SEDAR

Southeast Data, Assessment, and Review

Stock Assessment Report
of
SEDAR 8

Caribbean Yellowtail Snapper

SEDAR8
Assessment Report I

2005

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SEDAR 8 Stock Assessment Report I.

Caribbean Yellowtail Snapper

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SEDAR 4

Stock Assessment Report 1

Caribbean Yellowtail Snapper

SECTION I. Introduction

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1. SEDAR Overview

SEDAR (Southeast Data, Assessment and Review), is a process developed by the Southeast Fisheries Science Center and the South Atlantic Fishery Management Council to improve the quality and reliability of stock assessments and to ensure a robust and independent peer review of stock assessment products. SEDAR was expanded in 2003 to address the assessment needs of all three Fishery Management Council in the Southeast Region (South Atlantic, Gulf of Mexico, and Caribbean), and to provide a platform for reviewing assessments developed through the Atlantic and Gulf States Marine Fisheries Commissions and state agencies within the southeast.

SEDAR is organized around three workshops. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. Second is the Assessment workshop, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. Third and final is the Review Workshop, during which independent experts review the input data, assessment methods, and assessment products. SEDAR workshops are organized by the SEDAR staff and the lead Council. Data and Assessment Workshops are chaired by the SEDAR coordinator. Participants are drawn from state and federal agencies, non-government organizations, Council members and advisors, and the fishing industry, with a goal of including a broad range of disciplines and perspectives. The Review Workshop is chaired by a scientist selected by the Center for Independent Experts, an organization that provides independent, expert review of stock assessments and related work. Other participants include one reviewer from the CIE, one from the SEFSC, one from NOAA fisheries, one NGO representative, one or more Council Advisory panel representatives, and one or more Council technical (SSC or other panel) representatives.

This assessment, eighth in the SEDAR series, is charged with assessing Caribbean stocks of yellowtail snapper and spiny lobster. The Review Workshop will also consider an assessment of Atlantic and Gulf of Mexico spiny lobster conducted by the State of Florida in a SEDAR workshop format and with assistance from the Councils and NOAA Fisheries.

2. Management Summary

2.1 Management Unit Definition

Each fishery management plan (FMP) defines the management unit—the species or species complexes that are relevant to the FMP objective. Currently, the Caribbean Reef Fish FMP includes virtually all finfish that are known or believed to be captured by commercial, recreational, and/or subsistence fishers in the U.S. Caribbean. A draft amendment to this FMP would organize the management unit into species complexes. The current preferred alternative would have only the yellowtail snapper in Snapper Unit 4. Appendix A. provides a list of useful acronyms and abbreviations related to management.

2.2 Regulatory History and FMP Overview

The Caribbean Fishery Management Council (CFMC) manages 179 fish stocks under four FMPs':

Fishery Management Plan for the Reef Fish Fishery of Puerto Rico and the US Virgin Islands;
Fishery Management Plan for the Spiny Lobster Fishery of Puerto Rico and the US Virgin Islands; and
Fishery Management Plan for the Queen Conch Resources of Puerto Rico and the US Virgin Islands;

2.2.1 Reef Fish FMP

The following summarizes the history of management measures developed and implemented under the Reef Fish Fishery FMP. In September 1985, the Caribbean Reef Fish FMP was implemented by the CFMC (CFMC 1985; 50 FR 34850). The FMP, supported by an EIS, defined the reef fish fishery management unit (FMU) to include shallow water species only, described objectives for the shallow water reef fish fishery, and established management measures to achieve those objectives. Primary management measures included:

The definition of MSY as equal to 7.7 million lbs;
The definition of OY as "all of the fishes in the management unit that can be harvested by U.S. fishermen under the provisions of the FMP. This amount is currently estimated at 7.7 million lbs;"
The specification of criteria for the construction of fish traps, which included a minimum 1 ¼-inch mesh size requirement and a requirement that fish traps contain a self-destruct panel and/or self-destruct door fastening;
A requirement to identify and mark gear and boats;
A prohibition on the use of poisons, drugs, and other chemicals and explosives to take reef fish;
A prohibition on the take of yellowtail snapper that measure less than 8 inches total length for the first fishing year, to be increased one inch per year until the minimum size limit reached 12 inches;
A prohibition on the take of Nassau grouper that measure less than 12 inches total length for the first fishing year, to be increased one inch per year until the minimum size limit reached 24 inches; and
A prohibition on the take of Nassau grouper from 1 January to 31 March each year, a period that coincides with the spawning season of this species.

Amendment 1 to the Reef Fish FMP (CFMC 1990b; 55 FR 46214) was implemented in December 1990. That amendment was supported by an EA with a FONSI. Primary management measures included:

An increase in the minimum mesh size for traps up to 2 inches;
A prohibition on the take or possession of Nassau grouper; and
A prohibition on fishing in an area southwest of St. Thomas, US Virgin Islands from 1 December through 28 February of each year, a period that coincides with the spawning season for red hind (this seasonal closure would later become a year-round closure with the implementation of the Hind Bank Marine Conservation District through Amendment 1 to the Coral FMP).

Amendment 1 also defined overfished and overfishing for shallow water reef fish. “Overfished” was defined as a biomass level below 20% of the spawning stock biomass per recruit (SSBR) that would occur in the absence of fishing. For stocks defined as ‘Overfished’, “overfishing” was defined as a rate of harvest that is not consistent with a program that has been established to rebuild a stock or stock complex to the 20% SSBR level. For stocks that are not overfished, “overfishing” was defined as “a harvesting rate that if continued would lead to a state of the stock or stock complex that would not at least allow a harvest of OY on a continuing basis.”

A regulatory amendment to the Reef Fish FMP (CFMC 1991; 56 FR 48755) was implemented in October 1991. The primary management measures contained in this amendment, supported by an EA with a FONSI, included:

A modification to the mesh size increase implemented through Amendment 1 to allow a mesh size of 1.5 inches for hexagonal mesh, and a change in the effective date of the 2-inch minimum mesh size requirement for square mesh to 13 September 1993; and

A change in the specifications for degradable panels for fish traps related to the required number of panels (required two panels per trap), and their size, location, construction, and method of attachment.

Amendment 2 to the Reef Fish FMP (CFMC 1993; 58 FR 53145), implemented in November 1993, was supported by SEIS. Amendment 2 redefined the reef fish FMU to include the major species of deep-water reef fish and marine aquarium finfish. Primary management measures implemented through this amendment included:

- A prohibition on the use of any gear other than hand-held dip nets and slurp guns to collect marine aquarium fishes;
- A prohibition on the harvest or possession of goliath grouper (formerly known as jewfish);
- A prohibition on the harvest, possession, and/or sale of certain species used in the aquarium trade, including seahorses and foureye, banded, and longsnout butterflyfish;
- A prohibition on fishing in an area off the west coast of Puerto Rico (Tourmaline Bank) from 1 December through 28 February each year, a period that coincides with the spawning season for red hind;
- A prohibition on fishing in an area off the east coast of St. Croix, USVI (Lang Bank) from 1 December through 28 February each year, a period that coincides with the spawning season for red hind; and
- A prohibition on fishing in an area off the southwest coast of St. Croix, USVI from 1 March through 30 June each year, a period that coincides with the spawning season for mutton snapper.

Existing definitions of MSY and OY were applied to all reef fish within the revised FMU, with the exception of marine aquarium finfish. The MSY and OY of marine aquarium finfish remained undefined.

A technical amendment to the Reef Fish FMP (59 FR 11560), implemented in April 1994, clarified the minimum mesh size allowed for fish traps.

In January 1997, an additional regulatory amendment to the Reef Fish FMP (CFMC 1996b; 61 FR 64485) was implemented. That action, supported by an EA, reduced the size of the Tourmaline Bank closure originally implemented in 1993. In addition, this regulatory amendment prohibited fishing in two areas off the west coast of Puerto Rico (Abrir La Sierra Bank (Buoy 6) and Bajo de Cico) from 1 December to 28 February of each year, a period that coincides with the spawning season of red hind.

2.2.2 Generic FMP Amendments

The Caribbean Council submitted the *Generic Essential Fish Habitat Amendment to the Spiny Lobster, Queen Conch, Reef Fish, and Coral Fishery Management Plans* (Generic EFH Amendment) to NOAA Fisheries in 1998 to comply with the EFH provisions of the MSFCMA. NOAA Fisheries partially disapproved that amendment on 29 March 1999, finding that it did not evaluate all managed species or all fishing gears with the potential to damage fish habitat (64 FR 14884). The document was subsequently challenged by a coalition of environmental groups and fishing associations on the basis the Generic EFH Amendment did not comply with the requirements of the MSFCMA and NEPA (*American Oceans Campaign v. Daley v.* Civ. No. 99-982 [D.D.C.]). The Federal Court opinion upheld the plaintiffs' claim that the Generic EFH Amendment was in violation of NEPA, but determined that the amendment was in accordance with the MSFCMA. The Caribbean Council is currently preparing an EIS for the Generic EFH Amendment to comply with the 14 September 2000 court order. The notice of availability of the draft EIS, which could lead the Caribbean Council to further amend one or more FMP, was published in the *Federal Register* on August 1, 2003 (68 FR 45237). The comment period on that document ended October 30, 2003.

The Draft Comprehensive Sustainable Fisheries Act Amendment (Comprehensive SFA Amendment) to the Spiny Lobster, Queen Conch, Reef Fish, and Coral Fishery Management Plans (Comprehensive SFA Amendment) prepared by the Caribbean Council was noticed in the Federal Register on 25 January 2002 (67 FR 3679). The Draft SFA intended to amend all four council plans to meet additional requirements added to the MSFCMA in 1996 through a Congressional amendment known as the Sustainable Fisheries Act (SFA). A Federal review determined that the Comprehensive SFA Amendment was inconsistent with the requirements of the SFA and NEPA. The lack of an adequate range of alternatives for defining biological reference points, rebuilding schedules, and bycatch reporting standards was the primary deficiency cited in the notice of agency action to disapprove the document. That notice was published in the Federal Register on 1 May 2002 (67 FR 21598). The Council has revised the Comprehensive SFA Amendment to be consistent with the requirements of the SFA and has received comments through the associated public hearing process. Adoption of the Comprehensive SFA is pending final approval.

3. Assessment History

Research efforts in the Caribbean region have provided significant insight into much of the life history, growth and biology of fish and shellfish species, and into the effects of fishing pressure on some exploited stocks. In particular, fishery independent surveys have provided information on size-structure, density, abundance and community structure of coral reef fishes and invertebrates of commercial importance. Many studies have concentrated on spiny lobster and queen conch.

According to Sladek-Nowlis (2004, SEDAR8-DW-02), no formal assessment of the yellowtail snapper (*Ocyurus chrysurus*) populations in Puerto Rico and the US Virgin Islands has yet been conducted. As such, the yellowtail snapper portion of the SEDAR8 Data Workshop will provide new insight into the status of this population.

The only previous attempt to ascertain the status of yellowtail snapper in this region came as part of a broader assessment of shallow water reef fish (Appeldoorn *et al.* 1992). This effort came to a number of conclusions worth bearing in mind as we take a closer look at yellowtail snapper. First, they found that data were improving in quality but still insufficient to examine some key issues such as spawning potential ratios. Second, they found evidence of some general decline in all Puerto Rican reef fish fisheries combined. This evidence included landings, which had peaked in 1979, hit bottom in 1988, and increased slightly in 1989 and 1990. Composition of the snapper portion of this catch had shifted from mostly shallow water to deeper water. Comparable data was not available to assess the US Virgin Islands but total landings apparently stayed relatively constant from 1975 to 1989. In both Puerto Rico and the US Virgin Islands, catch-per-unit-effort, a possible index of abundance, had declined (Appledoorn et al. 1992).

Appeldoorn *et al.'s (*1992*)* analyses of the size-frequency of fish sampled from commercial catches provided additional details for each species. With respect to yellowtail snapper, there were minor changes between 1985 and 1990 that varied from island to island. Data were insufficient to make conclusions about St. Thomas and St. John. Yellowtail snapper caught off St. Croix were generally larger in 1990 than they had been in 1985 but small sample sizes in 1990 may have been an issue in that study. In Puerto Rico, the change in size-frequency varied across the island, with apparent increases in the north and west and apparent decreases in the south and east. Of greater concern for all islands was the number of small fish caught. Female yellowtail snapper mature somewhere between 20 and 25 cm FL (Cummings 2004, SEDAR8-DW-04). On Puerto Rico, the median yellowtail snapper was less than 25 cm in 1990, a decline from 1985. On St. Croix, the median yellowtail snapper in 1990 was larger than 1985, presumably because of larger trap mesh size. It is worth mentioning that the predominant gear for yellowtail snapper in the US Virgin Islands and in Puerto Rico is hook and line so trap mesh size should not be a great influence to the median size issue. Yield-per-recruit analyses suggest that yellowtail snapper may have been fully or slightly overexploited by the mid 1980s around Puerto Rico (Dennis 1991).

Like the US Caribbean stock, Florida yellowtail snapper was not quantitatively assessed until recently (Muller *et al.* 2003). Prior to the recent effort, Florida yellowtail snapper had only been examined in the context of larger multi-species efforts (NMFS 1990; Ault *et al.* 1998), much like the existing stock assessment for the US Caribbean. However, the 2003 effort regarding Florida stocks of yellowtail snapper built and analyzed formal assessment models, all of which focused on south Florida yellowtail snappers. These models provide some insight that could be applicable to yellowtail snapper in the US Caribbean, although in most cases the conclusions of the Florida assessment apply only to the Florida stock.

SEDAR

South**E**ast **D**ata, **A**ssessment, and **R**eview

South Atlantic Fishery Management Council
Gulf of Mexico Fishery Management Council
Caribbean Fishery Management Council
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SEDAR 8. Caribbean yellowtail snapper and spiny lobster
MASTER DOCUMENT LIST

I. Data Workshop Working Papers

NUMBER	TITLE	Author
SEDAR8-DW1	Fishery Management Plan Summary for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands	Kimmel, J.
SEDAR8-DW2	A History of Yellowtail Snapper (*Ocyurus chrysurus*) Assessments from the US Caribbean and Florida	Sladek Nowlis, J
SEDAR8-DW3	Lobster assessment history	Chormanski, S, D Die
SEDAR8-DW4	The biology of yellowtail snapper, *Ocyurus chrysurus*, with emphasis on populations in the Caribbean	Cummings, NJ
SEDAR8-DW5	A Review of the Literature and Life History Study of the Caribbean Spiny Lobster, *Panulirus argus*	Saul, S
SEDAR8-DW6	Status of NOAA Fisheries Commercial Landings and Biostatistical Data - Puerto Rico, 1983-Present	Bennett, J
SEDAR8-DW7	Status of NOAA Fisheries Commercial Landings and Biostatistical Data - USVI, 1973- Present.	Bennett, J
SEDAR8-DW8	The commercial reeffish fishery in Puerto Rico with emphasis on yellowtail snapper, *Ocyurus chrysurus* : landings, nominal effort, and catch per unit of effort from 1983 through 2003	Cummings, NJ
SEDAR8-DW9	An update on the reported landings, expansion factors, and expanded landings for the commercial fisheries of the United States Virgin Islands (with emphasis on spiny lobster and the snapper complex)	M. Valle-Esquivel, and Diaz, G. M
SEDAR8-DW10	Observations on yellowtail snapper caught in US Virgin Islands' commercial fisheries from 1983 through 2003	Sladek Nowlis, J
SEDAR8-DW11	The commercial lobster fishery on Puerto Rico and US Virgin Islands	Chormanski, S, D Die
SEDAR8-DW12	Puerto Rico recreational yellowtail snapper	Cummings, N.J.

SEDAR8-DW13	Preliminary Analysis of Fishery Independent Data Collected in the U.S. Caribbean for two commercially important species: Yellowtail Snapper and Red Hind	Saul, S
SEDAR8-DW14	<<<< BLANK >>>>	
SEDAR8-DW15	The Effects of Trap Fishing in Coral reefs and reef-associated habitats (submitted to GCFI proceedings?)	Hill, R, P Sheridan, G Matthews, R Appeldoorn
SEDAR8-DW16	A very brief description of the cost and earnings of the US Caribbean fish trap fishery	Agar, J
SEDAR8-DW17	Temporal Analysis of Monitoring Data on Reef Fish Assemblages inside Virgin Islands National Park and around St. John, US Virgin Islands, 1988-2000	Beets, J, A Friedlander
SEDAR8-DW18	Effects of artisinal fishing on Caribbean coral reefs	Hawkins, J. P. and C. M. Roberts
SEDAR8-DW19	Effects of fishing on sex-changing Caribbean parrotfishes	Hawkins, J. P. and C. M. Roberts
SEDAR8-DW20	Yellowtail snapper landings maps, Puerto Rico, 2000-2003	
SEDAR8-DW21	Spiny Lobster Landings Maps, Puerto Rico, 2000-2003	

II. SEDAR 8 Assessment Workshop Working Papers List

NUMBER	TITLE	Author
SEDAR8-AW1	US Virgin Islands Commercial Landings and Biostatistical data recovery project	Saul, S
SEDAR8-AW2	Preliminary Analysis and Standardized Catch Per Unit Effort Indices for Yellowtail Snapper Fishery Independent Data in Puerto	Saul, S., G. Diaz, and A. Rosario
SEDAR8-AW3	Standardized Catch Rates of Spiny Lobster (*Panulirus argus*) estimated from the U.S. Virgin Islands Commercial Landings (1974-2003)	Valle-Esquivel, M.
SEDAR8-AW4	Standardized Catch Rates of Spiny Lobster (*Panulirus argus*) estimated from the U.S. Virgin Islands Commercial Trip Interview Program (1983-2003)	Valle-Esquivel, M.
SEDAR8-AW5	Standardized Catch Rates of Spiny Lobster (*Panulirus argus*) estimated from the Puerto Rico Commercial Trip Interview Program (1980-2003)	Valle-Esquivel, M.
SEDAR8-AW6	A Review of Assumptions for the Application of a State-Space Age-Structured Production Model to the Spiny Lobster (*Panulirus argus*) Fishery of the U.S. Caribbean.	Valle-Esquivel, M.
SEDAR8-AW7	Preliminary information on Puerto Rico commercial size composition of yellowtail snapper, 1983-2003.	Cummings, N.
SEDAR8-AW8	Additional information on Commercial Size frequency samples: US Virgin Islands from 1983-2003	Cummings, N.
SEDAR8-AW9	Caribbean Yellowtail snapper yield per recruit summary information	Cummings, N.
SEDAR8-AW10	Catch-free assessment of Caribbean Yellowtail Snapper	Brooks, L.

III. Review Workshop Working Papers

NUMBER	TITLE	Author
SEDAR8-RW1	Further explorations of a stock production model incorporating covariates (ASPIC) for yellowtail snapper (*Ocyurus chrysurus*) in the US Caribbean	Sladek Nowlis, J
SEDAR8-RW2	Length frequency analysis of Caribbean spiny lobster (Panulirus argus) sampled by the Puerto Rico commercial Trip Interview Program (1980-2003)	Chormanski, S. D, D Die, S Saul
SEDAR8-RW3	Maturity of spiny lobsters in the US Caribbean	Die, D

IV. SEDAR Final Assessment Reports

NUMBER	TITLE	Editor
SEDAR8-SAR1	Stock assessment report for Caribbean yellowtail snapper	Cummings, Nancie Nowlis, Josh
SEDAR8-SAR2	Stock assessment report for Caribbean spiny lobster	Die, David Nowlis, Josh
SEDAR8-SAR3	Stock assessment report for South Atlantic – Gulf of Mexico spiny lobster	Muller, Bob Hunt, John

V. SEDAR 8 Reference Documents List

NUMBER	TITLE	Author
SEDAR8-RD1	USVI Caribbean spiny lobster assessment. 2004. USVI DFW	Gordon, S. and J. Vasques.
SEDAR8-RD2	Compilation and summary of ex-vessel fish prices in the U.S. Virgin Islands, 1974/75 to 2003/04.	Holt, M. and K. R. Uwate.
SEDAR8- RD3	Estimates of the number of licensed commercial fishers per year in the U.S. Virgin Islands, 1974/75 to 2003/04. 2004; USVI DFW	Holt, M. and K. R. Uwate.
SEDAR8-RD4	Nearshore habitats as nursery grounds for recreationally important fishers, St. Croix, U.S. Virgin Islands, October 1, 2000 to September 30 2001. 2002; USVI DFW	Mateo, I.
SEDAR8-RD5	Nearshore habitats as nursery grounds for recreational important fishes, October 12, 1995 to September 30 2002 2001; USVI DFW	Mateo, I.
SEDAR8-RD6	Activity and harvest patterns in the U. S. Virgin Islands recreational fisheries, October 1, 1995 to September 30, 2002. 2000; USVI DFW	Mateo, I. et alt.
SEDAR8-RD7	Compilation and summary of commercial catch report forms used in the U.S. Virgin Islands, 1974/75 to 2004/05. 2004; USVI DFW	Messineo, J.
SEDAR8-RD8	Coral reef monitoring in St. Croix and St. Thomas, United States Virgin Islands. Year four final report submitted to Dept. of Planning and Nat. Res. 2004. USVI DPNR	Nemeth, R. S., et al
SEDAR8-RD9	The determination of mangrove habitat for nursery ground of recreational fisheries in St. Croix, October 1 1991 to September 30., 1995. 1996; USVI DFW	Tobias, W. J.
SEDAR8-RD10	Quantitative estimates of species composition and abundance of fishes, and fish species/habitat associations in St. Croix, U.S. Virgin Islands. 2002; USVI DFW	Toller, W.
SEDAR8-RD11	Artificial reef development, nourishment, and monitoring, October 1 1996 to September 30, 2002. 2001. USVI DFW	Uwate, R. and W. Tobias
SEDAR8-RD12	Recreational fisheries habitat assessment for St. Thomas /St. John, October 1, 1996 to September 30, 2000. 2001; USVI DFW	Voulson, B.

SEDAR8-RD13	Recruitment of postlarval spiny lobster (*Panulirus argus)* in Southwestern Puerto Rico. PR DNR	Rosario, A. and M. Figuerola
SEDAR8-RD14	Overview of the spiny lobster , *Panulirus argus*, commercial fishery in Puerto Rico during 1992-1998. 1999; 52nd GCFI	Matos-Caraballo, D.
SEDAR8-RD15	Puerto Rico Fishery Census 1995-96. 1998; PR DNR	Matos-Caraballo, D.
SEDAR8-RD16	Comparison of size of capture using hook and line, fish traps, and gill nets of five species of commercial fish in Puerto Rico during 1988-90. ; GCFI	Matos-Caraballo, D.
SEDAR8-RD17	Comparison of size capture by gear and by sex of spiny lobster (*Panulirus argus)* I Puerto Rico during 1989-91. 1992; 45th GCFI	Matos-Caraballo, D.
SEDAR8-RD18	Overview of Puerto Rico's small-scale fisheries statistics 1998-2001. 2002; 55th GCFI	Matos-Caraballo, D.
SEDAR8-RD19	Comprehensive census of the marine fishery of Puerto Rico, 2002. 2004; PR DNR	Matos-Caraballo, D.
SEDAR8-RD20	CATCH-FREE STOCK ASSESSMENTS WITH APPLICATION TO GOLIATH GROUPER (*EPINEPHELUS ITAJARA*) OFF SOUTHERN FLORIDA	Porch, C. E., A.M. Eklund and G. P. Scott
SEDAR8-RD21	Maximum reproductive rate of fish at low population sizes	Myers, R.A. , K. G. Bowen, and N. J. Barrowman
SEDAR8-RD22	Compensatory density dependence in fish populations: importance, controversy, understanding, and prognosis.	Rose, K. A.et aln
SEDAR8-RD23	A preliminary assessment of Atlantic white marlin using a state-space implementation of an age-structured production model. DRAFT NOT TO BE CITED	Porch, C. E.
SEDAR8-RD24	Preliminary estimations of growth, mortality and yield per recruit for the spiny lobster *Panulirus argus* in St. Croix, USVI. *Proc. Gulf Carib. Fish. Inst.* 53: 59-75	Mateo, I, WJ Tobias
SEDAR8-RD25	Population dynamics for spiny lobster *Panulirus argus* in Puerto Rico: Progress report. *Proc. Gulf Carib. Fish. Inst.* 55: 506-520	Mateo, I

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Stock Assessment Report 1

Caribbean Yellowtail Snapper

SECTION II. Data Workshop Report

March, 2005

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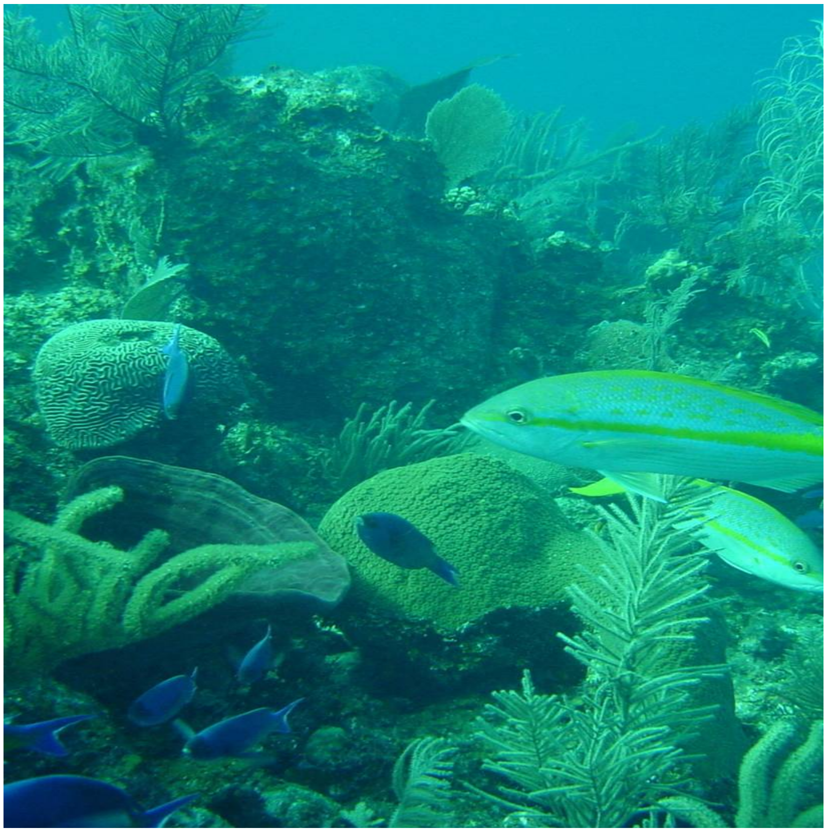
Caribbean Yellowtail Snapper, (*Ocyrurus Chrysurus*)



Prepared by the SEDAR 8 Data Workshop Panel

Edited by Nancie Cummings, SEFSC

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1. Introduction

Scientists and managers from several state and federal agencies and members of the academic community convened in St. Thomas, US Virgin Islands from December 6th to 10th 2004 to address yellowtail snapper. Participants were from.Puerto Rico, Department of Natural and Environmental Resources (DNER), the US Virgin Islands, Department of Fish and Wildlife (DFW), the University of Puerto Rico, Technical staff of the Caribbean Fishery Management Council, scientists and managers from the Miami, NOAA, NMFS, SEFSC, the NOAA, NMFS, SEFSC Regional Office (SERO), and the University of Miami. Section 1.3 of this document provides a list of participants. The main purpose of the meeting was to focus on the feasibility of using various data sets for developing information for use in stock assessments of Caribbean yellowtail snapper and spiny lobster.

Appendix B provides a general reference as to the spatial area involved for these two stocks.

The spatial area Many of the basic data sets considered at the 2003 SEDAR4 Data Workshop for Deep-water Snappers, were addressed again particularly as to improvements made since the 2003 Data Workshop. Recommendations made, during the 2003 SEDAR4 Data Workshop, regarding the quality and reliability of many of the basic data for use in determining total harvest and stock abundance were discussed. In addition, during the 2003 SEDAR4 Deep-water Snapper Data Workshop, recommendations regarding improvements needed for several of the data sets were made. In particular, landings and bio-statistical samples for the US Virgin Islands were of a concern. The findings from the 2003 SEDAR4 Deep-water Snapper Data Workshop are provided in the SEDAR4 Assessment Report.

Because of the uncertainty about some components of the data, the workshop participants chose to provide broad summaries of the information available on the US Caribbean fisheries, to indicate areas where further research is needed, and to consider which available information sets could be useful for conducting stock assessments in the near future.

Prior to the SEDAR8 Data Workshop, participants were requested to prepare initial summarizations of some of the basic data to be examined during the workshop. These findings were provided in the form of working group papers and a complete list of the documents considered at the Data Workshop is provided in section 1.5. During the Data Workshop, several working groups were formed by the participants. These working groups addressed compilation of necessary data to conduct a stock assessment evaluation of yellowtail snapper and in addition discussed appropriate analyses of these data.. The working groups were: 1) Life History, 2) Commercial Fisheries (US Virgin Islands and Puerto Rico), 3)Recreational Fisheries, 4) Fishery Independent Abundance Indices, 5) Fishery Dependent Abundance Indices, and 6) Socio-Economic considerations. In addition, during the Data Workshop additional analyses were conducted of some of the data as well as recommendations made of analyses needed prior to the Stock Assessment Workshop.

This report is organized into sections according a suggested outline set by the SEDAR Steering Group Coordinator and addresses each of the working group deliberations. Structure within each section generally follows that followed by previous SEDAR meetings. Figures and Tables are retained in separate units and follow the main text of the document and numbering is sequential. A list of references to the general literature (i.e., papers other than the working documents submitted to this Workshop) follows the text of the main document. Citations to papers submitted to this Workshop as 'working documents' are made in the text using the identifying numbers assigned by the SEDAR Coordinator and follow the form of SEDAR8-DW-xx.

This report is a complete and final documentation of the activities, decisions, and recommendations of the SEDAR8 Data Workshop. The content will also provide as input, one of the four components of the final SEDAR8 Assessment report for Yellowtail Snapper. The final SEDAR8 Assessment Report will be finalized subsequent to the last workshop in the SEDAR cycle (i.e., the Review Workshop). The SEDAR8 Assessment Report will contain the following sections: I) Introduction, II) Data Workshop Report, III) Assessment Workshop Report, and IV) Review Workshop Report.

1.1 Workshop Time and Place

The SEDAR8 Yellowtail Snapper met in St. Thomas, US Virgin Islands, at the Frenchman's Reef Hotel, December 6th through December 10th, 2004.

1.2 Terms of Reference

1. Characterize stock structure and develop a unit stock definition;
2. Evaluate the quality and reliability of life-history information (age, growth, natural mortality, reproductive characteristics, etc.) and provide models to describe growth, maturation, and fecundity by age, sex, or length as appropriate;
3. Evaluate the quality and reliability of fishery-independent measures of abundance, provide indices of population abundance by appropriate strata (e.g., age, size, and fishery), and provide measures of precision;
4. Evaluate the quality and reliability of fishery-dependent measures of abundance, develop indices of population abundance by appropriate strata, and provide measures of precision;
5. Evaluate the quality and reliability of fishery-dependent data for determining harvest and discard levels by species and fishery sector, tabulate total annual catch (including both landings and discard removals) in weight and number;
6. Evaluate the quality and reliability of data available for characterizing the size and age distribution of the catch (landings and discard), provide length and age distributions, tabulate landings and discards by appropriate strata (size, age, fishery sector;
7. Evaluate the quality and reliability of available data for estimating the impacts of management actions;
8. Recommend assessment methods and models that are appropriate given the quality and scope of the data sets reviewed and management requirements;

9. Provide recommendations for future research needs and priorities (research, sampling, monitoring, and assessment);

10. Prepare and provide complete documentation of workshop actions and decisions, generate a Data Workshop report (Section II of the SEDAR assessment report).

1.3 List of Participants, Affiliation, and Corresponding E-Mail Addresses:

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1.4 List of SEDAR8 Yellowtail Snapper Data Workshop Working Papers

Document Number	Manuscript Title	Author(s)
SEDAR8-DW1	Fishery Management Plan Summary for the Spiny Lobster Fishery of Puerto Rico and the US Virgin Islands	Kimmel, J.
SEDAR8-DW2	A History of Yellowtail Snapper (Ocyurus chrysurus) Assessments from the US Caribbean and Florida	Sladek Nowlis, J
SEDAR8-DW3	Lobster assessment history	Chormanski, S, D Die
SEDAR8-DW4	The biology of yellowtail snapper, Ocyurus chrysurus, with emphasis on populations in the Caribbean	Cummings, NJ
SEDAR8-DW5	A Review of the Literature and Life History Study of the Caribbean Spiny Lobster, Panulirus argus	Saul, S
SEDAR8-DW6	Status of NOAA Fisheries Commercial Landings and Biostatistical Data - Puerto Rico, 1983-Present	Bennett, J
SEDAR8-DW7	Status of NOAA Fisheries Commercial Landings and Biostatistical Data - USVI, 1973- Present.	Bennett, J
SEDAR8-DW8	The commercial reef fish fishery in Puerto Rico with emphasis on yellowtail snapper, Ocyurus chrysurus : landings, nominal effort, and catch per unit of effort from 1983 through 2003	Cummings, NJ
SEDAR8-DW9	An update on the reported landings, expansion factors, and expanded landings for the commercial fisheries of the United States Virgin Islands (with emphasis on spiny lobster and the snapper complex)	Valle-Esquivel, M. and G. M. Diaz
SEDAR8-DW10	Observations on yellowtail snapper caught in US Virgin Islands' commercial fisheries from 1983 through 2003	Sladek Nowlis, J
SEDAR8-DW11	The commercial lobster fishery on Puerto Rico and US Virgin Islands	Chormanski, S, D Die
SEDAR8-DW12	Puerto Rico recreational yellowtail snapper	Cummings, N.J.
SEDAR8-DW13	Preliminary Analysis of Fishery Independent Data Collected in the U.S. Caribbean for two commercially important species: Yellowtail Snapper and Red Hind	Saul, S
SEDAR8-DW14	<<<< BLANK >>>>	
SEDAR8-DW15	The Effects of Trap Fishing in Coral reefs and reef-associated habitats (submitted to GCFI proceedings?)	Hill, R, P Sheridan, G Matthews, R Appeldoorn
SEDAR8-DW16	A very brief description of the cost and earnings of the US Caribbean fish trap fishery	Agar, J
SEDAR8-DW17	Temporal Analysis of Monitoring Data on Reef Fish Assemblages inside Virgin Islands National Park and around	Beets, J, A Friedlander

	St. John, US Virgin Islands, 1988-2000	
SEDAR8-DW18	Effects of artisanal fishing on Caribbean coral reefs	Hawkins, J. P. and C. M. Roberts
SEDAR8-DW19	Effects of fishing on sex-changing Caribbean parrotfishes	Hawkins, J. P. and C. M. Roberts
SEDAR8-DW20	Yellowtail snapper landings maps, Puerto Rico, 2000-2003	Stone, Holly
SEDAR8-DW21	Spiny Lobster Landings Maps, Puerto Rico, 2000-2003	Stone, Holly
SEDAR8-DW22	Overview of US Virgin Islands Recreational Fishing	US Virgin Islands Division of Fish and Wildlife
SEDAR8-DW23	US Virgin Islands Data Concerns and Associated Comments	US Virgin Islands Division of Fish and Wildlife

2. Life History

Cummings (2004, SEDAR8-DW-04) reviewed the life history of yellowtail snapper from the U.S. Caribbean and much of that report is referenced in this section. Yellowtail snapper, *Ocyurus chrysurus* (Bloch, 1791), is a common reef fish species found extensively throughout the tropical and subtropical western Atlantic shelf and coastal waters (SEDAR8 DW-Figure 1a). Adult yellowtail snapper are smaller, more fusiform in shape, are less benthic oriented, and frequently observed in large schools when contrasted to most of the Lutjanids. Because of the excellent taste, rarity of parasites commonly found in many marine food fishes (Collins 1984), and common occurrence, this species is highly sought after by recreational and commercial fishers off the southeastern U.S. (Florida), Cuba, and in the Caribbean (Piedra 1969, Johnson 1983, Manooch and Drennon 1987). Off Puerto Rico, yellowtail snapper comprises a major component of the total commercial fishery landings along with lane, mutton, and silk snapper (Matos-Caraballo 2000). Biological information and the status of populations inhabiting the coastal areas of the southeastern U.S. was presented in Muller *et al.* 2003, while similar information for the U.S. Caribbean (*i.e.,* Puerto Rico and the virgin Islands) is presented in the Comprehensive Sustainable Fisheries Act Amendment (CFMC 2004).

Recent concern over the status of yellowtail snapper populations off Puerto Rico and the US Virgin Islands prompted the need to review and assemble the available biological information for yellowtail snapper in this region. Of major importance in the construction of population models is accurate information on the life history and ecology. This section reviews and synthesizes pertinent biological information from published and un-published sources, with emphasis on yellowtail snapper populations in the Caribbean. This information is needed in order to conduct informative stock assessment evaluations.

2.1 Distribution, Habitat and Trophic Structure

The yellowtail snapper ranges mainly from the Carolinas southward to southeastern Brazil (Druzhinin 1970, SEDAR8 DW-Figure 1). Occasional reports in Bermuda and off Massachusetts and in the Cape Verde Islands off the Atlantic coast of Africa exist, however these occurrences are not common (Druzhinin 1970). This species is observed most in the Bahamas, off south Florida, the Netherlands Antilles, Campeche Bank and throughout the Caribbean (Randall 1967, Hoese and Moore 1977, Fischer 1978, Allen 1985). Yellowtail snapper are also occasionally found in the eastern Atlantic along with the gray, queen, and lane snappers (Fischer 1978, Allen 1985).

Yellowtail snapper are considered ubiquitous and utilize a variety of habitat types during their life, making ontogenetic migrations between settlement, sub-adult, and adult developmental stages. In Puerto Rico, yellowtail snapper was the only species of over 200, recorded during all visual census counts made across habitats ranging from the mangrove shoreline, through grass beds, to the shelf-edge reefs (Kimmel 1985). Larvae undergo a relatively short pelagic existence, settling out in the sea grass after about 35-40 days of age (Lindeman 1997, Jones *et al*. unpublished). Seagrasses may be more favorable than mangrove roots as a larval and juvenile nursery habitat, as post settlement larvae and small sub adults are able to hide among the individual grass blades from predators (Dennis 1988). This author suggested that the mangrove prop root habitat could serve as an intermediary habitat refuge when the juveniles outgrow their seagrass habitat and before emigration onto the coral reef area. Nagelkerken (2000) suggested that yellowtail only use the seagrass habitat up to about 2.5 cm TL and thereafter moved into mangrove and other habitats (*e.g.,* hard rubble, coral reefs) off Curaco, Netherlands Antilles. Mateo and Tobias found that sub adult densities were highest in seagrass beds larger juveniles (> 10cm TL) were more abundant on patch reefs. Watson *et al.* (2002) found that sizes up to 7.5 cm always were in the seagrass and never observed on the reef. The lack of comparative studies across multiple habitats, using multiple sampling gears over a long time period especially in the Caribbean, has been problematic in interpreting the importance of each of these habitat types, (coral reef, mangrove, sea grasses) as a nursery area (see Dennis 1988; Nagelkerken *et al*. 2000, 2001; Mateo and Tobias 2001).

Throughout their geographical range, adult yellowtail snapper are commonly found on near- shore reefs, associated with hard or live bottom, and near the edge of shoals and banks, wrecks, and other artificial reefs. This species occurs in large numbers, nearly always off the bottom. Adults tend to be more abundant at depths of 20-40 m near the edges of shelves and banks (Thompson and Munro 1974- Jamaica). Interestingly, several researchers noted the lack of a relationship between individual fish size and depth distribution (see Thompson and Munro 1974). Yellowtail and vermilion snapper were reported to have a similar niche requirement in that they both are usually observed over the bottom, often swimming in large schools (Grimes 1976).

Yellowtail snapper are carnivorous, with adults and juveniles feeding above the bottom. Divers have reported observing yellowtails feeding on small crustaceans stirred up by stingrays feeding over sandy bottoms. Detailed information on feeding habits is limited to just a few studies off Cuba, Puerto Rico, Virgin Islands, south Florida, and the Netherlands Antilles (Randall 1967 lists other references). Longley and Hildebrand (1941, reported in Thompson and Munro 1974) indicated that yellowtail did not restrict feeding to nocturnal periods as commonly seen in other Lutjanids, but ranged freely throughout the reef and fed both by day and night, unlike most other lutjanids that are nocturnal feeders. The species has diverse feeding habits (eurphagous). Small juveniles <10cm, while inhabiting mainly seagrass tend to feed on zooplankton (Cocheret de la Moriniere *et al*. 2003- Netherlands Antilles) and later as they grow in size, benthic crustaceans (shrimp and crabs) (Piedra 1969, Sierra 1997- Cuba). Other food items include cephalopods and worms (Barbieri and Colvocoresses 2003- south Florida) and the spawn of other fishes (Rose, 1972- Grand Bahamas). Sierra found that by about one year of age, juvenile diets were similar to adults. The diversity of their diet as well as the size of the foraging area increases with the size of the juveniles, possibly reflecting ontogenetic changes in diet with growth.

2.2 Migration

Newly settled post-larvae (about 2-3 cm) rarely move outside the settling area while from about 3-4 cm the range increases up to several square meters (Watson et al. 2002, 2001). These authors confirmed that juveniles up to 5.5 cm TL had fairly restricted home ranges of less than 30 m^2 (see Watson et al. 2002, Figure 2.) and also observed that fish <7.5 cm were always in the seagrass and never on the reef. From about 4 cm to 10 cm TL the juveniles off St. Croix, US Virgin Islands, live in seagrass (*Thallassia testudinum*), and rarely venture more than just a few meters from their seagrass hiding place (Mateo and Tobias 2001). Limited information from tagging studies suggests that movements of adults are restricted to not more than a few miles at most (Randall 1968). The study of Eristhee et al. (2001) which aimed at using ultrasonic telemetry to evaluate movement in yellowtail snapper was unsuccessful using traps, nets and hook and lines to capture the species.

2.3 Stock Structure

This species undergoes a relatively short planktonic larval phase ranging from 30-45 days (Jones et al. unpublished, Lara unpublished data, Lindeman 1997, Lindeman et al. 2001). Recent investigations of surface current patterns for the region and information on the larval duration period for yellowtail suggested a low possibility for upstream recruitment of yellowtail snapper larvae from other areas in the Caribbean (Roberts 1997, Watson and Munro (2004). It was noted that some possibility exists of recruitment into areas off Puerto Rico, the British Virgin Islands and the US Virgin Islands (St. Thomas/St. John) from areas to the east (*i.e.*, Saba Bank, Anguilla, St. Marten (Netherlands Antilles)) however, for marine species with a larval duration period similar to yellowtail snapper (30-45 days), the probability is low (see Roberts 1997, Figures 1 and 2). Limited information exists to document adult movements however the available information suggests adult movement is restricted to only a few miles.

Based on the length of the planktonic phase, information on prevailing surface currents, the low probability of larval input from adjacent regions, and indication of restricted movement of adults (*i.e.*, 1 to 2 miles; Randall 1968) the SEDAR8 life history sub-group suggested a two stock hypothesis in the US Caribbean. The two stocks were: one stock on the Puerto Rico geological platform (*i.e.*, Puerto Rico, St. Thomas/St. John (US Virgin Islands) and the British Virgin Islands (BVI) and, one stock around St. Croix, US Virgin Islands.

2.4 Maturation/Reproduction, Fecundity/ Recruitment

The majority of maturation studies suggested that males mature at a slightly smaller size than females. Spawning of the yellowtail snapper has not been observed through direct observation although anecdotal accounts exist in a few regions. Information on spawning has been inferred from observations of ripe fish collected from many regions and across multiple studies. Based on this information, spawning is thought to occur year round in all regions. The study of Figuerola (1998) is the most relevant reproductive study for yellowtail snapper in the US Caribbean. That study suggested 50% of the yellowtail population off Puerto Rico was mature at 22 cm (males) and 25 cm (females) though minimum sizes at maturity were much smaller at 11 cm (males) and 19 cm (females) similar to fish observed in Cuba. Most studies reported some spatial differences seem to occur in the timing (seasonality) of the spawning event. A strong pulse of spawning during late spring months characterizes populations off south Florida, the Florida Keys and Cuba. There appears to be year-round spawning throughout the Caribbean as well. However, in some areas of the Caribbean, two pulses of spawning were observed (off Jamaica, Thompson and Munro) (SEDAR8-DW-Tables 1a and 1b and SEDAR8-DW-Figure 2).

2.5 Age and growth

Cummings (2004, SEDAR8-DW-04) reviewed growth in yellowtail snapper and information from that review is summarized here. Growth in yellowtail snapper is very rapid initially, near linear in form during the first two to three years, slowing down thereafter, and by age seven or eight reaching an asymptotic length. Hard part and length-frequency analysis studies suggested large uncertainty in the characterization of growth. Whether yellowtail snapper deposit multiple rings (i.e., annuli) each year is unclear as otolith and vertebral studies suggested that fish off Cuba and Mexico could deposit two annual rings particularly in the first year. Marginal increment (MI) analyses indicated the time of annulus formation could occur, over a long period, from early spring to late summer, varying somewhat with geographical location. Several studies suggested that male yellowtails grow somewhat more slowly than females but this information is not conclusive, as most studies did not statistically evaluate differences in growth between sexes. Growth parameter estimates are not easily compared across studies due to differences in sampling gears (hook and line vs. traps vs. trawls), locales (Puerto Rico, US Virgin Islands, Cuba, Yucatan, south Florida), and methodological differences in age determination method. In addition, fitting procedures used in parameter estimation varied between studies. Nearly all of the hard part ageing studies reported different maximum ages observed; some of the differences could be due to sampling biases, spatial and temporal differences and differences between year-classes. Maximum age reports vary between 8 to 14 to 17 years of age from south Florida, Cuba, and Puerto Rico and the US Virgin Islands respectively (Johnson 1983, Manooch and Drennon 1987, Garcia *et al* 2003, Piedra 1969, and Claro 1983). At least some of the differences between studies are due to different sampling gears as Johnson's fish were from commercial and recreational hook and line catches, Manooch and Drennon's samples were from the commercial trap fisheries and Garcia samples from commercial and headboat hook and line samples. The Cuban hard part collections were from hand lines, trawls, and seines. These ageing studies in summary found yellowtail snapper up to estimated ages from 8 to 17 years of age from south Florida, off Cuba, and Puerto Rico and the US Virgin Islands respectively.

