993-present)

24. Several fishery independent independent surveys from the Caribbean region, including a handline and trap (1988-89, 1998-2001) finfish survey conducted off Mayaguez, Puerto Rico, SEAMAP Puerto Rico (1990-1991,1994-2000?), Department of the Interior Visual Survey in U.S. Virgin Islands (? - ?), East Coast Puerto Rico study off Collebra (1996-1997), and Turromote - SW Puerto Rico survey (1995- present?).

Yellowtail SEDAR Data Workshop Agenda

Florida Fish and Wildlife Conservation Commission
Florida Marine Research Institute
St. Petersburg, FL

March 3-4, 2003

Objectives of Data Workshop
-- To identify and make available the appropriate data for use in the yellowtail stock assessment

Data sources

A. Life History
  Stock identification
    FWC Genetics

  Age, growth, maturity, and sex ratios
    NMFS headboat otoliths: 1717 from 1980 – 2001
    TIP Commercial otoliths: 2359 from 1980, 1981, 1992, 1997, 1999 – 2001
    MRFSS otoliths: 144 from 1997-2001
    FWC Fishery independent otoliths : 1557 from 2000 – 2002

  Natural mortality rates
    Oldest aged Yellowtail snapper was 17 years and 94 out of 5775 fish were aged 10 years and older. Manooch and Drennon (1987) had a 17-year-old fish in their study of yellowtail snapper from Puerto Rico and the U. S. Virgin Islands.

B. Landings
  Questions to be resolved
    Time frame
    Geographic regions

  Commercial
    NMFS Website – US landings: 1950-2001
    FAO – Western Central Atlantic landings: 1970 - 2001
    FWC Florida Trip tickets: 1985 - 2001
  Length samples
    Commercial TIP: 1984-2001
  Discards ?
    How much is discarded?
    Release mortality?
    What size / ages should be applied to dead discards?
  Uncertainty surrounding landings?

Yellowtail SEDAR Data Workshop Agenda (con't)

Recreational
- MRFSS: 1981 - 2001
- Headboat: 1981 - 2001
- Texas Parks and Wildlife: 1974 – 2001 deleted because according to Mark Fischer they don't get Yellowtail snapper

Length samples
- Headboat: 1981-2001
- MRFSS: 1981-2001

Discards
- MRFSS estimates numbers of fish released alive
- How many fish are discarded by headboat anglers?
- Release mortality?
- What size / ages should be applied to dead discards. MRFSS indicates only whether the released fish were legal size.

Uncertainty surrounding landings?
- MRFSS provides proportional standard errors for their catch estimates.

C. Catch per unit effort

Fishery Independent
- NMFS – UM Visual survey: 1979 - 2001
- FWC FIM Visual survey: 1999-2001
- FWC Southeast Florida Reef fish Trapping: 2000-2002
- REEF Visual survey: 1993-2002
- SEAMAP Reef fish surveys: 1988,1991-1993,1996-1997

Fishery Dependent
- FWC Florida Trip tickets: 1985 – 2001
- MRFSS intercept data: 1981-2001
- Everglades National Park: 1972-2001 Deleted because Yellowtail snapper are rarely encountered
- NMFS Reef Fish logbook: 1993-2001

Methods of standardization?

D. Other data sources?

E. Other stock assessment issues?

Appendix 1: Participants and email addresses
Goliath Grouper E-mail List

Atran, Steven	steven.atran@gulfcouncil.org
Barbieri, Luiz	luiz.barbieri@fwc.state.fl.us
Barnette, Mike	michael.barnette@noaa.gov
Bennett, Josh	joshua.bennett@noaa.gov
Bergmann, Charlie	charles.bergmann@noaa.gov
Blough, Heather	heather.blough@noaa.gov
Bolden, Stephania	stephania.bolden@noaa.gov
Bullock, Lew	lew.bullock@fwc.state.fl.us
Calay, Shannon	shannon.calay@noaa.gov
Chih, Ching-ping	ching-ping.chih@noaa.gov
Coleman, Felicia	coleman@bio.fsu.edu
Cowan, Jim	jhcowan@lsu.edu
Cufone, Marianne	mcufone@oceanconservancyFL.org
De Maria, Don	dondemaria@aol.com
Eklund, Anne Marie	anne.marie.eklund@noaa.gov
Garcia-Moliner, Graciela	graciela@coqui.net
Goode,Tim	timothy.goode@gulfcouncil.org
Holiman, Stephen	stephen.holiman@noaa.gov
Hood, Paul	phood1@tampabay.rr.com
Jensen, Jill	hms.consulting@prodigy.net
Kennedy, Stu	stu.kennedy@fwc.state.fl.us
Koenig, Chris	koenig@bio.fsu.edu
McIlwain, Tom	tom.mcilwain@noaa.gov
Muller, Bob	robert.muller@fwc.state.fl.us
Nichols, Scott	scott.nichols@noaa.gov
Poffenberger, John	john.poffenberger@noaa.gov
Rosario, Aida	lipdrna@coqui.net
Schmidt, Eric	capter@earthlink.net
Schull, Jennifer	jennifer.schull@noaa.gov
Shipp, Bob	rshipp@jaguar1.usouthal.edu
Steele, Phil	phil.steele@noaa.gov
Strelcheck, Andy	andy.strelcheck@fwc.state.fl.us
Toomer, Eddie	toomer@comcast.net
Toomer, Jane	toomer@comcast.net
Turner, Steve	steve.turner@noaa.gov
Uwate, Roger	ruwate@vitelcom.net
Williams, Kay	hkaywilliams@hotmail.com

Gladding, Peter - no e-mail address – 305-296-2821

Southeast Data, Assessment and Review (SEDAR)
Data Workshop on Vermilion Snapper

Florida Marine Research Institute
St. Petersburg, FL
March 6-7, 2003

Steve Turner opened the meeting by reviewing the agenda and the objectives of the workshop. The major objectives were to review the available information on vermilion snapper and to consider additional information which might be useful in developing the next stock assessment.

The previous assessment as reported by the Reef Fish Stock Assessment Panel from the September 2001 meeting was briefly reviewed. Catch data indicated declines in the commercial and recreational fisheries since the high of about 3 million pounds (mp) in 1993 and 1994. In the last assessment conducted in 2001, the three indices of abundance based on fishery dependent data (western gulf headboat, eastern gulf headboat, and commercial handline) indicated declines in catch-per-unit-effort (CPUE). Declines were most notable in the eastern gulf headboat index. A fishery independent index (considered an index for younger vermilion) showed lower catch rates in the late 1990s (1996-1999) than in most of the early 1990s (1990-1995); that index was developed from SEAMAP trawl surveys and was used in a sensitivity analysis.

Two different assessment models were used to estimate the status of the vermilion snapper resource; a virtual population analysis (VPA) and a production model analysis. The VPAs displayed a broad range of outcomes regarding the stock size with respect to the minimum stock size threshold (some indicating the stock was in good condition and others that it was overfished), while both the production model and the VPAs indicated that overfishing was occurring. One weakness in the data sets used in the assessment was the paucity of age information from the western Gulf.

Biological Information

Stock structure

Terri Bert presented a report (Schwartz and Bert 2003) on preliminary results of research on the stock structure of vermilion snapper based on genetic information. Samples were taken from the eastern and western Gulf as well as from the Florida Keys, the east coast of Florida, North Carolina, and Venezuela. Very few samples (<10) have been collected to date from some locations. Based on preliminary data, the Venezuelan samples (n=5) were different from the U.S. samples, and within the U.S., the western Gulf samples (n=4) were different from the other samples. The Panel recommended that sample sizes be greatly increased at least for the lightly sampled locations and that inter-year class samples be collected so that these patterns can be adequately tested. Jim Cowan indicated that he had collaborated in a genetics study conducted by John Gold for red snapper that showed genetic differences between year classes. He wondered if this might be the case for vermilion snapper. He also indicated that otolith microchemistry might be an alternative way to examine stock structure.

Habitat and Ecology

Bob Shipp reported that vermilion snapper are more structure oriented than red snapper, at least at small sizes. Some reported that mid-sized vermilion snapper are often associated with rocky bottom, and larger sized vermilion are associated with hard bottom. Bab Zales indicated that the half-day headboats often catch vermilion snapper off the Florida panhandle between 50 to 100 feet and indicated that larger vermilion can be found in deeper waters in that region. He thought the bottom type was probably important to where this species is located. Eric Schmidt indicated that off west Florida he saw few large fish until he got out to the 40 fathom break. In the deeper waters, he was able to target areas with larger fish.

Jim Cowan reported that no vermilion snapper had been found in the thousands of red snapper stomachs his research team had examined.

Ageing samples

Bob Allman reviewed the available aging data (Allman *et al.* 2003). He showed that there were a relatively low number of unread otoliths from 1994 to 1999 in addition to the roughly 3000 otoliths used in the previous assessment (primarily from the eastern Gulf). From the year 2000, about 1100 otoliths are available which have not been aged (about 440 have been aged). Otoliths have been collected from about 4,400 fish in 2001 and 2002. Of these otoliths, 91% were from the Florida and 72% were from the commercial fishery. He was also working up about 680 otolith samples collected by Allyn Johnson from the early 1990s. Peter Hood wondered if otoliths from previous Gulf studies, particularly from the western Gulf in studies by Zastrow and Barber were available. Jim Cowan indicated he would contact Colleen Zastrow about the whereabouts of the otoliths she examined. NOAA Fisheries personnel will try to arrange for sample collections in the western Gulf by port samplers and through the Gulf States FIN. Cowan wondered if age-length keys could be used even though length-at-age data were so variable.

Catch and Fishery Information

Shannon Cass-Calay reviewed updated catch data. The decline in commercial catches from 1994 through 1999 continued in 2000 and 2001 (Figure 1). The recreational landings estimated by the MRFSS were somewhat higher in 2001 and 2002 than in the late 1990s. No new estimates were available for headboat landings. The catch data presented covered 1950-2001. The 2001 assessment reported catches from 1962-1999 (recreational catches from 1979-1999) but used catches only from 1986 and later in the production modeling because of unrealistic results for 1980-1985. It was suggested that consideration be given to using catches from before 1986 in the next assessment if reasonable estimates can be obtained.