Information on the growth of yellowtail snapper from tagging data is limited to a study conducted by Randall (1962, 1963) off Lameshur Bay, St. Thomas, US Virgin Islands in the 1960's using dart and spaghetti tags. More extensive tagging experiments are needed to evaluate the use of tagging data to determine growth in this species.

Estimates of growth parameters for yellowtail snapper, derived from the length frequency analyses of Fournier and Breen (1983) are available for Cuba (Carrillo de Albornoz 1999), Puerto Rico (Dennis 1991), and south Florida (Acosta and Beaver 1999). Table 7 provides growth parameter estimates form length frequency studies and from Perez and Rubio (1986) who evaluated growth off southeast Cuba. Some researchers (Parrack and Cummings 2003, Johnson 1983, Barbieri and Colvocoresses et al. 2003) have suggested that there is a large variation in length at age for this species, especially at younger ages, and that length is therefore a poor indicator of age.

Given the above conditions and the extended spawning season, the use of length alone in determining age of this species is not recommended. The SEDAR8 life history sub-group noted the difficulties associated with estimation of age from length using length frequency modal separation techniques for species, characterized by continuous recruitment. For this reason, growth information derived from hard parts is likely more useful in ageing this species than from length frequency alone. The SEDAR8 life history sub-group emphasized the need for collection of hard part samples to further examine growth of this species in the Caribbean. Efforts to recover the original otolith samples of Manooch and Drennon (1987) were made however, the samples were not available at the time of this workshop. Future field sampling should focus on this aspect of life history. Estimates of predicted size at age for the hard part studies discussed above are presented in SEDAR8-DW-Tables 2a and 2b and SEDAR8-DW-Figure 3. In addition to needing information on growth, conversion formulae from length to length and from length to weight to length are needed for stock assessment modeling. Individual length to length and length to weight conversion formulae are provided in SEDAR8-DW-Tables 3 and 4.

2.6 Natural Mortality

Information on natural mortality (M) of yellowtail snapper was limited to a few studies, which derived empirical estimates using growth parameter estimates derived from length frequency analyses and information on water temperature and maximum age. The estimates from these methods ranged form 0.15 to 0.60. The values for M estimated from the Puerto Rico study were 0.32 and 0.44 (Dennis 1984).

2.7 Life History Research Recommendations

During the SEDAR8 data workshop, the participants reviewed the available information on the biology of the yellowtail snapper in regards to its adequacy in support of stock assessment. The sub-group noted the scant information available on movement of this species, in particular, on adult individuals. Therefore, the group identified a need for scientific tagging studies of adult yellowtail snapper to obtain data on large-scale movements. The life history subgroup recommended that studies further evaluate maturation (size and spatial variation) and growth of this species in the Caribbean are needed. In particular, the group emphasized the need for fecundity information. The SEDAR8 life history sub-group suggested that such studies be conducted in conjunction with the fishing industry. Another research need identified by the working group was the preparation of general regional-wide GIS maps of landings of this species throughout the geographic range of the species in US Caribbean waters.

3. Yellowtail Snapper Fisheries in US Virgin Islands and Puerto Rico

The SEDAR8 commercial sub-group discussed and reviewed the available commercial landings data in addition to the available bio-statistical data. Several major issues with the data identified and discussed in detail. These issues and recommendations appropriate to correct the problems with the basic data, were considered by the main group for further discussion. Several of the issues identified, particularly for the US Virgin Islands data, were of such a nature that postponement of the subsequent SEDAR8 Assessment Workshop was mentioned as a recommendation by some of the workshop participants (SEDAR8 DW-23). It was noted however, that in the context of total landings and species composition for the US Virgin Islands finfish, the as yet incomplete data from the US Virgin Islands would likely provide an improved basis for monitoring the resources from waters surrounding the US Virgin Islands. It was also noted, that current information suggests the volume of yellowtail snapper landings from US Virgin Islands is small relative to the quantity of removals of yellowtail snapper from Puerto Rico. As such, the addition of more precise data from the US Virgin Islands for yellowtail snapper may be of a substantially smaller impact considering a stock-wide (Puerto Rican Platform) form of stock assessment. Sensitivity of the assessment model outcomes to ranges of assumed uncertainty in the US Virgin Islands data could be used to test this condition

3.1 Commercial Fishery: US Virgin Islands

3.1.1 <u>Landings Overview</u>

A review of the history and characteristics of the commercial fisheries of the US Virgin Islands was presented in SEDAR4-DW-Caribbean (2004) and Valle-Esquivel and Diaz (2003) and is updated in document SEDAR8-DW-09 (Valle-Esquivel and Diaz, 2004). The status of the commercial landings and bio-statistical data available through NOAA, NMFS, SEFSC was provided by Bennett (2004, SEDAR8-DW-07). The following sections summarize the information presented in those documents.

> "Before describing the details of the fishery and the information available to date, it is important to note that due to the format and content of the catch report forms for the US Virgin Islands fisheries, and due to the multiple changes they have undergone since the data collection program began, landings data are not recorded separately by species. Over most of the period covered by the landings time-series (1974-1996) landings data were reported by gear type, and later on (1996-2004) by groups of species (e.g., snappers, groupers, etc.). The historical information content recorded for the US Virgin Islands commercial landings was given in SEDAR4-Carib. Table 12 and is reproduced here as Appendix C. This situation applies to the finfish data; therefore, landings for yellowtail snapper cannot be directly separated from the bulk finfish landings by gear (pots, nets, diving, hooks, etc.) or from the "snapper-category" landings. As additional catch-composition information becomes available through the NMFS, SEFSC, Trip Interview Program (TIP) sampling program or from earlier US Virgin Islands, DFW sampling program data, it is

> possible that the bulk landings could be separated at the species level to provide estimates of yellowtail snapper landings and other species of commercial or biological interest."

The 2004 SEDAR4 Caribbean Deep-Water Data Workshop Report, provided detailed information on the structure of the commercial landings data in the US Virgin Islands. Landings in the US Virgin Islands are reported in weight (pounds). The SEDAR8 working group papers by Bennett (2004, SEDAR8 DW-07) and Valle-Esquivel and Diaz (2004) (SEDAR8-DW-07 and 09) document the data currently available at NOAA-SEFSC and the development of a comprehensive commercial landings database for the US Virgin Islands from 57 annual files covering the period 1974 to 2003. Since the inception of the mandatory reporting system in 1974, the US Virgin Islands DFW has modified their monthly (trip level) reporting form several times to collect more detailed gear, effort and species composition information. Because of incompatible information fields, a comprehensive database made up of three data sets was assembled:

1. Data from Old Report Form 1 (1974-1986);
2. Data from Old Report Forms 2, 3, and 4 (1986-1999); and
3. Data from New Report Form (1994-2003)."

In addition, to summarize the reported landings, two expansion factors were developed to account for underreporting. The first expansion factor, EF1, was calculated as the ratio between the number of licensed anglers and the number of licensed anglers who turned in their catch reports. The expanded landings were calculated by multiplying this ratio by the reported landings. A second expansion factor, EF2, was estimated as the ratio between the maximum number of monthly reports (i.e., 12 monthly reports times the number of licensed anglers) and the number of submitted landing reports. This last ratio can be multiplied by the expanded landings to obtain the total estimated landings.

EF1 = No. of Licensed Fishermen/ Number of Reporting Fishers;

Expanded Landings = EF1 * Reported Landings;

EF2 = Max Number Reports Possible (i.e., 12 per year) / Number of submitted reports per year; and

Estimated Total Landings = EF2 * Expanded Landings

Expansion factors will be recalculated based on new licensing and reporting information provided by the US Virgin Islands, DFW at the SEDAR8-DW Data Workshop (Holt and Uwate, 2004), and will be used to calculate the estimated total landings. The expanded landings presented in Valle and Diaz (2004, SEDAR8-DW-09) and reproduced in this document are preliminary, and may be underestimations of the true landings, as only incomplete information for the first expansion factor was available."

3.1.2 Landings Trends and Status of the Data

It is important to note that US Virgin Islands, DFW has recently been conducting an extensive review and re-entry of the fisher landings reports. Approximately 75% of the fisher landings reports encompassing years 1974-1985 and 1993-2003 have been verified and error-proofed (Roger Uwate Pers. Comm). Fisher landings records for fiscal years 1986-1992 are currently still being entered and verified, and shall be completed within a two to three month period (Uwate, Pers. Comm.). Thus, the summary information presented in Valle-Esquivel and Diaz (2004) and reproduced below is preliminary, as the data for fiscal years 1986-1992 are incomplete. Corrections to the raw data included the removal of outliers and duplicates from all the datasets. The major points regarding the corrections are included below in addition to summary information on landings in the US Virgin Islands.

- SEDAR 8 DW-Tables 5 and Figure 4 summarize the reported and expanded landings for the overall multi-species (finfish and shellfish) landings. Snapper landings are presented only for the period 1996-2003 (SEDAR8-DW-Table 5 (by year), Table 6 (by gear) and Figure 5, as catch report forms from previous years did not differentiate this fish category;
- The difference between the reported and expanded landings was estimated at 34% for the overall multi-species fishery, and at 5% for snappers (SEDAR8-DW-Tables 5 and 6). The proportion of snapper landings by gear type and island obtained from the new catch report forms (inclusive of years 1994-2003) is illustrated in SEDAR8-DW-Figures 6 and 7. SEDAR8-DW-Figure 7 in particular illustrate the large variation year to year variability in the estimated percentage composition yellowtail was of the total landings;
- US Virgin Islands landings data before reporting years 1985/1986 are viewed as complete; It is noted that data for St. Thomas/St. John islands begins with fiscal year 1974/1975 while that data for the island of St. Croix begins with the reporting year 1975/1976.
- US Virgin Islands landings data from reporting years 1986/1987 through 1992/1993 are currently being re-entered by US Virgin Islands DFW staff who estimate 2-3 months will be required to complete the task from the time of this workshop. This task was required because electronic data file for those years indicated several fields in the data records were missing;
- US Virgin Islands landings data from reporting years 1993/1994 forward are considered complete; data for 2003 are complete only through June; and
- A recommendation was made that, a new data collection form and a new data entry program be developed in order to provide species-level information. Species level landings data would add more certainty to individual species based evaluations. Historically, the NMFS, SEFSC has provided guidance and data management help with bio-statistical

field sampling forms (i.e., the NMFS, SEFSC, TIP data entry system) in the US Virgin Islands and with landings data entry programs in Puerto Rico. It was recommended that the US Virgin Islands DFW coordinate revision of landings data entry program with the NMFS, SEFSC.

3.1.3 Discards

There is currently no information available on discards from the U.S. Caribbean commercial reef fish fisheries. Recently two studies have been funded through the NOAA, NMFS, Cooperative Research Program (CRP) aimed to provide some information on this topic in the near future. The focus of the NMFS, CRP bycatch study is to determine the feasibility of deploying observers in the US Virgin Islands to quantify bycatch. The NMFS, CRP project is being conducted by the Marine Resources Assessment Group (MRAG) in cooperation with the NMFS, SEFSC and the US Virgin Islands, DFW. The NMFS, CRP bycatch study began in 2004 off St. Croix and is expected to be implemented in St. Thomas in 2005. In addition, beginning with the 2003/2004 reporting year in the US Virgin Islands the fisher reporting form was modified to collect preliminary information on bycatch.

3.1.4 Sampling Intensity

Bennett (2004, SEDAR8-DW-07) provided a summary of the available bio-statistical sampling data for the US Virgin Islands and information on missing data. This latter deficiency in the basic data was discussed in depth at the SEDAR8 DW workshop (R.Uwate, US Virgin Islands DFW). In addition, there are numerous records with incorrect length and weight types in the existing data (Josh Bennett, NMFS, SEFSC Pers. Comm). This latter problem directly affects the US Virgin Islands database and subsequent analyses of the data in several ways. First, the inaccuracies in either length or weight type, preclude accurate estimation of catch at length or catch at weight frequency distribution. In addition, the relationship of sample weight to total weight landed is in error and precludes accurate information on sampling intensity. Finally, as the US Virgin Island landings are not available by species, no specific yellowtail snapper data exist in the landings tables so a specific relationship of sampling intensity directed solely to yellowtail snapper is problematic at this time.

SEDAR8-DW-Figures 8-11 and Table 8 provide relative sampling intensity in the US Virgin Island for St. Thomas and St. Croix according to data that currently exist in the NMFS, SEFSC, TIP data. SEDAR8-DW-Figures 8 and 9 relate numbers of yellowtail snapper sampled to total expanded weight of landings for all species and represents sampling intensity relative to all species. SEDAR8-DW-Figures 10 and 11, relate unedited sample weights of yellowtail snapper to total expanded weight of landings for all species. Commercial fishery sampling in St. Thomas was minimal or non-existent for a period from 1980-1984, between 1988 through 1991 and again from 1997-2001. During the years 1992-1996, the number of sampling events (i.e., interviews) conducted across all reef fish species in St. Thomas/St. John ranged from 16 to 81 interviews annually and the number of individual yellowtail snapper observations varied from 172 to 361 fishes (SEDAR8-DW-Table 8). Therefore the current US Virgin Islands bio-statistical data base for yellowtail snapper from St. Thomas/St. John from 1988-1991 and from 1997-2001 precludes analyses for yellowtail snapper based on size or individual weight samples with any level of confidence. These charts indicate that sampling intensity in St. Croix declined sharply after 1991 and became nearly non-existent in St. Thomas/St. John. Once the remaining data are re-entered and corrections are made to the length and weight type codes sampling intensity measures will be updated. The calculated yellowtail snapper relative sampling intensities shown in Table 8 and SEDAR8-DW-Figures 8-11 also can be compared to the overall sampling fishery rates provided by the 2003 SEDAR4 Data Workshop. On average yellowtail snapper was sampled in St. Croix in some years at a rate of about 0.1% or lower of the total landings. In St. Thomas/St. John little sampling occurred at all for this species. The 2003 SEDAR4-Data Workshop Report (2004) indicated that the overall fishery sampling rate ranged from 0.1% to 2.1% for all species since 1984 in St. Thomas/St. John and was about 1% in St. Croix (see section 4.1.5.2.1 of the SEDAR4 Data Workshop Report, pg. 26).

3.1.5 Status of Biostatistical Data

- US Virgin Islands, DFW staff (R. Uwate, Pers. Comm) estimated that 40% (based on the number of sampling events) of the TIP data that have been collected, has not yet been entered into an electronic database. DFW staff estimated the entry of bio-statistical data into an electronic database will take between one and two person-years (R. Uwate, Pers. Comm.). All bio-statistical data have been cataloged by date and by island. It was pointed by staff of the US Virgin Islands, DFW that the NMFS, SEFSC currently does not have the best available bio-statistical data for stock assessment purposes. US Virgin Islands, DFW and NOAA, SEFSC staff have been involved in a rigorous data clean-up process since 2000. Following the estimates from DFW, several more years could be required to fully clean-up the existing US Virgin Islands commercial bio-statistical data. DFW requested additional resources and support to computerize the bio-statistical data. In response to the request for additional support, during and immediately subsequent to the SEDAR8 Data Workshop, NOAA, SEFSC provided personnel, materials, and supplies to photocopy, transport to the SEFSC in Miami, Florida and keypunch some of the data identified by DFW staff as not yet incorporated into the TIP database. This work is on going, with an objective of updating the US Virgin Islands bio-statistical database available for analysis in time for the SEDAR8 Stock Assessment Workshop scheduled for March 2005.
- Outliers of lengths and weights need to be identified and corrected, if necessary, in the data set. This task should be completed prior to making computations of catch at length composition. This task has not yet begun.
- Efforts should be scheduled to identify incorrect length and/or weight type units in the TIP samples and correct these. This task is required before accurate estimates of catch at length can be made. This task is required to compute accurate estimates of sampling intensity. Sampling intensity information is needed in order to carry out informative allocation of sampling resources and funds. This task has not yet begun.

- After the missing bio-statistical data have been entered and all other needed edits of the data performed then analyses should be initiated to develop catch at size composition.

3.1.6 Commercial Catch-at-Age/Length

Summary information on average and maximum annual lengths observed for yellowtail snapper sampled from the commercial fisheries from 1983 to 2003 was documented in Sladek Nowlis (SEDAR 8-DW-10, 2004). Excerpts from that report are presented in this section. Biostatistical sampling data collected through the NMFS, SEFSC, TIP program were examined. These data are collected by sampling fish from catches of fishers. In the case of the US Virgin Islands, all of the sampling were taken from the commercial fisheries. Interviewers identify fish to species, record the sampling date, the gear used, the location sampled, and various aspects of the effort expended on the fishing trip (*e.g.*, number of gear units, soak time).

The results of Sladek-Nowlis' (2004) analysis are presented in Figures 12 and 13. Figure 12 shows the average length of yellowtail snapper sampled using various gear types by island. It is important to note that the samples observations were not raised to the total catch. Figure 12 also illustrates that there was minimal, if any decline, in the average length of yellowtail snapper sampled from 1983 to 2003. Linear regressions were fit separately to the four most prevalent sampled gear (i.e., fishery) strata: pot and hand-line catches from St. Croix and from St. Thomas/St. John. All of these showed non-significant trends downward. When maximum length was examined (Fig. 13), it showed a slightly stronger trend, again downward than did the trend for average length. It is important to note several important concerns regarding the bio-statistical data for the US Virgin Islands when discussing trends in size from these data. First, earlier in this report (see section 3.1.5) the status of the TIP bio-statistical data was reviewed and concerns regarding missing data, outliers¸ and incorrect length and weight type errors were discussed. Second, it should be noted that sampling of yellowtail snapper was either absent or scant in St. Thomas/St. John in nearly all years and that after 1991 sampling in St. Croix declined sharply (SEDAR8-DW-Tables 8a,b and Figures 8-11). In-fact sampling declined by nearly tenfold after 1991 in St. Croix while sampling rates remained at extremely low levels in all years in St. Thomas/St. John not only for yellowtail snapper but for all reef fish species. In light of the extremely low sampling intensities discussed above (see section 3.1.4) interpretation of changes in size (average or maximum as explored here) is very difficult at this time. It is worth mentioning here that the 2003 SEDAR4 Caribbean Deep-water Snapper Data Workshop reported that in general, sampling of the deep-water snappers in the US Virgin islands fisheries was too low to allow meaningful conclusions regarding the data and particularly so for St. Thomas and St. John (see section 4.1.6.2.3, pp. 28-29 of that report).

The bio-statistical data could allow examination of other aspects of the commercial fisheries in the US Virgin Islands in addition to evaluation of changes in size composition if sufficient sample sizes are available. These include changes in size or age composition spatially and/or by fishery (gear). These data could possibly allow partitioning of landings by species. Presently however, US Virgin Island landings are reported by broad species groups, gear types, or some combination of both type reports (i.e., hook-fish landings, snapper landings). These data also provide some information on the size composition of the catch of many species. Such an analysis was performed for yellowtail snapper, *Ocyurus chrysurus,* and is presented here in Sladek Nowlis (SEDAR 8-DW-10, 2004). Possibly one of the more functional uses in the bio-statistical data would be to allow post evaluation analyses of the allocation of sampling effort resources in particular as regards critical fisheries. These type analyses would allow managers to optimize sampling resources better for the US Virgin Islands fisheries and ultimately enhance the information content used to generate stock status evaluations.

The U.S. Virgin Island TIP samplers do not routinely collect hard parts for age composition. At the time of the data workshop, no direct length-at-age information was available for yellowtail snapper landed in the US Virgin Islands fisheries.

3.1.7 Research and/or Analytical Recommendations for US Virgin Islands Commercial Landings and Biostatistical Data

- Complete data entry and clean-up task of fisher landings reports for reporting years 1986/1987 through reporting years 1992/1993) within 2-3 months, prior to the SEDAR8- Assessment Workshop. This task is currently being carried out by the US Virgin Islands, DFW;
- Estimate landings based on complete catch report database after corrections to landings database are made and after reporting years 1986/1987 through 1992/1993 are entered;
- Recalculate expanded landings based on new lists of licensed fishers;
- Staff of the US Virgin Islands, DFW suggested that analyses of commercial bio-statistical data (size-frequency, catch-composition, CPUE) should be put on hold until all the field sampling data has been completely entered and checked for errors and both US, Virgin Island and NMFS, SEFSC staff have signed off on corrections;
- Avoid repetitive analyses on incomplete information. Use only complete data sets in stock assessment analysis. A solid foundation will then be established for the analysis of other species to be included in future assessments;
- If assessments proceed with incomplete databases, assumptions about the data should be clearly identified and formally documented;
- Immediate changes in the fisher landings report forms are not recommended. The fishing community in the U.S.Virgin Islands is reluctant to provide any additional information, unless they see their data of approximately 30 years reflected in the management decisions;
- Provide feedback to the fishing community after stock assessment analyses are performed, in order to reassure them that the information they provide is valuable and necessary to manage their resources; and
- CFMC and NMFS, SEFSC staff present at the SEDAR8 Data workshop, recommended to conduct stock assessments with the information currently available to support management decisions. Proper consid-

eration of uncertainty and documentation of missing or possibly inaccurate data was emphasized.

3.2 Puerto Rico Commercial Fishery

3.2.1 Historical Account of Fishing in Puerto Rico

Cummings and Matos-Caraballo (2003a, SEDAR4-DW-06) provided an extensive overview of the commercial multi-species fisheries in Puerto Rico and sections of that document are included here because the reef fish fisheries in the US Caribbean are complex multi-species in nature. Commercial fisheries removals have occurred in Puerto Rico since as early as the late 1800's however, detailed records documenting fishing activities, levels of removals, and information on fishing effort (i.e., number of vessels) is not available prior until about 1969. Early investigators reported that fishing for a livelihood was not occurring and that sport fishing was absent in Puerto Rico at least in the early 1900's (Wilcox 1899, 1900, Jarvis 1932). The first scientific investigations by U.S. scientists to Puerto Rico were conducted in 1899, soon after Puerto Rico was acquired from Spain, under the sponsorship of the United States Fish Commission. These early research trips were conducted mainly for the purposes of documenting imported fishery products and carrying out ichthyological surveys (Wilcox 1900 and Evermann and Marsh 1899, 1900; Gray 1900 (as cited by USGS 2002)). Nichols (1929) also conducted ichthyological studies in Puerto Rico under the sponsorship of the Puerto Rico government and The New York Academy of Sciences, describing additional species overlooked by earlier researchers. More recent ichthyological surveys were done by Erdman (1956) in 1944-1946 and Randall (1963) in 1958. Some other research excursions took place in Puerto Rico prior to U.S. scientific studies (e.g., Plee in 1820, Gundlach (1881) in 1873 and 1875-76 and Stahl (1883) however these were primarily limited to ichthyological studies (see Anonymous 1969, USGS 2002).

Jarvis (1932), also under the sponsorship of the U.S. Department of Commerce, Bureau of Fisheries, conducted a detailed survey in 1931 of the marketing and economic aspects of the fisheries and was one of the earliest to document Puerto Rico=s commercial fishery. Jarvis described fishing methods, number of fishers and number of boats operating, number of different gear being used (nets, pots, lines, etc.) and provided comprehensive descriptions on the regional differences of Puerto Rico=s fisheries. Jarvis's (1932) report illustrates the complexity and multi-species and multi-gear operations of the local fisheries in Puerto Rico as early as the early 1900s'.

Jarvis (1932) described in detail the topography of Puerto Rico coasts and described unique features that possibly affected the local fisheries production and this information is presented in an abridged form here. Off the northern coast of Puerto Rico, the 100- fathom curve occurs offshore 1 to 2 miles along the coast, offshore of which the bottom drops rapidly to depths of 667 to 1,409 fathoms. Commercial fishing along this portion of the coast is conducted very close to the shore. Many months are not conducive to fishing due to adverse weather. The amount of fishable area off the northern coast (i.e., the total area of bottom area from the coastline to the 100 fathom curve) is about 66,639 hectares. The southern coast (Yeguas Point on the southeast to Cape Rojo on the southwest), is also characterized by the bottom dropping deeply within a short distance of the shore, and has historically has been thought to offer more suitable near shore habitat for local fisheries than the north coast. Features that make the southern coast more suitable for fishing operations include less exposure to storms thus the use of fish pots is more conducive on the south coast than on the north. In addition, the south coastline is somewhat less abrupt in the drop-off, and the presence of a number of cays and sandy beaches on the southern coast where the use of beach seines is possible. The amount of fishable area off Puerto Rico's southern coast is about 123,660 hectares. Puerto Rico=s fishing area off the western coast, about 124,347 hectares, continues from Point Agujereada on the northwest to Cape Rojo on the southwest. The coast is markedly short in distance, about 1/3 the length of either the northern or southern coast. The western coast however has historically been the center of major production, at least in part due to the larger amount of total fishable area. The seafloor extends about six or so miles offshore at depths of 10-15 fathoms beyond which good habitat exists at depths ranging from 100 to 200 fathoms. Also, off the western coast of Puerto Rico lie several banks off where good fishing was reported historically, and the presence of two islands - Desecheo and Mona (10 miles and 20 miles respectively) are present. The eastern coast continues from Cape San Juan on the north to Point Yeguas on the south and includes the islands of Vieques and Culebra (14 and 11 miles offshore). The eastern coast fishing grounds, about 269,304 hectares, are rather shallow, not more than about 40 fathoms deep continuing from the coastline to the territorial waters of the Virgin Islands. Jarvis (1932) noted that if one considered the entire area off of Puerto Rico=s eastern coast (including, the U.S. and the British Virgin Isles in addition to Anegada Island, Kingfish and Barracuda Banks), the possible fishable area off Puerto Rico=s eastern coast was quite sizable. The total area of nearly 1500 miles^2, provides an extensive opportunity for possible increase in fisheries production from this area. The latter objective, evaluating the possibility of increasing production, was apparently a primary objective, which lead to some of the early Puerto Rican fisheries descriptions from the late 1890's through the 1930's.

3.2.2 Recent Fisheries

Recent studies since the late 1990s of the Puerto Rico commercial fisheries have raised concern as to the condition of several species or species groups commonly reported in these fisheries including several snappers and groupers (see for example Matos-Caraballo 2002). Declining total landings in some fisheries off Puerto Rico (i.e. pot fisheries) and increasing landings in other gears (i.e., hand lines, gill nets, and diver operations) were reported. Matos-Caraballo (2002) also reported declines in the percentage of total landings coming from the west coast of Puerto Rico and, for the first time, since 1972, a trend of increasing landings from the south coast of Puerto Rico. The increase in landings from the south coast was from hook and line landings. The yellowtail snapper, *Ocyurus chrysurus*, has historically been an important component of the Puerto Rico commercial landings, on average contributing about 5% of the total combined shellfish and finfish landings by weight and about 10% of the annual landings of reef fish (Cummings and Matos-Caraballo 2004, SEDAR8-DW-08, Matos-Caraballo 2004, 2002, 2001, 1998, Suárez-Caabro 1975).

3.2.3 Fisherman Landings Data Collection

Cummings and Matos-Caraballo (2004, SEDAR8-DW-08) summarized information on the current commercial fisheries of Puerto Rico, excerpts of which are reproduced below. This section provides summarized information on the historical commercial landings in

Puerto Rico as provided through computerized data documenting fishing activity from 1983 through 2003.

Commercial landings have been collected routinely in Puerto Rico since 1967. The administration of the Fisheries Statistics Program has been under the Department of Agriculture (1967-1979); CODREMAR (Corporation for the Development and Administration of the Marine, Lacustrine and Fluvial Resources of Puerto Rico; 1979-late 1980s) and most recently by the Puerto Rico, DNER. The Fisheries Statistics Program (FSP) was implemented under PL 88-309 and is supported as a cooperative program by NOAA. Until 2004, commercial fishers voluntarily surrendered landings data to port agents who visited the fishers, fishing associations and fish buyers around the Island. Since 1987, the FSP has continuously requested species-specific catch information. In addition to collecting data on landings, port samplers also have collected since 1984, data on bio-statistical samples from commercial fisheries throughout the 42 coastal municipalities and from 88 fishing centers. The status of the data currently available at NOAA, NMFS, SEFSC is reviewed in Bennett (2004, SEDAR8-DW-06) and its usefulness for yellowtail snapper assessed in Cummings and Matas-Carballo (2004, SEDAR8-DW-08. Summary information on the bio-statistical database is presented in Sladek Nowlis (2004, SEDAR8-DW-02) and Bennett (2004, SEDAR8-DW-07).

Reports from the Puerto Rico, DNER, annually submitted to the NOAA, NMFS, SEFSC were reviewed to develop a time series of information regarding the Puerto Rico's commercial fishery. These reports contained summarized information on the following: the number of fishers reporting annually, number of annual commercial sales tickets reported, number of total fishing vessels by length group, number of gear units and quantity of gear, and estimates of reporting rates of fisherman. In most years through 2000 the Puerto Rico, DNER, FSP has conducted a comprehensive census of the total number of fisherman operating in the fishery, the number of and type of vessels used, and information on the types and quantities of fishing gear in use. This information was utilized to establish a time series of the number of fishers, number of vessels, number of sales records, and rate of reporting.

Sales records of fisher catches are currently obtained through reports of sales tickets which have been reported by individual fisherman or from fishing cooperatives since about 1967 (the data base includes sales records reported to PR DNER although, not all sales have been reported). Annually the number of tickets submitted ranged from 16,260 (1985) to 43,564 (2003) with information missing for 1991 (Cummings and Matos-Caraballo 2004, SEDAR8-DW-08) and SEDAR8-DW-Table 9. Through the annual censuses conducted by the Puerto Rico, DNER, some information on the number of fisherman not cooperating (i.e., reporting their landings) and the number of fishermen submitting sales records has been collected by fisheries port agents. In general, it is believed that the degree of fisher cooperation (i.e., reporting) has increased over the years after 1983. Over the period for which information exists to adjust sales tickets, 1971-2002, reporting rates ranged from 0.60 to 0.78 (Cummings and Matos-Caraballo 2004, SEDAR8-DW-08)

3.2.4 Landings Trends

The landings data analyzed by Cummings and Matos-Caraballo (2004, SEDAR8-DW-08) included the years 1983 to 2003. SEDAR8-DW Table 9 summarizes the total annual commercial pounds of all finfish and shellfish landed and also the total pounds of yellowtail snapper. Total sales of all fish and shellfish combined ranged from about 2.0 million to 3.8 million pounds over the 21 year period. An increase in total sales (in pounds) was reported from around 1985 through 1997 followed by a declining trend from 1997 through 2002. Matos-Caraballo (2004) noted that during the middle 1990's there was increased fisher cooperation in reporting sales of fish and shellfish throughout Puerto Rico and suggested the increase in fisher cooperation could explain some of the observed increase in landings. This increase in reporting cooperation through 2002 is evident from the annual census data presented by Matos-Caraballo (2000) and Matos-Caraballo et al. (2004). Matos-Caraballo (2004) also reported a decline in fisher cooperation from 2002 to 2003 from 86% to 56% and a decline in the total number of fishing tickets submitted for all fish and shellfish combined. The decline in number of fishing tickets submitted for all fish and shellfish landed is evident in SEDAR8-DW-Table 9. Over the 21 year period, 1983-2003, the fisher reporting rate varied from 56% (1989) to 86 % (2002) and was 56% in 2003.

Annual pounds of yellowtail snapper sold in Puerto Rico from 1983 through 2003 ranged from 77,232 pounds (1988) to 363,037 pounds (2000) (SEDAR8-DW-Table 9 and Figure 14). The number of individual fisher sales of yellowtail snapper varied over the 21 year period from 2,024 (1984) sales to 7,694 (2001) sales over the same period. Peak years in the total pounds of yellowtail snapper sold and the number of individual fisher sales were 2000 and 2001 respectively. The statistics on commercial sales from the Puerto Rico, FRL, CFSP indicates an increasing trend of fisher sales of yellowtail snapper pounds in Puerto Rico from 1984 continuing through 1995 (see Figure 2b in Cummings and Matos-Caraballo (2004, SEDAR8-DW-08). From 1995 through 2000 fisher sales of this species varied without trend and after 2000, the data do not reveal a strong declining or increasing trend in fisher sales of yellowtail snapper.

Commercial landings of yellowtail snapper by gear are shown in SEDAR8-DW Table 10 (as taken from SEDAR8-DW-08 Table 2). Two principal gears for harvesting yellowtail snapper were identified by Cummings and Matos-Caraballo (2004, SEDAR8-DW Table 10 and Figure 15) being line gear (rod/reels) and pots. Rod and reel sales of yellowtail snapper throughout the time series analyzed represented between 50 to 85% of the pounds reported while pots varied between 6 and 31%. The highest percentages reported for pots were reported in the early 1980s; these show a decreasing trend overall in landings for pots while increased landings are documented for rod and reel. Most of the landings of yellowtail snapper occurred in 7 municipalities (these are in decreasing order of highest to lowest landings: San Juan, Fajardo, Guánica, Mayagüez, Humacao, Aguadilla and Vieques). There were no significant trends observed in the distribution by month, perhaps an increase in sales during February-March and August- September. It was suggested by some of the participants that yellowtail snapper commercial fishing is done at night and during a specific moon however, the data were not analyzed for lunar periodicity. It was recommended by some members of the Panel to explore further the individual landings data for lunar effects.

The total annual value of yellowtail snapper can be obtained from the information provided by the commercial fishers. The sales tickets for reporting to Puerto Rico DNER include information on catch per trip or trips, pounds sold per species or species groups, amount paid to the fisher for the catch and information on the gear used. The total value has varied between over $119,000 to almost $700,000 for 1988 and 2000, respectively. The value of the yellowtail snapper landed by rod and reel was usually higher that for other gears.

3.2.5 Status of Puerto Rico Landings Data

During the SEDAR8 Data Workshop review, Puerto Rican commercial landings data were reviewed and the information from 1998-2003 verified to examine the database for possible duplication. The results of these verification steps are summarized below for yellowtail snapper

Duplicate re-checks were re-run by the NMFS, SEFSC and Puerto Rico, DNER database coordinators to identify and remove duplicate landings records. The results of the data checks were:

YEAR	**TOTAL-LBS**	**YTS-LBS**	**SPINY-LBS**	**# Data Records**
1998	3452976.00	252010	298431	97823
1999	3326457.42	279101	326800	105923
2000	3252941.65	360518	256612	111419
2001	3390740.00	317055	281387	104661
2002	3271960.21	291024	300441	123378
2003	2387974.09	176567	241910	131283

YTS= Yellowtail snapper

SPINY = Spiny Lobster

Based on the review, the commercial subgroup found the Puerto Rican commercial landings data complete through year 2003

It was recommended that in the future, the price information be more closely examined in the database

3.2.6 Discards

At the present time there is no information available on discards in Puerto Rico's commercial fisheries. Data analyzed by Matos-Caraballo ( ) and reported on the various Puerto Rico, DNER Annual Cooperative Reports indicate that about 20 to 30% of the total harvest per year is below the minimum size at maturity. The size at maturity reported by Figuerola et al. (1998) is below the minimum size requirement in federal waters. The minimum size at maturity however was incorporated into the recently implemented Puerto Rico Fishing Regulation. The minimum size for yellowtail snapper is 12 inches for federal waters and 10.5 inches (FL or TL) for State Waters. Nonetheless, it is believed that no undersized fish harvested with the major gears are returned to the water. There are no studies on the yellowtail snapper discarded from beach seines.

Recently a study was funded through the NMFS, MARFIN program aimed at providing some information on this topic in the near future. The MARFIN bycatch study aims to provide some information on bycatch in Puerto Rico. The MARFIN study began in the summer of 2004 and is being conducted by the Puerto Rico, DNER.

3.2.7 Sampling Intensity

Bennett (2004, SEDAR8-DW-06) provided a summary of the available bio-statistical sampling data for the US Virgin Islands and information on missing data. Similar to the US Virgin Islands, Puerto Rico has multiple records with improper length and weight types in the existing data. These coding errors impact the Puerto Rico Biostatistical sample database and subsequent analyses in several important ways. First, the coding inaccuracies disallow accurate estimation of catch at length or catch at weight. In addition, the relationship of sample weight to total weight landed is in error and disallows accurate information on sampling intensity. SEDAR8-DW-Table 11 and Figures 16 and 17 depict sampling intensity in Puerto Rico according to data that currently exist in the NMFS, SEFSC, TIP database. Figure 16 relates numbers of yellowtail snapper sampled to total expanded weight of landings for all species. SEDAR8-DW-Figure 17 relates unedited sample weights of yellowtail snapper to total expanded weight of landings for all species. Yellowtail snapper have been sampled continuously since 1983 by the Puerto Rico, DNER. Throughout the 24 year-period, 1980-2003, the number of yellowtail snapper sampled ranged from 193 fishes to 977 fishes. Generally, the overall sampling rage was about 0.1% of the total fishery landed weight (by number and weight) over the 21 year- period however sampling was consistent in that it occurred in all years since 1983. The total number of interview conducted annually in Puerto Rico ranged from 193 (1983) to 977 (1992) with 571 interviews conducted in 2003. Over the 21 year period the number of fish measured and weighed ranged from 1,062 fishes to 6,865 fishes and in most years from two to three thousand fish were always measured.

It should be noted that these charts were produced subsequent to the Data workshop and that Puerto Rico bio-statistical data were replaced for 1988, 1989, and 1992, eliminating improper weight and length types recorded for those years however duplicate data checks have not been conducted. In general in Puerto Rico the sampling intensity values presented for yellowtail show a somewhat cyclical pattern with an overall upward trend since 1983. Sampling was conducted in all years however the overall sampling rate could be improved. It is recommended that a more comprehensive evaluation of the sampling intensity be conducted that incorporates spatial (geographic), temporal (monthly/seasonally),and individual fisheries (by gear) information into the analyses. This type of analysis would allow managers to optimize sampling resources across fisheries and geographical regions.

It should be noted that the primary purpose of the Puerto Rico TIP is to obtain data for length composition and the length-weight relationship and not necessarily to provide species composition information. Therefore, the data generally contains length and weight measurements for sampled individuals, and the trip information associated with the catch (date, area, gear, days fished etc.). The data do not contain estimates of the sampling fraction, or the total weight or number of fish landed on a trip, by species or otherwise. It is recommended that the Puerto Rico, DNER consider re-structuring their sampling form to allow for collection of landings data per trip. Collection of this data would provide information needed to determine if the basic field sampling protocol is reflective of the fishery (and thus population) landings.

3.2.8 Catch at Length and Age

Information on the total commercial catch at size and age composition of the Puerto Rico commercial landings is not available at this date. It is recommended that after all of the required edits and data replacements have been completed that this task be initiated. It is also recommended that analyses related to trends in average or maximum size or other statistics of interest be initiated only after a full and complete edit of the bio-statistical sample database is conducted and the database verified and signed off on by both NMFS and Puerto Rico parties.

The Puerto Rico TIP samplers do not routinely collect hard parts for age composition. At the time of the data workshop, no length-at-age information was available for yellowtail snapper for the directed fisheries.

3.2.9 Status of Puerto Rico Bio-Statistical Data

- For the Puerto Rico bio-statistical data, the TIP data for 1992 needs to be replaced with the PRBIO92 data file submitted by Puerto Rico DNER staff at the SEDAR8 Data Workshop and this should correct most of the outliers identified during the workshop. This task has been completed since the SEDAR8 Data Workshop however, duplicate record checks remain to be performed before analyses of the data can begin;
- In addition, for calendar years 1988 and 1989, the TIP sample data can be updated with the PRBIO88 and PRBIO89 data files, currently missing from the NMFS, TIP database. Following this addition, a check for duplicate trips in TIP will then need to be performed in advance of the SEDAR8 Stock Assessment Workshop. This task has been completed since the SEDAR8 Data Workshop however duplicate checks remain to be performed prior to data analysis; and
- For the future, it is recommended that an updated data entry program be written for Puerto Rico bio-statistical data. An additional recommendation was made that the data entry program consist of multiple-screen entry as opposed to the current one screen-entry system in use. It is recommended that the revised bio-statistical data entry program for Puerto Rico samples include a feature which screens the data for duplicate samples.

3.2.10 Research Recommendations for Puerto Rico Landings Data

- Puerto Rico commercial landings data are complete through 2003 however, preliminary estimates of yellowtail snapper landings will need to be updated prior to the SEDAR8 Stock Assessment Workshop to reflect changes made at the SEDAR8 Data Workshop; and
- Support the inclusion of coordinate locations in the Puerto Rico, DNER trip ticket forms.
- It is recommended that scientists from the Puerto Rico, DNER continue to work with federal scientists to carry out more updated analyses of the landings and bio-statistical data.

3.3 Recreational Fisheries in the US Caribbean

3.3.1 Recreational Fishery Overview

SEDAR8-DW-12 (Cummings 2004) summarized the recent "recreational" (which likely includes subsistence style fishing as well as recreational fishing activities) catch data for yellowtail snapper in US Caribbean waters. This information was also reviewed at the SEDAR4 Deep-water Snapper Data Workshop (November 2003). Recreational fishing in the U.S. Caribbean can be a significant source of fishing mortality, and consists of activities by both locals and tourists. The new Puerto Rico fisheries law requires charter and other recreational operators to have a license. In the Virgin Islands, recreational fishers are also moving toward a recreational license system and, approximately half of charter operators also have a commercial fishing license (G. Moliner-Garcia Pers. Comm..) However, detailed information on recreational fishing activities and catch levels in the region is generally lacking (Garcia-Moliner et al. 2001, 2002).

The Marine Recreational Fisheries Sampling Survey (MRFSS) surveys "recreational" fishers to provide information on the number and attributes of non-marketed fish, both those retained and released. This survey protocol was implemented in the US Virgin Islands in 2000 however apparently only two interviews were completed in the US Virgin Islands during 2000 (R. Uwate, Pers. Comm). Jennings (1992) performed a telephone survey of U.S.V.I. recreational fishers in 1986. The Eastern Caribbean Center performed a smaller survey in 2000 (Eastern Caribbean Center 2002). These studies should be examined further, but have not yet been considered. SEDAR8-DW-22 provides an overview of US Virgin Islands recreational fishing and its importance to the US Virgin Islands.

The MRFSS recreational fishing survey has been ongoing in Puerto Rico since 2000. This survey provides estimates of total fish landed, the variance of the total, and auxiliary information on the sizes of fish caught and their fate—retained (type A and type B2) or released (type B2). Consequently, the focus of this report is on recreational fishing activity in Puerto Rico.

3.3.2 Recreational Catch and Landings: US Virgin Islands and Puerto Rico

Based on MRFSS sampling conducted in the US Virgin Islands in 2000, the estimated landed catch of yellowtail snapper was approximately 6,500 fish, all of which were landed. Assuming an average weight of the catch of somewhat less than 1 lb based on observations that were available of individuals measured (SEDAR8-DW-Figure 18), this level of landed catch would equate to somewhat less than 6,500 lbs (whole weight). It is estimated that over 161,000 yellowtail were caught "recreationally" in Puerto Rico between 2000 and 2003 (SEDAR8-DW Table-12 and Figure 19). Yellowtail was caught by shore, charter and private anglers with the majority of recreationally caught yellowtail being taken by charter anglers (SEDAR8-DW-Table 12). Estimates of landed catch in Puerto Rico from 2000-2003 (combined across years) totaled approximately 138,000 fish, corresponding to an average annual removal of about 31,500 lbs (whole weight). Estimations are based on the length-weight relationship of Manooch and Drennon (1987) applied to the length frequency observations from all years. This level would represent about 10% of the recent, 2000-2003, annual commercial removals of yellowtail snapper by Puerto Rican fishers.

3.3.3 Recreational Discards in the US Virgin Islands and Puerto Rico

Information from Puerto Rico historically indicated that few fish caught "recreationally" are released. Anecdotal information suggests that the vast majority of fish caught in the U.S. Caribbean are retained for the market or for personal subsistence use—including species of low market value. With the exception of species that are commonly believed to be ciguatoxic, discards in this region are believed to be minimal. MRFSS estimates indicate that between 2000 and 2003, approximately 14% of the yellowtail snapper catch was discarded (SEDAR8-DW-Table 12 and Figure 19).

3.3.4 Recreational Fisheries Catch Rates (CPUE)

Because of the short time series of data from the recreational fishery in Puerto Rico, it was not considered useful from a stock assessment perspective to examine catch rate patterns.

3.3.5 Recreational Fisheries Catch at Length composition

Length frequency samples were sampled through MRFSS sampling from some of the Puerto Rican recreational landed catch of yellowtail snapper from 2000 through 2003. Sample sizes ranged from 26-36 fishes per year in Puerto Rico. Over these years, the size of fish ranged from 11-49 cm (4.3-19.7 in) FL (SEDAR8-DW-Figure 20). Only three fish were sampled for size in the US Virgin Islands in the 2000 survey year. These fish were measured only for individual weight and not size (length) and were 1.09, 0.2 0.9 pounds in weight.

3.3.6 Recreational Fishery RecommendationsIt is apparent that recreational and other forms of fishing not accounted for through commercial markets could be a substantial and potentially growing component of the overall fishing mortality for a number of US Caribbean fishery resources, as evidenced by the available information summarized in the recent CFMC, Comprehensive SFA Amendment to the Reef Resources Fisheries Management Plan (see Table 13). It is recommended that sampling surveys to estimate and monitor these catches in the US Caribbean be expanded to US Virgin Islands and maintained for Puerto Rico.

3.4 Stock-wide Total Landings Estimates

Given the prior discussion and caveats resulting regarding landings trends by individual island and the status of the data bases, the Data Workshop participants proceeded to estimate total removals by stock for yellowtail snapper and spiny lobster. Stocks were defined on the basis of island platform based on previous discussions of stock structure. Thus, landings for Puerto Rico and St. Thomas/St. John were grouped together to represent preliminary estimates of total landings for the Puerto Rico platform. Landings estimates for St. Croix were treated separately. Preliminary estimates of total landings of yellowtail snapper from all fisheries are presented in SEDAR8-DW-Figure 21 and Table 14. SEDAR8-Table 14 provides information on combined landings of all fisheries combined (commercial US Virgin Islands and Puerto Rico, recreational. US Virgin Islands and Puerto Rico. In the case of Puerto Rico commercial landings data for yellowtail snapper were taken directly form the species specific landings as previously discussed in section 3.2. In the case of US Virgin Islands, species estimates were obtained as detailed earlier (see section 3.1.1). Recreational catch estimates were taken from species specific catch databases previously detailed in section 3.3. It should be noted that these stock-wide landings estimates (SEDAR8-DW Figure 21 and Table 14) are preliminary and subject to revisions based, on the previous discussion related to incomplete data for some years in the US Virgin Islands, in particular 1987-1992, and also due to corrections and ongoing edits that under way for both the US Virgin Islands and Puerto Rico landings data.

4. Fishery Dependent Survey Data

4.1 US Virgin Islands Catch Per Unit of Effort (CPUE)

4.1.1 CPUE FROM TIP Bio-statistical Catch Samples for the US Virgin Islands

Sladek-Nowlis (SEDAR8-DW-10, 2004) examined CPUE for yellowtail snapper from the TIP data. For that analysis Sladek-Nowlis calculated CPUE in terms of grams per gear hour and samples were excluded where the island was not identified or the effort data were incomplete. Trips were treated independently but multiple fish caught on the same trip were combined. The results, shown after being logarithmically transformed (Figure 22), show conflicting information. The linear regression of transformed CPUE values indicates a decline in both the St. Croix and St. Thomas/St. John pot fisheries. However, the hand line fisheries showed non-significant trends upward, but these trends explained little of the variation.

Several weaknesses of the Sladek-Nowlis (20004, SEDAR8-DW-10) CPUE analyses were noted during the SEDAR8 Data Workshop: First the analysis could include some trips that are only partially sampled therefore the possibility of a negative bias in catch could exist for some trips. This bias might possibly be addressed by linking the TIP data back to the landings report however it is not likely that the individual sampled trips could be linked directly to the landings data as boat identification was not always available. A second weakness, which applies only to the catch per unit effort analyses, is that trips were only included if yellowtail snapper were caught. Another complimentary measure would be proportion of trips that caught yellowtail snapper and could be achieved through additional analysis of the TIP data. Thirdly, a number of TIP samples appear to have coding errors, particularly with respect to length and weight type, that would influence the calculations of CPUE.

Of major importance in any analyses of the current database of TIP CPUE samples from the US Virgin Islands is the fact that, recently it was discovered that a large number of samples had not been previously entered so trends in CPUE from these data could be misleading. It should be noted that the TIP samples available for these CPUE calculations do not represent a complete data set of all samples that have been collected but rather a sub-sample and as more data become available updated analyses should be considered. A large concern of these specific analyses relates to sample sizes (i.e., number trips sampled) and that information is helpful in judging the comprehensiveness of the TIP CPUE samples across years and by fishery. Table 15a provides the number of available CPUE samples by year, month, and island for each major gear (pots and hook and lines). Table 15b provides annual sample sizes for each gear and island. The 2003 SEDAR4 Caribbean Deep-Water Snapper Data Workshop suggested a baseline of a minimum of 20-30 CPUE samples per year per fishery stratum (e.g., pot, hook and line) were necessary to develop a representative (reliable) index of abundance. Table 15b indicates that in nearly all years less than ten hook and line trips were sampled from the US Virgin Islands hook and line fishery with yellowtail snapper. Similarly, only in the years 1983-1990 and 1994, was more than 20 pot catches sampled in St. Croix having positive catches of yellowtail snapper. These results may change when the various edits and replacements to the NMFS, TIP sample database are complete as discussed previously in section 3.1.5.

If corrections were made to the dataset, such analyses as done here would need to be re-run. Therefore, given the possibility of the types of biases related to partial sampling of catches, problems associated with weigh type errors, and existing low sample sizes that trends from these data should be viewed with caution. It is further noted that the predominant gear used to capture this yellowtail snapper is hook and line however, sample sizes from this fishery were not of the suggested minimum number of 20-30 per year thus trends in CPUE are not possible at this time for the US Virgin Islands hook and line fishery.

4.1.2 CPUE from Commercial Landings Data – US Virgin Islands

Nominal catch rates for yellowtail snapper were not estimated prior to the SEDAR8-Data Workshop because the available information does not yet include any reliable effort data that could be used as a proxy to calculate CPUE. In addition, no efforts had been made to disaggregate yellowtail snapper effort and landings data from the total landings either by gear (for a large part of the time-series (1974-1995)) or for the landings by species complex (i.e., "Snappers") in the later years (1996-2003).

It was suggested by some of the workshop participants that for future CPUE analyses, the effort unit, a fisher report, was the most consistent throughout the time series, 1974-2003. The key assumption will be that one record equals one trip, and that one trip is identified by a name/date combination. This topic was discussed in length by the group. It should be noted that this effort unit, fisher report, is not consistent throughout the entire time series. In early years, fishers may have reported landings on a monthly or weekly basis thus effort would be summed.

At the SEDAR8 Data Workshop it was further suggested that the time series be stratified into phases in which the definition of a 'fishery report' was more consistent. Additional analyses were made at the Data Workshop of the fisher landings records and these assumed one data record represented a single fishing trip and the following. It was suggested that the multi-species landings data could be disaggregated and catch rates could be calculated for the species of interest using the following approach:

- Disaggregate yellowtail snapper from "Pot fish, Net fish, diving" landings (Old Form 1986-1999) using TIP catch composition by gear (once the TIP data for those years becomes available). This analysis could be begun after the fisher landings data updates have been completed;
- Disaggregate yellowtail snapper from the "Snapper" category in New Form (1996-2003) using TIP catch composition by gear. factors: calendar year, location, time of the year, and area. This analysis could be initiated once the fisher landings updates have been completed ;
- It should be noted that partitioning the landings will be complicated for some years in that multiple forms were used as the 'New Form' was being phased in;
- For the area stratification, different boundaries across catch report forms it might be necessary to combine some areas; and
- For yellowtail snapper, a suggestion was made to consider the time of the year, in particular moon phase, so stratification could include sea-

son/moon phase. It was further suggested by one participant that prior to inclusion of such factors into CPUE analyses to examine the basic data to determine if patterns were present in the data by moon phase (or season). One participant noted that little monthly variability was reflected in the yellowtail snapper landings data suggesting that either moon phase was not important in catching success of this species or that perhaps the recorded date of sale did not correspond well with actual date of capture.

The above approach was applied at the workshop to estimate preliminary nominal CPUE for yellowtail snapper from the US Virgin Island fisher reports. Estimates were made of yellowtail snapper harvested with the primary two gears 1) lines and or 2) trap/line combination in the U.S.Virgin Islands for years 1995-2003 (St. Croix, STX) and 1997-2003 (St. Thomas/ St. John, STT/STJ). The calculated number of trips (i.e., number of records) that harvested yellowtail snapper using each gear, the reconstructed (disaggregated) catch, and the nominal CPUE by district are provided in SEDAR8-DW-Table 7 and illustrated in SEDAR8-DW-Figures 23 and 24.

At this point in the analyses of the US Virgin island fisher landings records for purpose of partitioning the landings by species, it is important to reflect on the conclusions of the 2003 SEDAR4 Caribbean Deep-Water Data Workshop. The 2003 SEDAR4 Data Workshop panel evaluated whether the TIP species composition (i.e., landings) samples were representative of the fisher reported landings for certain species groupings (i.e., snappers, groupers, etc.) for which species complex landings were available in the commercial landings data (1994 and later, see section 4.2.1.2, pp. 27-28 of the 2003 SEDAR4 Data Workshop report). Those analyses indicated that the sampled landings by species groupings did not closely resemble the reported landings by species groupings in the commercial data files; subsequently the SEDAR4 Panel recommended against using the TIP data to estimate species composition of the reported landings. During the SEDAR4 discussions it was pointed out, that some of the gear categorizations needed further stratification, by temporal periods, to better reflect sampler allocation of effort (i.e., lobster traps vs. fish traps, hook and line- pelagic vs. reef fish). Further work is suggested by state and federal analysts to resolve these issues. It is recommended that estimates of the variance around the estimated proportion of yellowtail snapper be developed for use as guidance regarding the confidence in this approach.

4.2 Puerto Rico CPUE

4.2.1 <u>CPUE from Puerto Rico Commercial Fisheries Landings Data</u>

Nominal Unadjusted CPUE

Cummings and Matos-Caraballo (2004, SEDAR8-DW-Doc08) provided preliminary results of CPUE analyses. Those authors used the raw commercial sales records to calculate unadjusted nominal catch per unit of effort (CPUE) for yellowtail snapper for future consideration as possible stock status measures. CPUE was computed using the fisher sales trip as the basic measure of effort as previously done for these data in Matos-Caraballo (2002). For yellowtail snapper, two sets of observations were constructed. The number of fishing trips variable, ‘ntrips’, was used in selection of data to include in the yellowtail snapper CPUE analyses. Although, the CFFSP, FSP data collection program was intended to collect trip specific sales records often fishers recorded as many as up to 95 trips comprising a single sales record. In total, there were some 99,668 individual fisher sales records identified as yellowtail snapper from the 1983-2003 Puerto Rico landings data. Of these observations, the 'ntrips' variable was coded as zero ('0') for 17% (16,990) of the records; these records were excluded from subsequent calculations of CPUE. 82,687 data records remained for use in evaluating CPUE for yellowtail snapper. The remaining data records were further reviewed in order to determine an appropriate cutoff value for the 'ntrips' variable for use in CPUE analyses. Mean nominal CPUE, calculated as total pounds per trip divided by the number of trips (i.e., 'ntrips'), was computed, the standard deviation of mean CPUE (stddev) along with several other univariate statistics were also computed and presented in Cummings and Matos-Caraballo (2004, SEDAR8-DW-Doc-08, Table 23). The average pounds per trip and the stddev variable plotted are presented in SEDAR8-DW-Figure 25. The standard deviation variable describes the 'between sale' variation in nominal CPUE.

The nominal CPUE result summaries indicate that the majority of fishers (71%) landing yellowtail snapper, reported only having made a single trip ('ntrip' = 1) on the sales form. Ninety-five percent (n = 78,112) of all of the yellowtail fisher sales observations recorded ntrips = 9 or less while the standard deviation (stddev) of mean CPUE increased nearly five fold for sales records indicating that the total weight represented ten or more trips (see SEDAR8-DW-25). One would expect the stddev to decline as 'ntrips' increases. It seemed illogical that fishers in Puerto Rico would conduct repeated fishing trips, especially more than a weeks worth, in sequence and retain that catch prior to processing. Most fishing trips are conducted during a single day. Retaining multiple day catches and having to maintain the freshness of the catch over several days prior to sale in order secure a reasonable price for the catch, would be difficult and burdensome to the fisheries operation. Therefore, the cutoff value of 'ntrips' ≤ 7 (i.e., one week) seems supported based on the day to day fishing operations. Subsequently this value was used as a cut-off point in forming the second CPUE data set One data set was formed 1) of only observations indicating the 'ntrips' variable equal to one and 2) another of observations in which the 'ntrips' variable was coded as seven or less. For each data set nominal un-adjusted CPUE of yellowtail snapper was calculated and is presented by year and each major (rod and reel, pot) and minor (nets, seines, dive, cast nets, other) gear in SEDAR8-DW-Tables 16a and 17a and Figures 26-27. SEDAR8-DW-Tables 16b and 17b provides sample size information for the data from the ntrips =1 and ntrips <=7 datasets.

Calculations of CPUE for yellowtail snapper for the two separate data series ('ntrips'=1 and 'ntrips' <=7) for each major and minor gear (rod and reel, pot, net, seines, dive, cast net) used to capture this species over the 21 year period are presented in SEDAR8-DW-Tables 16a and 17a and Figures 26-27. CPUE calculations were made and presented for all the gears capturing this species however the reader is reminded that the major gears responsible for the majority of yellowtail snapper landings in Puerto Rico are lines (coded as rod and reel here) and pots, followed by nets and seines. The major gears represented some 88 and 87 % of the total sales observations in the two data sets respectively (SEDAR8-DW-Tables 16b and 17b).

The tabled CPUE calculations from the 'ntrips' = 1 data set indicated that yellowtail snapper commercial CPUE from lines (rod and reel) varied without trend from 1985-2003 from about 31 to 54 pounds per trip and was 34 pounds per trip in 2003 (SEDAR8-DW-Table 16a, Figures 26a,c). The very high CPUE calculation in 1984 observed in the rod and reel nominal CPUE was evident in all gear categories. Pot CPUE of yellowtail snapper varied from about 15 pounds per trip to 31 pounds per trip over the 21 year period and was 13 pounds per trip in 2003 (SEDAR8-DW-Table 16a, Figures 26a, c). CPUE observations from pots and line gear contributed 88 % to the total all gear CPUE data set (SEDAR8-DW-Table 16b). CPUE from all gears combined varied from 25 pounds per trip to 45 pounds per trip over the 21 year period and was 28 pounds per trip in 2003 (SEDAR8-DW-Table 16a and Figures 26a,c). The 1984 data points are excluded from this discussion as it appears to be aberrant in all gear and closer inspection of all the data for 1984 is recommended for future analyses.

For the 'ntrips'≤ 7 CPUE data set, yellowtail snapper CPUE from line gear varied from about 21 pounds per trip to 42 pounds per trip and was 34 pounds per trip in 2003, again varying without strong trend over the 21 year period (SEDAR8-DW-Table 17a and Figures 27a, b). Pot CPUE of yellowtail from the 'ntrips' ≤ 7 data set varied from around 10 pounds per trip to 18 pounds per trip and was 14 pounds per trip in 2003. The lower mean value from pot fishers in the 'ntrips ≤ 7' data set could indicate pot fishermen are checking their gear more than once per day and counting each trap set haul as a trip. Yellowtail snapper CPUE from all gears combined ranged from 17 pounds per trip to 38 pounds per trip over the 21 year period and was 8 pounds per trip in 2003 (SEDAR8-DW-Table 17a, Figure 27a).

Over the 21 year time series from 1983-2003, yellowtail snapper nominal CPUE varied without major trend in nearly all fisheries except for the single outlier in 1984. Graphical comparisons of line and pot CPUE for yellowtail snapper are shown in SEDAR8-DW-Figure 28. The reader is cautioned to view the 1984 data points as questionable as CPUE in this year was nearly three to four fold that of neighboring years for all gear categories.

Standardized CPUE

Cummings and Matos-Caraballo (2004, SEDAR8-DW-DOC-08) also used the individual landings data records to calculate preliminary standardized CPUE trends using general linear modeling (GLM) procedures (Robson 1966) for yellowtail snapper from the Puerto Rico commercial fisher landings data. For the standardization analyses three data sets were constructed for yellowtail snapper. The first set contained only observations where the 'ntrips' variable was equal to one as described above under 'Nominal Unadjusted CPUE). Then a second data set was formed by only including observations from sales in which the 'ntrips' data variable equaled seven or less. Finally, a third data set of all the yellowtail snapper CPUE observations was formed. For each data set, a GLM model was fit which contained auxiliary terms for several independent variables traditionally considered statistically important in explaining the variation in fisheries CPUE data. The auxiliary data collected by the FSP on each sale considered in these analyses were year, month of sale, municipality as a proxy for general area of catch, and gear used in the capture. Some sales records also included information on depth of fishing however this information was incomplete in most cases. Incorporating auxiliary information into the calculation of CPUE is considered important in explaining the total variation in CPUE.

Models were fit for each separate data set (i.e., 'ntrips variable' =1, 'ntrips variable' <= 7, and all trips). In addition, separate models were calculated for the two primary gears, lines and pots, for yellowtail snapper using the 'all data dataset'. The same general linear model was fit to each data set and contained auxiliary terms for year, month, gear, and fishing center.

The CPUE measure was total pounds per trip as assumed in the calculations of nominal CPUE. The purpose of fitting these preliminary standardization models was mainly to evaluate temporal trends over the 21 year time series, 1983-2003, in commercial CPUE for yellowtail snapper in Puerto Rico and also to identify appropriate choices for data inclusion for future work.

Temporal patterns in the standardized CPUE results are in general very similar to those observed in the unadjusted yellowtail snapper CPUE data. Similar to the unadjusted CPUE values, standardized CPUE estimates for 1984 appear out of line with surrounding years and all comparisons are made from the 1985 year and later (SEDAR8-DW-Tables 18-22, Figures 29a-e). Standardized CPUE of yellowtail snapper across all gears from the 'ntrips=1' dataset varied from about 12 pounds per trip to 18 pounds per trip (SEDAR8-DW-Table 18, Figure 29a). Current CPUE was 14 pounds in 2003. The total percent of variation in the data explained with this model was 30%. Standardized CPUE of yellowtail across all gears form the 'ntrips<=7 trips' varied from 10 pounds to 14 pounds per trip and current CPUE in 2003 for this data set was 14 pounds per trip (SEDAR8-DW-Table 19, Figure 29b). The total percent of variation in the data explained with this model was 29%. Standardized CPUE of yellowtail snapper from the 'all fishing trips' data set ranged from 10 pounds to 14 pounds per trip over the 21 year period. Current CPUE in 2003 was 14 pounds per trip (SEDAR8-DW-Table 20, Figure 29c). The total percent of variation in the data explained with this model for the 'all observations data set' was 30%. Estimates of 95% Upper and Lower confidence intervals were very narrow for all three data sets however this is not surprising as the CPUE trend is rather flat.

Using the 'all data dataset option (i.e., 'ntrips variable'>0), separate models were also fit for the two major gears catching this species, lines and pots (SEDAR8-DW-Tables 21 and 22 and Figure 29d). CPUE ranged from 9 pounds per trip to 16 pounds per trip for lines and from 7 pounds to 16 pounds per trip for pots (SEDAR8-DW-Tables 21 and 22). Current CPUE in 2003 was 16 and 11 pounds per trip respectively. The total percent of variation in the data explained with the model for these two data sets was 25% and 19% respectively. The detailed results for these CPUE GLM model fits are available from the senior author regarding number of observations in the model, individual parameter estimates, and importance of each parameter to the model fit.

Uncertainty and Measures of Precision

Multiple analyses were conducted of the Puerto Rico landings data to provide preliminary information on temporal patterns in catch rates of yellowtail snapper CPUE. When the data were partitioned into separate sets according to the 'number of trips variable' (ntrips >=1) resulting trends in nominal unadjusted CPUE were similar (SEDAR8-DW-Figure 28, Tables 16a and 17a). In addition, standardized results of CPUE, adjusting for variation due to year, month, gear, and geographical area of landing yielded reasonably similar patterns (SEDAR8-DW-Figure 29d and 29e, and Tables 18-22). The CV of the annual index of CPUE ranged from 2-16% across all the standardization runs.

4.2.2 <u>CPUE from Puerto Rico Commercial TIP Data Samples</u>

The use of the NMFS, Puerto Rico TIP database to calculate CPUE was addressed at the 2003 SEDAR4 Data Workshop. It was noted at that time that field agents in Puerto Rico do not routinely collect landings data as part of the TIP sample (see section 4.1.4.1 of SEDAR4 Data Workshop Report). In addition, sometimes only partial catch samples were obtained. It was further recommended that state and federal biologists work together to identify complete catch samples (i.e., identify trips from which the sampler identified and weighed and measured 100% of all individuals in the catch). No additional work has been done since the 2003 SEDAR4 Caribbean Deep-Water Data Workshop on this specific issue. Thus, catch rates were not calculated for the Puerto Rico fisheries using the TIP data.

5. Fishery-Independent Survey Data

Several fishery independent surveys conducted by local state and federal agencies are on-going in the Caribbean that cover various parts of Puerto Rico and the US Virgin Islands. While these efforts may contribute to the general knowledge of yellowtail snapper (*Ocyurus chrysurus*), none of these programs provide a comprehensive evaluation of the yellowtail snapper populations. Several of the more comprehensive programs are relatively new and provide only a few years' data. These programs are identified in the following sections in order to document these efforts, their findings, the applicability of each study and their limitations. This section should serve as a foundation for research recommendations to improve the capabilities to assess US Caribbean reef fish stocks. At the SEDAR8 Yellowtail Snapper Data Workshop the participants discussed the various fishery independent data sets. Several factors were addressed for each data set where applicable including: methodologies employed, spatial and temporal coverage, trends in catch rates, overall usefulness in measuring abundance of yellowtail snapper, potential biases, and future survey improvements and needs.

5.1 Southeast Area Monitoring Program (SEAMAP)

The NMFS, SEFSC, Southeast Area Monitoring and Assessment Program (SEAMAP) collects and manages fishery independent data in the southeastern United States to assess the status of marine resources within US federal jurisdiction. In the US Caribbean, the Puerto Rico, DNER administers the program in Puerto Rico, while the US Virgin Islands, DFW administers the program in the US Virgin Islands. Historically, the program conducted sampling efforts in the Caribbean since 1975. Ingram (2003, SEDAR4-Doc-24, Tables 1 and 2) provided a chronological history of the NMFS, Caribbean SEAMAP as to sampling areas and time periods for 1975-2002 (reproduced here as SEDAR-DW-Table 23a and 23b. SEDAR8-DW-Doc-13 (Saul and Rosario, 2004) described the data from the more recent NMFS, Caribbean SEAMAP dataset time period (1992-2002).

5.1.1 <u>Methods, Gears and Coverage (US Virgin Islands)</u>

Detailed information regarding survey methodology was provided in Tobias, et al. (2002). The predominant gears used by SEAMAP are traps with mesh sizes either 1.25 or 1.5 inches (see discussion, section 5.1.5) and hook and line. Long-lines and bottom grabs were experimentally tested, but no data from those tests are included in this analysis. Sample locations are concentrated off the west coast of Puerto Rico and off the south coast of St. John in the U.S. Virgin Islands; a small amount of additional sampling has been done around St. Croix (SEDAR8-DW-Figure 30). Within these areas, sampling effort is distributed over a predefined grid. Within each 2 x 2 mile grid cell or quadrant, sub-quadrants (0.5 x 0.5 mi.) are used as sampling units and referred to as stations. Twelve traps (four strings with three traps per string) baited with red ear sardine or dwarf herring are deployed on each sample day. Traps and trap strings are set with at least 150 feet between traps, and allowed to soak for about six hours. During the time the pots are being fished, three individuals fish for six hours using handlines, with three hooks each, baited with cut squid. The following parameters are recorded at each sub-quadrant for each trip: date, time, latitude, longitude, trap soak time, number of traps hauled and lines and hooks fished, weather observations, water depth and substrate type. Bio-statistical measurements and macroscopic gonad analyses are recorded on each fish captured (Tobias, et. al. 2002).

5.1.2 Sampling Intensity

Experimental SEAMAP sampling was conducted between September 1991 and June 1992. Those surveys tested both hook sampling and trap sampling in developing the current SEAMAP sampling protocol in use in Puerto Rico and the US Virgin Islands. Dedicated monitoring began in 1991 and continues today in both the US Virgin Islands and Puerto Rico. In each area, sampling cruises are conducted, and identified by, each federal fiscal year (October – September). During each cruise, a number of sampling trips could occur, as day trips -- a few days each month (SEDAR8-DW-13, Table 1). A single cruise generally spanned several weeks or months with frequency of fishing events being variable (Pagán et al. 2004). Hours fished were recorded for a given fishing event on each individual boat, at each station fished. Total time fished was variable from one trip to another and from one boat to another (Saul and Rosario 2004, SEDAR-8-DW-13 and Figure 5). Consequently, while sampling intensity can potentially be quantified as time fished per gear type over any appropriate time stratum (e.g., days, weeks, or months per year) findings must be interpreted carefully. Preliminarily, sampling intensity was measured as hours fished on a research trip. Given the earlier discussion at this Data Workshop regarding stock structure of the yellowtail snapper it is suggested that for future analyses separate calculations be made for St. Croix vs. Puerto Rico, St. Thomas, St. John. Information on sampling incidence for the SEAMAP survey in the US Virgin Islands is given in SEDAR8-DW-Table 24.

5.1.3 Catch Rates – Number and Biomass

The NMFS, SEFSC Caribbean SEAMAP survey encounters a diverse range of reef fish species (SEDAR8-DW-Figure 31). The predominant species caught during the SEAMAP surveys were red hind (44.1%), coney (28.3%), sand tilefish (5.7%) and squirrelfish (2.5%) by weight. It should be noted that during the SEDAR8 Data Workshop strong evidence of outliers was provided for individual observations therefore subsequent calculations of some variables from these data, such as calculation of CPUE and also percentage species contribution by weight, may be in error and edits to these data are underway. Nonetheless, the sampling methodologies used in the, SEAMAP survey did not sample yellowtail snapper well. To date, only 45 yellowtail snappers have been captured in the Puerto Rico surveys and only 50 yellowtail snapper have been sampled in the US Virgin Islands surveys across all years, compared to the most abundantly sampled species (2,038 red hind in Puerto Rico; 2,679 red hind in US Virgin Islands). The low number of yellowtail snapper captured should be considered when following the subsequent analysis related to catch per unit of effort (CPUE).

Average CPUE, was calculated for each boat on each research cruise, as indicated by the "cruise landing date," the date a boat returned from a particular research cruise. Each cruise landing date is unique for a single boat on a single research trip. Effort was defined as the hours fished with either hooks or traps, while catch was computed as the sum of the weight (grams) of the fish caught. It is important to note again that these preliminary calculations of CPUE are in question because of problems in weight types discovered during the Data workshop. The calculations of CPUE from Saul and Rosario (2004, SEDAR8-DW-13) did not include adjustments for the changes in trap mesh size and type changed or the change in the number of hooks fished changed over the course of the surveys.

Red hind, the most abundant of the reef fish species sampled by SEAMAP, has a significantly greater CPUE when compared to that of yellowtail snapper; however, neither species shows any significant trend over time (SEDAR8-DW-Figures 32 and 33). It was also recommended at the Data Workshop that given discussion regarding yellowtail snapper stock structure, future analyses of the NMFS, SEAMAP samples should carry out separate analyses for surveys in Puerto Rico, St. Thomas, St. John vs. St. Croix in addition to accounting for the problems in weight unit types. An additional recommendation is that future CPUE analyses incorporate traditional analysis of variance methods as options for standardizing the CPUE and to handle multiple survey observations within a year. Important variables to control for include: area (Puerto Rico, St. Thomas/St. John, St. Croix), gear type (hook and line vs. pot, trap mesh size (1.5 vs. 1.25 inch mesh), variation in number of hooks (3 vs. 4), individual fisherman success for the hook and line gear), temporal period (month, week ,day) and possibly lunar and day/night effects. It is suggested that future SEDAR's that consider CPUE analyses from these specific data form a small working group to discuss possible model types appropriate for these data and important data stratifications to include prior to the Data Workshop.

SEDAR8-DW-Table 25 provides information pertaining to sampling frequency in the NMFS, Caribbean SEAMAP surveys for Puerto Rico and the US Virgin Islands separately. In general, these data indicate a low number of survey days for both regions, Puerto Rico and the US Virgin Islands, present in the current NMFS, SEAMAP database. SEDAR8-DW-Table 25a indicates that data for Puerto Rico after 1994 and prior to 1991 are absent in the current dataset, and that only 13 survey days in total represent Puerto Rico. SEDAR8-Table-25b indicates that only 8 survey days for the US Virgin Islands exist in the dataset. It was also discovered during the SEDAR8 Data Workshop that much of the US Virgin Islands SEAMAP data had not been entered in the current NMFS database (R. Uwate, Pers. Comm.). A suggestion was made to include this data in addition to accounting for other database problems discussed above (i.e., weight type errors). A further suggestion was made that given the low number of sampling days in the data set and the problems associated with weight units that the current NMFS, SEAMAP data not be used for purposes of computing CPUE.

5.1.4 <u>Size/Age Data –</u>

The majority of the yellowtail snapper captured during SEAMAP surveys ranged from 175 mm to 375 mm FL or from ages 2-8 (SEDAR8-DW-Figure 34). Comparing these sizes to size-at-maturity curves of Figuerola et al. (1998) suggests that 26.5% of the individuals sampled during the SEAMAP survey were below the length at which fifty percent maturity is achieved. Further, 76.8% of the individuals sampled were below 300 mm, the length at which nearly all of the individuals have reached maturity. The observed length frequency distribution from the sampled data indicated a slight decline over all years in both individual length and estimated age sampled by the SEAMAP survey however, no data existed in the database after 1994 for Puerto Rico and only 3 survey days were present for the US Virgin Islands after 1994. These results must be considered carefully in light of the extremely low incidence of capture of yellowtail snapper by the SEAMAP surveys (n=45 Puerto Rico, n=50 US Virgin Islands across all years). Again, future considerations of these data should separate the information for St. Croix from that of St. Thomas/St. John, and Puerto Rico given previous stock structure discussions.

5.1.5 Uncertainty and Measures of Precision

The NMFS, SEFSC, Caribbean SEAMAP surveys are limited in spatial distribution but the current database is limited more so in temporal coverage. For Puerto Rico, stations are concentrated around reef and spawning aggregation areas and are limited to the west coast and survey days were found only for 1991-1994 in the dataset. Off St. John sampling only took place along the south coast while off St. Croix sampling took place only off the north-east. Temporally, data existed for 1992-1994 and 1999-2000 in the dataset for the US Virgin Islands. Taken as a whole, this data set is also limited spatially for all reef fish species commonly caught in the US Caribbean and under management of the Reef Fish Fishery Management Plan of the CFMC, and particularly so for yellowtail snapper and other species that might inhabit similar areas as yellowtail snapper. In addition not all species seem to be well sampled by SEAMAP (i.e., the probability of capture does not appear to be equal for all species although this hypothesis needs to be tested statistically). The sampling methods employed do not sample yellowtail snapper as effectively as other species, e.g., red hind.

A specific analytical weakness of the analyses of Saul and Rosario (2004, SEDAR8-DW-13) was that the unadjusted CPUE did not account for changes in gears (trap mesh size and number of hooks per hand line). Those authors reported that methodological changes were poorly documented in the original survey documentation. For Puerto Rico, trap sampling apparently changed on cruise 942 (1994), when trap mesh size was changed from the original 1.25 inch hexagonal galvanized wire to a 1.5 square vinyl coated wire from that time onward. No changes in mesh size were recorded in the data for US Virgin Islands, but changes in number of hooks per hand line were apparent from cruise 932 (3 hooks) up to cruise 001 (6 hooks). If this is taken into consideration, the amount of hand line events for cruise 001 changes from 10 to 60 (Pagan et al. 2004, Table 12).

5.1.6 Overall Status of the NMFS, SEFSC, Caribbean SEAMAP Data and Future Recommendations

Evaluation of trends in catch rates and size composition was somewhat complicated for the current NMFS, Caribbean, SEAMAP data set for the reasons discussed above. In addition to various methodological changes that occurred during the surveys other major logistical problems are ongoing and in addition the dataset was limited temporally. At the SEDAR8 Data Workshop, scientists from the US Virgin Islands, DFW reported that approximately 60% of the data had not been entered into the database with paper copies in storage at the DFW, although funding for this task was previously awarded to DFW. Apparently, since the end of the workshop some progress has been made towards entering this information. In addition, although sampling is annual, it does not occur during the same time each year, potentially introducing some confounding seasonal variability with CPUE variability. The sampling variation is mainly caused by inconsistencies in the timing of the annual availability of funds. One way of avoiding this problem would be to compute CPUE as grams (or numbers) per hour fished (g/hrs) over time. This method of calculating CPUE assumes that each sampling hour is uniform when compared to other sampling hours. It is recommended, that all future analyses related to catch rates consider appropriate analysis of variance standardization procedures to adjust for various logistical and methodological concerns discussed above. It is recommended, that such analyses consider the relevance of the entire dataset of catch observations as compared to excluding zero catches of yellowtail snapper in the calculation of abundance (CPUE) trends from these data.

It is strongly suggested that future SEDAR's' that consider CPUE analyses from these data form a small working group to discuss possible model types to pursue and important data stratifications to include prior to the Data Workshop. It is recommended that further analyses be explored with the NMFS, SEFSC Caribbean SEAMAP Survey data once the missing US Virgin Islands samples have been computerized and the corrections to the weight type have been made for all species in the dataset. In addition, analyses should be done separately for St. Thomas/St. John vs. St. Croix and separately by gear. It is known also that a more complete fishery independent data set for Puerto Rico is maintained by the Puerto Rico, DNER. The latter data set is discussed in detail in section 5.2. Until the NMFS, Caribbean SEAMAP data set is up-dated to contain all of the Puerto Rico samples the Puerto Rico, DNER data set should be used since it is more complete (see section 5.2). It is noted that the missing SEAMAP data for the US Virgin Islands, discussed above has been computerized since the SEDAR8 Data Workshop. Preliminary review of the data indicated that only 95 catch observations of yellowtail snapper occurred from 1992-2002 (US Virgin Islands only) supporting the thought that this survey does not encounter yellowtail snapper frequently. Although the analyses conducted for the SEDAR8 DW could be further updated, it is not likely the new information would add significantly to the current information base for this particular dataset. SEDAR8-DW-Tables 23c and 23d provide a brief summary breakdown of the total number of stations sampled for each gear from the revised SEAMAP dataset for the US Virgin Islands. About 15% of the total sampling effort included hook and line samples over the period of the surveys, 1992-2002.

5.2 SEAMAP Puerto Rico

Department of Natural and Environmental Resources (DNER) Reef Fish Surveys, Puerto Rico, Mayaguez Laboratory

> The Puerto Rico Department of Natural and Environmental Resources (DNER) has been conducting fishery independent sampling of reef fish since 1988

5.2.1 Methods, Gears, and Coverage.

As with the NMFS, SEFSC, Caribbean SEAMAP Survey, the Puerto Rico DNER fishery independent survey is restricted to the west coast of Puerto Rico and in-fact sampling appears to be clustered around certain areas frequently those where spawning aggregations of a particular species can be found (e.g., red hind). The sampling gears used include hook and line (three lines each with three hooks per fisher) baited with squid and fish traps baited with sardines. During the earlier surveys, fish traps were constructed of a 1.25 inch hexagonal wire mesh, while during the later years, the traps were constructed of a 1.5 inch vinyl coated wire square mesh. Identical to SEAMAP protocol, sampling effort is distributed over a predefined grid. Within each 2 x 2 mile grid cell or quadrant, sub-quadrants (0.5 x 0.5 mi.) are used as sampling units and referred to as stations. Each station is located by GPS and stratified by depth. A research vessel sampling the station sets at least 12 fish traps; three traps set per string. A distance of 150 ft. is maintained between any adjacent traps to avoid interference. Traps are generally soaked for five to six hours. While traps are soaking, three fishers actively fish three lines each with three hooks for four to five hours. The following data are recorded: date, time, fishing location (latitude and longitude), depth, number of hooks fished, traps set and number of the trap in the set, and fish weight, length, species and sex (Rosario et. al. 2004).

5.2.2 Sampling Intensity –

Sampling intensity was variable from one year to the next with the number of survey days ranging from 17 to 71 (hook and line) and 1 to 59 (trap) between 1988 and 2001 with wide variation in some years (SEDAR-8-DW-Table 26). Total annual sampling effort declined from over 700 pot hours to less 75 pot hours after 2000. Total annual sampling effort for hook and line gear declined from about 400 hours to about 100 hours after 2000. Sampling effort was highest in the late spring each year ranging from 350 to almost 700 hours per month (Saul and Rosario 2004, SEDAR-8-DW-13, Figure 4)

5.2.3 Catch Rates (CPUE)–

Red hind dominated the Puerto Rico DNER survey catch composition (40.8% by weight followed by coney (24.0%), sand tilefish (8.3%) and squirrelfish (3.6%) (SEDAR8-DW-13 Figure-35) The percentage that yellowtail snapper made up of the total catch across all years by number was very low (0.6%, n=244 individuals) in comparison to the other species caught (e.g., red hind, n=16,043).

For purposes of calculating CPUE, effort was defined as hours fished with either hook and line or traps. Catch was computed as the sum of the weight of the fish caught in grams. For comparisons, red hind, the most abundantly caught reef fish in weight or number, was included in graphs and discussions (Saul and Rosario 2004, SEDAR-8-DW-13). CPUE (in weight) for hook and line sampling for both species was significantly greater than the CPUE for fish traps (Saul and Rosario 20044, SEDAR-DW-13). Red hind and yellowtail snapper both show slight declines in CPUE for both traps and hook and line gear over time (SEDAR8-DW Figures-36 and 37). Since CPUE was not standardized in these calculations trap and hook and line CPUE are not directly comparable.

5.2.4 Size/Age Data.

The majority of the yellowtail snapper sampled in the DNER survey had fork lengths between 160 and 380 mm or about ages 2 to 9 (SEDAR-DW-13). Comparisons with length-at - maturity curves determined by Figuerola, Matos and Torres (1998) suggest that 49.6% of the yellowtail snappers caught during the survey were below the length at which fifty percent maturity is achieved. Further, 82.0% were less than 300 mm in fork length, the length at which the majority of individuals have reached maturity. Over the survey period, 1988 through 2001, the overall length of yellowtail sampled declined slightly (SEDAR8-DW-Figure 38). It is important to consider sample sizes when discussing trends in CPUE or size composition. Over the entire 15 year period, 1987-2001, only 94 yellowtail snapper were caught making it difficult to interpret trends with any degree of confidence.

5.2.5 Uncertainty and Measures of Precision.

Given the similarity that exists between the NMFS, SEFSC, Caribbean SEAMAP and Puerto Rico, DNER sampling programs, the issues presented by each data set are also similar. As with the SEAMAP data, there were a few changes in methodologies over time and subsequent analyses should consider these. Comprehensive documentation of calibration between gear types has not been found although one during the Data Workshop reference was made to a study of some type in the CFMC files (Garcia-Moliner, pers. comm). Information of that type is needed to address factors that could affect catch rates and size composition. The mesh size was changed from the original 1.25-inch hexagonal galvanized wire to a 1.5 square vinyl coated wire. A study conducted by Aida Rosario references the effects of the abrupt change in trap size and style on effort, and should be included in the further analysis of this data. In addition, the number of hook and line events were at times variable, particularly in the early years (1988-1991) and this variability must be accounted for by standardizing CPUE calculations. The spatial distribution of samples is also limited and not spread over a variety of habitats and similar to the NMFS, SEFSC, Caribbean SEAMAP survey appears to have targeted reef and aggregation sites.

It is recommended that future analyses of the Puerto Rico DNER survey data include traditional analysis of variance techniques to control for some of the methodological changes that have occurred in the survey period. In addition, analyses should consider incorporating auxiliary information in order to explain the variation in CPUE.

At this date, the Puerto Rico DNER fishery independent survey database is the most comprehensive available for Puerto Rico and analytical efforts should focus on this set of data since the NMFS, SEFSC, Caribbean SEAMAP dataset is incomplete. Once the information for St. Thomas/St. John is updated and included in the NMFS, SEFSC Caribbean SEAMAP dataset then analyses of those data should be conducted and contrasted with information obtained from the Puerto Rico DNER data set. Given the previous discussion regarding stock structure of yellowtail snapper the data from St. Croix should be analyzed separately from that of the Puerto Rico platform. It is important to maintain the information separately by island for St. Thomas/St. John so that regional differences can be investigated in future analyses.

It is also recommended that a working group be formed to evaluate the Puerto Rico, DNER sampling methodology in light of the effective sampling for all reef fish species in Puerto Rico. The preliminary analyses of the Puerto Rico, DNER survey data suggests that the current methodology is not sampling all species equally. In light of the fact that both the NMFS, SEAMAP and Puerto Rico DNER surveys are following a similar field protocol it is suggested that the principal investigators from each agency address this issue in relation to the overall objectives of each program.

5.3 Trap Impacts on Coral Reefs and Associated Habitats

(NOAA, NMFS SEFSC, Galveston Laboratory)

This project is being funded under the NOAA, Coral Reef Program through the SEFSC Galveston, Texas laboratory in partnership with Florida Marine Research Institute (FMRI), US Virgin Islands. DFW, and Univ. Puerto Rico-Mayagüez, SEFSC, Galveston. This project aims to assess the distribution of trap fishing and to quantify the incidence of damage to structural organisms in Puerto Rico, the US Virgin Island and the Florida Keys. A brief description of the program is found in Hill et al (unpublished).

5.3.1 Methods, Gear, Coverage

Both fish and lobster traps are included in the surveys. Depths surveyed are typically from the shoreline to 100 ft. (~30 m).

5.3.2 Sampling Intensity – Time Series.

Sampling began in 2002 with the goal of sampling areas frequently enough to detect seasonal variability in trap placement. To date three main areas have been surveyed: 1) Puerto Rico - seasonal surveys focused on La Parguera with transects covering 2,575 ha.(n=488 traps). and 2) US Virgin Islands – seasonal surveys surrounding St. Thomas and St. Croix) using transects covering 3200 ha. (n=527 traps); and 3) the Florida Keys with transects across 9,137 ha. (n=3,940 traps). Data covers 2-3 years in each area with a minimum target of 3 years of seasonal sampling. In addition to the quantification of damage and distribution of traps by habitat, catch composition is recorded for each trap.

5.3.3 Catch Rates – Number and Biomass.

At this time data on catch rates of yellowtail snapper are not available, although their numbers are not expected to be high.

5.3.4 Size/Age Data.

At this time data on size/age of yellowtail snapper are not available.

5.3.5 Uncertainty and Measures of Precision.

Data are currently being converted from spreadsheets to a standardized database. Because of the emphasis on trap damage, entry of catch composition data has lagged behind distributional data. Data entry should be completed by about May 2005.

5.4 Coral Reef Ecosystem Studies (CRES)

A five-year project through Univ. of Puerto Rico (Mayagüez) has been conducting coordinated research to investigate causes of reef ecosystem degradation. Permanent benthic transects (benthic composition and fish assemblages) and randomly stratified transects are surveyed in La Parguera, Culebra, and around St. John. The study includes visual census surveys, benthic surveys, recruitment, spawning and diseases surveys; all associated with the reef ecosystem and detecting causes of degradation.

5.4.1 Methods, Gear, and Coverage

The study covers the insular platform from coast to shelf at La Parguera, southwestern Puerto Rico, as well a variety of sites at Culebra and around St. John. In each location, permanent transects have been established, primarily in for reef zones. Benthic surveys and surveys of reef fish assemblages are conducted regularly.

5.4.2 Sampling Intensity – Time Series.

The study began in 2001 and is to span a period of five years with consideration for future work if alternate funding if possible. Transects are surveyed on a monthly basis throughout the year.

5.4.3 Catch Rates – Number and Biomass.

Data has been received from NCCOS, a partner in the CRES project and information on catch and size is currently being evaluated.

5.4.4 Size/Age Data.

A preliminary graph of the observed size distribution of shows variation in the sizes sampled over time with the majority of fish falling in the 10-25 cm FL size classes (SEDAR8 DW-Figure 39).

5.4.5 Uncertainty and Measures of Precision.

As with any visual census technique, results are influenced by the training of divers involved in addition to a whole suite of other factors. These factors include: light levels, water clarity, currents, fish species diversity and densities, substrate complexity, diver familiarity with the fishes, and number and size of the sampling units (see Tests of accuracy in other visual census projects have demonstrated that reliable estimates of abundance and length can be obtained by these techniques. Variation between divers has also been cited, however, precision between can also be improved with adequate training. Binning size estimates has also been shown to reduce variability between observers.

5.5 NOAA, Oceans Biogeography Program Caribbean Surveys

This project, "Caribbean Reef Fish Biogeography: Linking Fish Distributions to Benthic Habitats in a GIS to Support the Implementations and Assessment of Marine Protected Areas," funded under the NOAA Coral Reef Program works in collaboration with the University of Puerto Rico, the National Park Service, the US Geological Service, the US Virgin Islands, DFW, and the Reef Fish Environmental Network Program (REEF).. The goals are: (1) to spatially characterize the distribution, abundance, and size of both reef fishes and conch, (2) to relate this information to *in-situ* data collected on associated habitat parameters, (3) to use this information to establish the knowledge base necessary for enacting management decisions in a spatial setting and to establish the efficacy of those management decisions.

5.5.1 Methods, Gear, and Coverage.

Using ArcView Geographical Information System (GIS) analytical software, benthic habitats are stratified using the near shore benthic habitats maps (<100 ft depth) created by NOAA's Biogeography Program in 2001 and NOS' bathymetry models. Sites are randomly selected within these strata. At each site, fish, conch, and associated habitat information is then quantified via visual survey techniques. All fishes are surveyed visually, identified to the lowest taxa possible, and binned into 5 cm-size classes.. These protocols are standardized throughout the sample sites in Puerto Rico to enable quantification and comparison of reef fish abundance and distribution trends between locations. Early work included gill-netting, gut-content analysis, and otolith ageing for a number of species.

5.5.2 Sampling Intensity – Time Series.

The Center for Coastal Monitoring and Assessment's Biogeography Program (BP) began sampling in August 2000, in the US Virgin Islands (St. Croix and St. John) and Puerto Rico (La Parguera). Each location is sampled 1-3 times per year. To date, almost 2000 fish surveys have been conducted in the US Caribbean: 725 in Puerto Rico, 653 in St. Croix, and 512 in St. John. Fiscal Year (FY) sampling 2004 efforts have resulted in the development of a web accessible database for data entry and access.

5.5.3 Catch Rates – Number and Biomass

Number of fish species observed is >250. In the approximately 2,000 surveys, 1,640 yellowtail snapper have been recorded ranging from 0-5 cm size class to 60 cm in length. The abundances and biomass vary by location and season (SEDAR8-DW Figures 40 and Figure 41).

5.5.4 Size/Age Data.

Data on size and abundance of fish recorded have been received from NOAA, Oceans and are being evaluated.

5.5.5 Uncertainty and Measures of Precision.

As with any visual census technique, results are influenced by the training of the divers and many other factors listed earlier (section 5.4.5) researchers involved. Tests of accuracy in other visual census projects have demonstrated that reliable estimates of abundance and length can be obtained by these techniques. Variation between researchers has also been cited, however, precision between researchers can also be improved with adequate training. Binning size estimates has been shown to reduce variability between observers although it also reduces the amount of detail of resolution available for analysis.

5.6 Shallow-water surveys of adjacent habitats (SEFSC-Galveston).

This project, funded through the NOAA, Coral Reef Program, examined the reef fish assemblages found in shallow water habitats with particular focus on juvenile life stages.

5.6.1 Methods, Gear and Coverage.

Paired visual transects and lift nets were used to compare densities of fish and invertebrates in shallow water habitats around St. John, US Virgin Islands. Transects 30 x 2 m were visually surveyed. All fish, lobster, conch and *Diadema* found within transects were enumerated and lengths were visually estimated. Transects were mapped *in situ* for GIS analysis of species-habitat associations. Juvenile yellowtail snapper were found in low densities in lift nets and medium densities (i.e., < xx fish) in visual surveys in seagrass and mangroves.