Fishermen reported that, the vermilion snapper fishery started to increase in 1981 when Vietnamese-American fishermen developed a market. In addition, about this same time the 12 inch minimum size limit was implemented for red snapper. This meant that red snapper fillet sizes were larger making the smaller vermilion snapper (plate sized) more desirable for restaurant fare.

Fishermen John Rawlings and Matt Murphy indicated that some of the variability in the landings may have been due to storm events. Both fishermen and scientists reported that major storms can move fish long distances. Fishermen believed that this occurred in 1985/86 and 1992/93 when fish were thought to have been transported by storms from Mexican to Texas waters. The fishermen indicated that storm events were thought to remove accumulated sediment around wrecks and uncover hard bottom, thus providing increased habitat for concentrating fish. Texas fishermen also indicated that vermilion snapper were most available in the summer, but other species are generally targeted at this time by recreational fishermen.

Fishermen identified several market variables that might affect vermilion snapper landings. Eric Schmidt indicated that in the Ft. Myers, Florida area there is only an occasional market for vermilion snapper. He can catch fish anytime he wants, but the dealers want groupers. He indicated this was also the case in Naples. Lent was identified by Matt Murphy as having a large influence on prices. If Lent occurs when the red snapper landings are prohibited, then vermilion snapper may be targeted. Many commercial fishermen will not fish for vermilion snapper unless the price is above two dollars a pound. Fishermen also indicated that price is influenced by the size of the fish. During the red snapper season, fishermen indicated that the first trip will often have a lot of vermilion snapper because they can load up with them prior to being able to fish for red snapper.

Peter Hood asked the fishermen what sort of discard rate they experienced in the fishery and what type of discard mortality was associated with discards. Fishermen indicated that vermilion snapper are an effective live bait for groupers, amberjack, and other large predators. Some fishermen estimated that the quantity of vermilion used for live bait was less than 5% of the recorded landings and that most vermilion used for live bait would be in the 10-12 inch size range. Mike Nugent indicated that with a 10-inch minimum size, there was very little discard off central Texas. Matt Murphy and John Rawlings indicated that they saw about a 15 to 18 percent discard rate. Most fish seemed to actively swim down after their swim bladder was deflated; however, the fate of those fish once they reached the bottom was unknown. Most fish were caught outside the 25-fathom contour. Bob Zales indicated that some 10 to 12 inch fish were used as bait and that small fish were in shallower waters off the Panhandle.

Indices of Abundance

Scott Nichols discussed SEAMAP data available for indices of abundance. He indicated that Lutjanid (snapper family) larval identification problems had been worked out and that a larval index could be developed from SEAMAP plankton surveys. He indicated that this work should be completed soon. Nichols also reported that the numbers of juveniles in trawl surveys was low; which might explain some of the year to year variability in the fishery independent index available for the 2001 assessment. He further reported that vermilion snapper was common in the trap and video surveys.

The SEDAR panel discussed how to identify fishing effort which might catch vermilion snapper and fishing effort targeted at other species such as red snapper. Shannon Cass-Calay indicated that the 2001 assessment used reef fish permit endorsement information and red snapper fishery status (open or closed) to attempt to classify trips into groups which might have had different catch rates of vermilion snapper. It was pointed out that the current red snapper individual fishing quota (IFQ) profile might have much of the information useful for classifying vessels and their targets. Fishermen pointed out that red snapper landings from a trip may provide useful information for defining targeting and/or vessel groups. Any commercial fishermen landing more than 200 pounds either has a permit or would be landing red snapper illegally. Mike Nugent indicated that any trip with vermilion snapper caught during the red snapper derby season by a vessel with a 2000 lb endorsement would be incidental catch. Fishermen indicated that where red snapper and vermilion snapper co-occurred, red snapper were more aggressive toward bait and were caught first. Trips made during the red snapper season by Class 1 endorsement vessels were generally shorter (generally 1-2 days) than trips that targeted vermilion snapper and that red snapper trips would be made in rougher weather. Some fishermen recommended focusing on winter catch rates of vermilion for an index of abundance because fewer interactions occur with red snapper during those months when the red snapper fishery is closed.

Recommendations

Factors identified as data needs for the next assessment included:

- a more detailed genetic analysis of the stock,
- obtaining more age data from the western Gulf,
- and gaining more information through fishery independent sampling.

.

Literature cited

Allman, R.J., L.A. Lombardi-Carlson, G.R. Fitzhugh. 2003. Summary of vermilion snapper otoliths archived at NMFS Panama City laboratory: for February 2003 SEDAR meeting. NOAA-Fisheries. Panama City Laboratory, Contrib. Ser. 2003-02.

Schwartz, T. and T. Bert. 2003. Preliminary assessment of genetic stock structure of vermilion snapper (*Rhomboplites aureorubens*). Special Report to the Florida Fish and Wildlife Conservation Commision. 17p.

Table 1. List of participants at the vermilion snapper section of the SEDAR March 6-7, 2003.

Name	Affiliation	Phone No.	Email
Steven Atran	GMFMC Staff	813-228-2815	steven.atran@gulfcouncil.org
Shannon Cass-Calay	NOAA Fisheries - Miami	305-361-4231	shannon.calay@noaa.gov
Robert Allman	NOAA Fisheries Panama City	850-234-6541	bob.allman@noaa.gov
Jill Jensen	Gulf Restoration Network	504-525-1528	hms.consulting@prodigy.net
Phil Steele	NOAA Fisheries SERO	727-570-5305	phil.steele@noaa.gov
Tim Goode	GMFMC Staff	813-228-2815	tim.goode@gulfcouncil.org
Jim Cowan	RFSAP, LSU	225-578-9400	jhcowan@lsu.edu
John Rawlings	Reef fisherman - TX	979-863-7357	jhrawlings@aol.com
Matt Murphy	Charter fisherman - TX	956-943-2511	
Mike Nugent	Charter fisherman - TX	361-779-8389	captainmike@fishportaransas.com
Kay Williams	GMFMC	228-826-2160	hkaywilliams@hotmail.com
Tom McIlwain	SEFSC - Pascagoula	228-762-4591	tom.mcilwain@noaa.gov
Roger Uwate	USVI FW	340-775-6762	ruwate@vizelcom.net
Graciela Garcia-Moliner	CFMC	787-766-5926	graciela@coqui.net
Aida Rosario	PR-DNER	787-833-2025	lipdma@coqui.net
Heather Blough	NOAA Fisheries SERO	727-570-5305	heather.blough@noaa.gov
Tony Lamberte	GMFMC Staff	813-228-2815	tony.lamberte@gulfcouncil.org
Stu Kennedy	FMRI/FWC	727-896-8626	stu.kennedy@fwc.state.fl.us
Terrie Bert	FMRI/FWC	727-896-8626	theresa.bert@fwc.state.fl.us
Tonia Schwarz	FMRI/FWC	727-896-8626	tonia.schwartz@fwc.state.fl.us
Eric Schmidt	Fisherman - FL	239-437-1630	capter@earthlink.net
Scott Nichols	SEFSC - Pascagoula	228-762-4591	scott.nichols@noaa.gov
Peter Hood	GMFMC Staff	813-228-2815	peter.hood@noaa.gov
Steve Turner	NOAA Fisheries - Miami	305-361-4482	steve.turner@noaa.gov
John Poffenberger	NOAA Fisheries - Miami	305-361-4263	john.poffenberger@noaa.gov
Bob Zales II	RFAP, PCBA	850-763-6242	bobzales@fishpc.com
Mark Fisher	TPWD	361-729-2328	mark.fisher@tpwd.state.tx.us
Bob Shipp	RFSAP, Univ. SA	251-460-6351	rshipp@jaguar1.usouthal.edu

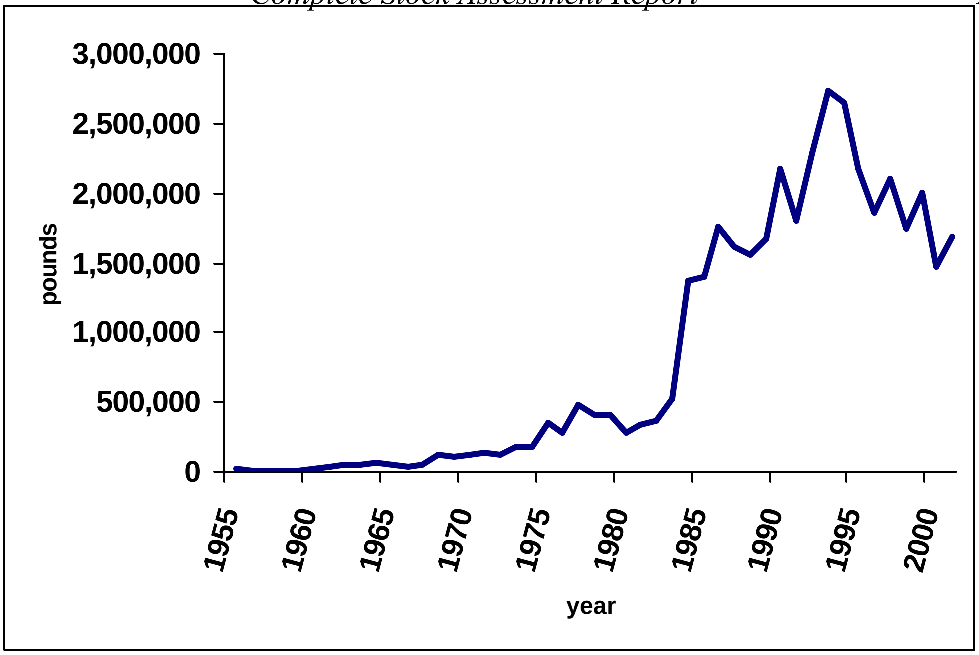


Figure 1. Vermilion snapper commercial landings recorded in the NOAA Fisheries Accumulated landings data base (1962-2001) and in Fishery Statistics of the United States (1955-1961).