5.6.2 Sampling Intensity – Time Series.

Surveys were conducted across 2 years in seagrass, sand, coral rubble or patch reefs, and mangrove edge.

5.6.3 Catch Rates – Number and Biomass

Data on catch rates of yellowtail snapper can be made available (Feb 2005) although the numbers are few and the time series is short.

5.6.4 Size/Age Data

Data on sizes of yellowtail snappers can be made available (Feb 2005) although the numbers are few and the time series is short.

5.6.5 Uncertainty and Measures of Precision

As with any visual census technique, results are influenced by the training of researchers involved. Tests of accuracy in other visual census projects have demonstrated that reliable estimates of abundance and length can be obtained by these techniques. Variation between researchers has also been cited, however, precision between researchers can also be improved with adequate training. To date all fish surveys have been performed by one researcher to maintain consistency.

5.7 Monitoring Reef Ecology

Project : Monitoring Reef Ecology, Coral Disease, and the Fortuna Reefer Coral Restoration in western and southwestern Puerto Rico (SEFSC-Galveston, NMFS OHC, University of Puerto Rico-Mayagüez)

This project is a coordinated effort to study the health of coral reefs and the abundance of fish assemblages, including spiny lobster and conch, across a gradient of anthropogenic impacts. Recent surveys in July 2004 identified a yellowtail aggregation, of unknown purpose, composed of several hundred adult fish. The occurrence is more unusual since yellowtail snapper are not typically seen in abundance in our fish surveys. Future trips will be planned to coincide with the time of year and moon experienced at that time.

5.7.1 Methods, Gears, and Coverage.

Modified AGRRA methods (30 x 2 m belt transects) are used to assess coral and fish communities. Benthic transect surveys for coral cover and incidence of coral disease are run. In the same area, fish transects enumerate and estimate sizes of all fish encountered. Recent surveys have also utilized the point count method of Bohnsack and Bannerot (1987) for improved inter-regional comparisons.

5.7.2 Sampling Intensity – Time Series

Benthic transect surveys (coral cover and incidence of disease) and fish surveys (30 x 2 m transects and cylindrical point counts) have been conducted off La Parguera, Desecheo, and Mona Island 2x to 3x a year. Surveys were conducted, sparsely, incorporating Earthwatch volunteers, from 1998 to 2000 years and more intensively under the NOAA Coral Reef Program since 2001.

5.7.3 Catch Rates – Number and Biomass

Fish surveys have included yellowtail snapper, lobster, and conch. Data is stored in Excel spreadsheets, while current in the process of converting them to an Access database. Sampling is planned to continue into the near future, dependent on funding.

Data on catch rates of yellowtail snapper can be made available (Mar 2005) although the numbers are few and the time series is short.

5.7.4 Size/Age Data

Data on sizes of yellowtail snapper sampled can be made available (Mar 2005) although the numbers are few and the time series is short.

5.7.5 Uncertainty and Measures of Precision

The spatial extent of the sampling is somewhat limited, covering areas only on the west and southwest of Puerto Rico, however, the information gathered over time should be useful in looking at trends in abundance and size distributions. As with any visual census technique, results are influenced by the training of researchers involved. Tests of accuracy in other visual census projects have demonstrated that reliable estimates of abundance and length can be obtained by these techniques. Variation between researchers has also been cited, however, precision between researchers can also be improved with adequate training.

5.8 Modeling the Effectiveness of Marine Reserves

NMFS, SEFSC, Galveston Laboratory in collaboration with the National Park Service (NPS) and various collaborators monitor the reef fish populations around the Virgin Islands National Park on St. John. Information is taken from Beets and Friedlander (2003, (SEDAR8-DW-17).

5.8.1 Methods, Gear, Coverage

Sampling has targeted reef sites with relatively high levels of live coral cover and topographic complexity in the 3-45 ft (1-15 m) depth range. Sample points include 18 reef sites around St. John. Point count and plot count surveys have been conducted in which all fish species within a prescribed cylinder are identified, enumerated, and sized Beets and Friedlander (2003, SEDAR-8-DW-17).

5.8.2 Sampling Intensity – Time Series

Sampling was begun in 1989 and continued relatively continuously, until 2000 with similar studies being continued to the present time. Annual sampling was conducted at 16 of the reef sites circumscribing St. John and monthly sampling was conducted at two of the sites on the south coast of St. John. Community statistics based on the data are reported for the total fish assemblages; trends in frequency of occurrence, abundance, and mean size are reported for some key species. Abundance trends for trophic groups and for some reef fish families are also reported in Beets and Friedlander (2004, SEDAR-8-DW-17). While yellowtail snapper were encountered in these surveys, data specific to the species was not reported in the report.

5.8.3 Catch Rates – Number and Biomass

A total of 211 species from 55 families were observed during 1,764 visual censuses conducted from 1989 to 2000 around the island of St. John (SEDAR-8-DW-17). Data has been requested for yellowtail snapper from the authors.

5.8.4 Size/Age Data

Data has been requested for yellowtail snapper from the authors.

5.8.5 Uncertainty and Measures of Precision

Spatially, the sampling is limited to St John, an area likely to experience fishing pressure different from other US Virgin Islands or to Puerto Rico, however, the information gathered over time should be useful in looking at trends in abundance and size distributions. As with any visual census technique, results are influenced by the training of researchers involved. Tests of accuracy in other visual census projects have demonstrated that reliable estimates of abundance and length can be obtained by these techniques. Variation between researchers has also been cited, however, variation between methods and between researchers was part of this report. At least two of the researchers were the same throughout the entire study.

5.9 Coral Reef Monitoring in St. Croix and St. Thomas, United States Virgin Islands

A cooperative monitoring project was initiated under the NOAA, Coral Reef Program in 2000. Under grant funding, the Univ. of the Virgin Islands (R. Nemeth) and the US Virgin Islands, DFW (W Toller) have collaborated to examine the reef fish communities in specific parts of the US Virgin Islands (SEDAR-8-DW xxx).

5.9.1 Methods, Gears, and Coverage.

Benthic assessment evaluate habitat characteristics such as coral abundance and coral cover. Both belt transects (30 x 2 m) and point counts (prior to 2003) have been used to quantify fish assemblages. In 2003 belt transects, recording fish species, abundances and size estimates, were paired with roving diver surveys, useful for frequency of occurrence and identification of species not found in transects, as a revised standard technique.

5.9.2 Sampling Intensity – Time Series

Sampling has occurred over four years and is continuing. Sampling frequency is being analyzed.

5.9.3 Catch Rates – Number and Biomass

Total numbers of fish sampled have been reported in annual reports (e.g., 25,473 fish representing 101 species in 2003 in St. Croix). Numbers and biomass of yellowtail snapper can be deduced from report appendices but may not be complete. Numbers are not high although clarification has been requested from the principal investigators (PI’s) (R. Nemeth).

5.9.4 Size/Age Data

Size distribution data has been requested from the PI (Nemeth).

5.9.5 Uncertainty and Measures of Precision

As with any visual census technique, results are influenced by the training of researchers involved. Tests of accuracy in other visual census projects have demonstrated that reliable estimates of abundance and length can be obtained by these techniques. Variation between researchers has also been cited, however, precision between researchers can also be improved with adequate training.

5.10 Modeling the Effectiveness of Marine Reserves

A cooperative monitoring project was initiated under the NOAA Coral Reef Program in 2000. Under grant funding, the University of Puerto Rico-Mayagüez (R. Garcia) was contracted by PR DNER to examine the reef fish communities and coral reef ecology.

5.10.1 Methods, Gears, and Coverage.

This work is a quantitative and qualitative baseline survey of the sessile-benthic and fish communities associated with coral reefs and seagrass habitats located in areas outside the U.S. shooting range in Isla de Vieques, including characterization of marine habitats within the Isla de Vieques Natural Reserve. On the west coast it focuses on baseline characterizations of the Tres Palmas Reef in Rincon, (now an MPA), shallow (10 m/33 ft) and deep (30-40 m/100-140 ft) zones of the Tourmaline Reef off the Mayagüez shelf, and shallow (20 m) and deep zones (30-40 m/100-140 ft) off Desecheo Island.

Reef sections of optimal coral growth were selected. Five replicate transects were permanently established at each reef. Specific positioning of transects aimed to follow consistency in depth range and structural formation of the reef.

Quantitative assessments of sessile-benthic reef communities were obtained using a

modified chain-transect method and a video-transect technique for comparison and archival reference. Motile mega-benthic (larger than 1 cm) invertebrates (lobsters, crabs, echinoids, molluscs, etc.) and diurnal, non-cryptic fishes associated with reefs and seagrass habitats were surveyed using a belt-transect technique. Transects were 10 meters long by 3 meters wide (surface area = 30 m^2). We identified and enumerated fishes and mega-benthic invertebrates present within 1.5 meters along each side of the linear transects used for the reef benthic community surveys. This method provides the basis for analysis of relationships between substrate variables, such as sessile biological components (e.g. live coral cover) and ichthyofaunal/megabenthic invertebrates taxonomic composition, diversity, and abundance. A total of five (5) belt-transects were surveyed at each reef/seagrass station (total area = 150 m^2). Abundance data on motile mega-benthic invertebrates and fishes was reported as number of individuals per 30 m^2 (belt-transect area). Fishes and mega-benthic invertebrates observed outside belt-transect survey areas were recorded and included as supplemental ecological information from each station.

5.10.2 Sampling Intensity – Time Series

Sampling began in 2001. Samples from Vieques were taken between Feb and May 2001. Samples from the west coast of Puerto Rico spanned 2002 to 2004. Sampling frequency is being analyzed. At this time only single characterizations are available. It is expected that this monitoring program will continue into the future.

5.10.3 Catch Rates – Number and Biomass

Exact numbers can not be determined from the report that is available at this time. Yellowtail snapper, both adults and juveniles, were recorded from seagrass habitats and reef zones fairly commonly. At the west coast sites, yellowtail snapper were rare.

5.10.4 Size/Age Data

Size distribution data should be requested from the PI (Garcia).

5.10.5 Uncertainty and Measures of Precision

As with any visual census technique, results are influenced by the training of researchers involved. Tests of accuracy in other visual census projects have demonstrated that reliable estimates of abundance and length can be obtained by these techniques. Variation between researchers has also been cited, however, precision between researchers can also be improved with adequate training.

5.11 Modeling the Effectiveness of Marine Reserves (SEFSC-Galveston)

While not a direct sampling project, this effort is contributing to the data management in the U.S. Caribbean. This project is developing a series of Ecopath-based trophic models to examine marine reserve dynamics in Puerto Rico. Part of the output will be general models for the USVI and for Puerto Rico. These models should incorporate current and historical data from both fishery-independent and fishery-dependent sources. These models will be presented to the Caribbean Fishery Management Council for consideration in their efforts to move from single-species management to more ecosystem-based fishery management. A part of the model development and planned simulation is a comprehensive data assessment, and incorporation of historical survey data covering the US Caribbean. Findings from the model development will be available for management and assessment purposes.

5.12 General summary and Research Recommendations

SEDAR8-DW-Table 27 provides an overall summary of the fishery independent initiatives ongoing in the Caribbean that may directly applicable to the yellowtail snapper populations being considered by the SEDAR8. It is recommended that the SEDAR8 Panel further consider these programs as to the importance of each program for the yellowtail snapper.

6. Socio-Economic Considerations

The paucity of socio-economic information continues to hinder the development of integrated biological, economic, and social assessments. To address this deficiency a number of steps could be taken to mitigate this situation. First, Memorandum of Understanding with the Territory and Commonwealth to obtain permit files on annual basis (or every four years in the case of Puerto Rico). Up to date license databases would aid in evaluating the impact of regulatory actions on anglers participation. In addition, the Commonwealth of Puerto Rico requires their anglers to have gear and species endorsements, which could further help to understand and predict targeting behavior and resource usage by various user groups. In USVI, the permit information is housed in the Enforcement Division in the Department of Planning and Natural Resources. In Puerto Rico, the 'Division de Permisos y Licencias' the permit information housed in the Department of Natural and Environmental Resources. Both USVI and Puerto Rico have this information in electronic form. This information should be readily available and integrated with the future licensing system, which will likely result for the limited entry proposal under consideration by the Caribbean Fishery Management Council. Another suggestion would be to consider collecting capital investment and fixed cost information (e.g., equipment and its value) during the license registration process. This information could be used to document the value of the gear and vessels in case of losses due to extreme weather conditions such as hurricanes. Another side benefit would be that future costs and earnings surveys less burdensome to the industry.

An additional suggestion would be to ensure that both angler's censuses and community profiles updates are collected on a regular basis to ensure that the Caribbean Fishery Management Council has the best scientific information to develop policies that foster the wellbeing and stability of fishing communities.

7. Major Workshop Recommendations

- Continue the updating and data correction checks ongoing for the US Virgin Islands commercial landings and Biostatistical data bases.
- Continue the data correction checks ongoing with the Puerto Rico commercial landings and bio-statistical data bases.
- Continue the analyses related to partitioning of US Virgin Islands bulk landings data into species groupings after the missing bio-statistical samples have been entered, proofed and agreed on by both US Virgin Islands DFW staff and NMFS, TIP staff.
- Work toward developing a species specific commercial landings sales ticket in the US Virgin Islands commercial fisheries.
- Work towards research to obtain bio-statistical samples in the US Virgin Islands and especially to improve much needed sampling in St. Thomas/St. John. Fisheries.
- Implement hard part biological sampling in US Virgin Island sand Puerto Rico.
- Work towards identifying the primary information needs regarding improving the ongoing fishery independent sampling initiatives for yellowtail snapper populations in the Caribbean.

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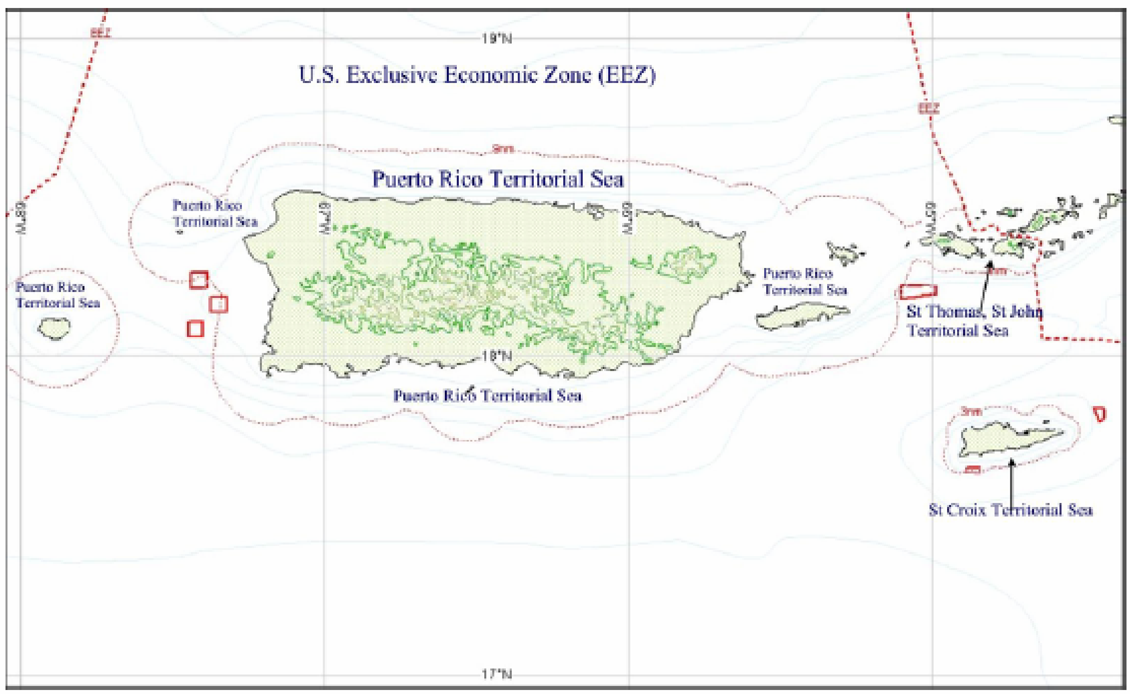
9. Appendices

9.1 Appendix A. Abbreviations and Acronyms

allowable biological catch (ABC)
advisory panel (AP)
biological opinion (BO)
biomass (B)
carapace length (CL)
catch (C)
catch per unit effort (CPUE)
Caribbean Fishery Management Council (CFMC)
Code of Federal Regulations (CFR)
draft environmental impact statement (DEIS)
Division of Fish and Wildlife – U.S. Virgin Islands (DFW)
Department of Natural and Environmental Resources–Puerto Rico (DNER)
Endangered Species Act (ESA)
environmental impact statement (EIS)
essential fish habitat (EFH)
exclusive economic zone (EEZ)
Federal Register (FR)
final environmental impact statement (FEIS)
fishery management plan (FMP)
fishery management unit (FMU)
fishing mortality (F)
fork length (FL)
habitat area of particular concern (HAPC)
highly migratory species (HMS)
Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)
Marine Mammal Protection Act (MMPA)
Marine Recreational Fisheries Statistical Survey (MRFSS)
maximum fishing mortality threshold (MFMT)
maximum sustainable yield (MSY)
minimum stock size threshold (MSST)
National Environmental Policy Act (NEPA
National Marine Fisheries Service (NOAA Fisheries)
National Marine Fisheries Service Southea Regional Office (SERO)
National Oceanic and Atmospheric Administration (NOAA)
national standard (NS)
national standard guideline (NSG)
natural mortality rate (M)
optimum yield (OY)
Paperwork Reduction Act (PRA)
Puerto Rico (PR)
Regulatory Flexibility Act (RFA)
regulatory impact review (RIR)
spawning potential ratio (SPR)
spawning stock biomass (SSB)
supplemental environmental impact statem (SEIS)
Sustainable Fisheries Act (SFA)
submerged aquatic vegetation (SAV)
total allowable catch (TAC)
total length (TL)
U.S. Virgin Islands (USVI)

9.2 Appendix B. Map of SEDAR8 Reference Area.

Source Graph: SEDAR4 DW Report, Carib-Figure 1. Map of Puerto Rico and the U.S. Virgin Islands, pg. 138.



9.3 Appendix C. Catch Report Fields

Fields contained in the different catch report forms used in the U.S. Virgin Islands between years 1974-2003. Source of Table: Taken from SEDAR4- Data Workshop Report (Carib-Table 12, pg 52.).

1	2	3	4	5
OLD FORM (1) (1974-1985)	OLD FORM (2) (1986-1999)	OLD FORM (3) (Short) (1988-1992)	OLD FORM (4) (1992-1999)	NEW FORM (Revised) (1994-2003)
1. ID#	1. LOCATION	1. ID CODE	1. ID CODE	1. GEAR TYPE
2. LAST NAME	2. FISHERMEN #	2. CLASS	2. FISHED (yes/no)	2. GEAR NO.
3. FIRST NAME	3. VESSEL #	3. ISLE: St. Croix	3. TRIP DATE	3. AREA FISHED
4. BOAT LICENSE	4. DATE	St. Thomas/ St. John	4. POT FISH	4. HOURS FISHED
5. FISHING LICENSE	5. POTFISH	4. TRIP DATE	5. POTS	5. GROUPED
6. DATE	6. NETFISH	5. FISH CODE:	6. HOOK FISH	6. SNAPPER
7. # OF HELPERS	7. HOOKFISH	Bait (B), Conch (C)	7. NET FISH	7. GRUNT
8. POT FISH SNAPPER GROUPER	8. SPEAR GUN	Finfish (S), Lobster (L),	8. SPEARGUN	8. JACK
9. POT FISH ALL OTHERS	9. POT LOBSTER	Whelk (W), Other(Z)	9. POT LOBSTER	9. SURGEON
10. NET FISH SNAPPER GROUPER	10. DIVED LOBSTER	6. GEAR CODE:	10. DIVED LOBSTER	10. PARROT
11. NET FISH ALL OTHERS	11. CONCH	Diving (D), Hook& Line (H)	11. CONCH	11. SHELLFISH
12. HOOK FISH SNAPPER GROUPER	12. WHELK	Net (N), Pot or trap (P).	12. WHELK	12. TRIGGER
13. HOOK FISH ALL OTHERS		7.NO. POTS	13. BAITFISH	13. BARRA
14. SPEAR/GUN FISH SNAPPER GROUPER		8. NO. SPEAR GUNS (S_G)	14. FISH AREA	14. GOAT
15. SPEAR/GUN FISH ALL OTHERS		9. NO. OTHER GEAR	15. DISTANCE FROM SHORE (> 3 miles)	15. MACKEREL
16. LOBSTER BY POT		10. FISH AREA	16. TUNA	16. OFFSHORE (D/T/W)
17. LOBSTER BY HAND			17. DORADO	17. FAD
18.OTHER KINDS CONCH, WHELK, OCTOPUS, SQUID, CLAM, OYSTERS			18. WAHOO	18. BAITFISH
19.AREA				19. LOBSTER
20. NOTES				20. CONCH MEAT
				21. WHELK MEAT
				22. DISTANCE FR LAND

SEDAR 8

Stock Assessment Report I

Caribbean Yellowtail Snapper

SECTION III. Assessment Workshop

SEDAR
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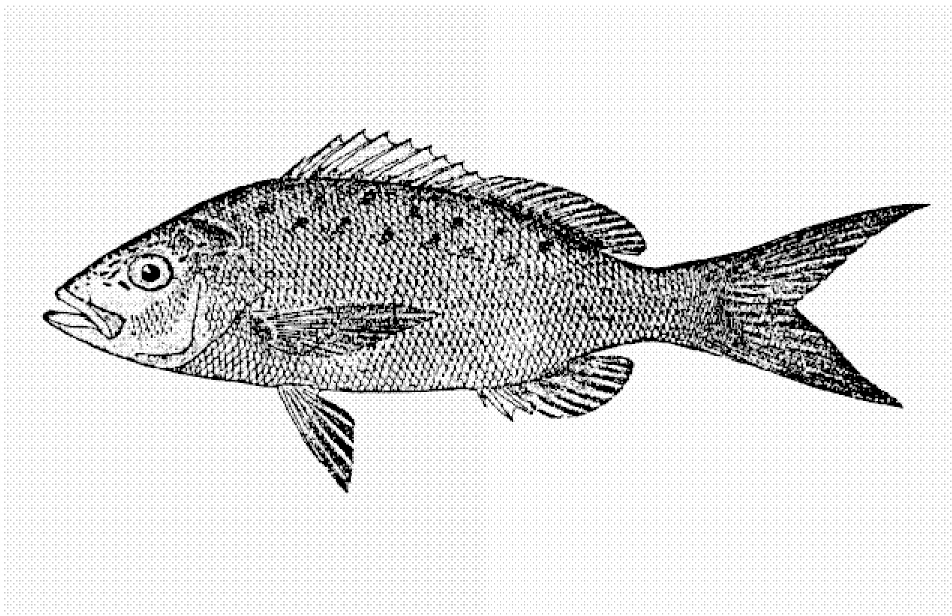
Charleston, SC 29414

Southeast Data, Assessment, and Review

SEDAR 8

Caribbean Yellowtail Snapper

Ocyurus chrysurus



SECTION III. Stock Assessment Workshop Report

Developed by the Assessment Workshop Panel

Edited by Joshua Sladek Nowlis, Southeast Fisheries Science Center, Miami, FL

March 2005

SEDAR

1 Southpark Circle #306

Charleston, SC 29414

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1 Introduction

1.1 Workshop Time and Place

The SEDAR 8 Assessment Workshop convened March 14–18, 2005, at the Divi Carina Bay Resort on St. Croix, US Virgin Islands.

1.2 Terms of Reference

1. Select several appropriate modeling approaches, based on available data sources, parameters and values required to manage the stock, and recommendations of the Data Workshop.

2. Develop and solve the chosen population models, incorporating data that are the best available, the most recent and up-to-date, and scientifically sound.

3. Provide measures of model performance, reliability, and goodness of fit.

4. Estimate values and provide tables of relevant stock parameters (abundance, biomass, fishery selectivity, stock-recruitment relationship, etc; by age and year; weights to be presented in pounds).

5. Consider sources of uncertainty related to input data, modeling approach, and model configuration. Provide appropriate and representative measures of precision for stock parameter estimates.

6. Provide Yield-per-Recruit and Stock-Recruitment analyses.

7. Provide complete SFA criteria: evaluate existing SFA benchmarks; estimate alternative SFA benchmarks if appropriate; estimate SFA benchmarks (MSY, Fmsy, Bmsy, MSST, and MFMT) if not previously estimated; develop stock control rules.

8. Provide declarations of stock status relative to SFA benchmarks: MSY, Fmsy, Bmsy, MSST, MFMT.

9. Estimate the Allowable Biological Catch (ABC) for each stock.

10. Estimate probable future stock conditions and develop rebuilding schedules if warranted; include estimates of generation time. Stock projections are to be prepared as follows:

    A) If stock is overfished:
    i. F=0, F=current, F=Fmsy, Ftarget (OY),
    ii. F=Frebuild (max that rebuild in allowed time)

    B) If stock is overfishing
    i. F=Fcurrent, F=Fmsy, F= Ftarget (OY)

C) If stock is neither overfished nor overfishing
   i. F=Fcurrent, F=Fmsy, F=Ftarget (OY)

11. Evaluate the impacts of current management actions, with emphasis on determining progress toward stated management goals.

12. Provide recommendations for future research and data collection (field and assessment); be as specific as possible in describing sampling design and sampling intensity.

13. Provide thorough justification for any deviations from recommendations of the Data Workshop or subsequent modification of data sources provided by the Data Workshop.

14. Fully document all activities: Draft Section III of the SEDAR Stock Assessment Report; Provide tables of estimated values; Prepare a first draft of the Advisory Report based on the Assessment Workshop's recommended base assessment run for consideration by the Review Panel. Reports are to be finalized within 5 weeks of the conclusion of the Assessment Workshop (Provided to Council and SEDAR Staff on April 22, 2005 for distribution to the Review Panel.)

1.3 List of Participants

SEDAR 8 Assessment Workshop Panel Members:

Juan Agar	SEFSC
Liz Brooks	SEFSC
Scott Chormanski	Univ. Miami, RSMAS/CUFER
Nancie Cummings	SEFSC
David Die	Univ. Miami, RSMAS/CUFER
Ron Hill	SEFSC
Walter Keithley	CFMC SSC/LSU
Daniel Matos	PR DNR
Jimmy Magner	CFMC Advisory Panel, St. Thomas
Josh Nowlis	SEFSC
David Olsen	St. Thomas Fishermans Assoc.
Francisco Pagan	Univ. Puerto Rico
Steven Saul	Univ. Miami, RSMAS/CUFER
Jerry Scott	SEFSC
William Tobias	USVI DFW
Roger Uwate	USVI DFW
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Observers

Tom Daly	St. Thomas Fishermen's Assoc.
Winston Ledee	St. Thomas Fishermen's Assoc.
Bob McAulffe	CFMC Advisory Panel, St. Croix
Julian Magras	St. Thomas Fishermen's Assoc.

Council Members

Barbara Kojis	CFMC

Support Staff

John Carmichael	SEDAR Coordinator
Tyree Davis	SEFSC IT
Graciela Garcia-Moliner	CFMC Staff
Cynthia Morant	SAFMC Administrative Assistant

1.4 List of Assessment Workshop Working Papers

Document No.	Manuscript Title	Author(s)
SEDAR8-AW-02	Preliminary analysis and standardized catch per unit effort indices for yellowtail snapper fishery independent data in Puerto Rico	Saul, S., G. Diaz, and A. Rosario
SEDAR8-AW-07	Preliminary information on the size composition of yellowtail snapper in the Puerto Rico commercial fisheries from 1983-2003.	Cummings, N.
SEDAR8-AW-08	Additional information on yellowtail snapper commercial catch size frequency samples: US Virgin Islands from 1983-2003	Cummings, N.
SEDAR8-AW-09	Caribbean yellowtail snapper yield per recruit	Cummings, N.
SEDAR8-AW-10	Catch-free assessment of Caribbean yellowtail snapper	Brooks, E.N.
SEDAR8-AW-11	US Virgin Islands commercial landings and biostatistical data recovery project	S. Saul

2 Data Issues and Deviations from Data Workshop Recommendations

Two data sets that were explored in the SEDAR 8 data workshop (SEDAR8-DW-Report) were further examined for the SEDAR 8 yellowtail snapper stock assessment workshop. These include the development of a standardized catch per unit effort-based abundance index from fishery independent sampling off Puerto Rico, and preliminary examination of size composition of yellowtail snapper sampled from commercial catches through the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Trip Interview Program (TIP).

2.1 Standardized Catch per Unit Effort from Puerto Rico Fishery Independent Sampling

An abundance index was developed by standardizing the catch per unit effort observed from fishery independent sampling off the southwestern coast of Puerto Rico (see Saul et al. SEDAR8-AW-02 for more detail). In sum, sampling was performed using fish traps and hook and line during the day. Yellowtail snapper were a fairly minor component of the fish sampled using either gear, contributing only 0.57 % (by weight) of the total catch across all years (Saul and Rosario, SEDAR8-DW-13).

Nominal catch per unit effort was calculated independently for each gear, using only sampling trips where yellowtail snapper were encountered. From these data, effort was computed as number of gear-hours and catches were computed as grams of yellowtail snapper (Table 1). Nominal CPUE from hook and line catches was fairly flat, except for a large spike up in 1992 and an absence of yellowtail snapper in 1998 samples (Fig. 1). These results were deemed inadequate because the sum total of yellowtail snapper caught in half the years was less than 1 kg and only exceeded 3 kg by a small amount in one year when a total of 8 fish were caught (Saul et al. SEDAR8-AW-02). Over the entire 13-year period (1988-2001) only 46 yellowtail snapper were captured using hook and line gear (Saul et al., SEDAR8-AW-02).

Though yellowtail snapper are believed to be more available to hook and line fishing than trap fishing, trap sampling proved more effective among fishery independent surveys. Roughly equivalent effort was expended using each sampling gear, and more than four times as many yellowtail snapper were caught using traps than hook and line (198 vs. 46). The frequency of catching yellowtail snapper per trap fishing trip varied among years, with a peak of nearly 50% of trips sampling yellowtail in 1989 and less than 5% sampling this species in 1994 and 1995 (Fig. 2). The largest variability in catch rate of yellowtail snapper between trap and hook and line occurred in the first two years of the survey 1988 and 1989, when the sampling survey was a pilot project for Puerto Rico’s Department of Natural and Environmental Resources (DNER) (Aida Rosario, personal communication, DNER).

Among trips that sampled yellowtail snapper, catch per unit effort varied among years (Table 1, Fig. 3). Note that the configuration of traps changed in 1994. Previously traps were constructed with a mesh size of 1.25 in. From 1994 onward, mesh size was changed to 1.5 inches. These positive trip data were used to construct a standardized index using a delta lognormal model (Lo et al. 1992). Parameterization was calculated using a generalized linear model (GLM) procedure (GENMOD; Version 8.02 of the SAS System for Windows 2000. SAS Institute Inc., Cary, NC, USA). GLM procedures were used to identify the significance of two factors, season (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec) and year, on the proportion of positive trips and catch rates on positive trips. Season parameters significantly improved the GLM, with peaks in CPUE occurring in the summer and winter. The year differences are presented in Table 1 and illustrated in Fig. 4.

We also examined the length distributions of yellowtail snapper sampled with each gear. The hook and line data again provided relatively little information because of small sample sizes (Fig. 5), although size composition did not appear to change over the time period (1988 to 2001). Trap sampling provided more samples (198 yellowtail snapper from traps over the study period vs. only 46 samples from hook and line). Size frequencies appear to have shifted up very slightly over the sampling timeframe although this change would be expected from the increase in mesh size used in the sampling gear starting in 1994 (Fig. 6), and so may not indicate any biological change.

2.2 Size Composition from Puerto Rico and Virgin Islands Trip Interview Programs

Since the mid 1980's samples of individual length and weight have been routinely collected from the Puerto Rico commercial fisherman landings. These collection programs have been supported by the Puerto Rico DNER Fisheries Statistics Program and also through ongoing state-federal cooperative statistical grants with the NMFS/SEFSC Miami Laboratory. For the most part the sampling protocol has followed that recommended by TIP, which aims to collect random samples of size from commercial fishing trips. Details regarding TIP sampling program are provided at the TIP website (http://www.sefsc.noaa.gov/tip.jsp). Sladek Nowlis (SEDAR8-DW-10) presented preliminary information on yellowtail snapper sampled in the US Virgin Islands commercial catches. Similar information for Puerto Rico is provided in this document for yellowtail snapper sampled in the Puerto Rico commercial fisheries.

Bennett (SEDAR8-DW-06, SEDAR8-DW-07) presented summary information regarding these data collections at the SEDAR 8 data workshop meeting held December 2004. During the workshop, participants addressed important concerns regarding missing data and the presence of outliers, the latter thought to be mainly from coding inconsistencies. Information presented in this report is preliminary and subject to change as edits of the Puerto Rico size frequency data are ongoing.

During the SEDAR8 assessment workshop, information on size frequency of yellowtail snapper from the Puerto Rico commercial fisheries was presented. Additional information on size frequency for yellowtail snapper in the US Virgin Islands commercial catches was also presented.

2.2.1 US Virgin Islands Commercial Size Frequency Samples

Annual distributions of yellowtail snapper sampled in TIP surveys of commercial fisheries of the US Virgin Islands are presented in Table 2 and Figures 7-11 for St. Croix, Figures 12 for St. John, and in Figures 13-14 for St. Thomas, by the major and minor gears used to harvest this species (hook and line, pots/traps, nets, dive gear, surface and bottom longlines, and seines) as identified in Cummings and Matos-Caraballo (SEDAR8-DW-Doc08). Note, however, that US Virgin Islands TIP data are incomplete and the subject of recovery efforts (SEDAR8-AW-11). Hook and line and pots/traps are the primary gears used to catch yellowtail snapper in the US Virgin Islands. Consequently, sampling fractions for these gears are higher (see Tables 3-5). Partitioning the samples by gear was considered important for purposes of evaluating gear selectivity at least on a crude level. In addition stratification of the available samples spatially was considered important as the quantity of landings varied spatially. Table 2 presents summary information on the number of samples and the mean size by year and major island area (St. Croix, St. John, and St. Thomas).

The summarized statistics indicate that during the 21-year time period, 1983-2003, sampling was extremely variable in all years, all islands, and within all gear strata. Overall, St. Croix was sampled most heavily, followed by St. Thomas. However, the US Virgin Islands have significant data gaps. On St. Thomas, sampling occurred during 1985-1987 and apparently was halted until 1992, continued for five years and stopped again. Tables 3-5 provide a similar breakdown for each island by major and minor gears. In both St. Thomas and St. John, sampling levels remained low throughout the 1990's and are non-existent today due to lack of funding. Low sampling efforts in those islands resulted in a great deal of regarding changes of size composition for yellowtail snapper fisheries on St. Thomas and St. John. Table 3 provides information for yellowtail snapper sampled on St. Croix. The basic summarized data indicate that trends in size composition may only be detectable for pots/traps fishing on St. Croix. Other gears were erratically sampled (e.g., nets have never been sampled well and lines only were in 1985, 1987, and 1988). The primary harvesting gear for yellowtail snapper on St. Croix is also hook and line and unfortunately pots/traps were sampled more often than were lines. This is to be expected given that pot fishing was more important overall, especially in the early sampling years, but is not conducive to gaining clear insight into the dynamics of the yellowtail snapper fishery.

It is suggested that the annual size composition summaries for St. Croix pot catches be further evaluated for changes in annual average size of yellowtail snapper. Given the historical sampling levels it is not likely that further stratification of the observations can be made (e.g., by time period – months, seasons or perhaps by intra island area). It is also suggested that these data be used as a guide by managers to hone future sampling by comparing historical sampling levels with landings levels, recognizing the need to balance effort across a wide range of important fishery species. It was further noted that additional biostatistical samples maybe forthcoming in the future that were previously collected by the US Virgin Islands DFW staff under contract with the NMFS/SEFSC Cooperative Statistics Program but which have not yet been processed. It is not know at this date how many additional samples this set of data will add to the overall database. Once these additional samples are processed it is recommended that the size composition analyses be revisited.

2.2.2 Puerto Rico Commercial Size Frequency Samples

Annual distributions of yellowtail snapper sampled from commercial fisheries of Puerto Rico are presented in Figure 15-18 by the major and minor gears used to harvest this species in Puerto Rico (hook and line, pots/traps, nets, dive gear, surface and bottom longlines, and seines) as identified in Cummings and Matos-Caraballo (SEDAR8-DW-Doc08).

Hook and line and pots/traps are the dominant gears for catching yellowtail snapper in Puerto Rico. Consequently, sampling fractions for these gears are higher. Partitioning the samples by gear was considered important for purposes of evaluating gear selectivity at least on a crude level. In addition stratification of the available samples spatially was considered important as the quantity of landings varied spatially. Table 6 presents summary information on the number of samples and the mean size by year and major area (north, east, south, and west coast as defined by Matos-Caraballo, 2002). Additional statistics (e.g., range, variance of the sample) are available from the author in addition to intra year summaries of samples (year- month, gear, region strata). This table indicates that during the 21-year time period, 1983-2003, all regions have been sampled in all years with the east region being the highest ranking, followed by the north, west and then south. Tables 7-10 provide a similar breakdown for each region by major and minor gears.

Sampling intensity was patchy across strata as defined by region and gear types. Many individual strata had no samples at all. Further examination of the landings by individual year, region, and gear is needed to identify suitable substitutions if determination of catch at size by year, gear, and region is needed. As a starting point it is recommended to use the pooled length compositions (across all regions) by gear to evaluate size composition changes by year and major gear for yellowtail snapper in Puerto Rico. In addition, the data (Table 11) suggest that sufficient samples exist may exist for only the hook and line, pot, and net strata and quite possibly only for island-wide summations as regional breakdowns of the data indicated many strata (i.e., year-fishing center-month-gear cells) without samples. Samples of yellowtail snapper from other gears (surface and bottom longlines, dive, net, and seines were present but for the most part were minor sources of removals for this species in Puerto Rico. The primary gears used to harvest yellowtail snapper in Puerto Rico are lines followed by pots and traps.

Further examination of the individual catch size composition samples is warranted. Examination of size distributions within each year could help determine whether pooling samples across season is justified. In addition, distributions within the minor gears should be examined to determine if pooling is supported across gears. These analyses should be done subsequent to the final editing of the data. It is noted that although all of the samples have been computerized that additional editing is needed to provide corrections to length units for some observations.

Table 11 provides an overview of the trends of yellowtail snapper sizes having been caught by the major and minor gears in Puerto Rico. The basic size composition data have not been raised to the total catch so these summaries represent unadjusted mean fork length. It is suggested that additional analyses be conducted to weight the individual size samples by the landings data in order to provide as accurate as possible information on size changes. In 1985, a federal size limit of 8 inches TL (6.5 inch FL) was implemented in 1985 with the regulation increasing by one inch each year till 12 inch TL (9 inches FL or 22.9 cm FL) was reached in 1989. Table 11 indicates the mean size of yellowtail snapper caught by the major gears (lines, Pots/traps) ranged from 25 cm FL to 32 cm FL over the time period. The overall unadjusted mean size has been above the minimum size (12 inches TL, 9 inches FL, 22.9 cm FL) in all years of the time series. Figuerola et al. (1998) reported that the 50% size of maturation for yellowtail snapper was 22.4 cm FL (males) and 25 cm FL (females). Table 6 indicates that some differences exist in mean size with region and suggests that further review of the size composition samples by region is warranted. Table 6 indicates that yellowtail snapper sampled on the south and the west coasts of Puerto Rico were smaller than in other regions in nearly all years. Further analyses are needed to identify the exact reasons for these observed differences (in mean length). It is suggested that within region, size composition samples be evaluated temporally and by gear. Figure 18 indicates that the unadjusted overall mean size of yellowtail snapper caught by lines has been about 30 cm FL (12 inch FL) since 2000 while the average size for pots/traps has been about 27 cm FL (10.6 inches FL) since 2000. These data also show that average sizes caught by pots/traps varied more than with line gear over the 21-year time period.

3 Stock Assessment Models and Results

There were many challenges in assessing yellowtail snapper in the US Caribbean, including the lack of species-specific catch reporting in the US Virgin Islands, little sampling of the size or species composition of catch, a complete lack of age-based sampling, and fishery independent sampling that is patchy in space and time. Consequently, we focused our efforts on simple models designed to make the most of limited data. Our main effort was an assessment model that was driven by abundance indices and did not rely on catch information. We also developed two independent production models, one for Puerto Rico (where catches were reported at the species level) and the other for St. Thomas/St. John (where catches were inferred at the species level and effort was obtained by interviewing fishermen attending the workshop). Finally, we used what size composition data was available from Puerto Rico to examine yield per recruit in the yellowtail snapper fishery there.

3.1 Catch-Free Assessment Model

3.1.1 Catch-Free Methods

3.1.1.1 Overview

Because data for yellowtail snapper populations in the Caribbean are sparse, a catch-free assessment model was constructed using the framework of Porch and colleagues (2004). This approach necessitated the development of hypothetical trends in historic fishing effort and stock depletion. The results should in no way be interpreted as representing true stock status; rather, they should serve to focus discussion on appropriate ways of dealing with the uncertainty or absence of fishery data and key biological parameters.

3.1.1.2 Data Sources

As noted in SEDAR8-AW-10, the catch-free model requires an assumption about a year when the stock could be considered to be in virgin conditions. The initial illustration of the model assumed virgin conditions in 1850, and the group accepted this date as reasonable. Data are not available until the 1980's or 1990's, depending on the indices included in the model. Consequently, assumptions were necessary about trends in effort and possible trends in population depletion from 1850 to 2003.

For example, one historic effort trend was developed from Kojis (2004), where three surveys of commercial fishing in the US Virgin Islands provided estimates of the total number of licensed fishers as well as the fraction that were full versus part-time. An attempt was made to partition this information between St. Croix and St. Thomas/St. John, to reflect the group's decision to model separately a St. Croix platform and a northern platform, which includes St. Thomas, St. John, and Puerto Rico. An estimate of relative effort was calculated by summing the number of full-time fishers and 0.5 times the number of part-time fishers. An exponential trend was fit to three points, corresponding to surveys conducted in 1932, 1970, and 2004, as reported in Kojis (2004). A straight line was plotted between 1850, where effort was assumed to be zero, and 1930, the first census point. These two platform-specific historic effort trends are shown in Figure 19.

During the assessment workshop, it was suggested that simply counting the number of fishers might underestimate true effort, because it would not reflect increases in gear quantity (more territory could be covered when a motor was used, so more traps could be employed by the same fisher) and efficiency (e.g., improvements in navigational aids, including GPS). A second index of relative effort was recommended, where the number of traps from the same three surveys was used to gauge the increase in effort over time (Table 62, Kojis 2004). The number of fish pots and lobster pots was summed, and then inflated to account for the fraction of fishers sampled.

No attempt was made to split this information to platform-specific values. As was done for the effort trend based on number of fishers, this second effort treatment was fit with an exponential trend between the three points, and a straight line from 1850 to 1930.

There was further discussion regarding the use of traps to track increases in fishing effort. The main point raised was that traps are not the primary gear in the yellowtail snapper fishery, and that the primary gear—hook and line—has not seen an increase in hooks used per person. An effort trend that included lobster pots, a relatively recent and recently expanded technique, would likely overestimate the recent overall effort directed at yellowtail snapper. A third possible effort trend was generated that was only based on the number of fish pots. Although yellowtail snapper are primarily caught using hook and line, it was reasoned that the capacity of vessels to carry fish pots would also be an indicator of the ability of individual vessels to catch fish. This effort trend might overestimate recent effort in that technological advances has allowed fishers to increase the number of traps they fish but may not have had an equivalent increase in their capacity to fish with a single hook and line. However, the increase might possibly be equivalent through increased ability to find fish and productive fishing grounds through enhanced navigation and greater mobility. The fish pot data suggested an increase in effort that fell between the number of fishers and the number of total traps (Figure 20).

It is important to emphasize that these effort trends were generated because the model requires some information to guide it in estimating population trends from virgin conditions until the time that data are available. These various effort treatments provide different pictures of the rate of increase in relative effort since 1930, but are not intended to assign cause or blame to a particular gear for the resulting model estimate of stock status. It is acknowledged that some of the gears used in deriving the effort trends do not target yellowtail snapper and may be less efficient than targeted gear (i.e., hook and line). However they were selected to represent overall effort trends. One alternative, which was not considered at the assessment workshop, would be to examine the US Virgin Islands statistics on the total number of licenses issued. This approach would be an improvement in terms of providing a more detailed picture of effort changes. However, it would suffer from three significant problems: it would at best be a crude measure of total fishing effort rather than of yellowtail snapper targeting, it would not include unlicensed fishers, and it would not capture increases in effective effort per fisher. Other suggestions included relating overall effort to external measures such as levels of tourism, island population, and general economic trends. There are likely other possible measures that were not discussed; however, given the wide range in effort trends for the three treatments considered, and the resulting wide range in stock status, it was agreed that these alternative approaches would not likely offer outcomes outside the bounds of the treatments considered.

An index of relative population decline (number of vulnerable fish) was created to reflect an assumption about the population level in 1930 as a fraction of virgin level. For illustration, a relative decline of 20% was assumed in SEDAR8-AW-10. During the assessment workshop, the group agreed that this was a reasonable value. However, in SEDAR8-AW-10 the group suggested that rather than carry that linear trend through to 2003, that it be truncated after 1975, when outboard motors came into more common use. This projected decline overlaps with the treatment of historic effort from 1930 to 1975. A sensitivity trial was made for each of the effort treatments by truncating the index of relative population decline in 1930 and letting the effort trend inform the model during the period 1930-2003.

For the northern platform, two abundance indices, both coming from the St. Thomas/St. John commercial fishery. One relied exclusively on the hook and line sector while the other examined both hook and line and fish traps. These spanned the years 1997-2003 and were used for six model runs. In developing these indices, we made a number of assumptions to separate yellowtail snapper from aggregated species landings. The accuracy of these species-specific landings may be low. In addition, it should be noted that the TIP sampling from the US Virgin Islands has been low in recent years (SEDAR8-DW-Report Table 15) due to a lack of funding, and that this database is incomplete and the subject of recovery efforts (SEDAR8-AW-11). The six model runs differed in the effort trend assumed and the time-span of the relative vulnerable population decline (either truncated in 1975 or 1930).