CIE Reports

Reports Submitted by Scientists provided for the SEDAR 3 Review Panel from the Center for Independent Experts

REPORT ON THE 3RD SOUTHEAST DATA, ASSESSMENT AND REVIEW (SEDAR III) MEETING

by

Andrew I.L. Payne
SEDAR III Chair (Appointed by CIE)
CEFAS
Pakefield Road
Lowestoft
Suffolk NR33 0HT
United Kingdom

Contents

Executive Summary and Recommendations

SEDAR III met in the last week of July 2003, and addressed an assessment of yellowtail snapper, along with a cursory examination of what was known about goliath grouper. The meeting arrangements were excellent, but I have two clear recommendations: **(1) to ensure the provision of a large-scale locator map in the meeting room (for those not familiar with the geography or sampling areas); (2) to appoint before the meeting a person (or two persons) well versed in the assessment and management of the stock in question to draft the report(s) produced.**

Those charged with assisting me in my capacity as Chair (John Merriner, Gregg Waugh, and Steve Atran) did an excellent job, and the meeting would not have been near so successful without their totally committed input. The panelists were a competent and disciplined group from across the stakeholder spectrum. Supplemented by two numerically astute non-local scientists (Chris Francis, Larry Jacobson), the panel was both efficient and fair, resulting in a fruitful meeting.

The terms of reference supplied were adhered to, though there was no need for any discussion of stock rebuilding, and the meeting decided unanimously also to devote a small portion of its time debating goliath grouper, a species that had been removed from the initial plans for the meeting owing to its data-poor situation.

Discussion was intense, probing, but fruitful, and it was unanimously agreed that yellowtail snapper are currently not overfished and likely not subject to overfishing. Goliath grouper data were deemed sufficient to conduct an assessment, but first the Councils must decide on their objective for managing it – for non-consumptive use or for a sustainable fishery. For both stocks, clear advice on future research and monitoring was given.

I have no criticisms of the process followed. Indeed, I was sufficiently impressed to feel motivated to hold out the SEDAR process as an example of the way to work in my part of the world. What was particularly gratifying was that, in chairing the meeting, I felt that the spirit of compromise and the will to reach consensus was very strong.

Background, Preliminaries and Documentation

The panel met from 26 to 31 July 2003 at the Hilton Hotel, Tampa Airport, Florida, with a Chair and 15 panelists (along with several advisers and observers, who also participated in discussions), as listed in Appendix 1. The terms of reference of SEDAR Stock Assessment Review workshops are outlined in Appendix 2, the Bibliography consulted in Appendix 3, and the Statement of the Task in Appendix 4.

I was notified of the website posting of the documentation for the meeting around 10 July 2003, in good time for me to download it and to prepare myself for the meeting. All material was in readable format thus posing no problems. My primary point of contact was John Merriner (the facilitator), but once I was in the email loop, I also received material from the two council staff representatives on the panel, Gregg Waugh and Steve Atran. All three were also responsible for the "housekeeping" arrangements at the meeting itself, namely the provision of refreshments and other hotel-provided materials, recording of the meeting proceedings, and the supply of hard copy of documentation.

Between 15 November and my departure for the USA, I studied the submitted material, familiarizing myself with its contents. John Merriner provided me with valuable background on the evolving SEDAR meeting procedures and clear direction of what was expected as output from the meeting itself. He also engaged me electronically in discussion about the meeting agenda, allowing for the presence of all the relevant staff and working group members at their times of availability.

The terms of reference were clear and, to my mind, eminently achievable in terms of yellowtail snapper. However, email discussions before the meeting revealed that there was a need for discussions also on goliath grouper (jewfish), a species originally tabled for consideration but withdrawn when the earlier data workshop concluded that data were too few to conduct an assessment at the current time. Therefore, arrangements were made for one of the researchers working on the species to present her material at the meeting, to allow the Panel to consider future research and management needs.

Overall, therefore, I was well briefed and prepared by the time the meeting convened in Tampa.

Conduct of the Meeting

The meeting convened at 13:30 on 28 July with all panelists and advisers present (other than Anne-Marie Eklund, who was to present the goliath grouper work). Dr Eklund arrived later in the week, as arranged. The facilitator opened the meeting with a welcome to all present and an introduction and warm welcome of the non-local members of the panel, myself as Chair, Chris Francis from New Zealand and also representing the CIE, and Larry Jacobson of the Northeast Fisheries Science Center, Woods Hole. He then handed the meeting over to me and I explained what I wanted to achieve (as per the Terms of Reference - Appendix 2) and how I wished to get there, through debate and consensus. Specifically, the two reports required of the Panel I saw were key outputs, namely the review of the yellowtail snapper assessment, and the summary of stock status. With respect to the second of these two reports, I stressed that I saw the Panel as mandated to provide information rather than advice, *sensu stricto*, and so requested the Panel to allow me to move the drafting of that particular contribution in that form. In terms of the panel itself, I stressed that I saw my own role as primarily process-orientated in terms of the meeting discussion, and that of Mr. Francis and Dr Jacobson as to delve deeper into technical aspects of the work than I would be able to while in control of the meeting.

After the preliminaries of personal identification by panel members, the agenda was confirmed with the addition of the presentation and discussion on goliath grouper, and the order of debate throughout the week stayed the same as initially agreed in the draft agenda provided by Dr Merriner. At this juncture, I pointed out that we were privileged to be able to count among the Panel representatives of industry (fishers) and the environmental lobby. I urged those panelists to take full advantage of their opportunity by providing the extra background their unique knowledge afforded us by participating fully in the discussions. Thus, the meeting commenced with a presentation of the yellowtail snapper assessment by Rob Muller, supported by Mike Murphy and Luiz Barbieri.

For report writing, Gregg Waugh undertook the responsibility of drafting the assessment review, and Larry Jacobson offered to do the same for the stock status summary. Each fulfilled their task admirably, providing Chris Francis and me with excellent drafts to develop for submission to the meeting later in the week. The intention was to finalize the stock status report before the meeting adjourned (which we achieved), but only to undertake a first revision of the more extensive review document and to allow panelists to revert by email to me with final comments within one week.

In the event, we were ready by the Wednesday afternoon to review both first drafts in detail. That was despite several extra runs and sensitivity analyses being requested (mainly carried out overnight) and their outputs discussed rigorously. Indeed, by adjournment on the Thursday, the panel was able to take away copies of the virtually final status report (only cosmetic/format changes were made subsequently) as well as an advanced draft of the assessment review (though without the section on goliath grouper). I was very satisfied with the manner in which the latter part of the meeting was conducted. There were inevitably a few sticking points and some counter views, but the spirit of consensus-seeking prevalent throughout the meeting was followed to the end.

Two specific points deserve mention here, the first a request, the second a recommendation. First, from my UK perspective, I found it a little hard to know always the geographic (or even Council) area being referred to by the presenters and in discussion. I did try to prepare myself for this eventuality before the meeting (I also successfully learned much of the acronym jargon that I knew would be used!), but I sometimes found myself lost geographically during the meeting. It is therefore my recommendation that future SEDAR meetings provide a large-scale locator map that is available at all times for participants to refer to, particularly the Chair, who seems traditionally to be contracted from outside the USA. The second point is perhaps more important. Although Gregg Waugh and Larry Jacobson willingly filled the requirements of drafters for this meeting, it would have been better for us all, and for them in particular, had someone involved in the assessment and management process for yellowtail snapper been responsible for producing the first drafts. Such a process is invoked in the NEFSC SARC assessments, and it works well, specifically in allowing for more background information than was produced in the current (draft) reports. I certainly do not mind making my inputs and working late to ensure fairness of reporting, but it is my opinion that Mr Waugh and Dr Jacobson would have been able to use their time as panelists better had they not been responsible for the drafting. I am well aware that the

SEDAR process is still evolving and that an appointment of facilitator is imminent, but I do recommend that future meetings ensure that identification of those responsible for the drafting process be made (and agreed) before the Chair arrives and that those made so responsible have a good understanding of the assessment and management process.

Finally, I wish to pay tribute to the positive manner in which the representatives of industry (Messrs Gladding, Gales and Kelly) conducted themselves. Throughout my fisheries career, I have always stressed that fisheries scientists who conduct their work without the benefit of fisher input miss a valuable opportunity. That the current process listened to and made use of the valuable inputs of the three fishers mentioned above, as well as that of the environmental lobby panelist, lends more credibility to the outcome, and I hope the precedent will be followed in future by SEDAR.

Summary of the Meeting Content

A comprehensive report of the meeting conclusions is given in the Assessment Review Report and the Stock Status Summary, but for the purpose of completeness, a summary is here given, highlighting the aspects I personally consider to be most important.

Yellowtail snapper

The panel was satisfied with the assessment provided, noting that best use had been made of the data provided to the stock assessment workshop. The overall conclusion was unanimously that currently the stock was not overfished and that overfishing was likely not occurring. That conclusion is, however, based on certain assumptions, notably those relating to the values selected in the models for M (natural mortality coefficient) and h (recruitment steepness parameter). Given the information placed at its disposal on how the values for both had been selected, the choice ultimately decided on in the assessment was deemed by the Panel to be well founded, but some of the work suggested for the inter-assessment period can hopefully place both selections on a sounder scientific footing.

Other issues addressed in the assessment review and not resolved, or resolved as best as possible and suggestive of further work included:

- Discard mortality rate – considered by the fishers on the panel to be overestimated for certain catching techniques (e.g. the value of 28% applied to the commercial fishery);
- General linear modeling – some of the new runs during the meeting were unable to assuage some doubts in the minds of certain panelists that trends were real;
- Recruitment variability – for a marine species, the recruitment seemed to be "too stable" from year to year, though there may be pertinent reasons for this. Continued use of annual age/length keys may be one way to investigate whether this trend is real or an artifact;

- Assessment model choice – although the ICA and fleet-specific models were appropriately chosen this time, the panel felt there would be value in exploring the use of other, e.g. length-based, models;
- Retrospective bias – this had not been explored adequately in the assessment, for reasons of time-limitation, so it remained a useful subject for investigation before the next assessment;
- Data series weighting – attempts were made during the workshop to evaluate the sensitivity of the models used to the weighting applied to the various data series, but the results were inconclusive. The results presented were therefore upheld and those responsible for the assessment asked to conduct more intensive analyses before the next assessment;
- Inconsistency in biomass index trends – the panel explored this subject intensively and drew heavily on the experience of the fishers. Technological creep in some indices was identified as an explanatory factor, but concern was expressed over the appropriateness of the reef visual survey index, given the survey protocol. Although the issue did not influence stock status conclusions, it was clearly another subject for review in future;
- Fishing power and catch-per-unit-effort (cpue) – there was much debate on the relationship between improving fishing power and the cpue indices in the commercial and recreational fisheries. No resolution was reached, but those responsible for the assessments and provision of data were asked to investigate this issue in greater detail in the months ahead.

To address all the above research concerns, some clear research proposals were tabled. They included better determination of the release mortality rate; collection of discard data for the headboat fishery and better determination of the discard rate in all sectors of the fishery; thorough evaluation of the reef visual survey index of cpue; investigation of alternative methods of incorporating changes in catching efficiency into the assessment; continued use of annual age/length keys and better validation of age estimates; and investigation of stock structure with, *inter alia*, genetics.

Goliath grouper

There was no assessment for this species, because the data workshop consensus had been that an assessment was not possible. That conclusion was challenged by many of those present, because many assessments of marine species are made in data-poor conditions, and the results are still accepted for management. Further, it was noted that a decision had not been made by the Councils on whether goliath grouper were to be managed as a potential non-consumptive resource or as a fishery to be prosecuted if stocks recovered sufficiently. Therefore, it was recommended that the Councils debate and make that decision on use of the resource and then put in place the means to conduct an assessment of current status.

Notwithstanding the generalization above on the need for an assessment, the Panel discussed what was currently known about the species and also recommended a few areas for enhanced research that could lend credence to future assessments. The primary suggestions were:

- Estimating population size across the geographic range of the species, a crucial parameter because of the apparently narrow home ranges and site fidelity of the species. Tag/recapture research and studies with data storage tags were mentioned as potential monitoring tools.
- Monitoring the demographics of the population, particularly age composition.
- Developing further understanding of the reproductive biology, e.g. identification of spawning locations, duration and periodicity of spawning, identifying spawning migrations, if any, early life history of the species in mangroves.
- Obtaining information on historical abundance, perhaps via old logbooks.

Of lesser importance, but still valuable should research funding be available, were estimating unrecorded mortality from accidental or intentional sources, deriving information on stock structure, investigating bioenergetics and trophic relationships, and seeking information identifying changes in mangrove abundance and distribution, and hence changing available nursery habitat (goliath grouper spend their first 6-7 years in mangrove areas).

Final Comments

The meeting had a clear objective, enshrined in the Terms of Reference of the meeting, namely to evaluate the assessment for yellowtail snapper. The system by which the yellowtail snapper assessment came into being is clearly sound and should be followed for other SEDAR-managed stocks and species. Rigorous evaluation of the data at a data workshop, followed by in-depth analysis of stock assessment options at a stock assessment workshop is obviously a healthy procedure, especially if both initial workshops involve as many of those involved in researching, monitoring and prosecuting the fishery as possible. In particular, the involvement of stakeholders in at least the data workshop and the review is a very healthy situation and should be continued. The fact that the assessment we were provided hardly changed despite being subjected to extra sensitivity tests and runs speaks volumes for its quality and the competence of those providing it, and the staffers of the Florida Marine Research Institute deserve much credit for what they produced. Scientifically it is a very good piece of work.

Perhaps a little frustrating for me as chair was not really knowing the audience for whom the review was being produced. I am distinctly aware that this is the first time two Fishery Management Councils have worked together on a SEDAR project, but it was a little disconcerting to have to be regularly reminded that each had their own agenda and that sometimes one, and sometimes the other, was ahead of the game in terms of management understanding. No doubt politics will play a large role in implementation of any of the proposals produced in the workshop, as they naturally will too in implementing enhanced management of the stock. However, I believe that the output from the review will be valuable in informing both Councils on how best to manage this stock for the benefit of present and future generations of citizens, so I think it also achieved its “political” objective, even though none was written. That statement applies equally to the work on yellowtail snapper and goliath grouper.

The SEDAR process is extremely valuable in ensuring the credibility of fisheries science and scientific advice. I would like to take that message back to Europe with me, and certainly will give my support for the process whenever I am asked. However, it would not work without the professionalism and competence of all panelists appointed and advisors mandated to work through the voluminous literature. Without a single exception, the meeting itself was conducted in excellent spirit, despite the rigorous and probing debate. I also enjoyed and personally benefited from the discussion around the fringes of the meeting, over refreshments and sometimes late into the evening. I can therefore say that I wholeheartedly enjoyed myself and consider myself privileged to have been selected to assist in some small manner. My personal thanks are due to the CIE for having sufficient confidence to entrust me with chairing this challenging meeting, to my two non-local co-panelists (Larry Jacobson, NEFSC; Chris Francis, NIWA/CIE), with whom I shared many hours of discussion inside and outside the meeting room, to John Merriner for efficiently coordinating the meeting arrangements with Gregg Waugh and Steve Atran and in ensuring that I had access to all material I required, and to all participants (panelists, presenters and observers) for their valuable, personally hugely appreciated, contributions. Without everyone's contributions, the meeting output would not have been as comprehensive and scientifically rigorous as it turned out to be.

Appendix 1

PANELISTS AND ADVISERS

Panel

PANEL CHAIR:	Dr Andrew Payne
REVIEW PANELIST:	Mr Chris Francis
SAFMC:	Mr Gregg Waugh
GMFMC:	Mr Steve Atran
NMFS SEFSC:	Dr Joseph Powers
NMFS NEFSC:	Dr Larry Jacobson
FISHERS:	Mr William Kelly Mr Robert Zales Mr Peter Gladding
NGO REPRESENTATIVE:	Ms Nadiera Sukhraj
SSC REPRESENTATIVES:	Mr Doug Gregory Mr Billy Fuls Dr Al Jones Ms Carolyn Belcher Dr Robert Trumble Dr Rocky Ward

---

Non-Panel

PRESENTERS:	
AW Coordinator	*Dr Luiz Barbieri*
Lead Analysts	*Dr Robert Muller* *Mr Michael Murphy*
Goliath grouper	*Dr Anne-Marie Eklund*
AW/RPanel SUPPORT STAFF:	*Dr John Merriner* *Dr Janaka de Silva*
	Mr Roy Williams *Dr Tom McIlwain* *Dr Joe Kimmel* *Mr Mark Robson* *Mr Stu Kennedy* *Dr Roy Crabtree* *Dr Behzad Mahmoudi*

Appendix 2

TERMS OF REFERENCE OF STOCK ASSESSMENT REVIEW WORKSHOPS

The Stock Assessment Review Panel consisting of assessment scientists, conducts an independent peer review of the stock assessment. Core participants include NMFS-SEFSC, NMFS-NEFSC, Special Reef Fish SSC, and 1 or more representatives from the Center for Independent Experts. Also included may be one representative each from the Reef Fish AP and NGO interests (non-AP representatives with assessment expertise may be substituted). The Stock Assessment Review Panelists will receive the Stock Assessment Workshop report, supplemental analytical materials and the consensus data sets for their review prior to the scheduled meeting. The Stock Assessment Review Panel will do the following:

1. Evaluate adequacy and appropriateness of fishery-dependent and fishery-independent data used in the assessment.
2. Evaluate adequacy, appropriateness, and application of models used to assess the stock and to estimate population benchmarks.
3. Evaluate adequacy, appropriateness, and application of models used for rebuilding analyses.
4. Develop recommendations for improving data collection and assessment and future research (both field and assessment)

The panel will provide a final brief report to the Council, including its comments on the assessment, its findings on stock and fishery status, and recommendations for management under SFA guidelines.

Appendix 3

BIBLIOGRAPHY

Anon. 2003. Goliath Grouper Data Workshop Report, March 2003. 11 pp.

Muller, R. G., Murphy, M. D., de Silva, J., and Barbieri, L. R. 2003. A stock assessment of yellowtail snapper, *Ocyurus chrysurus*, in the Southeast United States. Draft Report submitted to the National Marine Fisheries Service and the Gulf of Mexico Fishery Management Council as part of the Southeast Data, Assessment, and Review (SEDAR) III. St Petersburg, FL; Florida Marine Research Institute: 182 pp.

Restrepo, V. R. *et al*. (1998). Technical guidance on the use of precautionary approaches to implementing National Standard 1 of the Magnuson–Stevens Fishery Management and Conservation Act. NOAA Technical Memorandum NMFS–F/SPO–31.

South Atlantic Fishery Management Council 1990. Jewfish. Amendment Number 2, regulatory impact review, initial regulatory flexibility analysis and environmental assessment for the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. SAFMC, Charleston, South Carolina. 28 pp. + 4 Figures + 10 Tables.

Appendix 4

STATEMENT OF TASK

Consulting Agreement between the University of Miami and Dr. Andrew Payne

June 11, 2003

General

The **S**outh **E**ast **D**ata, **A**ssessment, and **R**eview (**SEDAR)** process for stock assessment and review is used in the NMFS- Southeast Fisheries Science Center's area of responsibility. This new program provides the framework for independent peer review of stock assessments undertaken jointly by NMFS-SEFSC, three Regional Fishery Management Councils, and two Interstate Fishery Commissions, and state fishery agencies. The SEDAR process uses a three phase approach: a data workshop, an assessment workshop, and a peer review panel workshop. The peer review panel is composed of stock assessment experts, other scientists, and representatives of the Council, the fishing industries, and non-governmental conservation organizations. The communication elements of SEDAR include a stock assessment report from the Assessment Workshop, a review panel report evaluating the assessment(s) (drafted during the Review Panel Workshop), presentation of the peer reviewed assessment results to the Council(s) and public, and publication of collected documents for stock assessments considered in that cycle of the SEDAR process.