During the assessment workshop, a standardized index from Puerto Rico DNER SEAMAP trap sampling data was presented. This index and its concerns are discussed above, in particular the inefficiency of the SEAMAP survey methods at sampling yellowtail snapper and the incomplete spatial coverage. The group agreed that this index should be included as a sensitivity trial, in that it spanned an earlier time period (1988-2000). After the initial trials of all the models had been run, it was noted that two additional indices spanning a greater time period (1983-2003) were available from the Puerto Rico commercial fishery. These indices were discussed by Cummings and Matos (SEDAR8-DW-08). Inclusion of these additional indices was supported on the basis that they represented the entire fishery spatially and also that the Puerto Rico component dominates the landings of the total northern platform. Three further sensitivity runs were made that included these indices, in addition to the two already in the model. A full factorial set of runs was not made for models with these new indices. These three runs used either the effort trend based on number of fishers or number of total traps, with the index of relative population decline truncated in 1975, and one run where the effort was based on total traps and the index of relative population decline was truncated in 1930. Fits to the two indices based on lines and lines/traps as well as the indices included for sensitivity (SEAMAP or Puerto Rico commercial landings) are shown in Figure 21 for the case where effort was based on the number of fishers and the population decline index was truncated in 1975. Fits to the indices did not vary based on the assumed effort treatment or the year of truncation in the population decline index.

For the St. Croix platform, two abundance indices were used. Both came from commercial fishery landings reports during 1994-2003, and differed in that one focused only on hook and line gear while the other examined both hook and line and trap gear. During the assessment workshop, we discussed the merits of using a third index based on TIP surveys. TIP data were available from 1983-2003 but had very low sample sizes for nearly all years. However, the group thought that the fish trap sampling could possibly be used for the earliest years, when the sample size was somewhat greater (i.e., >30 samples per year). Thus, the index was constructed using trap samples from 1983-1987. Only four models were attempted for the St. Croix platform. The effort trend in all four models was based on the number of fishers, and used the index of relative population decline truncated in either 1975 or 1930. The two for the commercial fishery were included in all four models, and as sensitivity trials, the TIP index from 1983-1987 was included in addition to the commercial indices. Fig. 22 shows fits to the two commercial landings indices (lines and lines/traps), as well as the sensitivity trial that also included the TIP index, for the case where the population decline index was truncated in 1975. Fits to the indices were not sensitive to the year of truncation in the population decline index.

3.1.1.3 Model Configuration and Equations

As the name implies, this model framework was created to handle situations where total catch estimates are unavailable but indices of abundance do exist. Without information on catch, estimates of absolute levels of abundance cannot be derived from traditional fisheries population models. Instead, the model estimates population sizes relative to virgin levels, where the number of recruits under virgin conditions is one, and all older ages are calculated relative to that (full details in Porch et al. 2004).

The underlying population equations follow an age-structured production model, which requires information on natural mortality, maturity, fecundity, and spawning time. A spawner-recruit function, which is parameterized in terms of α (maximum reproductive rate; see Myers et al. 1999), must also be specified. The parameter α can be translated to steepness (h) by the relationship $h = \frac{\alpha}{\alpha + 4}$.

Historic information, anecdotal evidence, or informed opinions can provide guidance on the year that the stock was in a virgin state, y_{virgin}. The time series from y_{virgin} to the last year that data is available, y_{last_data}, is split into a historic and a modern period. The historic period reflects years where data are sparse, while the modern period would presumably have some indices of abundance and/or effort.

3.1.2 Catch-Free Results

Management benchmark estimates are provided in Table 12 for all models. For the northern platform, F_{MSY} estimates fell in the range of 0.29-0.33 and SSB_{MSY} , relative to virgin levels, ranged from 0.26-0.28. The point estimates for M and α did not stray from their initial condition except for the model where the Puerto Rico DNER SEAMAP index was included as a sensitivity trial. This index suggested a strong decline in abundance in the late 1980s, which led the model to estimate that the stock had greater resilience (slightly larger α) and could therefore be exploited slightly more (this model had the largest F_{MSY} of 0.33). For the St. Croix platform, the two commercial indices showed slight increases at the end of the series, prompting the model to predict a more resilient stock (α for models Nfishers and NfishersXb30 were 20-50% larger than the initial condition). When the TIP index was included, which showed a very strong decline in the early 1980s, the model responded by estimating even larger α values (point estimates for α were 2.4 to 2.6 times the initial condition). Excluding the runs with the TIP index, estimates for F_{MSY} and SSB_{MSY} for the St. Croix were similar to those for the northern platform.

The estimates of stock status for each platform model runs are summarized in a phase plot (Figures 23). The colors on the phase plot can be interpreted as follows: green suggests that the stock is in a healthy condition and no management action is needed; red suggests that the stock is in a depleted state and management actions need to be developed to rebuild the stock; orange suggests that the stock is approaching a condition where management actions may soon be required.

Both northern platform and St. Croix platform model runs suggest that the condition of the stock could lie anywhere from a very healthy condition to a very depleted state. The conclusion about stock status depends to a great extent on the treatment of historic effort. There was less sensitivity to the point of truncation in the index of relative population decline. Including the indices with earlier information in the model (Puerto Rico DNER SEAMAP in the case of the northern platform, and TIP in the case of the St. Croix platform) led to estimates of a more depleted stock, because both of these indices showed rather strong declines in the early part of their time-series. It should be noted that the effort series applied to the northern platform was estimated from St. Thomas/St. John data and does not include effort for the Puerto Rico fishery, which lands the majority of yellowtail snapper. As such, these estimates should be treated as especially uncertain.

There is currently no basis on which to select one model over another for either platform, and no conclusion about the real condition of the stock can be made at this assessment workshop.

3.2 A Stock-Production Model Incorporating Covariates (ASPIC)

An ASPIC model (NOAA Fisheries Toolbox Version 2.5, 2004, http://nft.nefsc.noaa.gov) was explored using data from Puerto Rico and St. Thomas/St. John. St. Croix was not pursued because catch and effort data were limited to recent years (1994-2003).

A Stock Production Model Incorporating Covariates (ASPIC) is a non-equilibrium implementation of the well-known surplus production model of Schaefer (1954, 1957). ASPIC also allows one to run models with other stock-recruitment relationships along the continuum identified by Pella and Tomlinson (1969). More details can be found in Prager (1994). Both of these ASPIC models were conditioned on catch, forcing the model to match the catch inputs while estimating the abundance-related parameters (i.e., effort, CPUE).

3.2.1 Puerto Rico ASPIC Methods

3.2.1.1 Data Sources

The Puerto Rico model relied on two data series, one for the commercial line fishery and another for the commercial trap fishery, both of which spanned from 1983-2002. The data came from Cummings and Matos-Caraballo (SEDAR8 DW-08). The line fishery was characterized by increasing landings over the time period and catch per unit effort that generally increased with the exception of a large spike in 1984. The influence of this spike was explored by including some model runs without this data point. The trap fishery was characterized by declining landings in the early years of the series, which gradually increased in later years. Catch per unit effort was relatively flat but showed the same 1984 spike as the line fishing series (Figs. 24, 25).

3.2.1.2 Model Configuration and Equations

A base model was configured using a logistic stock-recruitment relationship, equal weighting of indices, and initial parameter estimates as follows: initial biomass relative to unfished abundance = 0.5 (i.e., MSY level), MSY of 300,000 (slightly less than the maximum observed catch) with a range of 100,000 to 500,000, carrying capacity of 3,000,000 with a range of 1,000,000 to 5,000,000, and catchability coefficients for the line and trap fleets of 0.01 and 0.003, respectively.

3.2.1.3 Parameters Estimated

ASPIC estimates surplus production parameters (carrying capacity, intrinsic population growth rate) and biomass trajectories over the course of the time period modeled. These parameters are then combined to determine other useful benchmarks, such as MSY-related biomass and fishing mortality rates, and fishing mortality rate trajectories.

3.2.1.4 Uncertainty and Measures of Precision

We explored uncertainties in the ASPIC models in two main steps. First, we checked for sensitivities to the starting point of the fitting procedure by varying those initial estimates. Then, we examined sensitivity to one or more key parameter.

3.2.2 Puerto Rico ASPIC Results

The base model converged on a solution with abundance that started at slightly above MSY levels in 1983, increased initially and then dropped, ending a bit above its starting level. Fishing mortality rates always remained below MSY levels dropping initially to about 10% of F_{MSY} early on and then gradually increasing to about 60% of F_{MSY} (Fig. 26).

However, these results were highly sensitive to the starting points used in estimating several parameters, including initial abundance, maximum sustainable yields (MSY), and carrying capacity. If initial abundance estimates were manipulated down to 10% of carrying capacity (20% of MSY) or up to 90% of carrying capacity (180% of MSY), the model converged on a result suggesting a fishery at low abundance and experiencing high fishing mortality rates (Fig. 27). Similar results were obtained if the initial estimate of MSY was changed to 200,000 or if carrying capacity was changed to 1,500,000 with a range of 500,000 to 2,500,000 (Fig. 27).

From these extreme sensitivities, one can conclude that the model is not being informed well by the data. One likely problem is the spike in CPUE in 1984 in both fishing fleets. Explaining such a dramatic spike in a production model would require tremendous productivity followed by extraordinary fishing pressure, but the fishing pressure aspect is not consistent with the landings from that time.

Indeed, when the model was run with the 1984 CPUE data point excluded, results were far more consistent, varying only slightly under different starting estimates for various parameters (Fig. 28). Results did vary, though, when the shape of the assumed stock-recruitment curve was changed from the Schaefer-logistic form to the Gompertz-Fox form. In either case, though, the model suggested the Puerto Rico yellowtail snapper sub-stock is experiencing excessive fishing rates and has been depleted to 15% or less of MSY levels. In the base case, the current biomass ratio (B/B_{MSY}) is estimated to be 0.135, while the current fishing mortality rate ratio (F/F_{MSY}) is estimated to be 4.05.

3.2.3 St. Thomas/St. John ASPIC Methods

3.2.3.1 Data Sources

Representatives of the St. Thomas/St. John fishing community developed a hook and line fishing effort index at the assessment workshop. As such, these data were not available for review at the SEDAR 8 data workshop but was discussed at the assessment workshop instead. The fishers identified the number of commercial fishers who fished hook and line each year, including consideration of partial year disruptions such as hurricanes. Their effort series is presented in Table 13. Catches were more complicated. Substantial questions were raised about the validity of quantifying landings of yellowtail snapper in the US Virgin Islands at the data workshop (SEDAR8-DW-Report). These included aggregated landings by gear type, small numbers of biostatistical samples, and ongoing data proofing efforts. Nonetheless, an approximation of yellowtail snapper catches was produced for the US Virgin Islands from 1983 to present (SEDAR8-DW-Report, Table 14). These estimates were derived using catch composition as indicated by TIP samples (2004, SEDAR4-DW-Report), and missing values were filled using averages of adjacent years. With awareness of the potential inaccuracies in this data series, it was nonetheless used in the surplus production model. From these data, it was assumed that St. Thomas/St. John made up 90% of total Virgin Islands catches. This assumption was necessary because St. Croix was included in the total landings but was not within the geographic scope of this model. Additionally, reported catches in 2003 were doubled since the data came from only half the year. These data were used to construct a catch per unit effort index (Table 13, Fig. 29).

3.2.3.2 Model Configuration and Equations

A base model was configured using a logistic stock-recruitment relationship and initial parameter estimates as follows: initial biomass relative to unfished abundance = 0.5 (i.e., MSY level), MSY of 50,000 (slightly less than the maximum observed catch) with a range of 20,000 to 80,000, carrying capacity of 500,000 with a range of 200,000 to 800,000, and catchability coefficients for the line fleet of 0.01.

3.2.4 St. Thomas/St. John ASPIC Results

The base model converged on a solution with abundance that started in 1983 well below MSY levels and slowly increased over the model run. Fishing mortality rates always remained above MSY levels, mostly fluctuating between just over F_{MSY} to about 75% above this value (Fig. 30).

These results were not very sensitive to the starting points used in estimating several parameters, including initial abundance, maximum sustainable yields (MSY), and carrying capacity. Changes in initial abundance estimates and MSY levels only changed the results very slightly (Fig. 31). The model was highly sensitive, nonetheless, to assumptions about the shape of the stock-recruitment curve. When a Gompertz-Fox model was fit, the results were dramatically different from the Schaefer-logistic model described above (Fig. 31). Instead of an overfished fishery experiencing overfishing, the Gompertz-Fox model would suggest a healthy fish stock experiencing little fishing pressure. One can compare these models using their objective function scores, although better still to select the best fit across a reasonable range of shape parameter values (which was not completed prior to the workshop due to time constraints). The

Schaefer-logistic model shows a better fit to the data (objective functions: S-L 1.3, G-F 3.82—smaller numbers indicate better fits). However, the uncertainty surrounding these models renders such conclusions to be weak at best.

4 Model Comparisons

Essentially five models were compared: four catch-free models for St. Thomas/St. John, St. Thomas/St. John/Puerto Rico and St. Croix, and a single ASPIC surplus production models for Puerto Rico and St. Thomas/St. John. Results varied among the models and within a model depending on how it was formulated.

For St. Thomas/St. John yellowtail snapper, the catch-free model estimated fishing mortality ratios that varied between 0.78 and 2.11 of F_{MSY}, while the ASPIC model estimated ratios between 0.04 and 1.89 of F_{MSY}. These models estimated biomass ratios between 0.27 and 1.37, and 0.32 and 2.61, respectively, of B_{MSY}. These comparisons highlight that the surplus production models, which relied on catch data, were a bit more optimistic than the catch-free models, which did not rely on catch data but did take into account size structure. Neither is a very satisfying model, though, because of the sensitivities to data inputs, especially considering the many uncertainties in those inputs (e.g., growth information has not been updated, catches are poorly specified, biological parameters, such as steepness or α and natural mortality, are poorly understood).

For Puerto Rico, we ran a catch-free model that combined data from this island and the northern US Virgin Islands. It estimated fishing mortality ratios between 0.81 and 1.24 of F_{MSY} and biomass ratios between 0.59 and 1.24 of B_{MSY}. The Puerto Rico-only ASPIC surplus production model estimated fishing mortality and biomass ratios, respectively, between 4.05 and 32, and between 0 and 0.13. In this case, the surplus production models were more pessimistic and could be influenced by the fact that this model only examined Puerto Rican data whereas the catch-free model used data from Puerto Rico, St. Thomas, and St. John. Finally, the catch-free St. Croix model estimated fishing mortality ratios between 0 and 2.22, and biomass ratios between 0.14 and 3.56. In most cases, the ranges of possible data treatments make definitive conclusions about stock status difficult.

Since definitive conclusions for the US Virgin Islands may not be possible at this time, it is recommended that future efforts focus on the potential impacts of current fishing practices. For example, size frequencies should be monitored to insure compliance with minimum size regulations. An attempt should be made to determine whether the minimum size regulation leads to substantial misreporting or discards, and what a plausible range of discard mortality might be. Such efforts will require that a more stable funding source is identified for US Virgin Islands TIP data collection. The risk associated with this and other uncertainties can also be addressed through the enactment of risk-averse management strategies. Since risk minimization will surely have associated costs, any such future efforts should also identify and specify these costs to facilitate reasoned balance of various trade-offs.

5 Population Modeling

5.1 Yield Per Recruit Models

Yield per recruit (YPR) analyses were performed on yellowtail snapper, a more detailed explanation of which can be found in Cummings (SEDAR8-AW-09). Dennis (1991) used length frequencies of fish collected in 1984 and 1985 from the Puerto Rico commercial fishery. These data were used to estimate von Bertalanffy growth parameters (Table 14) using the ELEFAN method (Pauly and David 1981). He also estimated these parameters using ageing data obtained from Manooch and Drennon (1987), which were collected from the US Virgin Islands commercial fishery in the mid-1980s (Table 14). In both cases, natural mortality estimates were derived from the growth rate parameter (K), the asymptotic size (L_∞), and mean annual water temperature using Pauly's (1980) method (Table 14).

Dennis (1991) also estimated total mortality using four methods: length-converted catch curve, age-length key catch curve, Beverton and Holt's (1956) equation, and Hoenig and colleagues' (1983) equation. These estimates could then be partitioned into natural mortality (M) and fishing mortality (F) rates, the sum of which is equal to total mortality. From these values, he was also able to estimate lengths of first capture (Table 15), and optimal size of first capture under a range of natural mortality rate values (20 percent above and below the estimated value, in increments of 10 percent) and fishing mortality rates (Table 16).

5.1.1 Methods

We used length frequencies of fish collected during 1983 to 2003 from the Puerto Rico commercial fishery (Cummings, SEDAR8-DW-08) to update these results. In addition, data from the 2002-2003 samples were used to provide a crude reference as to current length at first capture (Table 17). The use of length frequency data as an indicator of age frequency has been shown to be accurate for young age classes (in this case, ages 2-5) in fish like yellowtail snapper with rapid early growth and relatively high variability in length within age groups (Parrack and Cummings 2003). Data gaps precluded an analysis by gear, and of any examination of the US Virgin Islands (although sufficient data may be available to examine the St. Croix trap fishery). Instead, the focus of analyses was mainly on Puerto Rico.

YPR runs were made using the growth parameters K = 0.17 per year and L_∞ = 60 cm FL, and a length-weight relationship from Manooch and Drennon (1987). Runs varied in their values for natural mortality rates. In most cases, natural mortality rates were not age-specific. Values ranged from 0.3 to 0.7 in increments of 0.1. Additionally, one run was conducted using age-specific natural mortality rates. Values were determined using a power curve with M = 1.2 per year for 2 inch fish and M = 0.6 per year for 18 inch fish.

5.1.2 Results

Table 18 provides summary information on YPR for yellowtail snapper off Puerto Rico. Since precise information on total mortality is not available from traditional fisheries analyses, results should be viewed as preliminary. With more information, YPR calculations could be updated and strengthened. The analyses here using the historical information on growth suggested that the critical size at which maximum yield would be achieved ranged from 9 to 14 inches (FL) for fixed M values ranging from 0.3 to 0.7, respectively. This size corresponds to 4.6 year to 1.8 year old fish. During the recent two calendar years (2002-2003), length at first capture has been larger than critical size for the dominant fisheries (hook and line and pots) in most regions for the Puerto Rico platform (Table 17). Sample sizes are extremely low in the US Virgin Islands. Thus size composition trends are more difficult to interpret there.

It should be noted that enforcement of the current 12 inch federal size limit is a concern in Puerto Rico (Daniel Matos, personal communication) and thus the degree to which the size samples reflect reality is unknown. In addition, a lower minimum size limit may be implemented soon in Puerto Rico-controlled inshore waters, which would introduce additional uncertainty as to current size composition of yellowtail snapper.

6 Biological Reference Points (SFA Parameters)

6.1 Existing Definitions and Standards

Amendment 1 to the Reef Fish FMP (55 FR 46214) was implemented in December 1990. This amendment defined overfished and overfishing standards for shallow water reef fish. "Overfished" was defined as a biomass level below 20% of the spawning stock biomass per recruit (SSBR) that would occur in the absence of fishing. For stocks defined as overfished, "overfishing" was defined as a rate of harvest that is incompatible with a program that has been established to rebuild a stock or stock complex to the 20% SSBR level. For stocks that are not overfished, "overfishing" was defined as a fishing rate that would jeopardize the capacity of the stock or stock complex to produce optimum yield on a continuing basis. Existing definitions of MSY and OY were applied to all reef fish within the revised FMU, with the exception of marine aquarium finfish.

The Caribbean Fishery Management Council is in the process of modifying these definitions to make them biomass-based. The proposed amendment defines stock status with reference to MSY-based fishing mortalities (F_{MSY}) and biomass levels (B_{MSY}) when these quantities can be estimated. When they cannot, the proposed amendment relies on expert opinion to determine the status of stocks. Since these changes have not yet been enacted, our present discussion can touch upon how status would be determined under the proposed rules but must mainly focus on

6.2 Estimation Methods

Biological reference points were estimated using various model configurations, as discussed above.

6.3 Results

6.3.1 <u>Overfished Definitions and Recommendations</u>

<u>SSBR</u>: Although catch-free models were variable in their estimate of stock status, they were consistent in their estimate of SSB_{MSY} relative to virgin levels, which roughly ranged from 0.25-0.3 (the low value of 0.18 was driven by the TIP index). Thus, as a proxy for MSY benchmarks, one could recommend an SPR of 0.3. Note that this SPR is a result of life-history parameters

and selectivity, and is not dependent on assumed effort trends. Although there is uncertainty in M and α, the modeled values were selected to correspond with maximum observed ages and an assumption that the stock would have a resiliency similar to other species with comparable life-history patterns. The ASPIC surplus production model was not age-based and therefore did not provide estimates of this sort.

Biomass: The overfished definition for yellowtail snapper is likely to be amended in the near future, with the new definition based on biomass. Often, the overfished threshold is defined as (1-M) B_{MSY}, where M = natural mortality, as long as M < 0.5. In other cases, the overfished threshold is defined as ½ B_{MSY}. For yellowtail snapper, the former technique would generally identify a threshold at 0.69 B_{MSY}, although the value could be as low as 0.54 B_{MSY}. The estimated biomass in 2003 (B2003) varied among catch-free runs from 0.27 to 1.37 B_{MSY} for the northern platform and 0.14 to 3.56 B_{MSY} for the St. Croix platform. The ASPIC surplus production model generated a similarly broad range, from 0 to 0.13 B_{MSY} for Puerto Rico and 0.32 and 2.61 B_{MSY} for St. Thomas/St. John.

6.3.2 Overfishing Definitions and Recommendations

One feature of the various models that was relatively constant was the estimate of the fishing mortality rate associated with MSY (F_{MSY}). The northern platform version of the catch free model estimated F_{MSY} within a few hundredths of 0.3 across all configurations. Estimates varied more across other models. The base case ASPIC surplus production model for Puerto Rico estimates a higher F_{MSY} at 0.495 while the ASPIC model for St. Thomas/St. John estimated F_{MSY} of 0.442 under a logistic production curve but a much higher 2.72 under a Gompertz-Fox curve. The catch free model of the St. Croix platform was also more variable, with F_{MSY} estimates ranging from 0.34 to 0.6.

Relative to F_{MSY}, an overfishing threshold which has not yet been adopted, various model configurations produced widely divergent results. The catch-free models estimated current fishing mortality rates ranging from 0.78 and 2.11 F_{MSY} for the northern platform (St. Thomas, St. John, and Puerto Rico) and from 0 and 2.22 F_{MSY} for the St. Croix platform. The ASPIC surplus production model estimated fishing mortality rates of 4.05 and 32 F_{MSY} for Puerto Rico and 0.04 and 1.89 F_{MSY} for St. Thomas/St. John.

6.4 Status of Stock Declarations

The SEDAR 8 Assessment Workshop Panel determined that insufficient information was available to make a definitive declaration as to the status of the US Caribbean yellowtail snapper stock.

7 Projections and Management Impacts

Because of our inability to define a base model, we were unable to derive meaningful projection scenarios.

8 Management Outcomes and Risk Analysis

Similarly, our agreement on the large uncertainties surrounding the US Caribbean yellowtail snapper stock precluded an extensive analysis of management outcomes. It might be possible to perform a more detailed risk analysis, and such an exercise is recommended for the future.

9 Research Recommendations

Various sources of fishery independent data have been collected about the Puerto Rico and US Virgin Islands reef fish fisheries through the NMFS SEAMAP Caribbean sampling program. The SEDAR 8 Data Workshop Panel concluded that the most complete fishery independent data set available for Puerto Rico was collected through the Puerto Rico DNER, while the most complete fishery independent data set available for the US Virgin Islands was collected by the Department of Fish and Wildlife through NOAA/NMFS/SEFSC's SEAMAP survey (SEDAR8-DW-Report).

During the SEDAR 8 assessment workshop, several issues regarding the fishery independent data were discussed, specifically whether these data and the analysis conducted should be considered in the assessment models pertaining to yellowtail snapper. One specific issue was whether a conflict exists between the fishery independent sampling procedures used and traditionally successful yellowtail snapper fishing technique. Sampling protocol for the surveys was designed to sample the greatest diversity of fish species during the day using a standard amount of time and gear type. Local knowledge of the yellowtail snapper fishery contributed by individuals in the St. Thomas/St. John and St. Croix Fisherman's Associations suggest that yellowtail can only be captured efficiently at night when certain fishing techniques are applied. Such methods of harvesting yellowtail snapper include the use of chumming in the evening, fishing with hook and line, and using thin line not easily detected by the yellowtail snapper. The majority of the yellowtail snapper caught during fishery independent sampling were caught using traps during daylight hours, suggesting that the hook and line sampling was not conducive to catching yellowtail snapper. A second issue is that the Puerto Rico DNER sampling only occurred on the west coast of Puerto Rico and some participants raised the concern that a region specific index may not adequately represent the total yellowtail population. In fact, some support for this exists from analyses of the commercial landings data which showed variability in landings between regions (Cummings and Matos-Caraballo, SEDAR8 DW-08).

Trap sampling captured the greatest number of yellowtail snapper off the West Coast of Puerto Rico. Though still a small sample size, sufficient proportion positive data was present to calculate standardized catch rates using the GLM model. The small sample size raised questions about whether or not the data ought to be used in the assessment of yellowtail. In January 2005, an updated version of the SEAMAP data was made available. This updated information contained additional SEAMAP data from the US Virgin Islands but no additional data from Puerto Rico. It was decided by the SEDAR 8 assessment panel that the additional fishery independent information did not contain enough yellowtail snapper data to yield an informative analysis for the US Virgin Islands.

The following recommendations were made to increase the utility of these data in the future:

- Increase the fishery independent sampling effort in the U.S. Caribbean. It is critical that the sampling effort be diversified across the region to include equal coverage of appropriate habitats/depths. Inquiry among the fishing community should provide appropriate information on the location, habitats and best fishing methods appropriate to acquire the most complete set of information on all species in the region. Cooperative sampling design and implementation between the fishermen and scientists is strongly encouraged. If every species captured cannot be completely sampled, then those species deemed to be important to the local fishing economy or those species considered representative of relevant habitat types should be given sampling priority. A list of commercially important species to the region can be obtained from the Caribbean Fishery Management Council.
- The ideal survey would utilize hook and line and traps as the primary sampling gears in order to maintain consistency with those surveys that have been completed in the past. The number of gear fished and the hours fished each sampling period should be standardized and strictly adhered to from one sampling period to the next. Sampling in the US Virgin Islands for reef fish has not been conducted on a consistent basis each year. Funding needs to be allocated to allow for consistent annual sampling (or at least bi-annual).
- Visual surveys could be used in the Virgin Islands and in Puerto Rico to collect additional size and abundance information on the reef fish resource. This is the fastest way to obtain a large quantity of information, and data collected can be paired with efforts to link ages to lengths. Such data would provide abundance indices, particularly for shallow water species. Several potential sources of visual survey data were identified for the SEDAR8 Data Workshop but were not pursued at present because of the aggregate nature in which data were presented. Further work with the scientists who conducted these surveys is recommended.
- Mark recapture techniques could be used to estimate abundance and learn more about the movements and habitat preferences of yellowtail snapper. However, such studies should focus on movement patterns as well as recapture rates to avoid potential misinterpretation especially if fish show site fidelity. This project could be performed cooperatively between scientists and local fishers. Important components would include communicating and educating the fishermen such that they are encouraged to return the tags.
- Due to the lack of adequate and consistent historical data in the Caribbean, it is difficult to determine stock status using many of the traditional quantitative methods. However, the relatively good knowledge of habitat distributions and of habitat usage by various species/life stages provides a valuable opportunity to explore the power of habitat based spatial models in this region.

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11 Tables

Table 1—CPUE from Puerto Rico SEAMAP

Catch per unit effort calculated from fishery independent sampling efforts in Puerto Rico, including the number of stations sampled each year (# sites) and of those stations that yielded yellowtail snapper (# pos.).

Year	Nominal Hook and Line					Nominal Trap					Standardized Trap	
	# sites	# pos.	Effort	Catch	CPUE	# sites	# pos.	Effort	Catch	CPUE	CPUE	Std Error
1988	66	2	127.8	495	3.9	65	16	1206.3	11640	9.6	1.000	2.360
1989	80	6	680	3082	4.5	73	25	2134	20599	9.7	0.402	0.981
1990	103	1	81	210	2.6	---	---	0	0	--	--	--
1991	57	1	97.2	925	9.5	31	6	672	3740	5.6	0.307	1.516
1992	118	3	40.5	1810	44.7	82	7	408.5	5425	13.3	0.138	0.597
1993	108	4	81	1350	16.7	102	4	480	1944	4.1	0.053	0.336
1994	106	5	72.27	2180	30.2	61	3	222.3	327	1.5	0.009	0.132
1995	99	6	102.99	2705	26.3	52	2	148.5	605	4.1	0.020	0.218
1996	26	4	60.3	1725	28.6	---	---	0	0	--	--	--
1997	58	1	15	425	28.3	---	---	0	0	--	--	--
1998	63	0	0	0	--	31	5	390	2330	6.0	0.064	0.394
1999	72	3	43.59	905	20.8	36	6	553.6	3661	6.6	0.328	1.400
2000	27	3	45	1135	25.2	9	3	233.3	1578	6.8	0.275	1.639
2001	18	2	29.49	410	13.9	1	0	0	0	--	--	--

Table 2—US Virgin Islands Size Frequency Summary from TIP

Number of commercial catch size frequency observations for yellowtail snapper in the US Virgin Islands by island from 1983-2003. Blanks indicate no observations available. Note: US Virgin Islands TIP data incomplete at present (SEDAR8-AW-11).

	region									
	St. Croix		St. John		St. Thomas		Virgin Isl		All	
	forkcm		forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
iy										
1983	832	28							832	28
1984	2654	28							2654	28
1985	341	31	5	33	1014	35	1	25	1361	34
1986	153	29			144	35			297	32
1987	483	29			12	29			495	29
1988	308	30							308	30
1989	105	28							105	28
1990	71	29							71	29
1991	84	29							84	29
1992	1	30			278	34	85	41	364	35
1993	11	29	106	33	255	34			372	33
1994	114	26	93	35	79	34			286	31
1995	34	24	2	29	186	35	2	29	224	33
1996	82	27			188	35			270	32
1997	59	28							59	28
1998	40	26							40	26
1999	42	27							42	27
2000	39	28							39	28
2001	226	31							226	31
2002	245	29			69	31			314	29
2003	48	30					3	30	51	30
All	5972	29	206	34	2225	35	91	40	8494	30

Table 3—St. Croix Size Frequency from TIP

Number of commercial catch size frequency observations for yellowtail snapper in the US Virgin Islands for St. Croix by major gear from 1983-2003. Blanks indicate no observations available. Note: US Virgin Islands TIP data incomplete at present (SEDAR8-AW-11).

astate=Virgin Islands region=St. Croix

	cgear								All	
	Net		RR		dive		pot			
	forkcm		forkcm		forkcm		forkcm		forkcm	
iy	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
1983							832	28	832	28
1984							2363	28	2363	28
1985			127	36			208	27	335	31
1986			2	24			151	29	153	29
1987			85	36			396	27	481	29
1988			81	36			226	28	307	30
1989			2	37			103	27	105	28
1990							67	29	67	29
1991			11	31			47	28	58	29
1992			1	30					1	30
1993			2	35			9	28	11	29
1994			1	27			113	26	114	26
1995	2	33	3	33			29	22	34	24
1996							82	27	82	27
1997							59	28	59	28
1998							40	26	40	26
1999			4	28			38	27	42	27
2000							39	28	39	28
2001	1	27					225	31	226	31
2002	23	27					222	29	245	29
2003			33	30	11	34	4	27	48	30
All	26	28	352	35	11	34	5253	28	5642	29

Table 4—St. John Size Frequency from TIP

Number of commercial catch size frequency observations for yellowtail snapper in the US Virgin Islands for St. John by major gear from 1983-2003. Blanks indicate no observations available. Note: US Virgin Islands TIP data incomplete at present (SEDAR8-AW-11).

------ astate=Virgin Islands region=St. John -----

	cgear						All	
	RR		Seine		pot		All	
	forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean
iy								
1985	5	33					5	33
1993			98	33	8	31	106	33
1994	93	35					93	35
1995					2	29	2	29
All	98	35	98	33	10	31	206	34

Table 5—St. Thomas Size Frequency from TIP

Number of commercial catch size frequency observations for yellowtail snapper in the US Virgin Islands for St. Thomas by major gear from 1983-2003. Blanks indicate no observations available. Note: US Virgin Islands TIP data incomplete at present (SEDAR8-AW-11).

astate=Virgin Islands region=St. Thomas

	cgear										All	
	LLBot		Net		RR		Seine		pot		All	
	forkcm		forkcm		forkcm		forkcm		forkcm		forkcm	
iy	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
1985	109	36	48	37	640	37			201	31	998	36
1986					80	36			64	33	144	35
1987									12	29	12	29
1992					110	36	127	32	41	33	278	34
1993					151	35	66	32	38	31	255	34
1994			1	38	59	35			19	29	79	34
1995					144	36	13	37	29	31	186	35
1996					182	35			6	30	188	35
2002					37	32			32	30	69	31
All	109	36	49	37	1403	36	206	33	442	32	2209	35

Table 6—Puerto Rico Size Frequency Summary from TIP

Number of commercial catch size frequency observations for yellowtail snapper in Puerto Rico by major region from 1983-2003 (North = Isabela-Luquillo, East=Fajardo-Vieques, South=Patillas-Lajas, West=Cabo Rojo-Aguadilla). Blanks indicate no observations available.

	region										All	
	PR East		PR North		PR South		PR Unknown		PR West		All	
	forkcm		forkcm		forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
iy												
1983	209	24	37	28	118	26			97	23	461	25
1984	473	24	806	28	242	25	1	27	243	26	1765	26
1985	829	30	308	29	133	27	65	3	164	25	1499	27
1986	890	29	20	32	757	25			848	23	2515	26
1987	418	26			376	24			192	23	986	25
1988	1029	28	306	29	97	26			52	29	1484	28
1989	359	26	85	32	258	25	5	22	345	28	1052	27
1990	846	28	127	32	277	25			871	27	2121	27
1991	976	30	7855	29	110	24	47	37	356	28	9344	29
1992	699	27	7753	28	555	26	91	27	807	26	9905	28
1993	795	30	5497	28	116	23			456	24	6864	28
1994	492	31	3324	29	212	25			162	25	4190	29
1995	1115	29	2326	30	85	25			20	25	3546	30
1996	284	27	219	29	45	25			133	27	681	28
1997	596	29	73	34	78	24	16	27	75	25	838	28
1998	1382	33	67	32	165	27	255	34	335	31	2204	32
1999	4505	30	194	26	157	25	20	32	664	29	5540	29
2000	3229	31	605	26	121	28			920	30	4875	30
2001	1577	33	221	28	312	26	5	25	1193	27	3308	30
2002	2989	31	244	30	83	26	80	27	1247	30	4643	31
2003	2725	35	1360	28	165	27	1	38	1097	30	5348	32
All	26417	30	31427	29	4462	25	586	28	10277	28	73169	29

Table 7—East Puerto Rico Size Frequency from TIP

Number of commercial catch size frequency observations for yellowtail snapper in Puerto Rico for the east region from 1983--2003 (North = Isabela-Luquillo, East=Fajardo-Vieques, South=Patillas-Lajas, West=Cabo Rojo-Aguadilla). Blanks indicate no observations available.

astate=Puerto Rico region=PR East

	cgear												All	
	Net		RR		Seine		dive		other		pot		All	
	forkcm		forkcm		forkcm		forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
iy														
1983			33	25							176	24	209	24
1984			29	26							444	24	473	24
1985			681	31							148	23	829	30
1986	168	25	441	30			14	28			267	30	890	29
1987	1	35	279	25							138	27	418	26
1988	60	29	767	28	1	34					133	25	961	27
1989	45	30	147	27			7	28			160	24	359	26
1990	38	25	777	28							31	25	846	28
1991			802	30							172	27	974	30
1992	4	27	654	27							41	30	699	27
1993			713	30							82	29	795	30
1994			360	31							7	30	367	31
1995	10	24	752	29							38	26	800	29
1997	7	25	507	29							82	28	596	29
1998	3	34	1278	33							80	28	1361	33
1999			4198	30			60	27			247	28	4505	30
2000			3132	31							97	30	3229	31
2001			1333	33			7	37			232	28	1572	33
2002			2667	32			162	29	46	26	114	33	2989	31
2003			2688	35							37	31	2725	35
All	336	26	22E3	31	1	34	250	29	46	26	2726	27	26E3	30

Table 8—North Puerto Rico Size Frequency from TIP

Number of commercial catch size frequency observations for yellowtail snapper in Puerto Rico for the north region from 1983--2003 (North = Isabela-Luquillo, East=Fajardo-Vieques, South=Patillas-Lajas, West=Cabo Rojo-Aguadilla). Blanks indicate no observations available.

---------- astate=Puerto Rico region=PR North ----------

	cgear										All	
	LLBot		Net		RR		other		pot		All	
	forkcm		forkcm		forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
iy												
1983					37	28					37	28
1984					805	28			1	26	806	28
1985					308	29					308	29
1986					20	32					20	32
1988					304	29			2	35	306	29
1989					84	32			1	35	85	32
1990					127	32					127	32
1991	1	44	3	33	7819	29	32	25			7855	29
1992					7753	28					7753	28
1993					5497	28					5497	28
1994					2266	29					2266	29
1995					1701	30					1701	30
1997					67	34			6	30	73	34
1998					61	33			6	26	67	32
1999					194	26					194	26
2000					604	26			1	27	605	26
2001	1	27			220	28					221	28
2002					237	30			7	24	244	30
2003			6	27	1341	28			13	27	1360	28
All	2	36	9	29	29E3	28	32	25	37	27	3E4	28

Table 9—South Puerto Rico Size Frequency from TIP

Number of commercial catch size frequency observations for yellowtail snapper in Puerto Rico for the south region from 1983--2003 (North = Isabela-Luquillo, East=Fajardo-Vieques, South=Patillas-Lajas, West=Cabo Rojo-Aguadilla). Blanks indicate no observations available.

astate=Puerto Rico region=PR South

	cgear														All	
	LLBot		LLSurf		Net		RR		dive		other		pot		All	
	forkcm		forkcm		forkcm		forkcm		forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
iy																
1983					2	24							80	25	82	25
1984							84	25					158	25	242	25
1985					4	27	44	30	2	23			83	25	133	27
1986					261	26	1	27					114	26	376	26
1987					33	25	47	30					239	23	319	24
1988					15	30	2	21			1	27	79	26	97	26
1989			6	28	32	28	84	26	1	24			135	24	258	25
1990					52	24	108	27			1	29	116	24	277	25
1991					12	26	7	24					91	24	110	24
1992					3	21	259	28	1	34			279	24	542	26
1993					2	25	1	32					113	23	116	23
1994							107	27					46	21	153	25
1995	6	29			8	26			1	31			46	23	61	24
1997					53	24							25	24	78	24
1998					117	28			2	31			33	25	152	28
1999					23	25			2	26			132	25	157	25
2000					6	26	41	34	1	43			73	25	121	28
2001					131	27	116	26					65	26	312	26
2002					21	26	21	28	3	34			37	25	82	26
2003					46	23	49	34					70	23	165	27
All	6	29	6	28	821	26	971	28	13	30	2	28	2014	24	3833	26

Table 10—West Puerto Rico Size Frequency from TIP

Number of commercial catch size frequency observations for yellowtail snapper in Puerto Rico for the west region from 1983--2003 (North = Isabela-Luquillo, East=Fajardo-Vieques, South=Patillas-Lajas, West=Cabo Rojo-Aguadilla). Blanks indicate no observations available.

astate=Puerto Rico region=PR West

	cgear													
	LLBot		LLSurf		Net		RR		dive		pot		All	
	forkcm		forkcm		forkcm		forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
iy														
1983											97	23	97	23
1984							9	41			234	25	243	26
1985					5	27	60	30			86	24	151	27
1986					63	29	1	19			470	24	534	25
1987					4	30	1	37	1	26	186	23	192	23
1988			24	31	5	28	14	29			9	26	52	29
1989	3	27	46	28	28	29	95	32			20	24	192	30
1990	126	29			21	29	231	31			65	23	443	29
1991	153	25			18	31	105	33			80	28	356	28
1992					22	30	304	29			49	25	375	28
1993					7	31	208	26			17	26	232	26
1994					6	27					6	28	12	28
1995					9	29					3	28	12	29
1997					44	28	3	24			1	26	48	27
1998					71	28	103	31	3	102			177	31
1999					61	29	164	33	1	33	5	37	231	32
2000					183	28	538	33	13	28	29	33	763	31
2001					5	28	226	35					231	35
2002					91	27	612	34			62	32	765	33
2003					39	26	419	37					458	36
All	282	27	70	29	682	28	3093	33	18	41	1419	25	5564	30

Table 11—Puerto Rico Size Frequency by Gear from TIP (All Regions Combined)
Number of size frequency observations and mean length (FL cm) by year and major gear for yellowtail snapper in Puerto Rico commercial fisheries, 1983-2003. Federal minimum size rule of 8 inches TL (6.5 inches FL, 16.4 cm FL) enacted 1985 increasing by one inch to 12 inches TL (9 inches FL, 22.9 cm FL) in 1989. Blanks indicate no observations available.

astate=Puerto Rico island=Puerto Rico

	cgear																All	
	LLBot		LLSurf		Net		RR		Seine		dive		other		pot		All	
	forkcm		forkcm		forkcm		forkcm		forkcm		forkcm		forkcm		forkcm		forkcm	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
iy																		
1983					2	24	70	26							353	24	425	25
1984							927	28							838	24	1765	26
1985					9	27	1093	30			2	23			317	24	1421	29
1986					492	26	463	30			14	28			851	26	1820	27
1987					38	25	327	26			1	26			563	24	929	25
1988			24	31	80	29	1087	28	1	34			1	27	223	26	1416	28
1989	3	27	52	28	105	29	410	29			8	27			321	24	899	27
1990	126	29			111	25	1243	29					1	29	212	24	1693	28
1991	154	25			33	29	8780	29					32	25	343	26	9342	29
1992					29	29	9060	28			1	34			370	25	9460	28
1993					9	30	6419	28							212	25	6640	28
1994					6	27	2733	29							59	23	2798	29
1995	6	29			27	26	2453	30			1	31			87	25	2574	30
1997					104	26	577	29							130	27	811	29
1998					191	28	1697	33			5	73			119	27	2012	32
1999					84	28	4576	30			63	27			384	27	5107	29
2000					189	28	4315	31			14	30			200	29	4718	31
2001	1	27			136	27	1900	33			7	37			297	28	2341	32
2002					112	27	3537	32			165	29	46	26	220	31	4080	32
2003					91	25	4498	33							120	26	4709	33
All	290	27	76	29	1848	27	56E3	30	1	34	281	29	80	26	6219	25	65E3	29

Table 12—Catch-Free Model Benchmarks

Benchmark estimates for catch-free model applications to the northern platform, including St. Thomas, St. John, and Puerto Rico (a) and St. Croix Platform (b). The model name in the table indicates effort treatment (Nfishers, Ntraps, or Nfishpots). When the index of population decline was truncated in 1930, legend names are followed by "Xb30". Sensitivity trials including additional indices are indicated in the legend name as well (SEAMAP and PR for Puerto Rico platform, and TIP for the St. Croix platform).

(a) Northern Platform (St. Thomas, St. John, and in some cases a Puerto Rico SEAMAP index)

Model	F2003/ Fmsy	B2003/ Bmsy	Fmsy	Bmsy	SPRmsy	F30% SPR	B30% SPR	F40% SPR	B40% SPR	M	alpha	steepness
Nfishers	0.87	1.25	0.29	0.28	0.32	0.32	0.25	0.23	0.36	0.31	15.01	0.79
Ntraps	1.84	0.46	0.29	0.28	0.32	0.32	0.25	0.23	0.36	0.31	15.17	0.79
Nfishpots	1.21	0.87	0.29	0.28	0.32	0.32	0.25	0.23	0.36	0.31	15.05	0.79
Nfish_SEAMAP	1.48	0.58	0.32	0.27	0.31	0.33	0.26	0.24	0.36	0.32	16.91	0.81
NfishersXb30	0.78	1.37	0.30	0.28	0.32	0.32	0.25	0.23	0.36	0.31	15.17	0.79
NtrapsXb30	2.01	0.38	0.29	0.28	0.33	0.32	0.25	0.23	0.36	0.31	14.93	0.79
NfishpotsXb30	1.19	0.89	0.30	0.28	0.32	0.32	0.25	0.23	0.36	0.31	15.09	0.79
Nfish_SEAMAPXb30	2.11	0.27	0.33	0.26	0.31	0.34	0.26	0.24	0.36	0.34	16.57	0.81
Nfish_PR	0.81	1.24	0.29	0.28	0.33	0.32	0.25	0.23	0.36	0.31	14.93	0.79
Ntraps_PR	1.33	0.69	0.30	0.27	0.32	0.32	0.25	0.23	0.36	0.31	15.44	0.79
NtrapsXb30_PR	1.45	0.59	0.30	0.28	0.32	0.32	0.25	0.23	0.36	0.31	15.28	0.79

(b) St. Croix Platform

Model	F2003/ Fmsy	B2003/ Bmsy	Fmsy	Bmsy	SPRmsy	F30% SPR	B30% SPR	F40% SPR	B40% SPR	M	alpha	steepness
Nfishers	0.00	3.56	0.35	0.25	0.28	0.33	0.27	0.24	0.37	0.33	22.61	0.85
Nfish_TIP	2.05	0.18	0.60	0.18	0.21	0.43	0.28	0.31	0.38	0.46	36.89	0.90
NfishersXb30	0.00	3.15	0.34	0.26	0.30	0.33	0.26	0.24	0.37	0.33	18.44	0.82
Nfish_TIPXb30	2.22	0.14	0.59	0.18	0.20	0.42	0.28	0.30	0.38	0.45	40.18	0.91

Table 13—St. Thomas/St. John CPUE from Fishers

Nominal catch per unit effort series for St. Thomas and St. John. Catches were estimated by extrapolating catch composition from TIP samples but may have substantial inaccuracies, as discussed in the text. Effort numbers were provided by members of the St. Thomas Fishermen's Association who determined the number of line fishers that participated each year.