The assessment to be reviewed by this SEDAR Peer Review Panel is yellowtail snapper in the area of jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils. The Review Panel will meet July 28-31, 2003 at the Tampa, Florida Airport Hilton Hotel. A data workshop was held March 3-4, 2003 in St. Petersburg, FL. The assessment workshop was held during week of June 9-13, 2003 in St. Petersburg, FL. The SEDAR Review Panel for the yellowtail snapper assessment may include 12+ members: 1 senior assessment scientist each from NMFS- NEFSC and -SEFSC, 2 Council Staff scientists (South Atlantic and Gulf of Mexico), 2 assessment scientist members of the Scientific and Statistical Committee of South Atlantic and Gulf of Mexico Fishery Management Councils, commercial/recreational fishermen from the Snapper-Grouper (SA) and Reeffish (GM) Advisory Panel with special experience with the species, 2 scientist representatives (SA and GM) from non-governmental organizations, and 2 members from the Center for Independent Experts (Chairperson and reviewer). Assessment scientists from Florida FWC and NMFS-SEFSC will present the assessment and be available to provide supplemental information as requested by the review panel.

SEDAR Assessment Review Panel Tasks

The Panel will evaluate the yellowtail snapper assessment, the input data, assessment methods, and model results as put forward in the stock assessment workshop report.

Specifically, the review panel will:

1. Evaluate the adequacy and appropriateness of fishery-dependent and independent data used in the assessment (i.e. was the best available data used in the assessment).
2. Evaluate the adequacy, appropriateness and application of models used to assess these species and to estimate population benchmarks (MSY, Fmsy, Bmsy and MSST, i.e. Sustainable Fisheries Act items).
3. Evaluate the adequacy, appropriateness, and application of models used for rebuilding analyses.
4. Develop recommendations for future research for improving data collection and the assessment.
5. Prepare a report summarizing the peer review panel's evaluation of the yellowtail snapper stock assessment. (Drafted during the Review Workshop; Final report due two weeks after the workshop-August 15, 2003).
6. Prepare a summary stock status report including management recommendations. (Drafted during the Review Workshop, Final report due two weeks later -August 15, 2003)

It is emphasized that the panel's primary duty is to review the existing assessment. In the course of this review, the Chair may request a reasonable number of sensitivity runs, additional details of the existing assessment, or similar items from technical staff. However, the review panel is not authorized to conduct an alternative assessment, or to request an alternative assessment from the technical staff present. To do so would invalidate the transparency of the SEDAR process. If the review panel finds that the assessment does not meet the standards outlined in points 1 through 3, above, the panel shall outline in its report the remedial measures that the panel proposes to rectify those shortcomings.

The Review Panel Report is a product of the overall Review Panel, and is NOT a CIE product. The CIE will not review or comment on the Panel's report, but shall be provided a courtesy copy, as described below under "Specific Tasks." The CIE products to be generated are the Chair's report, also discussed under Specific Tasks.

Specific Tasks

Designee will serve as Chair of a SEDAR Stock Assessment Review Panel which is to convene in Tampa, FL at the Airport Hilton during 28-31 July 2003. The Panel meeting will begin mid-day on the 28^{th} and conclude early afternoon on the 31st. The Panel will review the stock assessment provided for yellowtail snapper in the area of jurisdiction of South Atlantic and Gulf of Mexico Fishery Management Councils. The SEFSC shall provide the Chair with copies of the all background documents.

It is estimated that the Chair's duties will occupy a total of 17 days - several days prior to the Review Panel meeting for document review; four days at the SEDAR meeting; several days following the meeting to ensure that the final documents are completed, and several days to complete a Chair's report for the CIE.

Roles and responsibilities:

1. Prior to the Review Panel meeting the Chair will be provided with the stock assessment workshop report and other associated documents on yellowtail snapper. The Chair shall read and review these documents to gain an in-depth understanding of the stock assessment itself and the resources and information considered in the assessment.
2. During the Review Panel meeting, the Chair shall control and guide the meeting, including the coordination of presentations and discussions, and document flow.
3. The Chair shall facilitate the preparation and writing of the Peer Review Panel Report (item 5 above) and a Draft Summary Stock Status Report (item 6 above). Review panel members, SEFSC staff, and stock assessment scientists present will assist the Chair as needed. The Chair shall be responsible for the editorial content of the two review workshop reports. These reports shall be drafted during the Review Workshop, with the final reports due to the recipients listed below in item 4 two weeks after the workshop- August 15, 2003. These reports are products of the Review Panel meeting, and are not CIE products.
4. The Review Panel Report and the Draft Summary Stock Status Report, which are not CIE products, shall be provided to Nancy Thompson, NMFS-SEFSC, 75 Virginia Beach Drive, Miami, FL 33149 (e-mail, Nancy.Thompson@NOAA.GOV); John Merriner, NOAA Beaufort Laboratory, 101 Pivers Island Road, Beaufort, NC 28516 (e-mail, John.Merriner@NOAA.GOV); Robert Mahood, South Atlantic Fishery Management Council, One Southpark Circle, Suite 306, Charleston, SC 29407 (e-mail, Robert.Mahood@safmc.net), and Wayne Swingle, Gulf of Mexico Fishery Management Council, 3018 North U.S. Highway 301, Suite 1000, Tampa, FL 33619-2272 (e-mail, Wayne.Swingle@noaa.gov). Dr. David Sampson of the CIE shall also be provided a courtesy copy of these documents via e-mail at david.sampson@oregonstate.edu.
5. The Assessment Workshop Chair and SEDAR Coordinator will assist the Chair prior to, during and after the meeting to ensure that final documents/results are distributed in a timely fashion.
6. No later than August 15, 2003, the Chair shall submit a written chair report[1] addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Sampson, via email to David.Sampson@oregonstate.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu.

Contact persons:
NMFS contact: Dr. John Merriner, Beaufort Laboratory, 101 Pivers Island Road, Beaufort, NC 28516. Phone 252-728-8708. FAX 252-728-8784. E-mail john.merriner@noaa.gov
SAFMC contact: Mr. Gregg Waugh, One Southpark Circle, Suite 306, Charleston, SC 29407, phone 843-571-4366, FAX 843-769-4520, E-mail gregg.waugh@safmc.net.

[1] The written report will undergo an internal CIE review before it is considered final. After completion, the CIE will create a PDF version of the written report that will be submitted to NMFS and the consultant.

ANNEX I: Contents of Chair Report

1. Synopsis/summary of the meeting – to provide context for the comments rather than to rewrite the summary report. (The latter is a product of the meeting, and is not a CIE product.)

2. Views on the meeting process, including recommendations for improvements on:
    The meeting process itself;
    The outcome(s) of the meeting;
    Materials provided for the meeting, including their timeliness, relevance, content, and quality;
    The guidance provided to run the meeting.

3. Other observations on the meeting process.

4. Appendices, including:
    Statement of Work;
    Bibliography of the materials provided for the meeting;
    Summary report (if available at the time of report submission).

Report on the 2003 Assessment of Yellowtail Snapper in the Southeast United States

NIWA Client Report: WLG2003-54
August 2003

NIWA Project: ERI04901

Report on the 2003 Assessment of Yellowtail Snapper in the Southeast United States

R.I.C.C. Francis

Prepared for

University of Miami

Independent System for Peer Review

NIWA Client Report: WLG2003-54
August 2003

NIWA Project: ERI04901

National Institute of Water & Atmospheric Research Ltd
301 Evans Bay Parade, Greta Point, Wellington
Private Bag 14901, Kilbirnie, Wellington, New Zealand
Phone +64-4-386 0300, Fax +64-4-386 0574
www.niwa.co.nz

Contents

Reviewed by:

Approved for release by:

Executive Summary

The 2003 assessment of yellowtail snapper in the southeast United States was reviewed as part of the SEDAR (South East Data, Assessment and Review) process. The Assessment Review Panel met 28-31 July 2003 at the Hilton Hotel in Tampa Florida. The assessment was presented to the Panel, additional analyses were requested and carried out, and the Panel discussed the assessment and wrote its two reports (one evaluating the assessment, and one on stock status).

The data used in the assessment appear to be the best available, and the assessment methods, and their presentation to the Panel, were of a high standard. I support the finding of the Panel that, according to the best available information, the stock is not overfished and not undergoing overfishing. However, I note that this conclusion is sensitive to assumptions about two key parameters (recruitment steepness and natural mortality) which are not well known for this stock.

Recommendations are presented which are intended to improve future assessments by improving

– the standardisation of CPUE

– the weighting applied to each data set

– the quality of age data

– the documentation of assumptions, and

– other minor matters.

Some suggestions are also made concerning the terms of reference of future Panels.

1. BACKGROUND

This report reviews the 2003 assessment of yellowtail snapper in the southeast United States, at the request of the University of Miami (see Appendix 1). The author was provided with a draft stock assessment report and web access to many associated files and documents (Appendix 2), and participated in the SEDAR (South East Data, Assessment, and Review) Assessment Review Panel Workshop that considered this assessment. This workshop constituted the last of the three phases of the SEDAR process, with the earlier phases being a data workshop (3-4 March) and an assessment workshop (9-13 June), both held in St Petersburg, Florida. The Panel also discussed data available for goliath grouper but that discussion is outside the scope of this report.

2. REVIEW ACTIVITIES

The Assessment Review Panel Workshop was held 28-31 July 2003 at the Hilton Hotel in Tampa Florida (see Appendix 3 for the Panel membership and a list of other attendees).

Bob Muller presented the draft assessment (see Appendix 2) which used two models: Integrated Catch at Age Analysis (ICA) and a fleet-specific model. He also presented some additional material, including more details of the CPUE (catch per unit effort) data and analyses. The panel discussed the assessment and requested some additional analyses. These were done and the results presented to the Panel (see below). The Panel drafted their two reports (one evaluating the assessment, and one on stock status) with input from others present.

Anne Marie Eklund presented a summary of available knowledge on goliath grouper. This was discussed, and a note added to the Panel's assessment-evaluation report. I make no further comment on goliath grouper because it is outside my terms of reference (Appendix 1).