YEAR	CATCH (lbs)	EFFORT (# line fishers / yr)	CPUE (lbs / line fisher)
1983	23385	25	935.4
1984	19327	25	773.08
1985	21313	25	852.52
1986	10628	25	425.12
1987	10460	25	418.4
1988	11720	25	468.8
1989	15167	20	758.35
1990	17825	28	636.6071
1991	24754	28	884.0714
1992	21110	28	753.9286
1993	25929	28	926.0357
1994	24743	28	883.6786
1995	34920	25	1396.8
1996	32758	20	1637.9
1997	29741	20	1487.05
1998	27455	20	1372.75
1999	30438	30	1014.6
2000	37805	30	1260.167
2001	46599	30	1553.3
2002	43133	30	1437.767
2003	43542	30	1451.4

Table 14—Natural Mortality and Von Bertalanffy Growth Parameter Estimates
Data for age-derived estimates are from the US Virgin Islands (as derived from the Manooch and Drennon 1987 growth equation, see section 5.1 in the text) while the length data used in the length-derived analyses were from 1984 and 1985 Puerto Rico commercial catch length frequency samples. All lengths in cm FL. Taken from Dennis (1991).

	Age Derived estimates	**Length derived estimates (ELEFAN)**
M	0.321	0.437
L_∞	54.48	53.42
K	0.1041	0.166
Tzero	-1.83	not estimated in model

Table 15—Total Mortality and Length at First Capture Estimates
Estimates of total mortality, Z, and length at first capture, t_c, from Dennis (1991) for yellowtail snapper sampled in 1984 and 1985 from Puerto Rico commercial catches.

Year	**1984**		**1985**	
Derived from	Lengths	Otoliths	Lengths	Otoliths
Length-converted catch curve estimated Z	1.148	0.727	1.051	0.608
Beverton & Holt estimated Z	0.978	0.641	0.824	0.542
Hoening estimated Z	0.962	0.628	0.865	0.566
Age-length key catch curve estimated Z	1.26	1.26	1.14	1.14
L_C (estimated from ELEFAN per Gulland 1983)	23.53	23.58	25.37	25.20

Table 16—Optimal Size at First Capture

Optimal size at first capture (lc) in cm (FL) to maximize yield per recruit as a function of exploitation (E), defined as the ratio of fishing mortality to natural mortality (F/M), and natural mortality (M) rates, assuming constant recruitment, non-varying selectivity and M over age.

(a) Estimates derived for the Length-derived growth equation parameters presented by Dennis (1991, Table 3).

M	**Change in M (%)**	**Relative Exploitation Rate (E = F/M)**						
		0.2	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**
0.524	+20	13.36	16.03	18.70	21.37	21.37	24.04	24.04
0.481	+10	14.42	17.63	18.70	21.37	21.37	24.04	24.04
0.437	0	16.03	18.70	21.37	21.37	24.04	24.04	26.71
0.393	+10	16.03	18.70	21.37	24.04	24.04	26.71	26.71
0.350	-20	16.03	18.70	21.37	24.04	26.71	26.71	29.38

(b) Estimates derived for the Age-derived growth equations parameters presented by Dennis (1991, Table 3).

M	**Change in M (%)**	**Relative Exploitation Rate (E = F/M)**						
		0.2	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**
0.524	+20	10.9	16.34	16.34	19.07	19.07	21.79	21.79
0.481	+10	13.62	16.34	19.07	19.07	21.79	21.79	24.52
0.437	0	13.62	16.34	19.07	21.79	21.79	24.52	24.52
0.393	+10	16.34	19.04	19.07	21.79	24.52	24.52	27.24
0.350	-20	16.34	19.04	21.79	23.15	24.52	27.24	27.24

Table 17—Yellowtail Snapper Size Distributions in 2002-03
Calculated Percentage Quantiles for the distribution of size (cm FL) of yellowtail snapper in the US Virgin Islands and Puerto Rico during 2002 and 2003, combined, from biostatistical TIP samples. ND=no data. Current federal minimum size = 12" TL (approx. 9" FL).

AREA	Quantile	RR/Lines	Dive	Net	Pots
Puerto Rico East	Smallest 1%	21	19		19
	5%	23	19		22
	10%	25	21		22
	25%	28	22		25
	Mean	33.4	28.9		32.7
	# observ.	5,355	162	ND	151
Puerto Rico North	Smallest 1%	19		26	19
	5%	19		26	19
	10%	21		26	19
	25%	22		27	20
	Mean	28.2		27.3	25.7
	# observ.	1,578	ND	6	20
Puerto Rico South	Smallest 1%	19	29		17
	5%	21	29	21	20
	10%	23	29	21	20
	25%	28	29	22	21
	Mean	32.5	34.3	24.2	23.7
	# observ.	70	3	67	107
Puerto Rico West	Smallest 1%	24		19	18
	5%	27		20	24
	10%	29		22	27
	25%	32		23	30
	Mean	35.3		26.7	31.7
	# observ.	1,031	ND	130	62
St. Thomas/St. John	Smallest 1%	24			22
	5%	24			27
	10%	25			28
	25%	27			29
	Mean	32.2			30.2
	# observ.	37	ND	ND	32
St. Croix	Smallest 1%	25	29	22	21
	5%	26	29	22	23
	10%	26	30	23	24
	25%	27	30	23	26
	Mean	29.7	34.1		28.7
	# observ.	33	11	23	ND

Table 18—Size Distributions in 2002-03

Yield per recruit statistics for four fixed values of natural mortality rate (M) for yellowtail snapper using the Manooch and Drennon (1987) age derived estimates of growth rate (K) and asymptotic size (L_∞) and one length variable M run. Weight-length equation parameters from Manooch and Drennon (1987). Federal minimum size = 12" TL (approx. 9" FL) since 1989.

Natural Mortality Value	0.3	0.4	0.5	0.6	0.7	Variable M[1]
Critical age (years)	4.6	3.5	2.6	2.1	1.8	3.7
Critical age (months)	55	39	31	25	21	44
Critical size (FL)	**14 in (35.6 cm)**	**13 in (33 cm)**	**11 in (27.9 cm)**	**10 in (25.4 cm)**	**9 in (22.3 cm)**	**14 in (35.6 cm)**

[1] Variable M power curve: Values input to determine curve were M=1.2 per year (2 inches) and M=0.6 per year (18 inches).

12 Figures

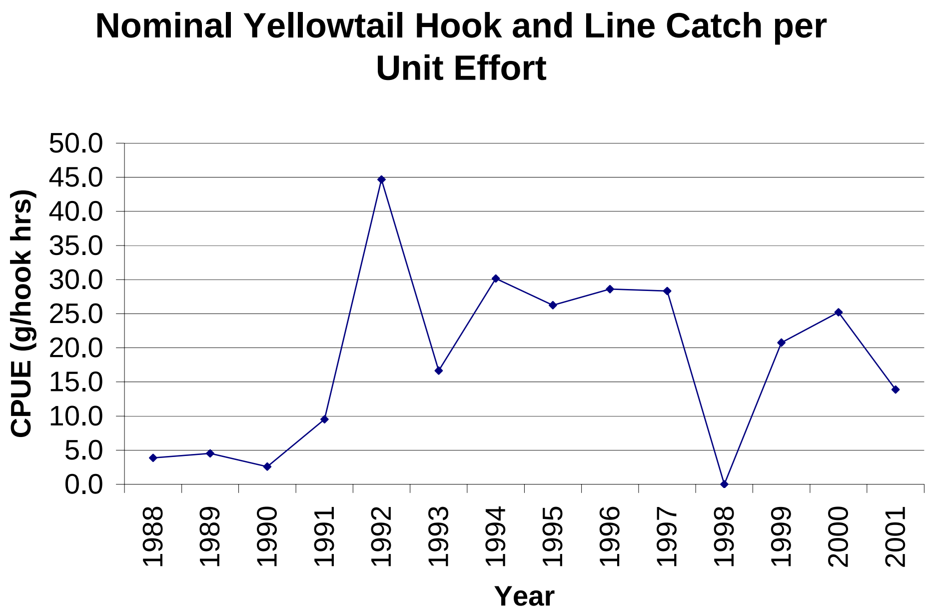


Figure 1—Nominal CPUE from Puerto Rico SEAMAP Handlines
Nominal hook and line catch per unit effort calculated for positive trips only (those days on which yellowtail snapper were captured).

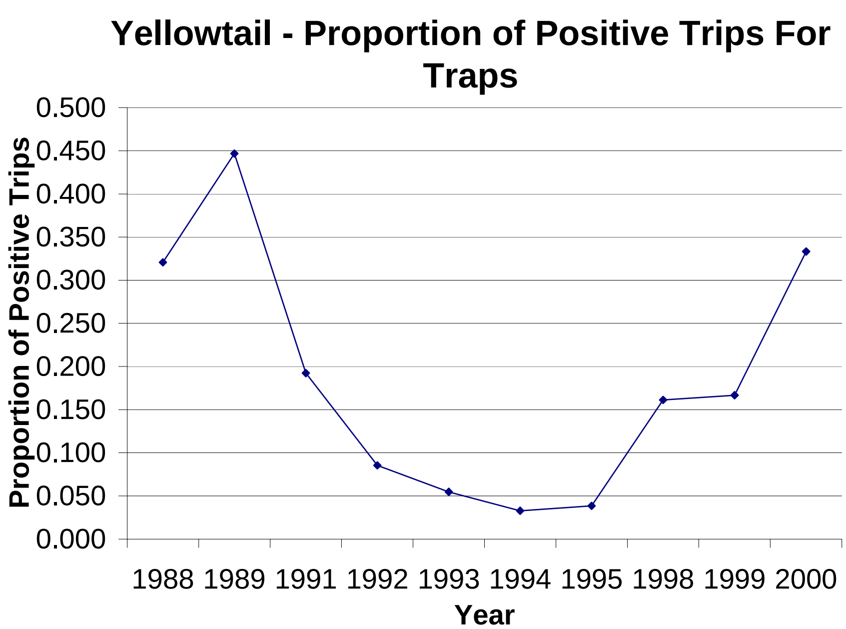


Figure 2—Proportion Positive Trips from Puerto Rico SEAMAP Traps
The proportion of positive trips (those days on which yellowtail were sampled) for traps.

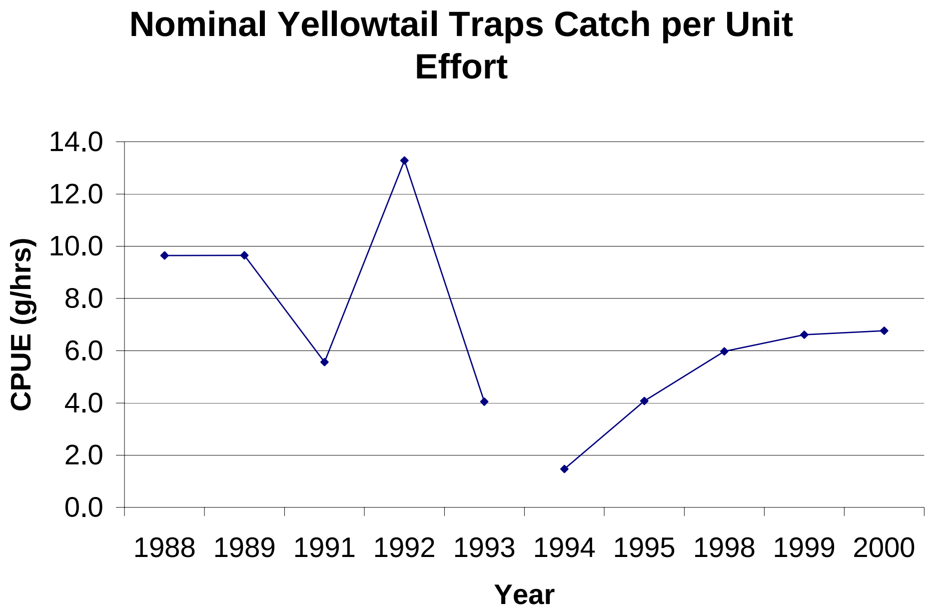


Figure 3—Nominal CPUE from Puerto Rico SEAMAP Traps
Nominal trap catch per unit effort calculated for positive trips only (those days on which yellowtail snapper were captured). The break in the curve represents the change in mesh size from 1.25 to 1.5 inches.

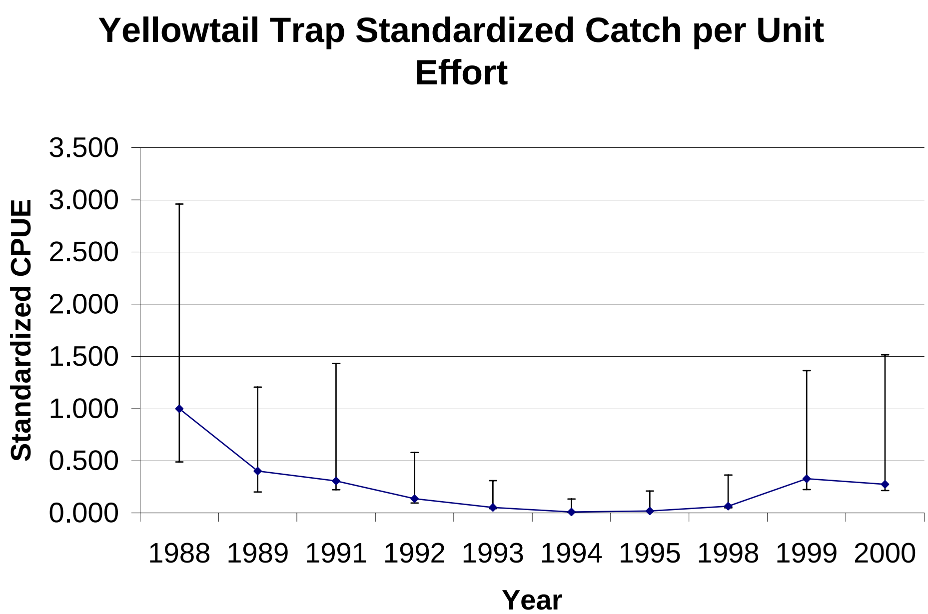


Figure 4—Standardized CPUE from Puerto Rico SEAMAP Traps
Standardized catch per unit effort for yellowtail snapper sampled with traps calculated for positive trips.

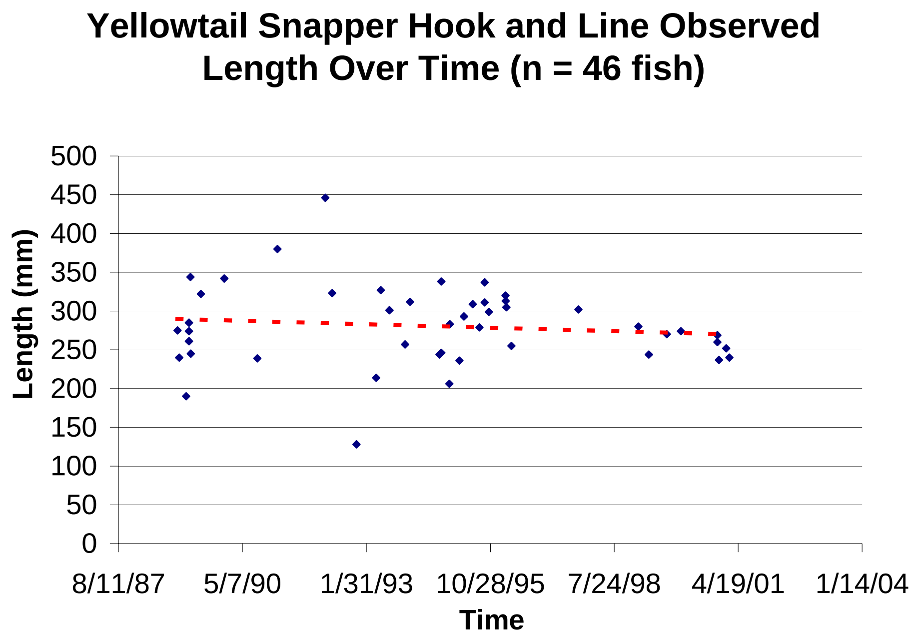


Figure 5—Length Distribution from Puerto Rico SEAMAP Handlines
The observed lengths of individuals captured over time using hook and line ($R^2 = 0.0146$).

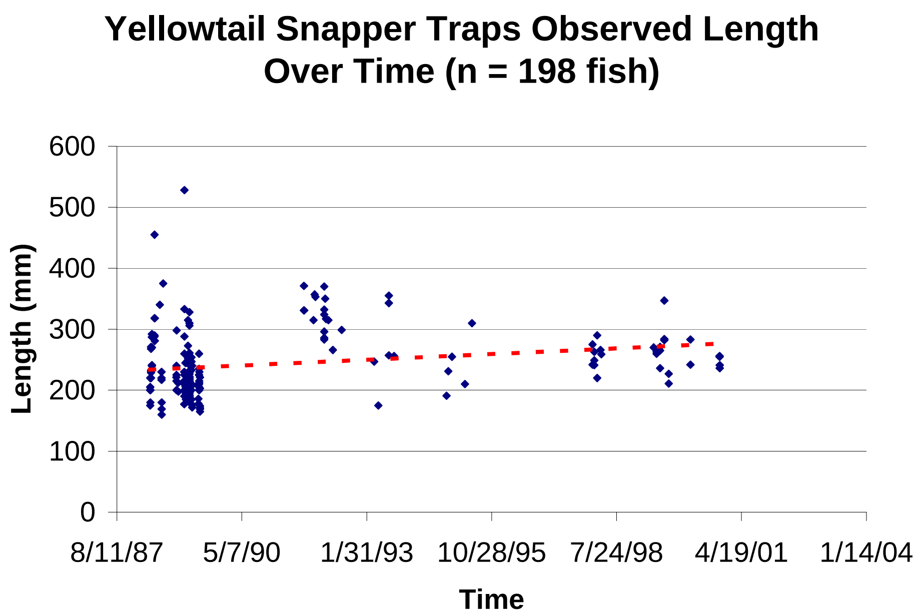


Figure 6—Length Distribution from Puerto Rico SEAMAP Traps
The observed lengths of individuals captured over time using traps ($R^2 = 0.0522$).

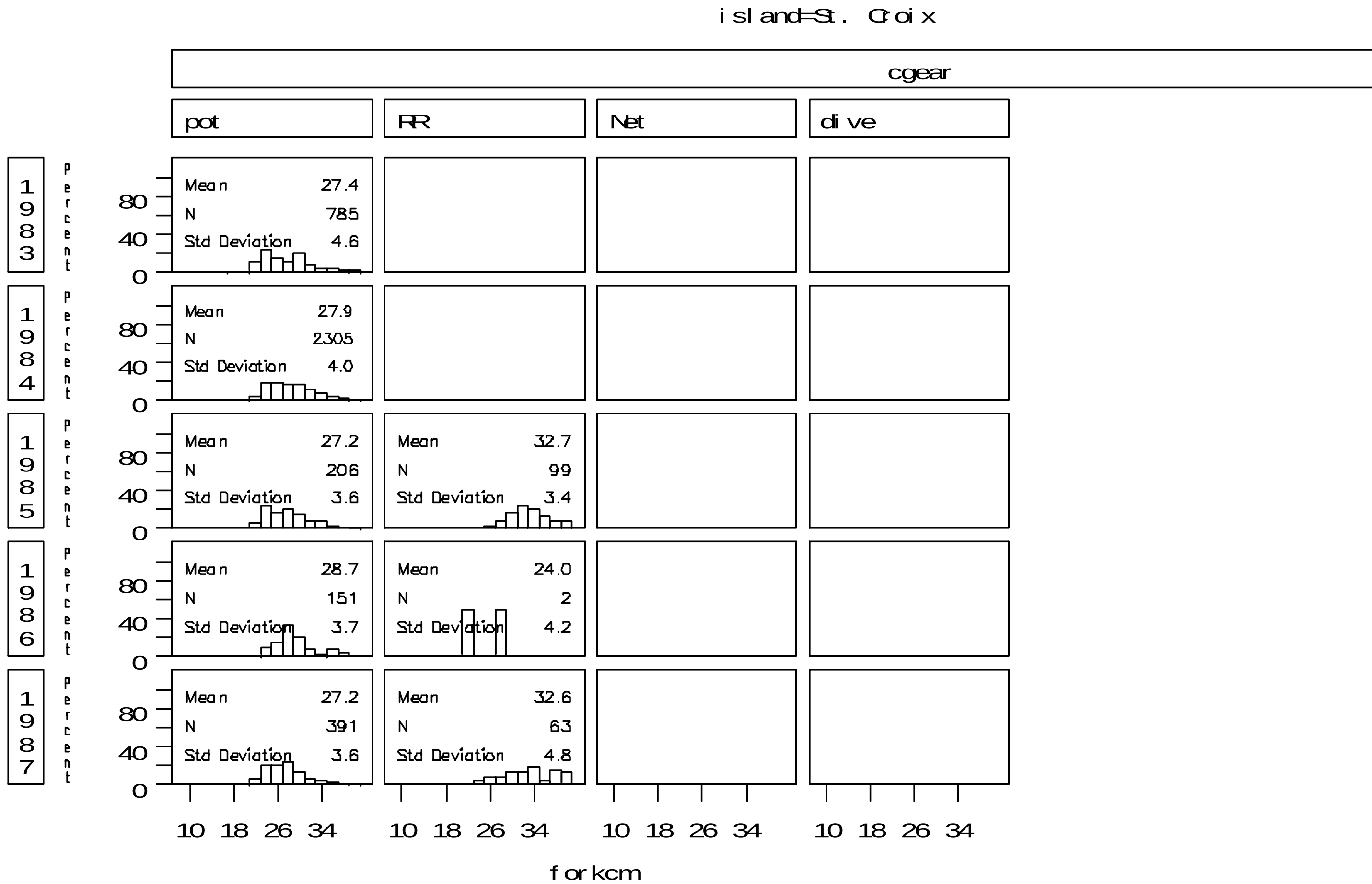


Figure 7—St. Croix Size Frequency from TIP 1983-1987
Distribution of yellowtail snapper commercial catch size frequency samples 1983-1987 by fishing gear. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

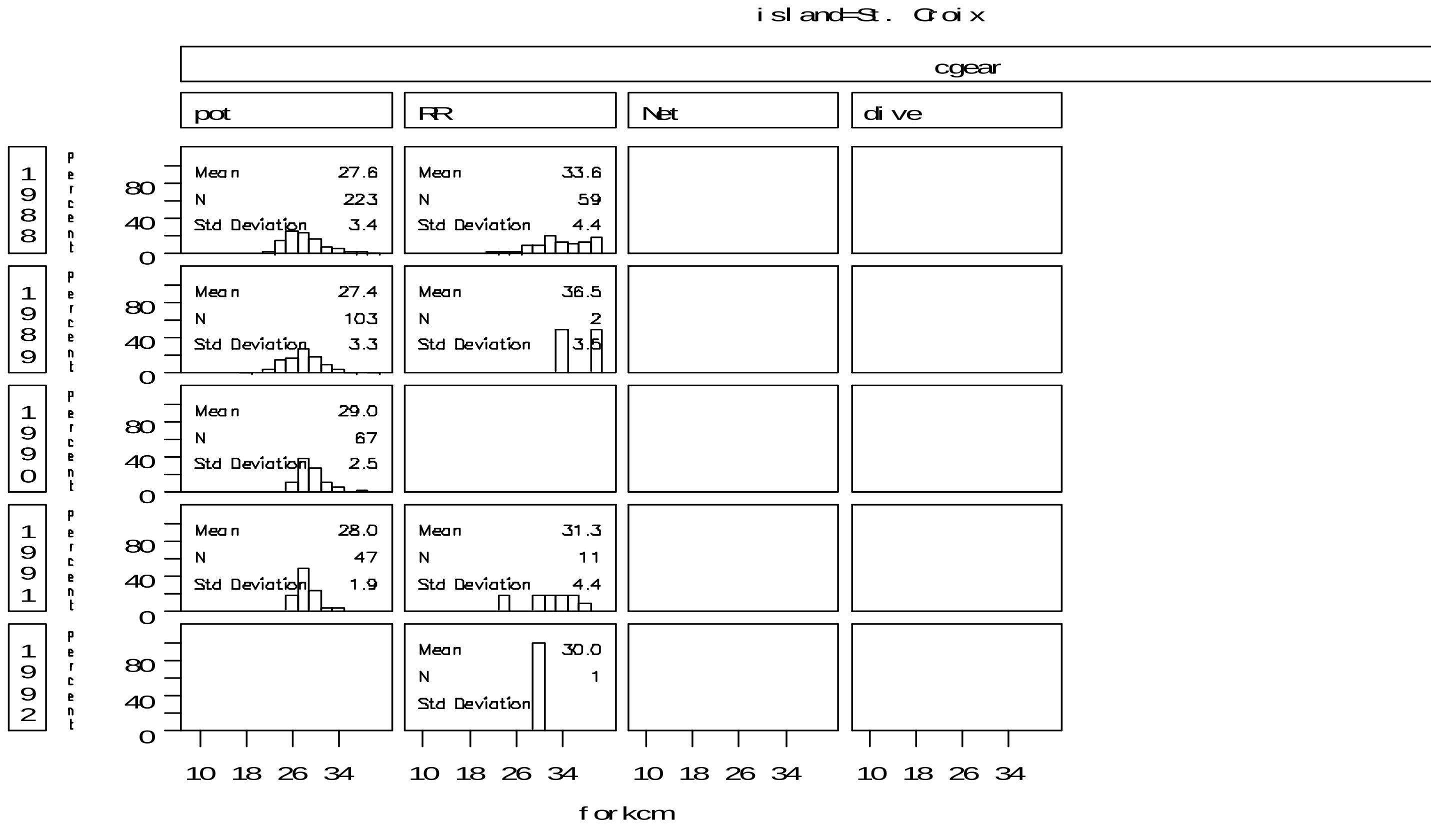


Figure 8—St. Croix Size Frequency from TIP 1988-1992
Distribution of yellowtail snapper commercial catch size frequency samples 1988-1992 by fishing gear in St. Croix. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

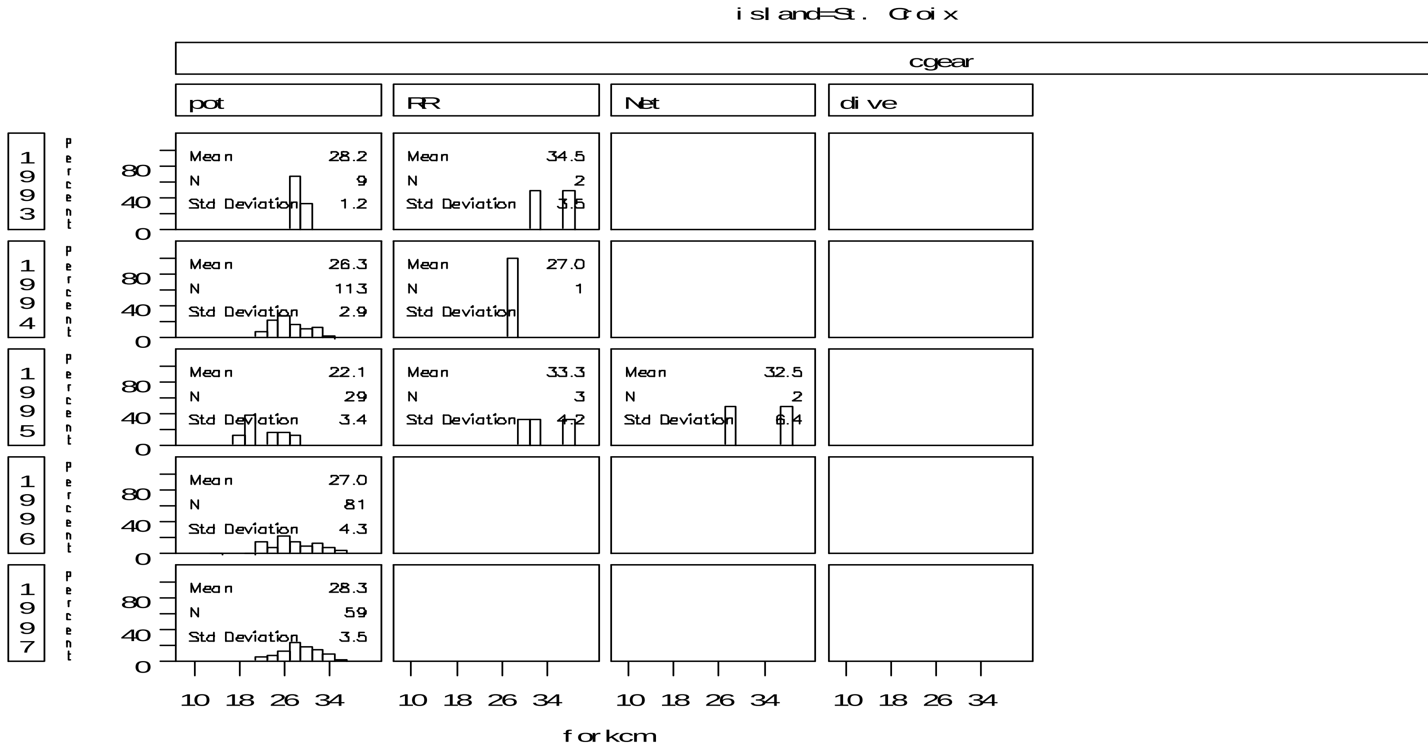


Figure 9—St. Croix Size Frequency from TIP 1993-1997
Distribution of yellowtail snapper commercial catch size frequency samples 1993-1997 by fishing gear in St. Croix. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

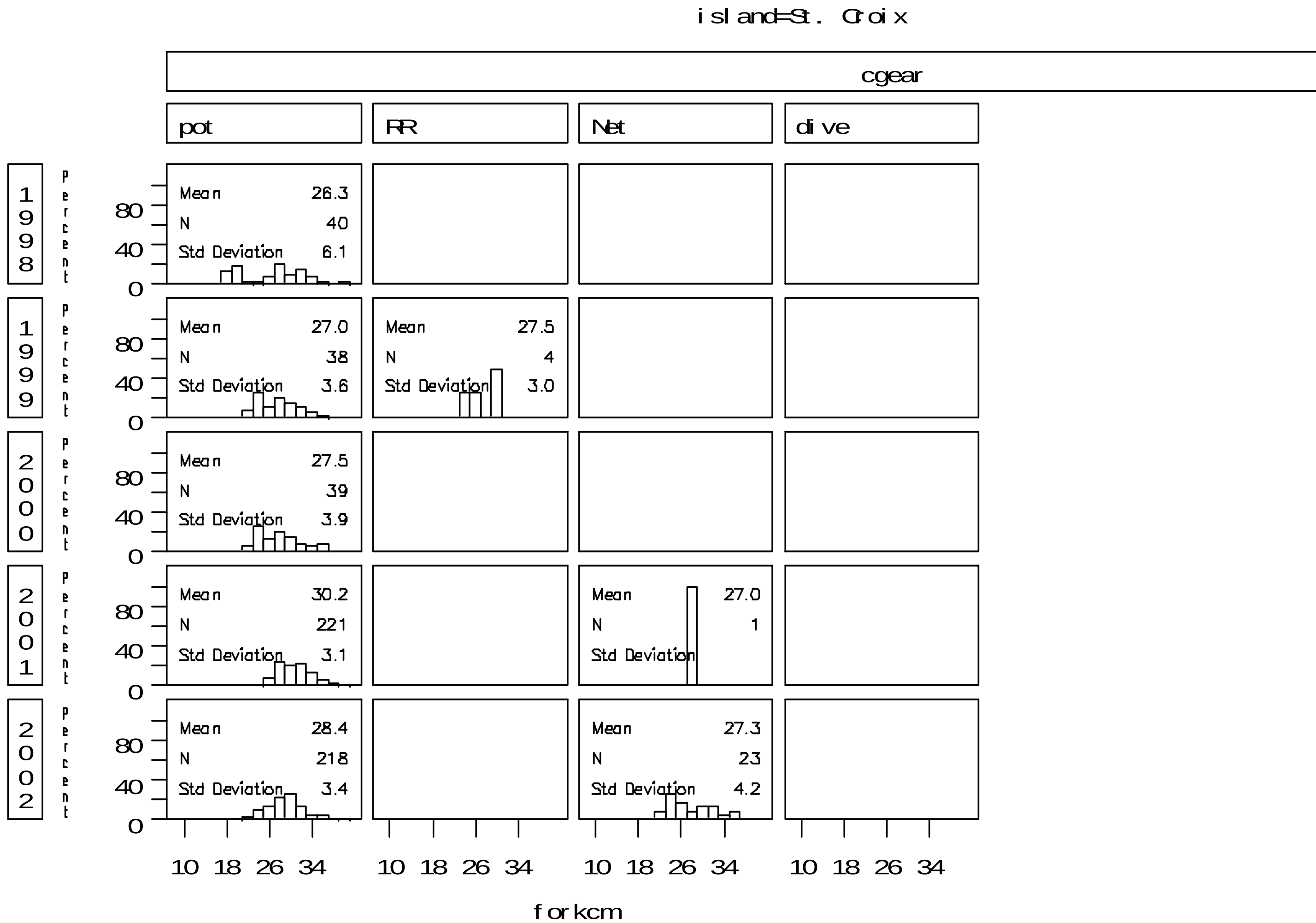


Figure 10—St. Croix Size Frequency from TIP 1998-2002

Distribution of yellowtail snapper commercial catch size frequency samples 1998-2002 by fishing gear in St. Croix. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

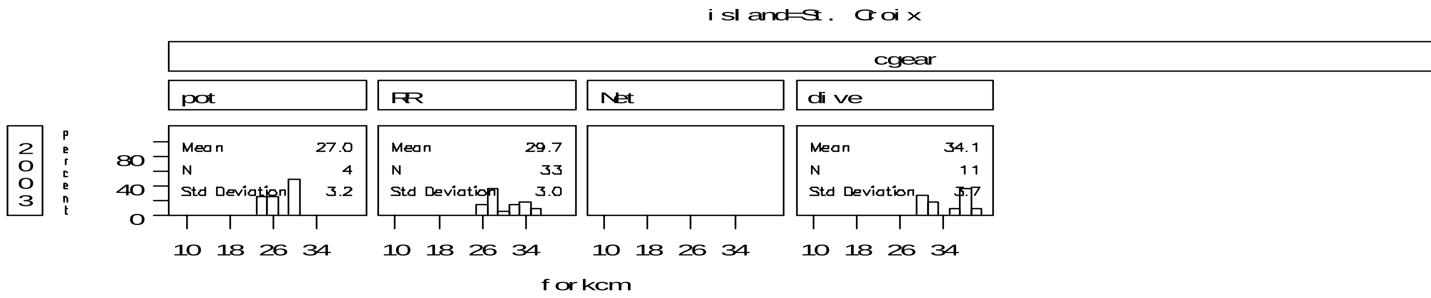


Figure 11—St. Croix Size Frequency from TIP 2003
Distribution of yellowtail snapper commercial catch size frequency samples 2003 by fishing gear. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

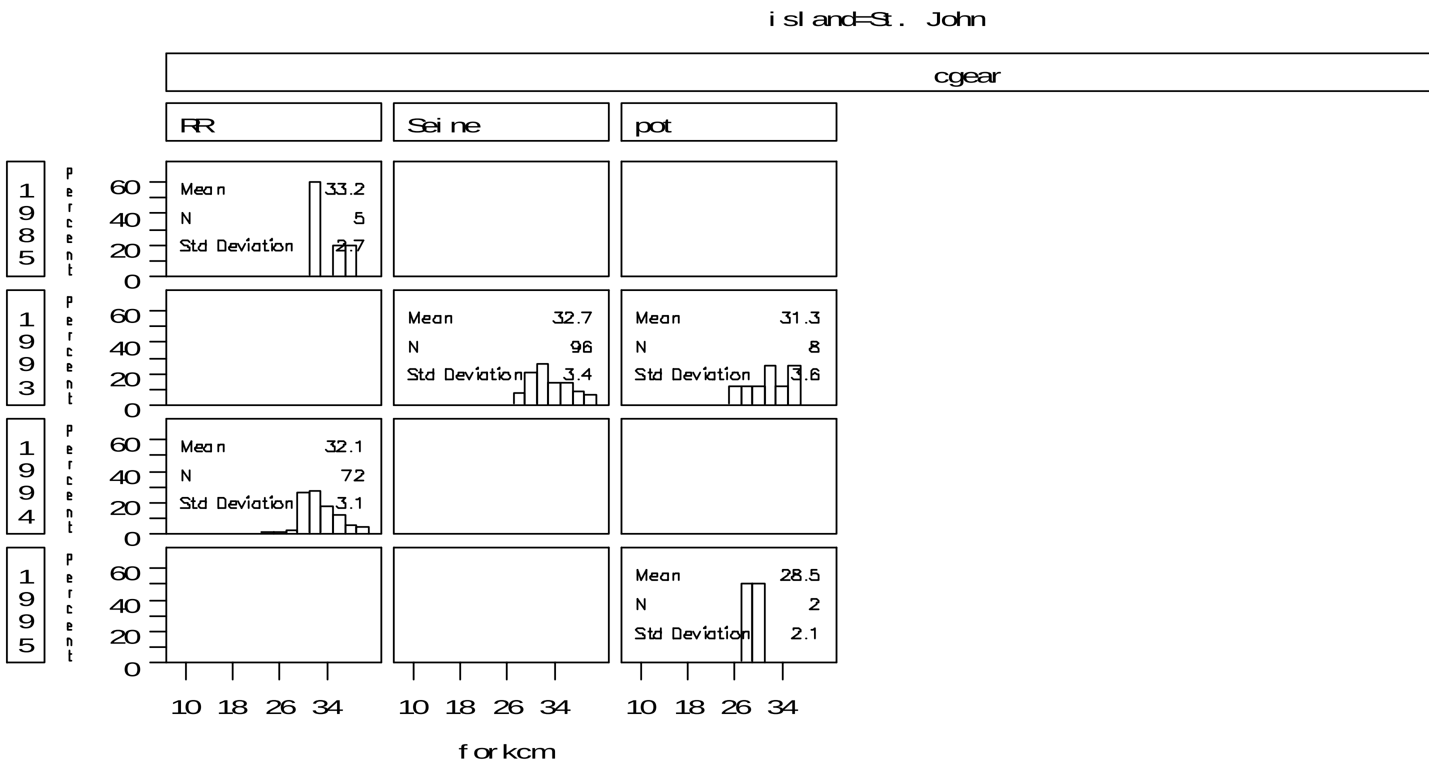


Figure 12—St. John Size Frequency from TIP 1983-1995
Distribution of yellowtail snapper commercial catch size frequency samples 1983-1995 by fishing gear in St. John. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

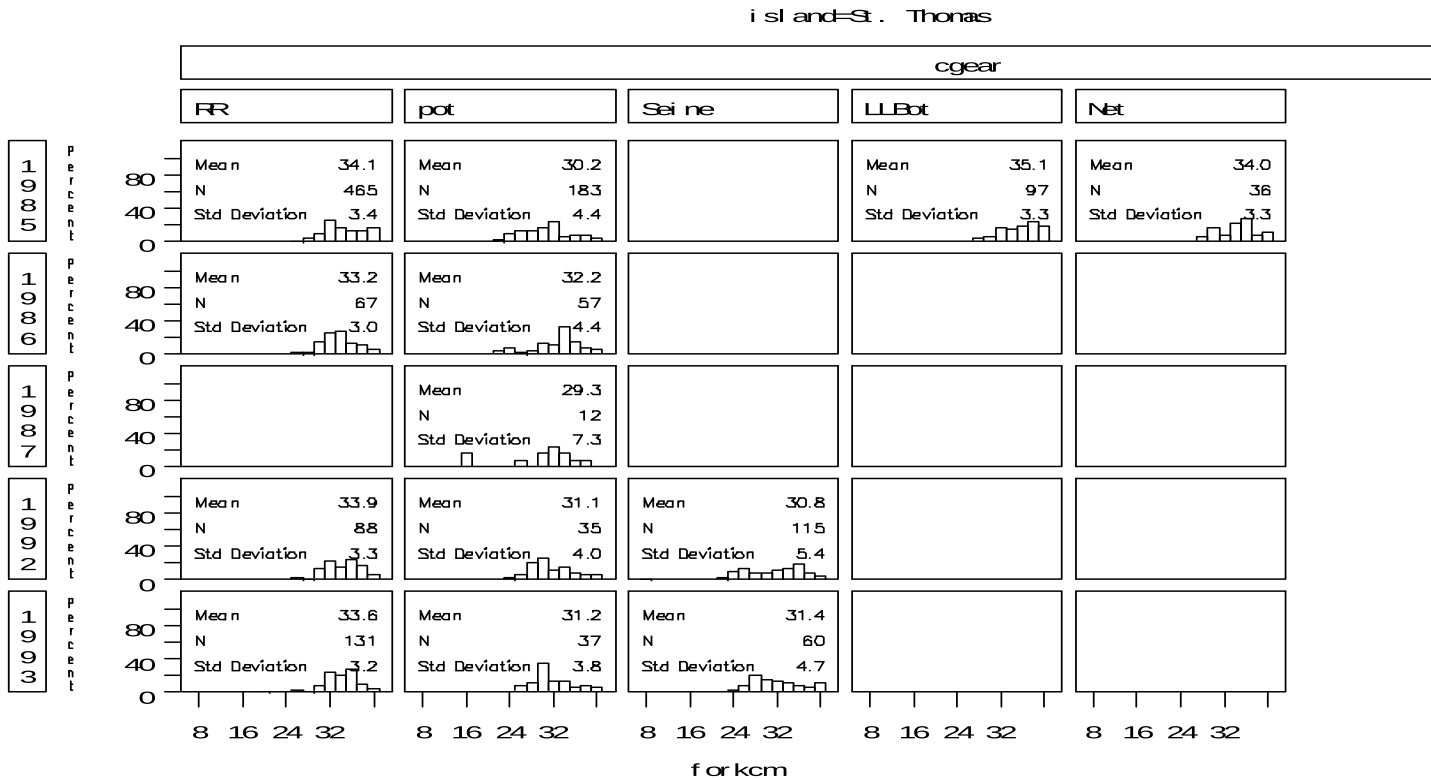


Figure 13—St. Thomas Size Frequency from TIP 1983-1993
Distribution of yellowtail snapper commercial catch size frequency samples 1983-1993 by fishing gear in St. Thomas. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

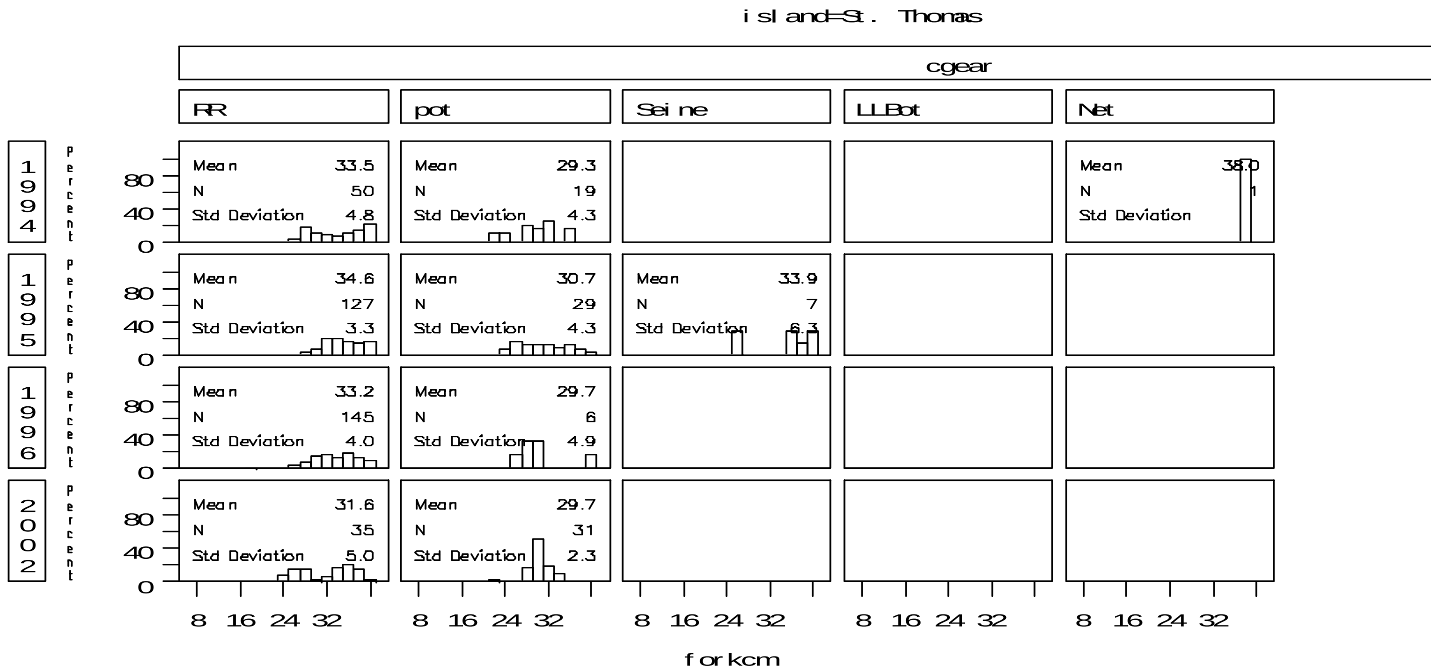


Figure 14—St. Thomas Size Frequency from TIP 1994-2002
Distribution of yellowtail snapper commercial catch size frequency samples 1994-2002 by fishing gear in St. Thomas. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