2.1 Additional analyses

The additional analyses requested by the Panel, and the results from these, are described here very briefly. The reasons for requesting these analyses and the implications of their results are discussed more fully in Section 3.

A catch-curve analysis was done, and this produced an estimate of $Z = 0.54\ y^{-1}$ (Z is the total mortality expressed as an instantaneous rate).

Those GLMs (generalised linear models) for biomass indices that included terms for interactions with year were redone without these interactions. This made the commercial index slightly steeper and the MRFSS (Marine Recreational Fisheries Statistics Survey) index less variable and flatter. Many of the model runs (all which produced results for the Panel's stock-status report) were rerun with these new indices.

SDSRs (standard deviations of standardised residuals) were calculated for each data set for the main runs for both the ICA and fleet-specific models. These were all less than 1 and had higher values for the two visual-survey indices than for other indices (which suggests that the visual-survey indices were over-weighted).

The iterative reweighting facility of the ICA model was used to balance the weights assigned to each data set. This made little difference to the model outputs.

The ICA model was run with the early catch-at-age data (which is poorly known because of the lack of early otolith data) more strongly down-weighted. This produced unsatisfactory results because it denied the model information about total catches and the selectivity in the early years.

A retrospective analysis was done for the main run using the ICA model. This showed no strong retrospective trends.

The main ICA model run was rerun without the commercial CPUE biomass index. This made little difference to the model outputs.

The fleet-specific model was rerun with the total catch removed from the likelihood function. This made little difference to the model outputs.

3. FINDINGS

I was impressed by this assessment and the way it was presented to the Panel. The data used seem to be the best available and the approach to modelling was consistent with international best practice, with only relatively minor exceptions (see below). I agree with the assessment team's conclusion that production models were not useful for this assessment. I also support their decision to present results from two age-structured models (ICA and fleet-specific). There is little to choose between these models (each has its advantages and disadvantages) and the fact that different models produced similar conclusions (in terms of stock status) is reassuring and strengthens the overall conclusions of the assessment. The presentation of the assessment to the Panel was always clear and the assessment team was unfailingly helpful in response to requests for clarification or further analyses.

I support the general finding of the assessment team, and the Workshop, that, according to the best available information, the stock is not overfished and not undergoing overfishing. However, I note that this conclusion is sensitive to assumptions about two key parameters (recruitment steepness, *h*, and natural mortality, *M*) that are not well known for this stock.

My more detailed comments on the assessment, which are covered in the remainder of this section, fall into two parts: the first concerning the assessment; the other relating to the SEDAR terms of reference.

3.1 The assessment

3.1.1 Standardisation of CPUE

It is normal practice to standardise CPUE indices using GLMs, as was done in the assessment. This helps to ensure that these indices track abundance and are not affected by extraneous factors (such as changes in the region or season of fishing). There were three ways in which I thought the standardisations could be improved.

The first concerns model selection. By this I mean the decision as to which of the candidate predictor variables (and interactions between these variables) should be included in the GLM. In the yellowtail snapper assessment, this decision was based on statistical significance. In my experience this criterion is usually poor for CPUE data. It tends to include too many terms in the model because the assumptions necessary for this statistical test (independent and identically distributed errors) are not met. I suggest instead a two-step process of model selection. First, use a stepwise procedure, starting with a model with only year as a predictor, and then adding predictors according to how much additional deviance they explain. Use a sensible threshold for "additional percent deviance explained" (in New Zealand we usually use a threshold of 1% or 0.5%) and stop the stepwise addition of predictors when this threshold is no longer met. Second, reject predictors that are not "plausible", where plausibility is judged from a graph of the estimated effect. For example, if the factor month is to be included we should expect a plot of the estimated month effect to show a reasonably smooth trend. A plot which showed a more or less random fluctuation of predicted CPUE from month to month would be implausible. For a month-year interaction to be plausible we would expect that the predicted annual trends for adjacent months would be relatively similar. Note that the adjective "plausible" applies to the estimated coefficients, not to the model term itself. It is certainly plausible that catch rates might vary from month to month in a way that is consistent from year to year. However, in some CPUE analyses the data are inadequate to estimate this variation plausibly. My experience is that the test of plausibility often rejects interaction terms because CPUE data sets are commonly inadequate to estimate many interactions.

The second possible improvement concerns interactions with year. When such interactions are included the GLM produces more than one time trend in CPUE. For example, a year-region interaction produces a different time trend for each region; a year-month interaction produces a different trend for each month. Such interactions are not implausible, but they are problematic for stock assessments. If they arise we have three options. The first is to accept them and use the multiple time trends in our assessment. This means we must complicate the structure of our assessment model. For example, if we accept a year-region interaction we must include the associated regions in our assessment model in such a way that the model can calculate the biomass in each region at any time and allow for different biomass trends in different regions. This approach is acceptable only if there are sufficient data to justify this increase in model complexity. The second option is not to use any CPUE indices from this source on the grounds that they contain conflicting information. The third option is to drop year interaction terms from the GLMs. The effect of this option is to generate a single time trend that is a data-weighted average of the multiple trends that would have been produced had the year interactions been included. (In the draft assessment, although year interactions were included, only a single time trend was produced from each GLM. It was unclear what this time trend was; it may have been a simple average of the multiple trends, or the trend associated with the reference level for each factor in the interaction.) I believe that this last option was most appropriate in the present assessment, and that was what the Panel adopted (there was not sufficient time to check to see whether these year interaction terms would have passed the model selection criteria described above). Where this option is used it is sensible to describe the interaction as background information for the assessment. For example, with a year-region interaction it would be useful to present a graph showing the different time trends in each region (as output from a GLM with a year-region interaction) but then to drop the interaction when generating a CPUE index for the assessment model.

The third possible improvement concerns explanatory variables that are continuous (e.g., DEPTH and TIMEFISH in Table 4.1.2.1.1). In the assessment, each such variable contributed just one degree of freedom, which implies that CPUE was treated as a linear function of these variables. This is clearly inappropriate for some variables (e.g., we might expect CPUE to be maximum for some optimal depth and less for smaller and larger depths). Unless a linear trend is obviously required I would suggest using a higher order polynomial, perhaps a cubic. (The naive way of doing this — including DEPTH, $DEPTH^2$, and $DEPTH^3$ — is sometimes not satisfactory because of co-linearity. A better way is to use orthogonal polynomials.)

3.1.2 Data weighting

In assessments with multiple data sources, the weighting of individual data sets (and even parts of data sets) can have a profound effect on the assessment results. For this reason, it is important that data weightings should be the best possible, and that the model's sensitivity to alternative weightings be evaluated. I'd like to emphasize that this is not easy to do. There is sometimes no obvious "correct" weighting for a data set, and it is sometimes quite a lot of work to generate an appropriate weight, which may turn out to have little effect.

In approaching this problem I think it is better to express the objective function in the form used for the fleet-specific model, rather than that used for the ICA model. That is, the contribution of the *i*th datum should be expressed as $0.5(\ln(obs_i) - \ln(pred_i))^2/\sigma_i^2$ rather than $\lambda_i(\ln(obs_i) - \ln(pred_i))^2$. These two forms are mathematically equivalent (if we define $\lambda_i = 0.5/\sigma_i^2$) but the latter makes you think of weighting (which is an essentially arbitrary, and thus subjective, process) whereas the former makes you seek an appropriate variance for each datum (i.e., the variance of its error distribution). The standardised residual for the datum is $(\ln(obs_i) - \ln(pred_i))/\sigma_i$. You can tell if you've got approximately the right variances (or weightings) by calculating the SDSR (the standard deviation of the standardised residuals) for each data set. These should have a value near 1. When all SDSRs are less than 1 (as they were in the yellowtail snapper assessment) then the σ_i are too big and overall uncertainty (in the form of parameter c.v.s in Table 4.2.2.1.4 and 4.2.2.2.2, and scatter in Fig. 4.2.2.1.9) will be overestimated. The SDSRs for the visual-survey indices were higher than those for other data sets, indicating that the visual-survey indices were (relatively) over-weighted. It should be noted that the SDSR is only an estimated quantity, and that small data sets produce poor (imprecise) estimates.

One circumstance in which it is not reasonable to expect an SDSR to be equal to 1 is when a data set is considered to be biased. This was the case for the early catch-at-age data, which were down-weighted because they are likely to underestimate strong year classes and over-estimate weak ones. Here, there is little choice but to down-weight arbitrarily, and the SDSR should be greater than 1 (but how much greater is hard to say). Some people like to down-weight CPUE indices on the grounds that they are not strictly proportional to abundance (and thus are biased). My preference is to leave them out as a sensitivity analysis (as was done during the Workshop).

The SDSR can also be used to examine the weighting within a data set. My guess is that if this were done with the catch-at-age data it would show that the small proportions (the tails of the age distribution) are over-weighted.

The σ_i represent the combination of sampling error (the difference between observations and the real world) and process error (the difference between the real world and the model). The approach that I have used, where possible, is to estimate the size of the sampling error from the data and then add a process error that is either derived from a meta analysis (e.g., Francis et al. 2003 for trawl surveys) or estimated within the model. The sampling error will typically be different for every datum within a data set, but the process error should be the same across the data set (and even across data sets of similar types). For some data sets (e.g., trawl surveys and the visual surveys used in the assessment) estimation of sampling error is straightforward. For other more complicated data a simulation approach can be used (e.g., I did this for survey- and catch-at-age data in Francis 2003).

On a related topic, a likelihood profile is a useful tool to examine the contribution of different data sets to a parameter estimate. The overall likelihood profile (which will have a maximum at the parameter estimate) may be thought of as a sum of the contributions from each data set. That is, for a given parameter (e.g., F_{2001}) we can construct a separate profile for each data set, and value of F_{2001} at the maximum of each profile is the preferred value of this parameter for that data set. This also shows which data sets have a strong preference for a specific value for the parameter and which are relatively uninformative about that parameter.

3.1.3 Recruitment variability

The recruitment variability estimated for yellowtail snapper is very low compared to values estimated for other marine species. From Table 4.2.2.1.7 I estimated σ_R =

0.15 for 1-year old recruits (σ_R is the standard deviation of log recruitment) whereas typical values are much higher (quantiles of σ_R for the data sets analysed by Beddington and Cooke (1983) are approximately 0.4, 0.6, and 0.8; see Myers et al. (draft) for a more comprehensive data set). This may be an under-estimate, because the use of multi-year age-length keys will tend to produce low estimates of σ_R. However, a back-of-the-envelope calculation using data from the years with individual age-length keys produced σ_R = 0.19 (I took the last 5 rows of Table 4.2.2.1.1, ignoring the plus-group column; divided each column by its mean; calculated the mean for each diagonal vector representing a year class, which gives an approximate year-class strength for each of the cohorts that were age 0 in years 1987 to 1997; and calculated the standard deviation of the logs of these year-class strengths).

Now it may be that this species really does have unusually low recruitment variability. On the other hand the low estimates of σ_R could be caused by either large ageing errors or non-representative age-length keys. Further work on age validation would address the issues of ageing errors (the current validation is based solely on marginal increment analysis, which is not a strong method). Because the distributions of ages for fish of a given length is likely to vary by month, region, and (possibly) fishing method (recreational versus commercial), age-length keys will be unrepresentative if otolith sampling does not match the month-region-method mix in the catch. I agree with the suggestion (on p.15 of the assessment report) that direct age estimation is preferable to the use of age-length keys (though I did not understand the explanation given, in the same paragraph, for the direct age estimates of Table 3.6.2 being so different from those based on age-length keys). However, I note that there is still a need for representative sampling of otoliths.

3.1.4 Natural mortality and recruitment steepness

The estimated stock status depends strongly on the values of these parameters and there is very little information from which to estimate them. Although I had no reason to question the values used in the assessment I didn't feel that the rationale for their use was well documented. The only information in support of M = 0.2 was a brief section (2.7) mentioning two rules of thumb that provide estimate of Z (total mortality), not M. Other estimates from the literature (which were presented to the Panel, but not included in the assessment report) should have been mentioned, as should have the catch-curve estimate of Z = 0.54. My opinion is that there do not seem to be any reliable data-based estimates of M for this species so we must fall back on analogies with other species based on life-history considerations. With regard to estimates of Z (which provide little more than an upper limit on *M*) I believe the catch-curve estimate is more reliable than those that arbitrarily assign a percentile to the maximum observed age.

I have no problem with the assumed steepness of 0.8 (it is close to the default value of 0.75 I recommended in Francis (1993)) but I think the reasons underlying the Stock Assessment Workshop Panel's recommendation of this value (p. 25) should be spelled out more fully.

3.1.5 Retrospective analysis

I support the Panel's concern about retrospective bias but do not believe that we can learn much from the brief analysis that was carried out during the Workshop.

Retrospective bias occurs in an assessment model if there is a consistent trend in the model's sequential estimates of some parameter. For example, consider the current assessment's estimate of F_{2001}. We can think of this as being the first in a sequence of estimates of that parameter for this stock. If a new assessment were carried out next year, with a further year's data, we would get the second estimate of F_{2001} in our sequence. A third estimate would result from a further assessment in 2005, etc. There is a similar sequence of estimates for F_{2000}, and another for F_{1999}, etc. If when we plot these sequences they all show a trend in the same direction then we have an instance of retrospective bias (see, e.g., Sinclair et al. 1991; Parma 1993; fig. 1 in Francis & Shotton 1997). Unfortunately, we do not then know what caused this bias, and nor do we know whether the sequence tends towards or away from the true value.

With a relatively short data series, such as was available for yellowtail snapper (very short if we consider that only the last five years of catch-at-age data were really reliable) it is difficult to draw any strong conclusions from a retrospective analysis. Even if some trends occur this may not be serious. For example, a biomass index may, by chance, have several positive residuals (overestimates) in a row. This will mean that a biomass estimated near that time will be overestimated, but that as additional years' data are added that overestimate will gradually be corrected. In other words, estimates of that biomass will show a trend, but this is normal model behaviour and not indicative of the sort of data or model problem that a retrospective analysis is intended to find.

3.1.6 Other minor assessment matters

The ignoring of stage 7 gonads in Section 2.5 will probably produce bias in the maturity curves because it is unclear what proportion of such fish were mature. The possible extent of this bias could be evaluated by plotting two additional maturity curves on each panel of Figure 2.5. Both curves would be calculated using all the data (including stage 7), but in one we would assume that all stage 7 fish were mature, and in the other we would assume that they were all immature. These two curves would then bound the true maturity curve.

I think it would have been useful to include a plot, for each fishery sector, of mean length against time. This would have had no direct input to the assessment, but would have been useful background information for the Panel. It is more reliable information than the catch-at-age data (because of the problem of multi-year age-length keys). The lack of a strong trend in the stock biomass ought to mean no strong trend in mean lengths. Also, it would have been good to see whether fishers' perception of increasing mean length in recent years (as expressed during the Workshop) was evident in the data.

It was unclear to me why the commercial logbook hook-and-line index was used in the fleet-specific model but not in the ICA model.

It would have been useful to see more discussion about the reasons for the decline in effort in recent years in the three fishery sectors (commercial, recreational, and headboat). It is unusual to see effort decline in a fishery where biomass is stable or increasing. Unless we are given good reasons for the decline in effort there is a temptation to doubt the assessment and assume that effort had declined because there were fewer fish.

There were some model outputs that I felt were unnecessary. I now (after the Workshop) understand what the "phase plot" (Figure 4.2.2.1.9) represents and how it was generated (though this not described in the assessment report) but I still don't know why it was presented. What should we infer from it? The assessed stock status seems to have been based on point estimates from various model runs, not the uncertainty surrounding these point estimates. Most of Table 4.2.2.1.5 is unexplained, and some of the parts I think I do understand don't make sense to me. The statistics for skewness, kurtosis, and partial chi-square are neither explained nor interpreted for the reader. The assignment of degrees of freedom to each data set, the associated ANOVA table, and the significance of fit values make no sense to me. These imply that we can assign each estimated parameter to a particular data set, whereas I believe that many of the parameters affect the fits of several data sets. A similar comment applies to Table 4.2.2.2.1.

I have some difficulty with the inclusion of total catch in the likelihood function for the fleet-specific model (p. 29). Certainly, it looks like double counting to include both this and numbers at age in the catch. This double counting could be avoided if the catch-at-age data were used a proportions, rather than numbers, at age. Even then, I'm unsure of the advantage of treating total catch as a quantity observed with error (and thus to be included in the likelihood function) rather than being known exactly (as is the done in New Zealand assessments).

The term "asymptotic recruitment" is mistakenly used as being synonymous with R_0 (the mean recruitment when $F = 0$). Actually, the stock-recruitment curve used has an asymptote at $R = 1/\beta = 4hR_0/(h–1)$.

3.2 SEDAR Terms of Reference

3.2.1 Management Recommendations

The phrase "including management recommendations" in the sixth term of reference for the Assessment Review Panel caused some difficulty during the Workshop and in the drafting of the stock-status report. It was unclear to the Panel what this meant, particularly given that two Fishery Management Councils (whose requirements appeared to differ) were involved. The Panel's primary job was to review the stock assessment. This leads quite naturally to drawing conclusions about the status of the stock, and the Panel found no difficulty in doing so. However, it is a big step from conclusions about stock status to management recommendations, and this step requires a complete change of framework and a great deal of additional information. Fisheries management is an essentially political process that involves balancing the needs of various stakeholders in the context of complex legislative and administrative requirements. If management recommendations are to be required from future SEDAR panels then some very clear guidelines will be necessary.

3.2.2 Assessments and Assessment Reports

There is a distinction to be made between the assessment and the assessment report. My understanding is that the Panel's task was to review the former, not the latter. I felt free to comment on various parts of the assessment report (which was my main, but not only, source of information about the assessment) but I did not feel that I was reviewing this document. I raise this matter because I learnt, after the Workshop, that at least one Panel member had concerns (not expressed during the Workshop) about some aspects of the assessment report. My experience is that what is deemed necessary in an assessment report varies widely amongst institutions (and I understand that the Fisheries Management Councils for the Gulf of Mexico and the South Atlantic have quite different expectations). Thus the Panel could not have reviewed the assessment report without clear guidelines as to what was required in it. My view is that it is preferable to restrict the Panel to reviewing the assessment only. However, should a review of the assessment report be desired from the Panel then clear guidelines would be necessary, and these might vary according to which fisheries management council(s) was involved.

4. RECOMMENDATIONS

1. That consideration be given in future assessments to:

   – the issues of year interactions, polynomial terms, and model selection in the standardisation of CPUE (see Section 3.1.1);

   – the use of less arbitrary data weightings (see Section 3.1.2);

   – further validation of yellowtail snapper ageing, an examination of the "representativeness" of age-length keys, and more work on direct age estimation (see Section 3.1.3);

   – better documentation of the rationale for the assumed values of natural mortality and recruitment steepness (see Section 3.1.4); and

   – the various minor matters discussed in Section 3.1.6.

2. That consideration be given, in writing of terms of reference for future SEDAR Assessment Review Panels, to

   – either removing the phrase "including management recommendations" or giving clear guidance as to what sort of management recommendations are appropriate (see Section 3.2.1); and

– clarifying what is to be reviewed — the assessment or the assessment report — and, if the latter (not recommended), providing clear guidelines as to what is required in an assessment report (see Section 3.2.2).

5. REFERENCES

Beddington, J.R.; Cooke, J.G. (1983). The potential yield of fish stocks. *FAO Fisheries Technical Paper 242*. 50 p.

Francis, R.I.C.C. (1993). Monte Carlo evaluation of risks for biological reference points used in New Zealand fishery assessments. *Canadian Special Publication of Fisheries and Aquatic Sciences 120*: 221-230.

Francis, R.I.C.C.; Shotton, R. (1997). "Risk" in fisheries management: a review. Canadian Journal of Fisheries and Aquatic Sciences 54: 1699-1715.