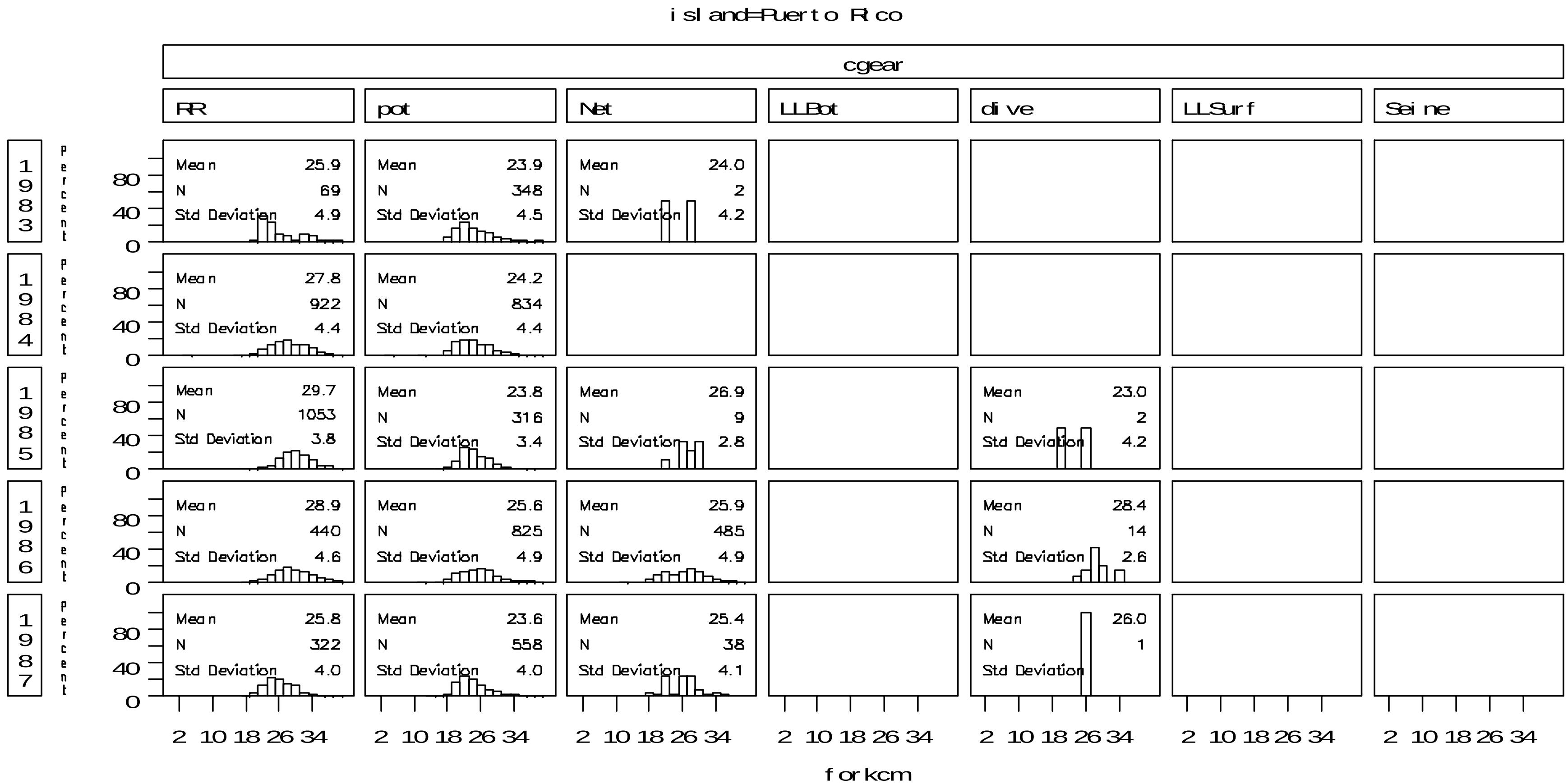


Figure 15—Puerto Rico Size Frequency from TIP 1983-1987

Distribution of yellowtail snapper commercial catch size frequency samples in Puerto Rico 1983-1987. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

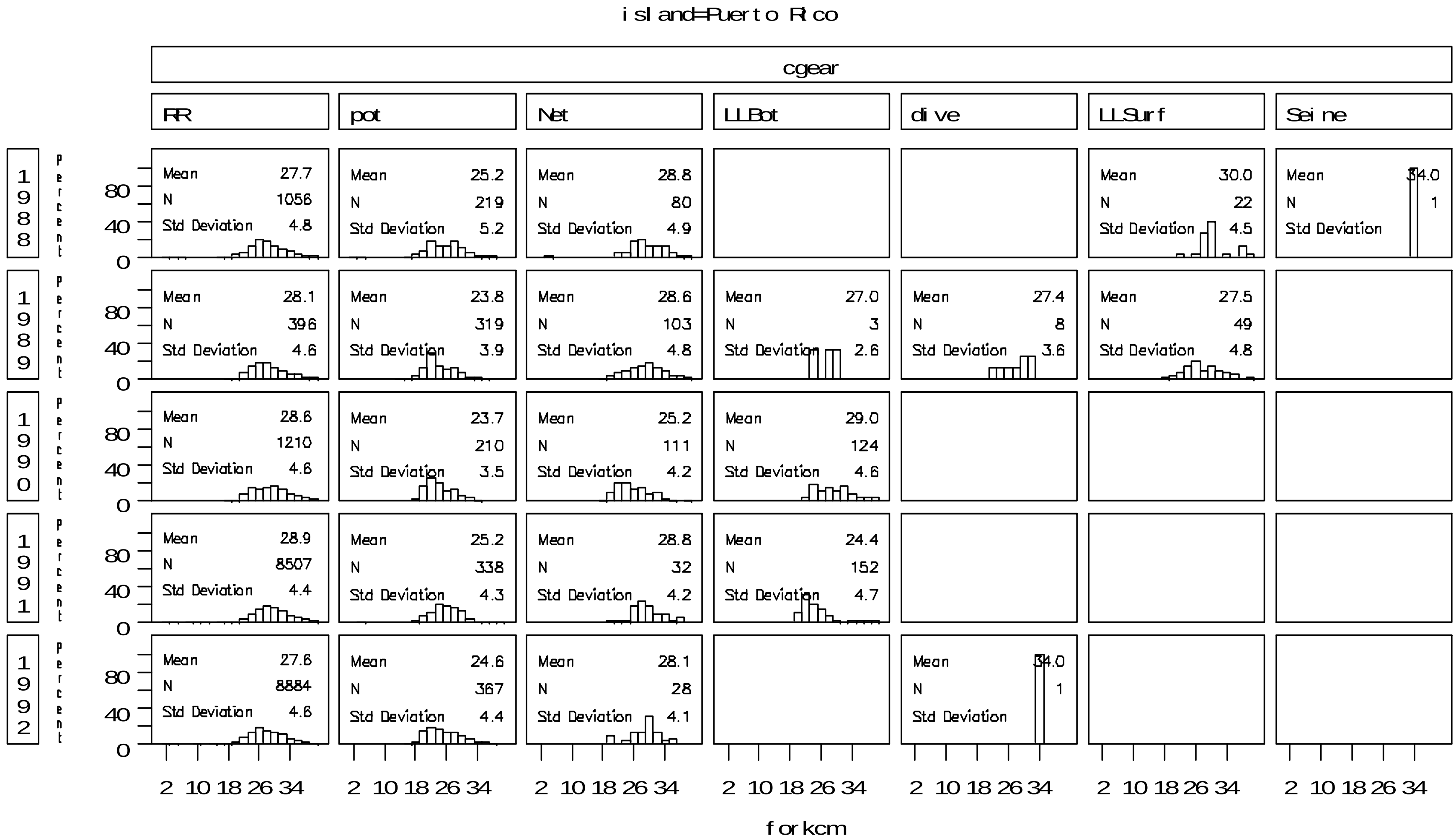


Figure 16—Puerto Rico Size Frequency from TIP 1988-1992
Distribution of yellowtail snapper commercial catch size frequency samples in Puerto Rico 1988-1992. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

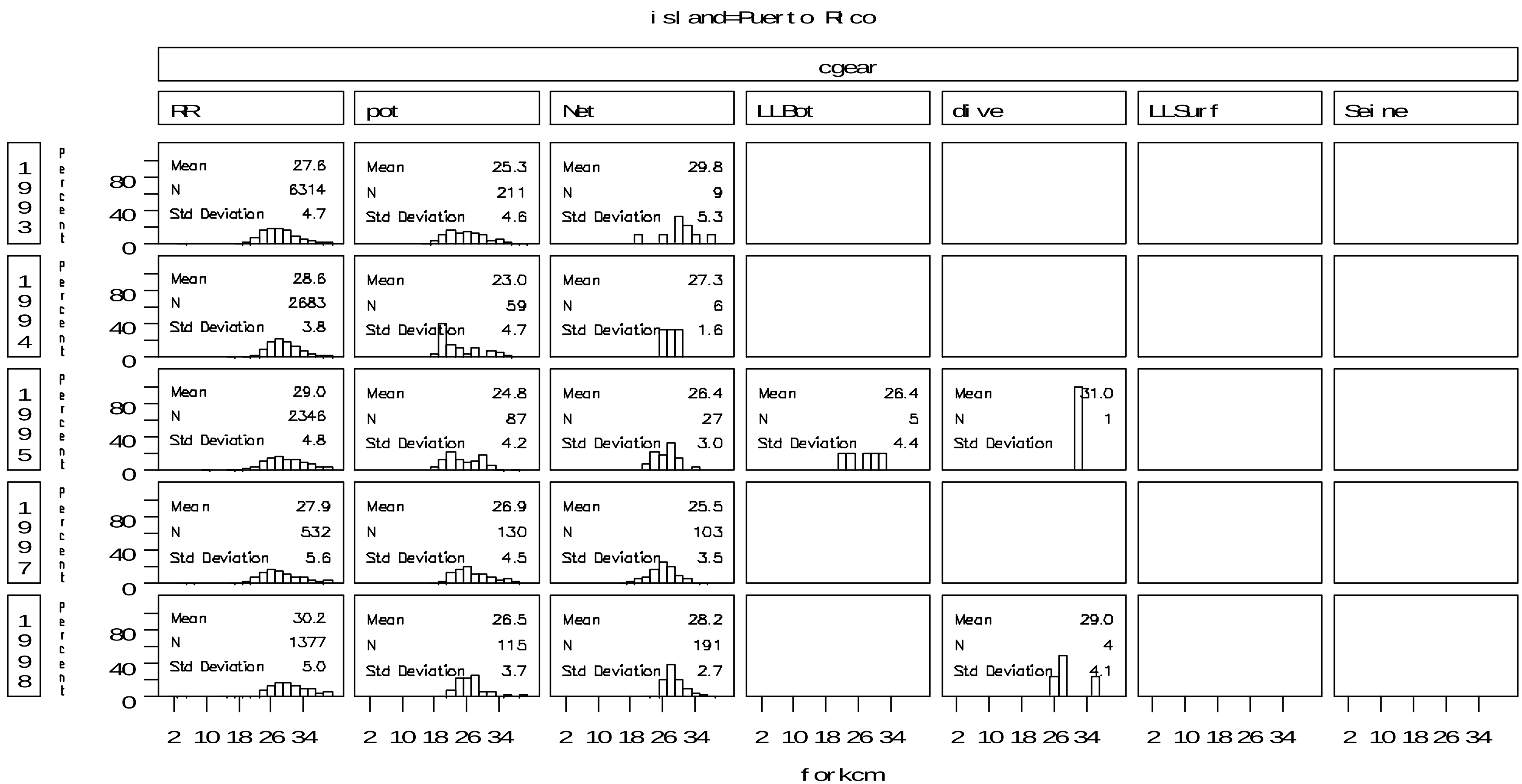


Figure 17—Puerto Rico Size Frequency from TIP 1993-1998
Distribution of yellowtail snapper catch size frequency samples in Puerto Rico 1993-1998. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.

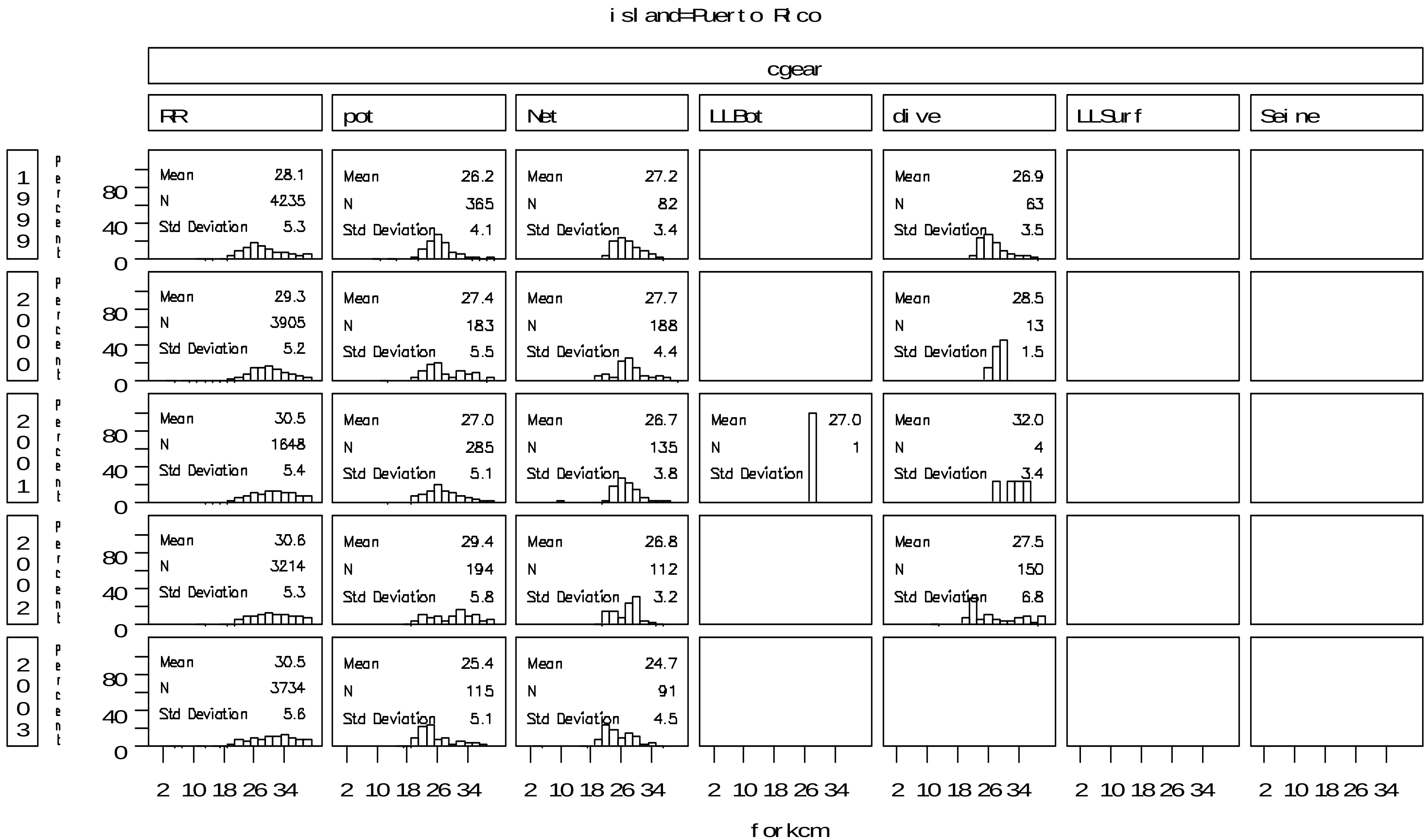
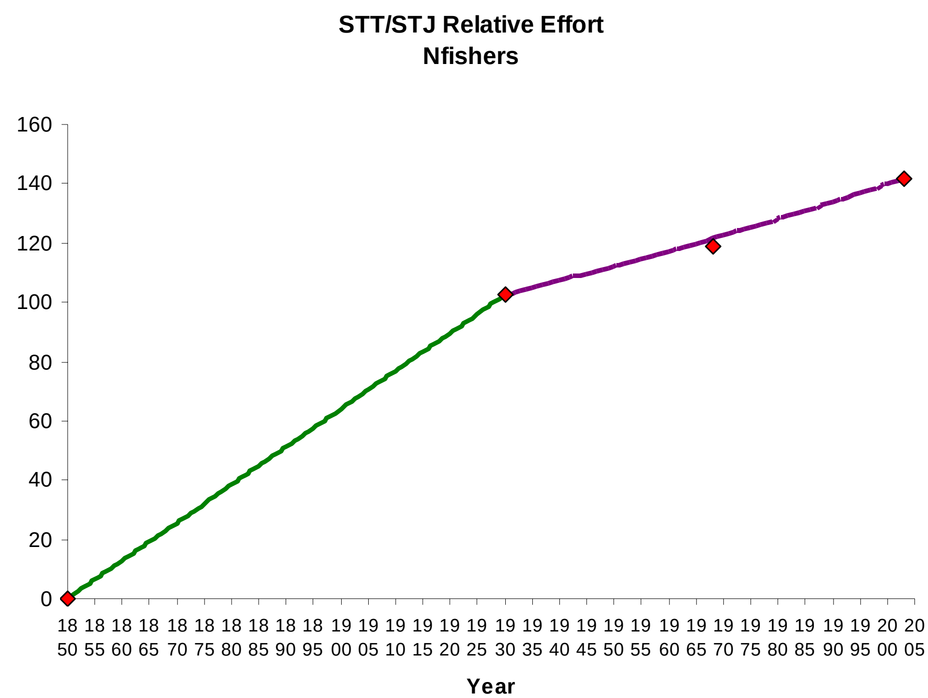


Figure 18—Puerto Rico Size Frequency from TIP 1998-2003

Distribution of yellowtail snapper catch size frequency samples in Puerto Rico 1998-2003. Federal minimum size rule of 8 inches TL (approx 6.5" FL) enacted 1985 increasing to 12" TL (approx. 9" FL) in 1989.



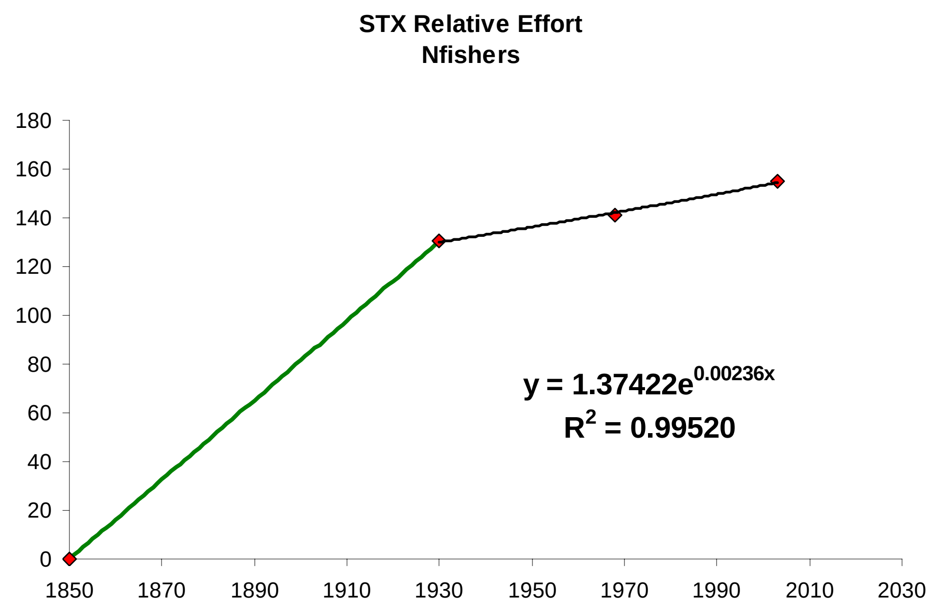
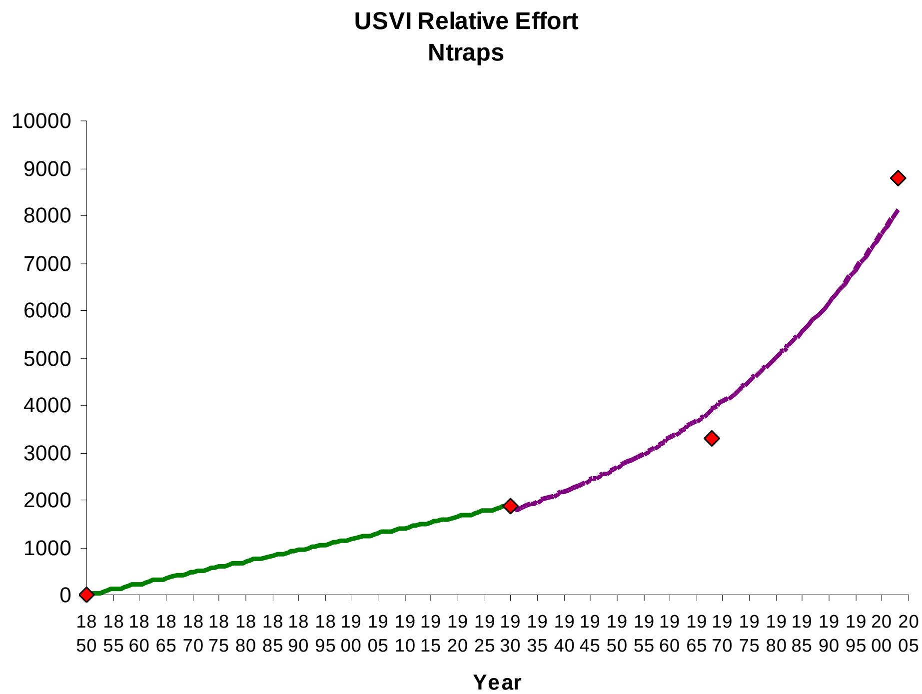


Figure 19—US Virgin Islands Effort for Catch-Free Model Based on Number of Fishers
Platform-specific estimates of historic relative effort trend based on the number of fishers as reported in Kojis (2004). An exponential trend was fit to the three survey points (1930, 1968, 2003) and a straight line connects the first survey point (1930) to the origin (assumes zero effort at virgin conditions).



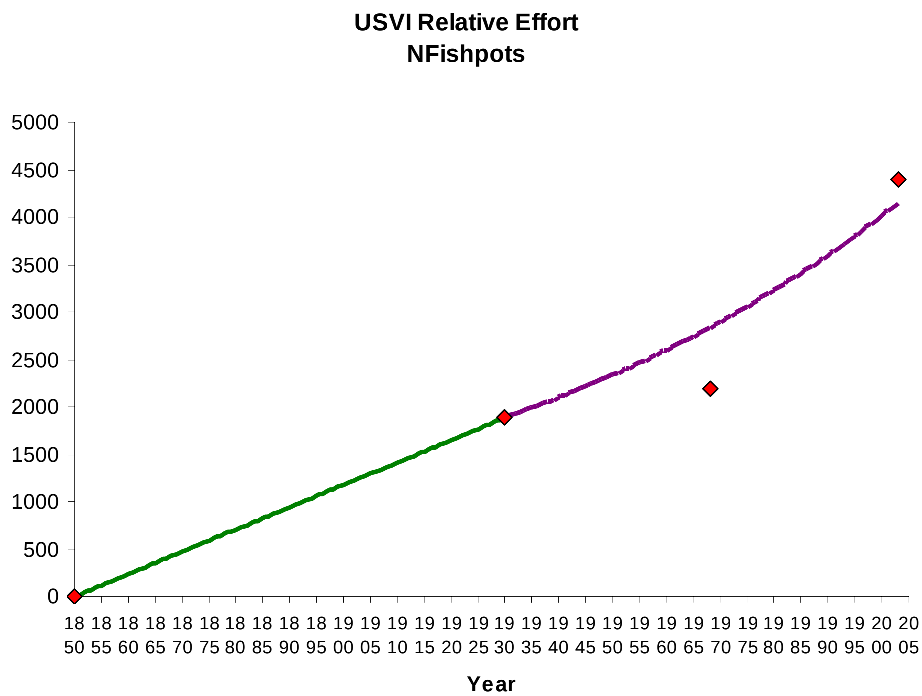
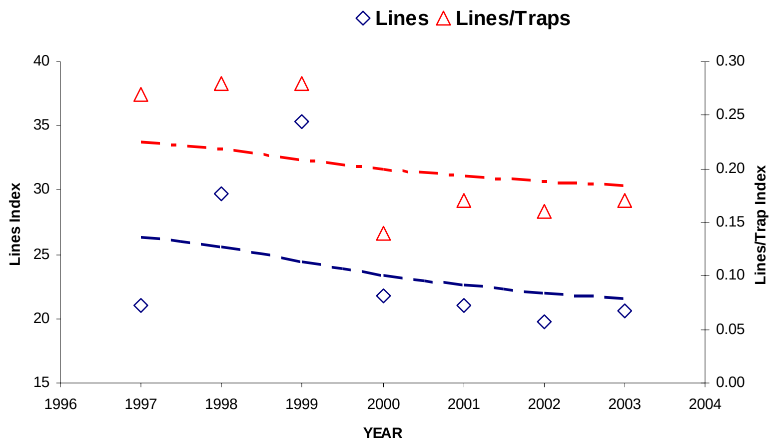
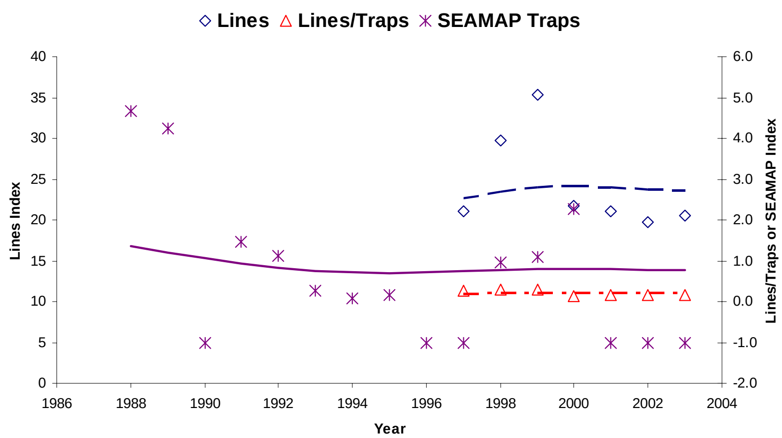


Figure 20— US Virgin Islands Effort for Catch-Free Model Based on Number of Traps
Historic relative effort for the USVI based on the total number of traps (fish pots + lobster traps; top panel) or the number of fish pots (bottom panel) as reported in Kojis (2004). An exponential trend was fit to the three survey points (1930, 1968, 2003) and a straight line connects the first survey point (1930) to the origin (assumes zero effort at virgin conditions).





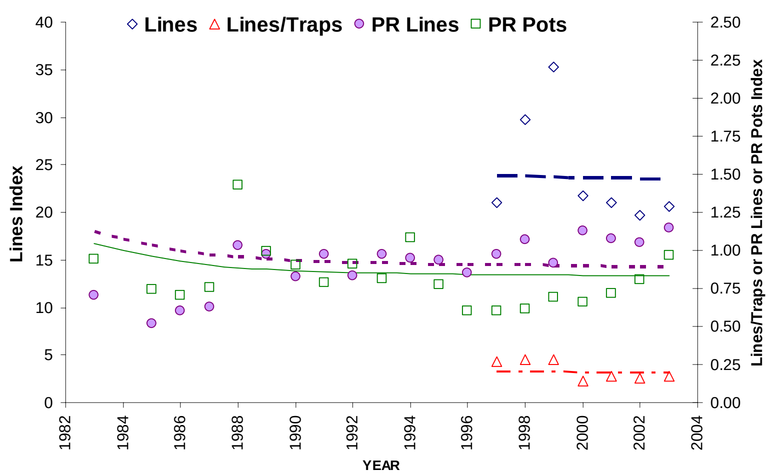
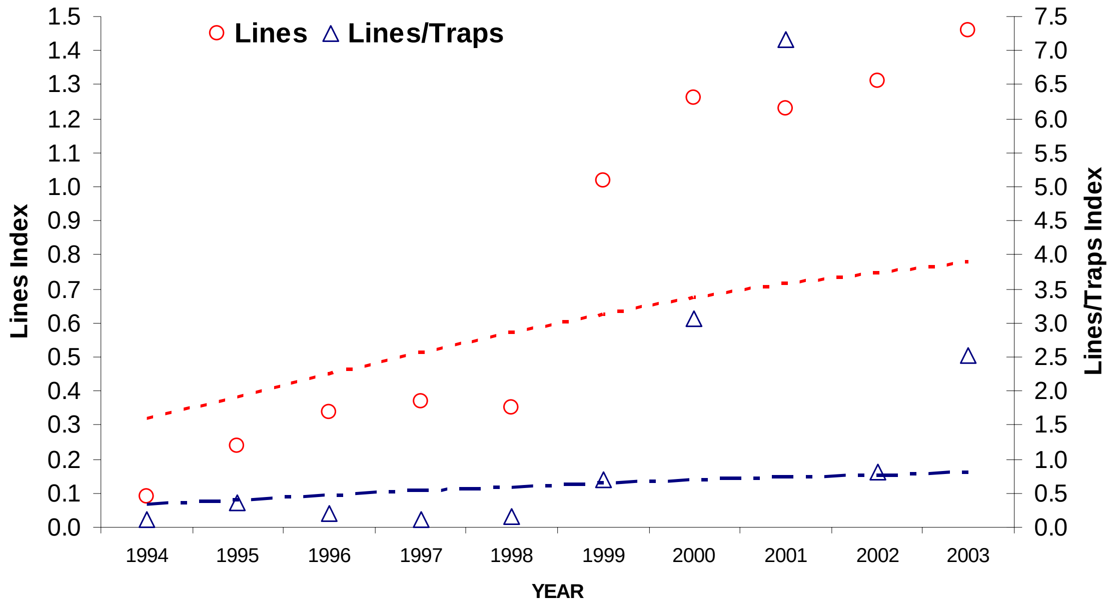


Figure 21—Catch-Free Model Fit for St. Thomas, St. John, and Puerto Rico

Fits to indices for the northern platform model runs. These models used historic effort based on number of fishers, and the index of population decline was truncated in 1975. Lines and Lines/Traps refer to St. Thomas/St. John commercial fisheries, while PR Lines and PR Pots are Puerto Rico commercial fisheries. SEAMAP refers to the SEAMAP trap index.



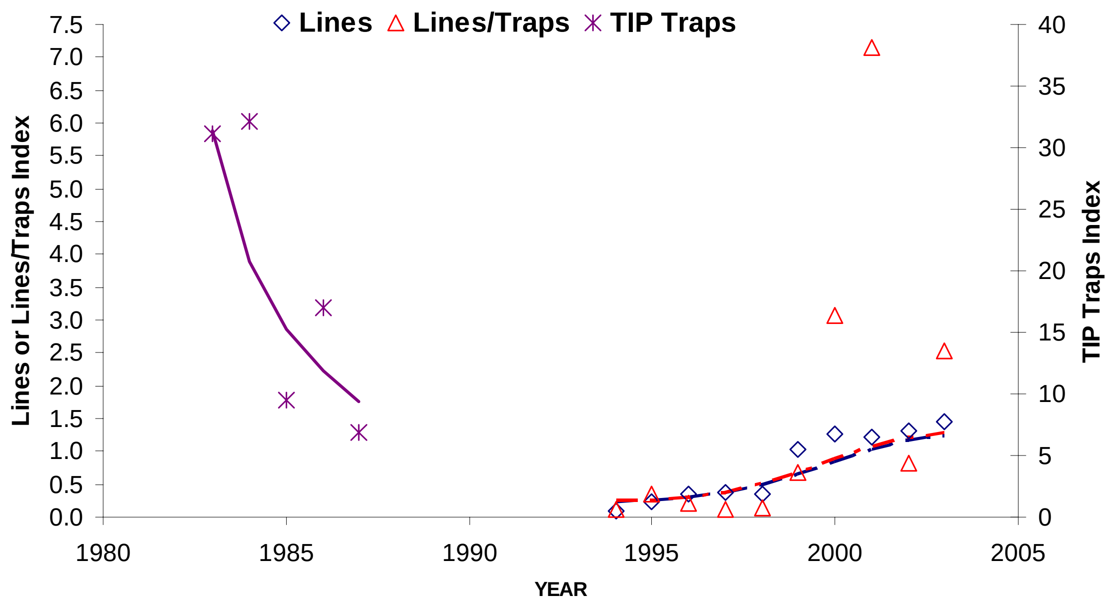
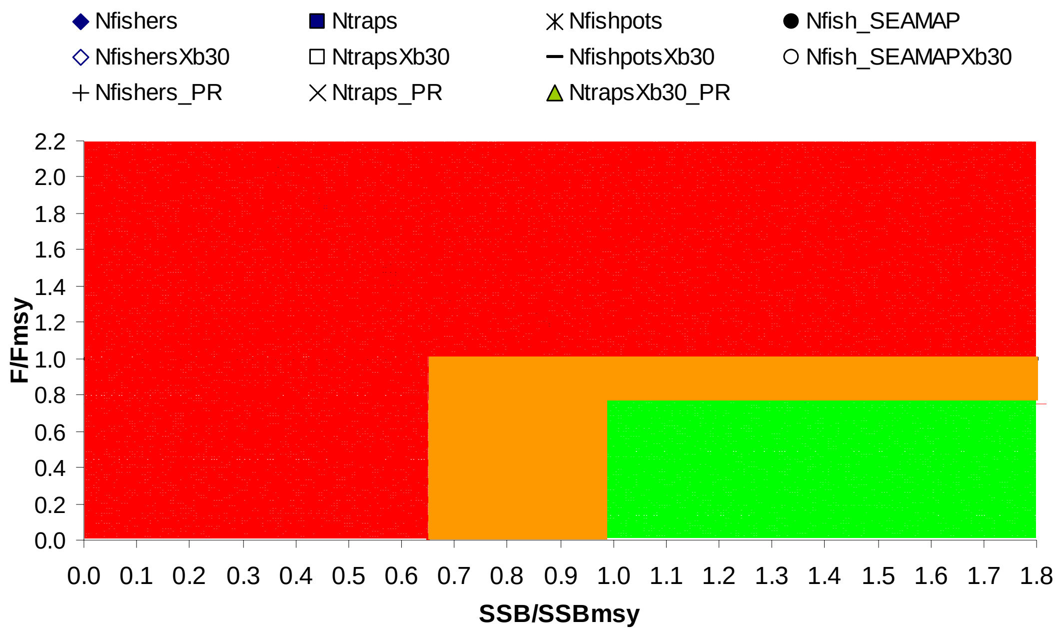


Figure 22— Catch-Free Model Fit for St. Croix
Fits to indices for the St. Croix platform model runs. These models used historic effort based on number of fishers, and the index of population decline was truncated in 1975. Lines and Lines/Traps refer to St. Croix commercial fisheries, and TIP comes from the TIP survey of trap samples.



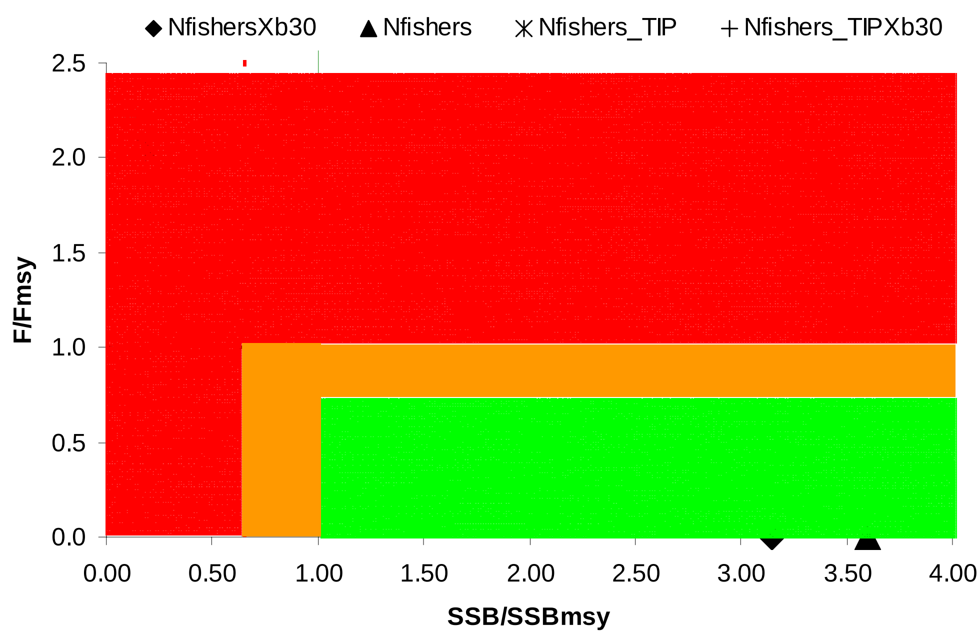


Figure 23—Stock Status from Various Runs of Catch-Free Model
Phase-plot of stock status for the Puerto Rico platform (top panel) and St. Croix platform (bottom panel). The legend key indicates effort treatment (Nfishers, Ntraps, or Nfishpots). When the index of population decline was truncated in 1930, legend names are followed by "Xb30". Sensitivity trials including additional indices are indicated in the legend name as well (SEAMAP and PR for Puerto Rico platform, and TIP for the St. Croix platform). Colored regions on the phase plot indicate: management action is needed (red), no management action is needed (green), or, approaching conditions where management action may be needed (orange).

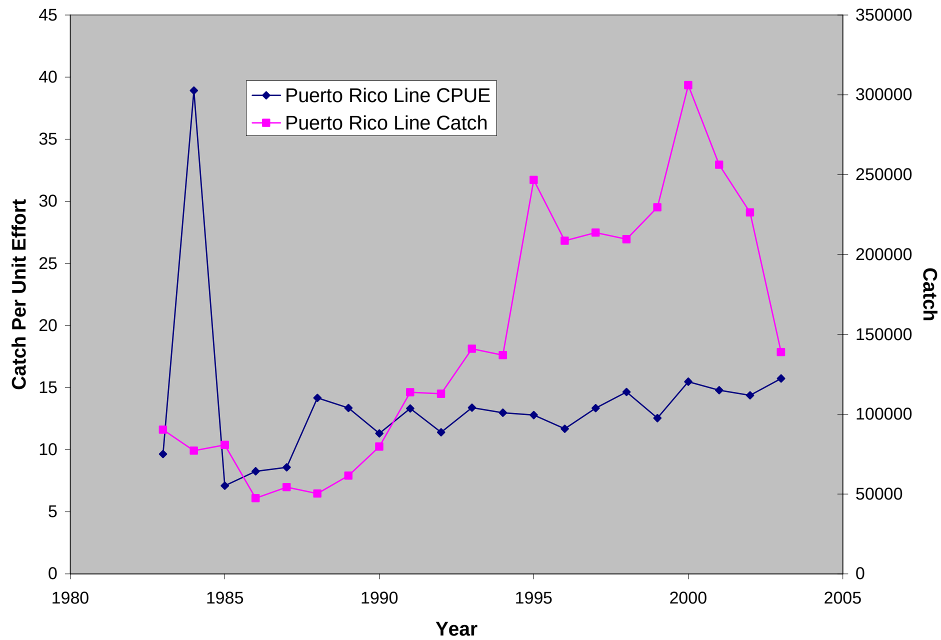


Figure 24—ASPIC Puerto Rico Data Input from Handlines
Catch and Catch Per Unit Effort for the Puerto Rico Line Fleet. From Cummings and Matos-Caraballo (SEDAR8-DW-08).

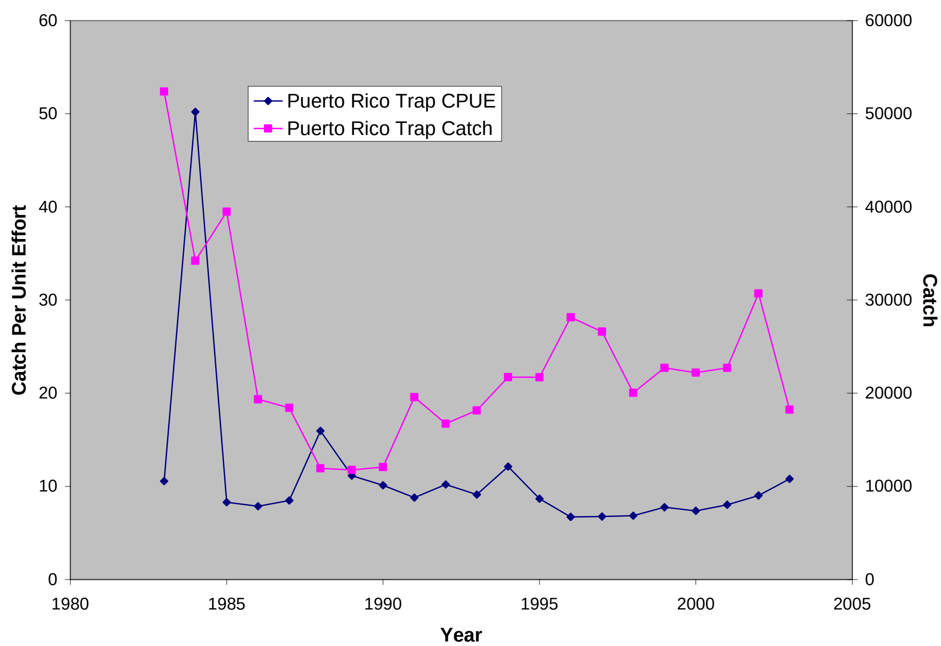


Figure 25—ASPIC Puerto Rico Data Input from Traps
Catch and Catch Per Unit Effort for the Puerto Rico Trap Fleet. From Cummings and Matos-Caraballo (SEDAR8-DW-08).

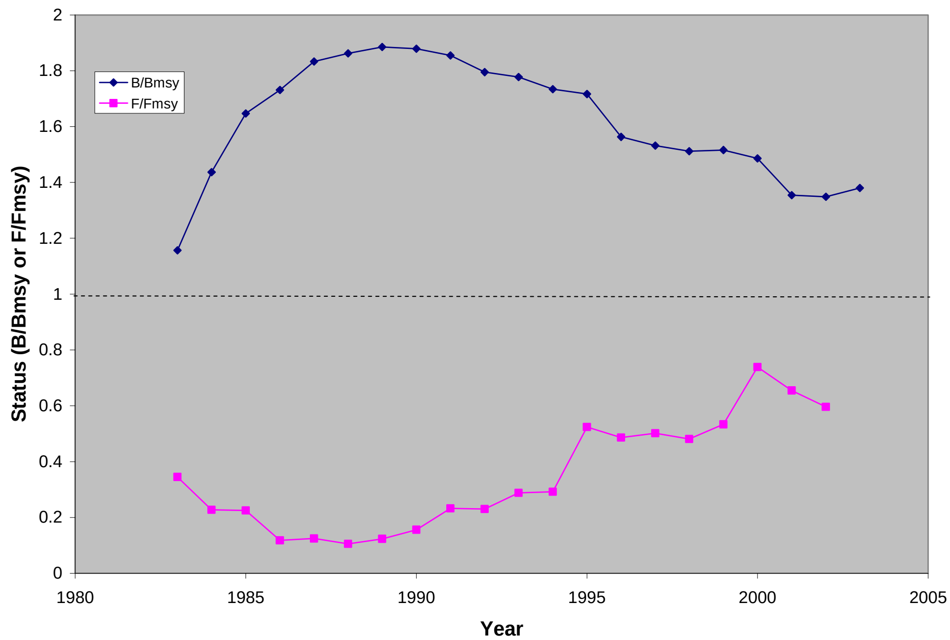


Figure 26—ASPIC Puerto Rico Trajectories
Abundance and fishing mortality rate trajectories for Puerto Rico Yellowtail Snapper.

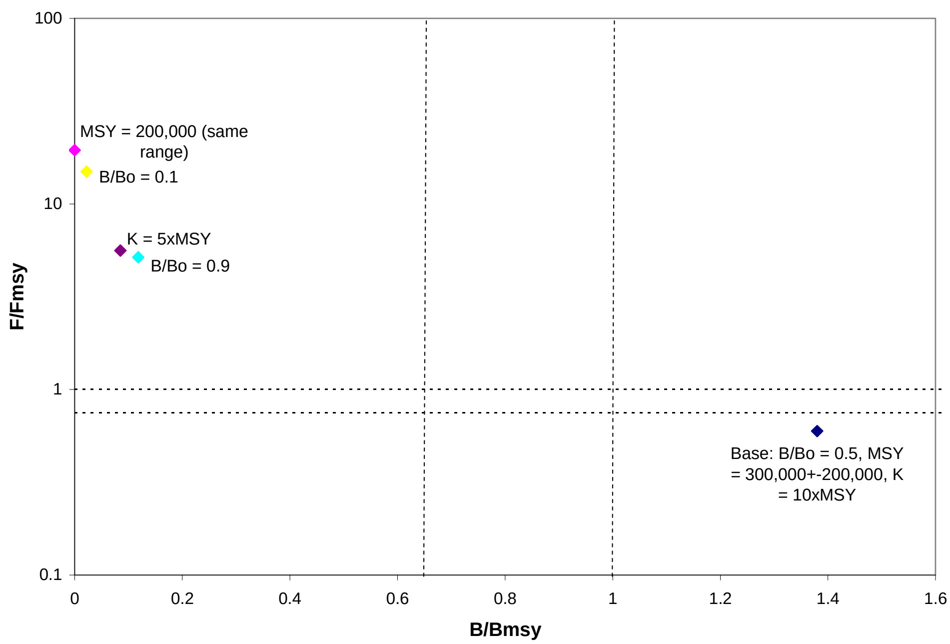


Figure 27—ASPIC Puerto Rico Status with All Data
Abundance (B/B_{MSY}) and fishing mortality rates (F/F_{MSY}) for Puerto Rico yellowtail snapper. Abundance estimates from 2003 and fishing mortality rate estimates from 2002. Color code: Red—management action is required; Green—no management action is necessary; Orange—approaching conditions where management action would be needed.

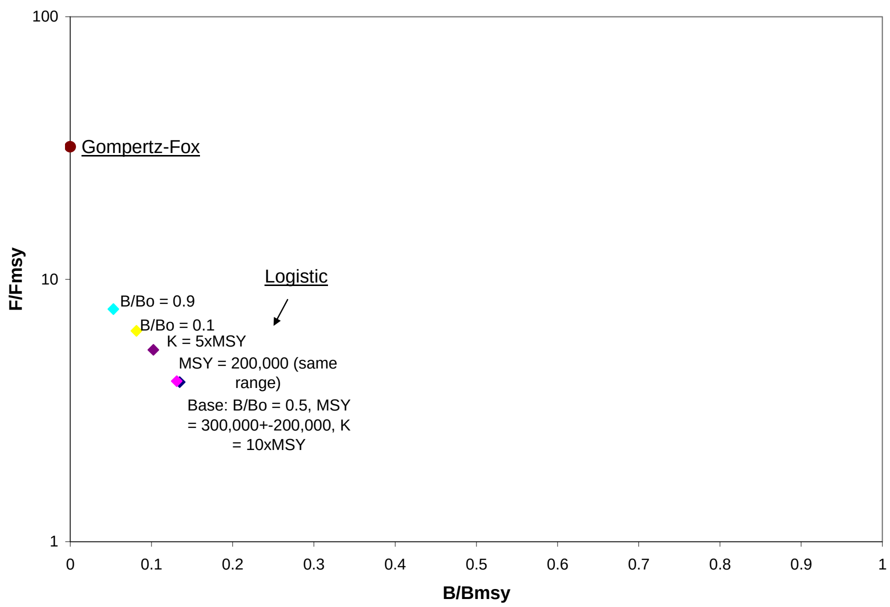


Figure 28—ASPIC Puerto Rico Status without 1984 CPUE
Abundance (B/B_{MSY}) and fishing mortality rates (F/F_{MSY}) for Puerto Rico yellowtail snapper without 1984 CPUE. Abundance estimates from 2003 and fishing mortality rate estimates from 2002. Color code: Red—management action is required; Green—no management action is necessary; Orange—approaching conditions where management action would be needed.

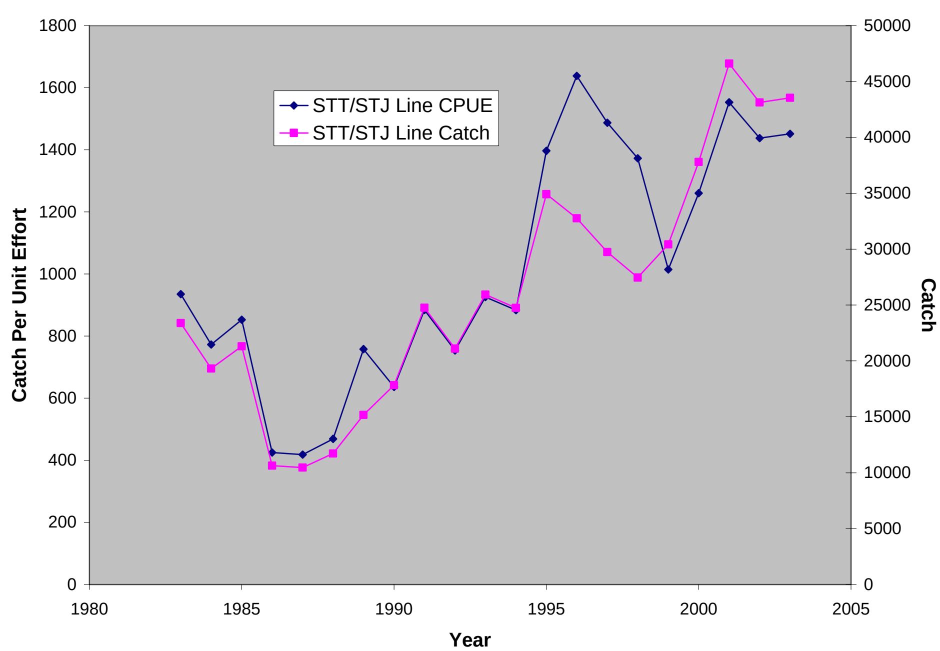


Figure 29—ASPIC St. Thomas/St. John Data Input
Catch and Catch Per Unit Effort for the St. Thomas/St. John Line Fleet. Effort reported from St. Thomas fishers who participated in the assessment workshop. Catches extrapolated from TIP sampling but with potentially substantial inaccuracies, as discussed in the text.

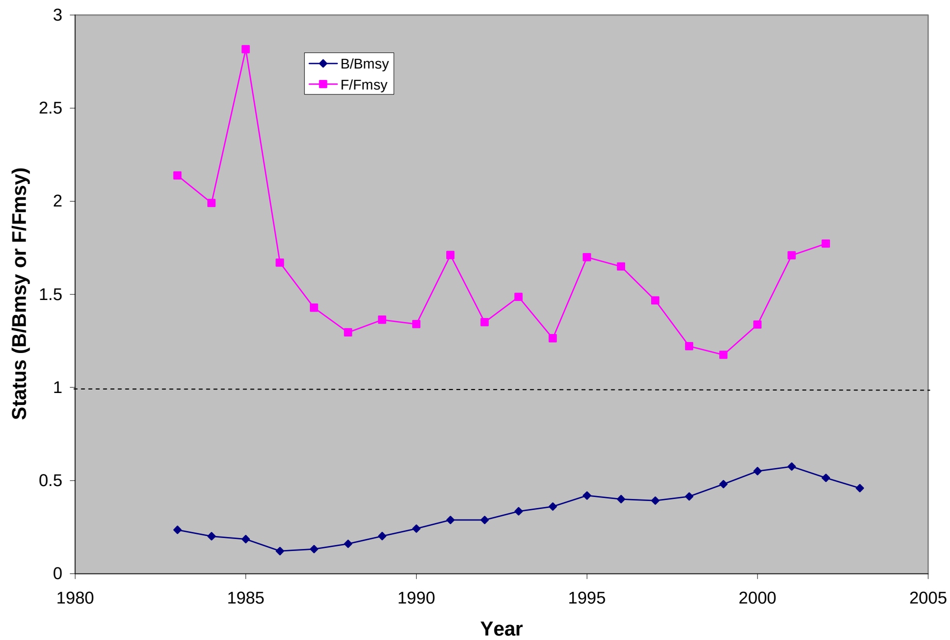


Figure 30—ASPIC St. Thomas/St. John Trajectories
Abundance and fishing mortality rate trajectories for St. Thomas/St. John Yellowtail Snapper.

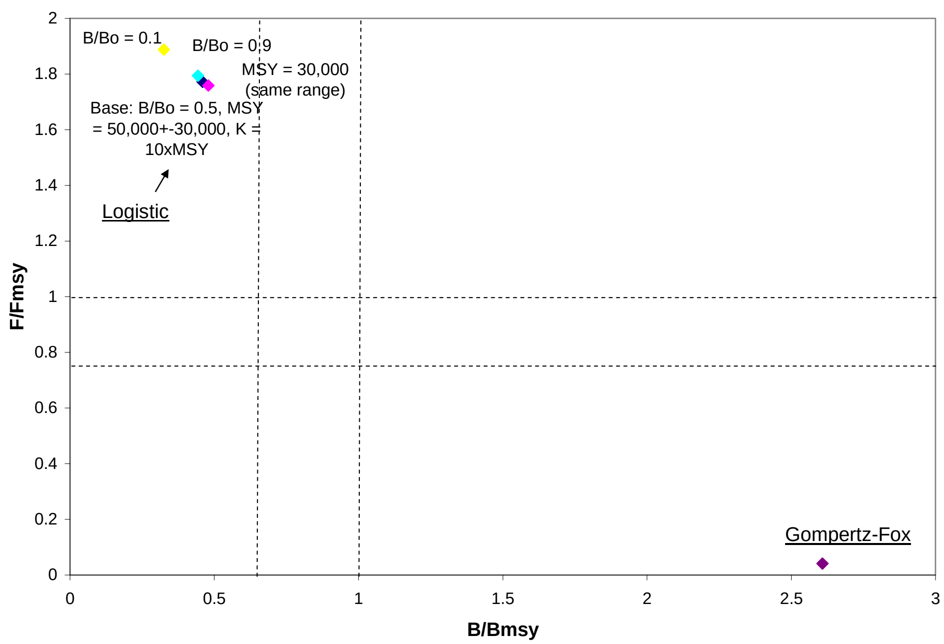


Figure 31—ASPIC St. Thomas/St. John Status
Current Estimates of Abundance and Fishing Mortality Rates for St. Thomas/St. John Yellowtail Snapper. Abundance (B/Bmsy) estimates from 2003 and fishing mortality rate (F/Fmsy) estimates from 2002, both scaled relative to MSY levels. Colored regions on the phase plot indicate: management action is needed (red), no management action is needed (green), or, approaching conditions where management action may be needed (orange).

SEDAR 8

Stock Assessment Report I

Caribbean Yellowtail Snapper

SECTION IV. Review Workshop

SEDAR
1 Southpark Circle # 306
Charleston, SC 29414

Consensus Summary Report

Caribbean yellowtail snapper (*Ocyurus chrysurus*)
Caribbean spiny lobster (*Panulirus argus*)
South Atlantic – Gulf of Mexico spiny lobster (*Panulirus argus*)

Prepared by the SEDAR 8 Review Panel for:

Caribbean Fishery Management Council
Gulf of Mexico Fishery Management Council
South Atlantic Fishery Management Council

Edited by Andrew I. L. Payne for
SEDAR 8, 16-20 May 2005
San Juan, Puerto Rico

Executive summary

The SEDAR 8 Review Workshop met in San Juan, Puerto Rico, from 16 to 20 May 2005. The Panel itself comprised the Chair and a reviewer appointed by the CIE, four US technical experts, the SEDAR facilitator, and two stakeholder representatives. All documentation, including background documentation provided to earlier Data and Assessment Workshops, was provided to the Panel in good time for prior review, and was comprehensive for the job in hand.

The meeting considered three stocks, Caribbean yellowtail snapper, Caribbean spiny lobster, and South Atlantic – Gulf of Mexico spiny lobster. Able presenters had been assigned by the Assessment Workshops and went to great trouble to explain the background behind and the output from the assessments. For only one of these stocks, South Atlantic – Gulf of Mexico spiny lobster, were extensive additional runs requested during the meeting. Discussions for all three stocks focused on the assessments and what they meant in terms of the Review Workshop's Terms of Reference, the documentation of relevant comments about them, derivation of suggestions for future research and monitoring, and canvassing of stakeholder opinion. Finally, some time was spent evaluating the SEDAR assessment process in full, as requested.

For Caribbean yellowtail snapper, the data were deemed insufficient to provide a signal to underpin management advice, though the assessment methodology itself was sound. The importance of well-designed, systematic, long-term targeted research programs needed to construct adequate time-series of catch and abundance indices was stressed. Currently, it seems that data quality control independent of the data collection process has not been effectively realized, and validation of historical and future collections is urgently needed. Partnerships with fishermen are clearly one way to achieve this, and the need to look at the stock as part of a species assemblage or community was noted. Of the many research suggestions made, highest priority was assigned to the carrying out of fishery-independent surveys, the collection of more catch data, including specifically the recreational fishery, and the collection of age and length data from commercial and recreational catches and from fishery-independent surveys.

For Caribbean spiny lobster, the data were also deemed currently insufficient to provide the required management advice, though again the methodology applied was sound. The Panel noted that the data series could seemingly be split into two components, before and after about 1992, and focused much discussion on why this might be and how best to model it in future. Additional factors and modifications to the modelling approach were proposed for consideration in an attempt to understand better the dynamics of the population, and high priority was suggested be assigned to the creation of a standardized recruitment index. Other priority research and monitoring included incorporating historical data into existing data sets, and utilizing refined models (better to identify viable hypotheses). Partnerships with fishermen were again proposed to facilitate the data collection process.

In respect of South Atlantic – Gulf of Mexico spiny lobster, the data and assessments were accepted, as was the base-case ICA model of stock dynamics. Several further runs were requested and provided, but overall the base-case results were considered the best and not likely to be unreliable. Some time was spent discussing relative stock status with respect to overfished levels and the importance of this stock in terms of the whole population in the Western Atlantic. The various stocks likely primed each other with larvae and recruits. There was also strong support to re-establish an observer program for the commercial trap fishery. Other research priorities should include a broadening of the fishery-independent indices of abundance, the provision of improved growth information, perhaps through tagging, and *modelling of various scenarios covering a range of hypotheses concerning recruitment and changes in gear selectivity, as well as suitable performance indicators.*

Comments on the SEDAR assessment process stressed: the need for better communication with and dissemination of information to stakeholders; the need for an advanced plan for assessments and a comprehensive glossary of terms; the continuity of personnel throughout each workshop process, in terms of stakeholders perhaps finding new ways of ensuring their participation; incorporation of fishermen's knowledge into the assessment process better; the need to maximize the time for preparing data series; the importance of independence in the review process, though not solely through CIE-contracted reviewers; and the importance of providing for the Review Panel an executive summary for substantive documents, a succinct table of model parameters, and if appropriate a table of management options.

1. Introduction

1.1 Time and Place

The SEDAR 8 Review Workshop met in San Juan, Puerto Rico, from 16 to 20 May 2005.

1.2 Terms of Reference for the Review Workshop

1. Evaluate whether data used in the analyses are treated appropriately and are adequate for assessing the stocks; state whether or not the input data are scientifically sound.
2. Evaluate the adequacy, appropriateness, and application of the methods used to assess the populations; state whether or not the methods are scientifically sound.
3. Recommend appropriate or best-estimated values of population parameters such as abundance, biomass, and exploitation.
4. Evaluate the adequacy, appropriateness, and application of the methods used to estimate stock status criteria (population benchmarks such as MSY, F_{msy}, B_{msy}, MSST, MFMT). State whether or not the methods are scientifically sound.
5. Recommend appropriate values for stock status criteria.
6. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status and, if appropriate, evaluate stock rebuilding; state whether or not the methods are scientifically sound.
7. Recommend probable values for future population condition and status.
8. Ensure that all desired and necessary assessment results (*as listed in the SEDAR Stock Assessment Report Outline*) are clearly and accurately presented in the Stock Assessment Report and that such results are consistent with the Review Panel's consensus regarding adequacy, appropriateness, and application of the data and methods.
9. Evaluate the Data and Assessment Workshops with regard to fulfilling their respective Terms of Reference and state whether or not the Terms of Reference for previous workshops are adequately addressed in the Data Workshop and Stock Assessment Report sections;
10. Develop recommendations for future research for improving data collection and stock assessment.
11. Prepare a Consensus Report summarizing the peer review Panel's evaluation of the reviewed stock assessments and addressing these Terms of Reference. (Drafted during the Review Workshop with a final report due two weeks after the workshop ends.)

1.3 List of Participants

Participants	Affiliation
Review Panel:	
Andrew Payne	CIE, Chair
Paul Medley	CIE, Reviewer
Richard Appeldoorn	University of Puerto Rico
James Berkson	NOAA Fisheries/RTR Unit
Edward Schuster	St Croix Fisheries Advisory Cttee
Simon Stafford	GMFMC Advisory Panel
Ian Stewart	NOAA Fisheries/NWFSC
Doug Vaughan	NOAA Fisheries/SEFSC
Presenters:	
Liz Brooks	NOAA Fisheries/SEFSC
Nancie Cummings	NOAA Fisheries/SEFSC
David Die	University of Miami, RSMAS
John Hunt	Florida FWC
Robert Muller	Florida FWC
Mike Murphy	Florida FWC
Josh Sladek Nowlis	NOAA Fisheries/SEFSC
Francisco Pagan	University of Puerto Rico
Jerry Scott	NOAA Fisheries/SEFSC
Monica Valle	University of Miami, RSMAS
Observers:	
Mark Drew	Nature Conservancy, St Croix
Michon Fabio	CFMC Advisory Panel
Tony Iarocci	SAFMC
Joe Kimmel	NOAA Fisheries SERO
Barbara Kojis	US Virgin Islands DFW
Jimmy Magner	St Thomas Fishermen’s Assn
Eugenio Pinero	CFMC
Julian Magras	St Thomas Fishermen’s Assn
John Merriner	NOAA Fisheries SEFSC
Miguel Rolon	CFMC
Roger Uwate	US Virgin Islands DFW
Roy Williams	GMFMC
Staff support:	
John Carmichael	SEDAR
Cynthia Morant	SAFMC
Lloyd Darby	SEFSC
Graciela Garcia-Moliner	CFMC

1.4 Review Workshop working papers

An impressive quantity of documentation was provided before the meeting by the facilitator. Much of this pertained to material provided to either the Data Workshop or Assessment Workshop for each of the three review species. However, specific material for the review workshop itself was also provided, and this is listed below.

NUMBER	TITLE	Author
	Working Papers	
SEDAR8-RW1	Further explorations of a stock production model incorporating covariates (ASPIC) for yellowtail snapper (*Ocyurus chrysurus*) in the US Caribbean	J. Sladek Nowlis
SEDAR8-RW2	Length frequency analysis of Caribbean spiny lobster (*Panulirus argus*) sampled by the Puerto Rico commercial Trip Interview Program (1980-2003)	S.D. Chormanski, D. Die, S. Saul
SEDAR8-RW3	Maturity of spiny lobsters in the US Caribbean	D. Die
	Supplementary Documents	
SEDAR8-RD24	Preliminary estimations of growth, mortality and yield per recruit for the spiny lobster *Panulirus argus* in St. Croix, USVI. *Proc. Gulf Carib. Fish. Inst.* 53: 59-75	I. Mateo, W.J. Tobias
SEDAR8-RD25	Population dynamics for spiny lobster *Panulirus argus* in Puerto Rico: Progress report. *Proc. Gulf Carib. Fish. Inst.* 55: 506-520	I. Mateo
	Assessment Reports	
SEDAR8-SAR1	Stock assessment report for Caribbean yellowtail snapper	J. Sladek Nowlis
SEDAR8-SAR2	Stock assessment report for Caribbean spiny lobster	J. Sladek Nowlis
SEDAR8-SAR3	Stock assessment report for South Atlantic – Gulf of Mexico spiny lobster	R. Muller, J. Hunt

2. Terms of Reference

2.1 Background

Generally, the Review Workshop is the third meeting in the SEDAR process, and this situation pertained to all three stocks reviewed during SEDAR 8. The Panel was pleased to be able to record that the terms of reference set for Data Workshops and Assessment Workshops for the three stocks were fully met, but there was some concern expressed that pressure may have been brought to bear on participants at some of those workshops to progress management further than was possible from the available data. Quite simply, data time-series, and in some cases recent basic biological data, were likely unable to support the development of meaningful assessments for the stocks just yet.

Notwithstanding, the Panel was impressed by the quantity and quality of the work that had gone into the various assessments. The presentations were well structured and clear, and the information provided through the presentations, and in response to questions, gave an excellent basis for the Panel's subsequent deliberations and conclusions.

2.2 Review of the Panel's deliberations

The deliberations on each species are presented in the form of responses to the terms of reference questions specifically, followed by relevant comments on the discussions, suggestions for future research, and stakeholder opinion, the last two not specifically in order of priority.

A. *Caribbean yellowtail snapper*

Terms of reference

1. Evaluate whether data used in the analyses are treated appropriately and are adequate for assessing the stocks; state whether or not the input data are scientifically sound.
The data were treated appropriately, but were not adequate yet for assessing the stocks.

2. Evaluate the adequacy, appropriateness, and application of the methods used to assess the populations; state whether or not the methods are scientifically sound.
The two methods were appropriate for exploring the potential for an assessment, but ultimately merely showed the inadequacy of the data. Nonetheless, the methods are scientifically sound, if given appropriate data.

3. Recommend appropriate or best-estimated values of population parameters such as abundance, biomass, and exploitation.
An acceptable assessment had not been developed, so appropriate population parameters were not produced.

4. Evaluate the adequacy, appropriateness, and application of the methods used to estimate stock status criteria (population benchmarks such as MSY, F_{msy}, B_{msy}, MSST, MFMT). State whether or not the methods are scientifically sound.
An acceptable assessment had not been developed, so estimates of stock status criteria were not produced.

5. Recommend appropriate values for stock status criteria.
An acceptable assessment had not been developed, so appropriate stock status criteria were not produced. Although a number of key reference points were provided (B_{msy}/B_0, SPR_{msy}, F_{msy} – given selectivity vector) and seem to be robust across the various models, they do not provide information on current stock status.

6. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status and, if appropriate, evaluate stock rebuilding; state whether or not the methods are scientifically sound.
No population projections were possible.

7. Recommend probable values for future population condition and status.
No population projections were made or possible, so probable values for future population condition and status were not produced.

8. Ensure that all desired and necessary assessment results (*as listed in the SEDAR Stock Assessment Report Outline*) are clearly and accurately presented in the Stock Assessment Report and that such results are consistent with the Review Panel's consensus regarding adequacy, appropriateness, and application of the data and methods.
All desired and necessary assessment results are clearly and accurately presented in the Stock Assessment Report for the species, but they are currently uninformative on stock status. These results are consistent with the Review Panel's consensus regarding adequacy, appropriateness, and application of the data and methods.

9. Evaluate the Data and Assessment Workshops with regard to fulfilling their respective Terms of Reference and state whether or not the Terms of Reference for previous workshops are adequately addressed in the Data Workshop and Stock Assessment Report sections.
The Data Workshop fulfilled its Terms of Reference. The Assessment Workshop fulfilled its Terms of Reference to the extent possible, given the limitations of the data.

10. Develop recommendations for future research for improving data collection and stock assessment.
See below the comments section.

<u>Comments</u>

The Review Panel offers the following comments regarding research needs and the data and assessment of yellowtail snapper.

1. Well-designed, systematic research programs are essential to providing the data necessary for effective management. Much of the research reviewed lacked the necessary sample sizes and regular (ongoing) data collection needed to construct an adequate time-series of catch and abundance indices.

2. The yellowtail snapper fishery is unique among Caribbean fisheries with regard to fishing methods and timing, and the needed research designs. It is an important fishery in the U.S. Caribbean. The design of data collection must take into account the unique aspects of the fishery, and therefore sampling effort will need to be either added or redirected to target yellowtail snapper more effectively.

3. A commitment to long-term research and data collection is essential for effective management. Short-term research and data collection are not the solution to the data

problems identified in this assessment. Long-term research and monitoring are necessary in the Caribbean, as in any other managed fishery. Based on the studies and data available, it is clear that the resources necessary to collect essential data are not currently available to support scientifically based management of yellowtail snapper in the region.

4. Throughout the region, data quality control independent of the data collection process has not been effectively realized. Validation of historical and future collections is needed for the data to be used appropriately for any type of assessment. Documentation of changes in data collection and management methods must be maintained and provided to those charged with conducting the assessments and reviews.

5. The Panel recognizes the significant effort that has been put into data collection in the region and emphasizes that, although the resulting data are insufficient for an assessment at this time, they will be useful for assessment in future when combined with additional data identified elsewhere in this report. Past efforts are not wasted, but rather their data will play an important role, providing the temporal contrast needed by assessment models. The recommendations below are offered as improvements to the current data collection, not as replacements.

6. The Panel strongly endorses the need to develop partnerships with local fishermen to conduct research and to collect needed data. Partnerships with the fishing community and other stakeholders are a cost-effective way to collect components of the data necessary for the assessment process. Currently, it is clear that there is a high level of interest in the fishing community to cooperate with management agencies in collecting data, and this partnership should be encouraged and strengthened. This would also facilitate ongoing cooperation and participation by fishermen in the management process, benefiting all involved.

7. Monitoring and assessment of yellowtail snapper should be undertaken with due consideration given to the species' importance in the overall species assemblage and community. Future ecosystem management will likely dictate such a course of action.

Recommendations for future data collection and research

Fishery-independent data

- A new independent sampling regime to target yellowtail snapper more effectively should be created, because current methods do not allow temporal or spatial coverage.
- Visual surveys can provide useful fishery-independent data. The methods would, however, vary, based on the depth of the insular shelf.
- The output of other existing studies (NOAA and non-NOAA) should be examined to see if alternative fishery-independent sampling already exists.

Life history data

- Fecundity data should be collected
- Maturity data should be collected
- Growth information should be collected
- The parameter natural mortality needs investigation on the basis of better data

Catch data

- Recreational catches need to be sampled and quantified better
- Information on trip species targeting is needed
- Information on the location of catches is sometimes not good, and should be improved
- Identification of species in the snapper complex in the US Virgin Islands is crucial to future assessments
- Historical data from the US Virgin Islands need to be collected from fishermen, if they exist
- Port samplers need to modify their schedules to target yellowtail snapper landings, and to sample sizes of the species need to increase
- TIP sampling in the US Virgin Islands needs to be revitalized

Age and length frequency data

- These are needed from all commercial catches
- These are urgently required from recreational catches
- Fishery-independent surveys can provide these crucial data

Genetic / otolith microchemistry studies

- Stock structure is important in assessments, and genetics and otolith microchemistry offer hope to unravel it in future

Spatially explicit studies

- Identification of spawning areas and the source of recruits is important
- Construction of habitat maps will help identify stratification for research designs
- Combination of habitat maps with fish counts and habitat models will aid in providing population estimates
- Development of a GIS map of yellowtail snapper landings throughout the species' geographical range could help in the production of a distribution map of catches

Mark-recapture studies

- This could help identify movements and migrations
- Fishing mortality estimates could be derived
- Population estimates would be enhanced with such studies
- Such studies could help solve the perplexing question of stock structure

Of the above, the Panel places the highest priority on the following, understanding the need to maximize the likelihood of generating an acceptable assessment of the stock in the near future:

- The carrying out of fishery-independent surveys
- Collection of more catch data, including specifically the recreational fishery
- The collection of age and length data from commercial and recreational catches and from fishery-independent surveys

Stakeholder opinion

- The need for robust education of fishermen and other stakeholders is acknowledged. Such education should be of a two-way nature and would potentially lead to an enhancement of their trust in the assessment and management process, especially if they were to become involved in research program design.
- The fact that most of the product in the yellowtail snapper fishery is sold retail and that there are no fish houses (at least in the US Virgin Islands) makes any meaningful future stock assessment in the region extremely dependent on cooperation with the local fishermen.
- A paucity of recent socio-economic information continues to hinder the development of integrated biological, economic, and social assessments.
- Partnerships with organizations such as NGOs, which are often staffed by highly qualified people and are perhaps also less constrained by political influence, can mobilize extra resources in meeting some of the research objectives.
- Biological and habitat/ecosystem research information is as important in the assessment process as catch data.
- Over the past 35+ years of fishing, yellowtail snapper abundance has remained stable.
- Detailed data (information) on yellowtail snapper catch are lacking for US Virgin Islands commercial landings. The lack of this type of data has introduced uncertainty into the determination of stock status. Therefore, collection of detailed catch information there is suggested as a top research priority.

B. *Caribbean spiny lobster*

<u>Terms of reference</u>

1. Evaluate whether data used in the analyses are treated appropriately and are adequate for assessing the stocks; state whether or not the input data are scientifically sound.
The data were treated appropriately, but they were not sufficiently informative to assess stock status. An alternative explanation is that the data may be inconsistent with the assumptions of the models being applied.

2. Evaluate the adequacy, appropriateness, and application of the methods used to assess the populations; state whether or not the methods are scientifically sound.
The methods were appropriate to explore the potential for an assessment, but ultimately were limited by the uninformative nature of the data. The Panel expressed some concern about the method used to standardize the stock abundance indices. The GLM and delta-lognormal approach is appropriate, but determining terms in the model based purely on statistical criteria can lead to bias in the index. Future assessment workshops need to reconsider how the various effects might influence an abundance index, and choose to test GLM terms accordingly.

3. Recommend appropriate or best-estimated values of population parameters such as abundance, biomass, and exploitation.
It had not been possible to produce an acceptable assessment so appropriate population parameters were not recommended.

4. Evaluate the adequacy, appropriateness, and application of the methods used to estimate stock status criteria (population benchmarks such as MSY, F_{msy}, B_{msy}, MSST, MFMT). State whether or not the methods are scientifically sound.
An acceptable assessment had not been developed, so estimates of stock status criteria were not produced.

5. Recommend appropriate values for stock status criteria.
An acceptable assessment had not been developed, so appropriate stock status criteria were not produced. Analysis of % catch under minimum size coupled with other YPR studies showed the current minimum size to be appropriate to maximize YPR, and trends in relative abundance indices and length distributions indicate some stability over the past 20 years, but these results do not provide information on stock status. YPR analyses suggest that the Caribbean spiny lobster fishery is not experiencing growth-overfishing (i.e. the ratios of current to MSY-level exploitation rates were consistently <1). Although it would be tempting to draw a specific conclusion on stock status from this information, there are a number of reasons to avoid doing so. The recruitment-based models indicated a wider range of uncertainty regarding overfishing, and the YPR analyses were limited by assumptions about key parameters (e.g. natural mortality, stock-recruitment shape) and a limited time frame. Consequently, the Review Panel concluded that Caribbean spiny lobster stock status remained unknown.

6. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status and, if appropriate, evaluate stock rebuilding; state whether or not the methods are scientifically sound.
No population projections were possible.

7. Recommend probable values for future population condition and status.
No population projections were possible, so probable values for future population condition and status were not produced.

8. Ensure that all desired and necessary assessment results (*as listed in the SEDAR Stock Assessment Report Outline*) are clearly and accurately presented in the Stock Assessment Report and that such results are consistent with the Review Panel's consensus regarding adequacy, appropriateness, and application of the data and methods.
All desired and necessary assessment results are clearly and accurately presented in the Stock Assessment Report, but they remain uninformative on stock status. The results are consistent with the Review Panel's consensus regarding adequacy, appropriateness, and application of the data and methods.

9. Evaluate the Data and Assessment Workshops with regard to fulfilling their respective Terms of Reference and state whether or not the Terms of Reference for previous workshops are adequately addressed in the Data Workshop and Stock Assessment Report sections.
The Data Workshop fulfilled its Terms of Reference. The Assessment Workshop fulfilled its Terms of Reference to the extent possible, given the limitations of the data.

10. Develop recommendations for future research for improving data collection and stock assessment.
See below the comments section.

<u>Comments</u>

1. With the available data, an interesting story becomes evident. The data series can seemingly be split into two components, before and after about 1992. In the first part of the time-series, the abundance indices decline. The models were able to recreate the decline in nominal CPUE on Puerto Rico / St Thomas / St John. This is a common pattern found in exploited fish populations, biomass steadily decreasing, and fishing mortality steadily increasing. The second part of the time-series shows the abundance index remaining steady while the catch increases, a trend inconsistent with our expectation of a fishery in a closed system. As catch increases above the level that was causing a population decline in the first portion of the time-series, we would expect the abundance index either to continue to decline or for the decline potentially to accelerate. Instead, the abundance index levels off as the catch increases. Because of this situation, standard production model approaches do not fit the entire time-series, because they do not have the ability to recreate the observed behavior.

The Panel therefore suggests that additional factors be considered in an attempt to understand better the dynamics of the population. One possibility is that recruitment may have increased during the second half of the time-series, allowing for increased catch without reducing population size. Another possibility is that fishermen may have moved into new areas, accessing a previously unexploited portion of the population, so allowing for increased catches. Other possible hypotheses involve changes in the gear used, or in post-settlement survival, and/or changes in post-larval settlement rates.

It should be possible to modify the modelling approach to produce a model that would support the observed data. One way to do this would be to allow the recruitment parameter r to increase over the second part of the time-series. This would require refining a model unique to the system, perhaps moving beyond the standard modelling software currently used. Once a model can recreate the behavior observed in the data, it should be possible better to identify hypotheses for the cause of the behavior.

Clearly, understanding the dynamics of recruitment in this fishery is crucial. There is therefore a great need to create a standardized annual recruitment index to support any assessment of this stock.

2. The Panel strongly endorses the development of partnerships with local fishermen, to conduct research and to collect the data needed for assessments. Partnership with the fishing community is a cost-effective way to collect components of the needed data. Currently, there is a high level of interest in the fishing community to cooperate with management agencies in collecting data, so the partnership should be encouraged and strengthened. This would also facilitate ongoing cooperation and participation by fishermen in the management process, benefiting all involved.

Recommendations for future data collection and research

Improve and complete historical data on relative abundance indices and catch

- For the commercial fishery
  - Recover pre-1983 data for Puerto Rico
  - Create/recover pre-1975 data for the US Virgin Islands by working with the fishermen's associations
  - Use the newly available US Virgin Islands data for the period 1987–1992
  - Use structured interviews with fishermen to assess gear changes
- For the recreational fishery
  - Estimate historical and current levels

Fishery–independent monitoring

- The Panel identified an apparent inconsistency between the assessment model assumptions of recruitment as a direct function of spawning stock. This appeared to be important enough to warrant two recommendations: 1) to build additional flexibility into the models to allow time-varying recruitment (or at least recruitment dynamics); and 2) to seek to establish a fishery-independent index of recruitment, which is deemed to be crucial. Based on presentations made during the review, there appears to be a tested method for conducting such a survey, and these types of data are currently being used in the SA-GOM lobster assessment. The method consists of placing a series of post-larval collectors in appropriate areas and consistent sampling their catch. This approach appears to be conducive to cooperative research, utilizing fishermen's knowledge of the area as well as their frequent visits to sampling areas. The Panel strongly endorses the need for such a survey to provide a data series for use in the Caribbean spiny lobster assessment, preferably with a sampling design covering both platforms, given the uncertainty about the spatial coupling of recruitment dynamics
- It is necessary to develop and implement sampling program(s) specific to both pre-recruit and adult Caribbean spiny lobsters
- It is crucial to increase sampling effort in the US Caribbean.
- There will be benefit in further diversifying the regions sampled to include equal coverage of areas frequently fished
- Visual surveys for size structure, abundance, and YPR could provide useful time-series of data

Revise the trip interview program (TIP) database exhaustively

- Completing the historical data set would be valuable
- Revitalizing TIP sampling in the US Virgin Islands would have many benefits, not just for the Caribbean spiny lobster stock
- Effort should be directed at key species, generating trip-target information, and obtaining needed detail

Length distribution of the catch

- For the commercial fishery
  - Complete incorporation of non-digitized data for the US Virgin Islands (TIP)
  - Recover historical length data for Puerto Rico and the US Virgin Islands from other studies prior to the TIP

- For the recreational fishery
  Determine length distributions

Conduct studies to understand the ecology of early juveniles (25 mm carapace length)

- Habitat use needs to be understood better
- More needs to be known about settlement habitat
- Information on movements and migrations needs to be sought
- Clarity of the mortality rates needs to be sought

Spatially explicit studies

- Identify spawning areas and sources of recruits
- Build/acquire habitat maps to identify stratification for research designs
- Combine habitat maps with density counts and habitat models to provide population estimates
- Develop a GIS map of spiny lobster landings throughout the geographic range of the stock, producing catch distributions

Mark-recapture techniques

- Such studies could hone knowledge of abundance
- The techniques could provide additional information on movements and migrations
- Habitat preferences would be better understood

Stock structure

- Stock structure is important in assessments, and genetics offers hope to improve knowledge

Future assessments

- These should explore further use of length structure and density from closed areas as reference points
- Assessments need to be repeated when significant quantities of previously unavailable historical data have become available
- Alternative stock assumptions need to be considered during assessment
  That of a wider Caribbean stock
  That of the stock of the US Caribbean and neighboring islands
- The use of nominal CPUE should be considered in future assessments
- The modelling approach needs to be modified to produce a model that would support the observed data. Within the model, the recruitment parameter r should be allowed to increase over the second part of the time-series, perhaps moving beyond the standard modelling software currently used.

Of the above, the Panel places the highest priority on the following, understanding the need to maximize the likelihood of generating an acceptable assessment of the stock in the near future:

- Develop/strengthen fishery-independent data collection
- Incorporate historical data into existing data sets
- Utilize refined models (better to identify viable hypotheses)

Stakeholder opinion

- Priority should be given to research that supports efforts to collect new catch data and increase port sampling. Research efforts should foster involvement of and collaboration with fishers.
- The fact that most of the product in the Caribbean spiny lobster fishery is sold retail and that there are no fish houses (at least in the US Virgin Islands) makes any meaningful future stock assessment extremely dependent on cooperation with the local fishermen.
- There is need at least to explore approaches to identify and incorporate socio-economic and other data types into the model. Some such data may indirectly be reflected but still influence CPUE, and may be available for 20 years or more. Examples are (i) employment; (ii) fuel costs; (iii) coastal development, e.g. on St Croix the number of homes per hectare is a significant predictor of water quality, and water quality may impact habitat and species populations; (iv) km of roads; (v) average *per capita* income.

C. *Spiny lobster in the Southeast United States*

Introduction

A comprehensive overview of the data and models used for the SE lobster assessment was provided. The assessment models explored included ASPIC, a modified DeLury model, catch-curves, untuned VPA, and an integrated catch-at-age (ICA, developed by Ken Paterson) model. The results presented focused primarily on the DeLury and ICA models, with ICA the preferred base-case assessment model.

Panel requests for further analyses during the meeting

1. Additional sensitivity runs using the ICA model, intended to explore the effect of the base-case selectivity assumptions on the results:

- Try an alternate year (>1993) to transition from estimated to constant selectivity
- Try constant selectivity in the early period, then estimated selectivity thereafter, if possible.

The values estimated with three alternative selectivity assumptions were very close to the base-case model result. However, the CVs of recent fishing mortality did increase when the shortest period of constant recruitment was assumed. The second part of the request was not feasible using the current model framework. The Panel was nevertheless satisfied that the base-case results were not likely to be unreliable as a consequence of the selectivity assumptions used.

2. Try a run estimating natural mortality (M) using the DeLury model.

On attempting this, M was not considered to be reliably estimated, but the value used in the base-case model did appear to be consistent with the data.

3. Explore alternative methods for projecting future recruitments with uncertainty, possibly including

- Extrapolation of the recent estimated trend
- Re-sampling from residuals about the mean
- Re-sampling from Monte-Carlo results

A projection including variability in model parameters was completed. The qualitative results were similar for projections based on $F_{current}$ and $F_{20\%}$, although projected harvest levels were somewhat lower than the deterministic values. The Panel was satisfied that the approach adequately reflected uncertainty in future projections.

4. Subsequent to the first three requests, an additional request was made to produce a decision or scenario table based on the model runs already completed and evaluated by the Panel.

Three alternate recruitment scenarios were presented: similar to the last 12 years, similar to the last 4 years, and based on a stock-recruit curve. Respectively, these roughly corresponded to two levels of constant (high and low) recruitment, and to stock-sensitive recruitment. Three alternate management targets were simulated through F values of $F_{5\%}$, $F_{20\%}$ and $F_{30\%}$. However, after reviewing a series of results from this analysis, the Panel concluded that no further material needed to be included in this report or for them to formulate their decisions.

<u>Terms of reference</u>

1. Evaluate whether data used in the analyses are treated appropriately and are adequate for assessing the stocks; state whether or not the input data are scientifically sound.
The data used in this assessment were treated appropriately and are considered fully adequate to assess the stock.

2. Evaluate the adequacy, appropriateness, and application of the methods used to assess the populations; state whether or not the methods are scientifically sound.
The methods used in this assessment were adequate, appropriate, and scientifically sound.

3. Recommend appropriate or best-estimated values of population parameters such as abundance, biomass, and exploitation.
The base-case assessment model provided the best estimates for these values.

4. Evaluate the adequacy, appropriateness, and application of the methods used to estimate stock status criteria (population benchmarks such as MSY, F_{msy}, B_{msy}, MSST, MFMT). State whether or not the methods are scientifically sound.
Because of the lack of direct linkage between spawning stock and subsequent recruitment, there is no comparable proxy benchmark for SSB. For this reason, SSB/SSB_{msy}, MSY, and related criteria could not be estimated. A proxy benchmark for F was available from the SAFMC Fishery Management Plan for Spiny Lobster (Amendment 6) based on static SPR (F_{oy} = 30% SPR, and $F_{msy\ proxy}$ = 20% SPR). The method used in this assessment for estimating stock status criteria for F was adequate, appropriate, and scientifically sound.

5. Recommend appropriate values for stock status criteria.
There was considerable discussion as to whether the $F_{20\%}$ threshold makes biological sense, given that values are likely to be close to this level under historical rates of fishing mortality. It was noted that, if all portions of this Caribbean stock had high fishing mortality rates, this might not be biologically reasonable over longer time-scales. The long-term average is currently estimated to be SPR = 19%, presumed to be sustainable though slightly below the limit. The Panel concluded that there was no basis for recommending alternative benchmarks. Based on the assessment model results presented, overfishing does not appear to be occurring at the moment. Indeed, there is no evidence that growth-overfishing would occur even at very high rates of fishing mortality, given current estimated selectivity patterns. However, the stock status relative to overfished levels cannot be evaluated.

6. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status and, if appropriate, evaluate stock rebuilding; state whether or not the methods are scientifically sound.
The methods used in this assessment were adequate, appropriate, and scientifically sound. The Panel preferred the revised projections including uncertainty in estimated model parameters.

7. Recommend probable values for future population condition and status.
There was no indication that future population conditions and status would be below the current levels reported from the base-case assessment model.

8. Ensure that all desired and necessary assessment results (*as listed in the SEDAR Stock Assessment Report Outline*) are clearly and accurately presented in the Stock Assessment Report and that such results are consistent with the Review Panel's consensus regarding adequacy, appropriateness, and application of the data and methods.
The necessary results fulfilling the SEDAR stock assessment report outline were presented. Additional analyses were performed in response to requests made by the Panel, the summary results of which are included in this report.

9. Evaluate the Data and Assessment Workshops with regard to fulfilling their respective Terms of Reference and state whether or not the Terms of Reference for previous workshops are adequately addressed in the Data Workshop and Stock Assessment Report sections.
The Data and Assessment Workshops appeared to have met their respective terms of reference fully.

10. Develop recommendations for future research for improving data collection and stock assessment.
See below the comments section.

<u>Comments</u>

The Review Panel offers the following comments regarding research needs:

1. Discussion of the ability to estimate the relative stock status with respect to overfished levels focused on the connectivity of the entire Caribbean spiny lobster population and the relative importance of the SA-GOM area in the total. It was noted that catches from the area make up <10% of the catch in the western Atlantic, and that present understanding of oceanographic patterns indicates that it is quite likely that the area receives larvae from other areas. This statement is based on the duration of the larval period and the speed and direction of prevailing currents. Critical information required to evaluate fully whether the stock is overfished include: identifying the source of the larvae settling in the SA-GOM area as well as determining the proportion of larval production from the area that is retained locally. A broad assessment of the Caribbean population would be desirable, but is impractical at this time.
2. There was support from both stakeholders and scientists at the Panel to re-establish an observer program for the commercial trap fishery. This program could supply useful data to be used directly in the present assessment model including: an index of pre-recruit numbers, adults, and other information that cannot be gained through other methods. Efficient coordination and communication between participants (both industry and scientists) must be a priority in planning this program. The Panel recognized that the program will be most valuable as the duration of the time-series increases, and planning should reflect this.

Recommendations for future data collection and research

Data from the commercial fishery

- Re-establish a commercial fishery observer program (described above).

Fishery-independent indices of abundance

- Standardize existing data sets that may be used for juvenile and legal-sized indices of abundance
- Design new monitoring programs to collect systematic, consistent, and statistically rigorous data.

Improved growth information

- Tagging projects should be initiated to obtain growth-rate data from larger (CL >100 mm) lobsters
- Activity may need to be focused in areas of reduced exploitation (such as the Tortugas) to allow capture of these larger individuals in appreciable numbers
- Reconcile growth information from Lipofuscin and tagging data

Modelling

- Conduct Monte Carlo simulations to test $F_{20\%}$ and $F_{30\%}$ threshold and target reference points against various performance criteria. The stock assessment workshop for the stock should develop various scenarios covering a range of hypotheses concerning recruitment and changes in gear selectivity, as well as suitable performance indicators, including catch and measures of SSB. Risks in the performance indicators associated with applying the threshold and target should be generated in future assessments.

Stakeholder opinion

- Fishing pressure has decreased in the Keys because (i) there are less traps as a result of the Trap Certificate Program, (ii) recent efforts to curtail a rapidly expanding illegal dive fishery, (iii) the loss of dock space and subsequent selling out as gentrification continues at an increasing rate, (iv) the loss of suitable crew as a direct consequence of the increasing cost of living in the Keys.
- Fishermen are very willing to sit down with scientists to devise long-term observer/sampling programs that enmesh with operational activity and satisfy crucial needs for data.

2.3 Recommendations for future SEDAR assessments

In terms of the terms of reference provided to the Review Workshop, opportunity was given to all participants (as well as to the Review Panel) to comment upon the whole SEDAR assessment process. What follows is a non-prioritized list of the main points made.

- There is a strong need for enhanced communication, specifically to stakeholders, about what SEDAR is trying to achieve in terms of management.
- To date, there has not been full acceptance from all, and this is put down at least partially to the lack of education and training of certain key parties about the process. Their cooperation is essential if SEDAR is to succeed in its objectives.
- An advanced plan of what species is to be handled when is essential for all those who need and wish to be involved in the process.
- There is need for a (web-based) Glossary of Terms used.
- Continuity of personnel in the workshops is crucial to ensuring both acceptance and enhanced understanding.
- Dissemination of the information created and the results in terms of management action are not always perceived by stakeholders to have been achieved, so it was felt that Councils should make greater effort in this regard, at all levels of the process.
- Several participants, both technical and representing fishermen, felt that greater effort should be made to maximize the time for preparation of data series, assessments, and review material. The Panel shied away from suggesting a deadline for receipt of material prior to each workshop, realizing that the very nature of some data would always make collection to the last possible moment necessary, but stressed that late receipt could easily lead to delayed or less informative assessments of stock status.
- As mentioned several times elsewhere in this report, strong cases were made for incorporating fishermen's knowledge better into the assessment and management process.
- The Review Panel requires the presence of scientists who have not been involved in the Data and/or Assessment Workshops. This may not be a preferred requirement for the participating stakeholders. Stakeholders would clearly benefit and be better able to participate fully in the review process if they had been present throughout all meetings. The Councils could maximize meeting this recommendation by considering paying stipends to participating stakeholders to compensate them for lost earnings.

- There was strong feeling that the anticipated changed representation on the Review Panel may not be most appropriate for the SEDAR area. While understanding and wholeheartedly endorsing the need for independent peer review, a strong case could be made for Panel representation to include stakeholders, biologists knowledgeable about the species, and stock assessment scientists who were not involved in the immediate assessment. It was felt unlikely that such people would be able to participate in the discussions at the current enthusiastic level unless they were formally accepted as members of the Panel.
- Allied to the above and notwithstanding what was ultimately decided on the make-up of the Panel, there was unanimity that the independence of the Review Panel chair (currently appointed by the CIE) was paramount and matched well the objective of independence.
- Given the volume of documentation associated with such reviews and the shortage of time often available to assimilate it, the Review Panel and other participants stressed the need for a clear executive summary to be provided for all substantive documents being addressed. Further, there was a call for a succinct table of model parameters (estimated and observed) to be provided for each assessment along with, if appropriate, a table of management options (e.g. a decision table) and the risks associated with them.