Francis, R.I.C.C. (2003). Analyses supporting the 2002 stock assessment of hoki. *New Zealand Fisheries Assessment Report 2003/5*. 34 p.

Francis, R.I.C.C.; Hurst, R.J.; Renwick, J.A. (2003). Quantifying annual variation in catchability for commercial and research fishing. Fishery Bulletin 101: 293-304.

Myers, R.A.; Bowen, K.G.; Zouros, I.A. (draft). Recruitment variability of fish and aquatic invertebrates. Draft paper available in pdf form from http://fish.dal.ca/~myers/papers.html.

Parma, A.M. (1993). Retrospective catch-at-age analysis of Pacific halibut: implications on assessment of harvesting policies. *In*: Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant College Program Report 93-02. Kruse, G.; Eggers, D.M.; Marasco, R.J.; Pautzke, C.; Quinn II, T.J. (eds.). University of Alaska, Fairbanks. pp 247-265.

Sinclair, A.; Gascon, D.; O'Boyle, R.; Rivard, D.; Gavaris, S. (1991). Consistency of some northwest Atalantic groundfish stock assessments. *Northwest Atlantic Fisheries Organization Scientific Council Studies 16*: 59-77.

APPENDIX 1: Statement of Work

This appendix contains the Statement of Task that formed part of the consulting agreement between the University of Miami and the author.

STATEMENT OF TASK

Consulting Agreement between the University of Miami and Dr. Chris Francis

June 11, 2003

General

The **S**outh **E**ast **D**ata, **A**ssessment, and **R**eview (**SEDAR)** process for stock assessment and review is used in the NMFS- Southeast Fisheries Science Center's area of responsibility. This new program provides the framework for independent peer review of stock assessments undertaken jointly by NMFS-SEFSC, three Regional Fishery Management Councils, and two Interstate Fishery Commissions, and state fishery agencies. The SEDAR process uses a three phase approach: a data workshop, an assessment workshop, and a peer review panel workshop. The peer review panel is composed of stock assessment experts, other scientists, and representatives of the Council, the fishing industries, and non-governmental conservation organizations. The communication elements of SEDAR include a stock assessment report from the Assessment Workshop, a review panel report evaluating the assessment(s) (drafted during the Review Panel Workshop), presentation of the peer reviewed assessment results to the Council(s) and public, and publication of collected documents for stock assessments considered in that cycle of the SEDAR process.

The assessment to be reviewed by this SEDAR Peer Review Panel is yellowtail snapper in the area of jurisdiction of the South Atlantic and Gulf of Mexico Fishery Management Councils. The Review Panel will meet July 28-31, 2003 at the Tampa, Florida Airport Hilton Hotel. A data workshop was held March 3-4, 2003 in St. Petersburg, FL. The assessment workshop was held during week of June 9-13, 2003 in St. Petersburg, FL. The SEDAR Review Panel for the yellowtail snapper assessment may include 12+ members: 1 senior assessment scientist each from NMFS- NEFSC and -SEFSC, 2 Council Staff scientists (South Atlantic and Gulf of Mexico), 2 assessment scientist members of the Scientific and Statistical Committee of South Atlantic and Gulf of Mexico Fishery Management Councils, commercial/recreational fishermen from the Snapper-Grouper (SA) and Reeffish (GM) Advisory Panel with special experience with the species, 2 scientist representatives (SA and GM) from non-governmental organizations, and 2 members from the Center for Independent Experts (Chairperson and reviewer). Assessment scientists from Florida FWC and

NMFS-SEFSC will present the assessment and be available to provide supplemental information as requested by the review panel.

SEDAR Assessment Review Panel Tasks

The Panel will evaluate the yellowtail snapper assessment, the input data, assessment methods, and model results as put forward in the stock assessment workshop report.

Specifically, the review panel will:

1. Evaluate the adequacy and appropriateness of fishery-dependent and independent data used in the assessment (i.e. was the best available data used in the assessment).
2. Evaluate the adequacy, appropriateness and application of models used to assess these species and to estimate population benchmarks (MSY, Fmsy, Bmsy and MSST, i.e. Sustainable Fisheries Act items).
3. Evaluate the adequacy, appropriateness, and application of models used for rebuilding analyses.
4. Develop recommendations for future research for improving data collection and the assessment.
5. Prepare a report summarizing the peer review panel's evaluation of the yellowtail snapper stock assessment. (Drafted during the Review Workshop; Final report due two weeks after the workshop-August 15, 2003).
6. Prepare a summary stock status report including management recommendations. (Drafted during the Review Workshop, Final report due two weeks later -August 15, 2003).

It is emphasized that the panel's primary duty is to review the existing assessment. In the course of this review, the Chair may request a reasonable number of sensitivity runs, additional details of the existing assessment, or similar items from technical staff. However, the review panel is not authorized to conduct an alternative assessment, or to request an alternative assessment from the technical staff present. To do so would invalidate the transparency of the SEDAR process. If the review panel finds that the assessment does not meet the standards outlined in points 1 through 3, above, the panel shall outline in its report the remedial measures that the panel proposes to rectify those shortcomings.

The Review Panel Report is a product of the overall Review Panel, and is NOT a CIE product. The CIE will not review or comment on the Panel's report, but shall be provided a courtesy copy, as described below under "Specific Tasks." The CIE products to be generated are the Chair's report, also discussed under Specific Tasks.

Specific Tasks

Designee will serve as panelist of a SEDAR Stock Assessment Review Panel which is to convene in Tampa, FL at the Airport Hilton during 28-31 July 2003. The Panel meeting will begin mid-day on the 28th and conclude early afternoon on the 31st. The Panel will review the stock assessment provided for yellowtail snapper in the area of jurisdiction of South Atlantic and Gulf of Mexico Fishery Management Councils. The SEFSC shall provide the Panelist with copies of the all background documents.

It is estimated that the Panelist's duties will occupy a total of 14 days - several days prior to the Review Panel meeting for document review; four days at the SEDAR meeting; several days following the meeting to ensure that the final documents are completed, and several days to complete a Chair's report for the CIE.

Roles and responsibilities:

1. Prior to the meeting panelists will be provided with the stock assessment workshop report and other associated documents on the yellowtailsnapper. All panelists shall read these documents to gain an in-depth understanding of the stock assessment and the resources and information considered in the assessment.
2. During the review panel meeting, participate, as a peer, in panel discussions on assessment validity, results, recommendations, and conclusions. Participate in the development of the Peer Review Panel Report and Summary Stock Status Report.
3. Review and provide comments to the Panel Chair on the Draft Peer Review Panel Report and Summary Stock Status Report.
4. No later than August 14, 2003, submit a written report[1] consisting of the findings, analysis, and conclusions, addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Sampson, via email to David.Sampson@oregonstate.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu.

Contact persons:
NMFS contact: Dr. John Merriner, Beaufort Laboratory, 101 Pivers Island Road, Beaufort, NC 28516. Phone 252-728-8708. FAX 252-728-8784. E-mail john.merriner@noaa.gov
SAFMC contact: Mr. Gregg Waugh, One Southpark Circle, Suite 306, Charleston, SC 29407, phone 843-571-4366, FAX 843-769-4520, E-mail gregg.waugh@safmc.net.

[1] The written report will undergo an internal CIE review before it is considered final. After completion, the CIE will create a PDF version of the written report that will be submitted to NMFS and the consultant.

Annex I to Appendix 1: Report Generation And Procedural Items

1. *The report should be prefaced with an executive summary of findings and/or recommendations.*

2. *The main body of the report should consist of a background, description of review activities, summary of findings, conclusions/recommendations, and references.*

3. *The report should also include as separate appendices the bibliography of all materials provided and a copy of the statement of work.*

Please refer to the following website for additional information on report generation: http://www.rsmas.miami.edu/groups/cie.

APPENDIX 2: Materials Provided

All material provided to the author was web-based. The primary web site was ftp://ftp.floridamarine.org/users/assess/SEDAR_YT_Assessment, which, as well as holding many data and model-output files, included the draft assessment report:

Muller, R. G., Murphy, M. D., de Silva, J., and Barbieri, L. R. 2003. A stock assessment of yellowtail snapper, *Ocyurus chrysurus*, in the Southeast United States. Draft Report submitted to the National Marine Fisheries Service and the Gulf of Mexico Fishery Management Council as part of the Southeast Data, Assessment, and Review (SEDAR) III. St Petersburg, FL; Florida Marine Research Institute: 182 pp.

Two other sites described key data sources:

http://www.st.nmfs.gov/st1/recreational/survey for the Marine Recreational Fisheries Statistics Survey, and

http://www.sefsc.noaa.gov/alsprogram.jsp for commercial catch data.

APPENDIX 3: Attendees at SEDAR Assessment Review Panel Workshop

Panel

PANEL CHAIR:	Dr Andrew Payne
REVIEW PANELIST:	Mr Chris Francis
SAFMC:	Mr Gregg Waugh
GMFMC:	Mr Steve Atran
NMFS SEFSC:	Dr Joseph Powers
NMFS NEFSC:	Dr Larry Jacobson
FISHERS:	Mr William Kelly Mr Robert Zales Mr Peter Gladding
NGO REPRESENTATIVE:	Ms Nadiera Sukhraj
SSC REPRESENTATIVES:	Mr Doug Gregory Mr Billy Fuls Dr Al Jones Ms Carolyn Belcher Dr Robert Trumble Dr Rocky Ward

Non-Panel

PRESENTERS:

AW Coordinator	*Dr Luiz Barbieri*
Lead Analysts	*Dr Robert Muller* *Mr Michael Murphy*
Goliath grouper	*Dr Anne Marie Eklund*

AW/RPanel SUPPORT STAFF:

Dr John Merriner
Dr Janaka de Silva

MEETING SUPPORT STAFF & OTHER ATTENDEES

Mr Roy Williams
Dr Tom McIlwain
Dr Joe Kimmel
Mr Mark Robson
Mr Stu Kennedy
Dr Roy Crabtree
Dr Behzad Mahmoudi